

Chapter 4 Transportation Environment Surveys

4.1 The Selection of the Cooperative Companies

During the first Site Survey of the first year, the cooperating companies have been pre-selected through the recommendations of the counterpart institutes of each Member Country. Based on this, the JICA Study Team decided to contact again the companies in order to explain the guidelines and details of the Study and to select the routes for surveys related to the products to be analyzed. Also, regarding to the Transportation Environment surveys, the details were given about the measuring devices to be used during the surveys (sensors and Global Positioning System GPS), the dummy cargoes for collecting impacts data and the work schedule as well.

The selected companies on each country are as follows:

Argentina:	Nucete e Hijos (Agro-aceitunera), Herederos de A. Williner SA, Frimetal SA
Brazil:	Multibras SA, BSH (Bosch und Siemens Hausgeräte), Klabin SA
Paraguay:	Cooperativa Chortitzer Komitee
Uruguay:	CONAPROLE (Cooperativa Nacional de Productores de Leche)

4.2 The Selection of the Distribution Routes for the Study

A series of meetings have been held between the JICA Study Team and the cooperating companies of the 4 countries, in order to discuss the details of the routes for surveys of the Study, and the work schedule as well.

For the first field surveys, it was defined the organization to be led by the JICA Study Team and with the participation of the members of the counterpart. The working groups have been divided to one per each country.

The target products for the surveys, classified by countries, are as follows:

Argentina:	Olive products, dairy products, refrigerators, edible oil
Brazil:	Refrigerators, air conditioning equipment (outdoor type)
Paraguay:	Dairy products
Uruguay:	Dairy products

The routes studied during the Transportation Environment Surveys are indicated in the following map and summary table (See Fig 4.2-1 and Table 4.2-1).

Table 4.2-1 Transportation Environment Surveys, Routes and Itinerary

County	Original Plan				Actual Plan				
	Route	Target Product	Distance One way	Company	Route	Target Product	Distance	Company	Date
Argentina	Bs.As. - Aimogasta	Processed Olive	1,200km	NUCETE	Bs.As. - Aimogasta	Processed Olive	2,500km (Round trip)	NUCETE	2/9 - 2/12 '05
	Rafaela - Asunción	Powdered Milk	800km	Willner	Rafaela - Asunción	Powdered Milk	1,600km (Round trip)	Willner	7/3 - 7/7 '05
	Aimogasta - Curitiba	Olive Product	2,500km	NUCETE	Aimogasta - Curitiba	Olive Product	2,500km	NUCETE	7/19 - 7/23 '05
	Rafaela - Neuquen	Dairy Product	1,300km	Willner	Rafaela - Neuquen	Dairy Product	1,800km	Willner	7/8 - 7/12 '05
					Neuquen-Santa Rosa	Only measurement	500km	Willner	7/11 '05
	Neuquen - Bariloche	Dummy Cargo Handling Survey		Willner	Neuquen - Bariloche	Dummy Cargo Handling Survey		Willner	Dummy was improved for impact test after 3 months past
					Aimogasta-Iguazú	Olive Product	1,600km	NUCETE	11/20-21 '05
	Rosario - Mendoza - Santiago	Refrigerator, Showcase	1,500km	FRIMETAL	Cancelled because of Chile boarder closing due to heavy snow ('05)				
	Uruguaiana - Medoza - Los Andes	Refrigerator	1,700km	Multibras	Uruguaiana - Mendoza - Los Andes	Refrigerator	1,700km	Multibras	10/11-20 '05
	Rosario - Mendoza - Santiago	Refrigerator, Showcase	1,500km	FRIMETAL	Cancelled because of Chile boarder closing due to heavy snow ('06)				
	Bs.As. - Mendoza	Vegetable Oil	1,000km	MOLINOS	Bs.As. - Mendoza	Vegetable Oil	1,000km	MOLINOS	5/26 '06
Bs.As. - Rosario	Refrigerator	300km	FRIMETAL	Bs.As. - Rosario	Refrigerator	300km	FRIMETAL	Several times including model projects in 2006	
Brazil	São Paulo - Recife	Refrigerator	3,000km	Multibras	Joinville - Salvador	Refrigerator	2,500km	Multibras	9/8 - 9/12 '05
	Sã Paulo - Recife	Refrigerator	3,000km	BSH	Campinas - Recife	Refrigerator	2,650km	BSH	10/21 - 26 '05
	Manaus - Belem - São Paulo	Refrigerator, Other Home Appliances	4,700km	Multibras	Manaus - Belem - São Paulo	Air Conditioner	4,700km	Multibras	9/14 - 9/23
	São Paulo - Uruguaiana - BsAs	Refrigerator	2,500km	Multibras	Joinville - Uruguaiana - Santiago	Refrigerator	2,700km	Multibras	10/11 - 20 '05

County	Original Plan				Actual Plan				
	Route	Target Product	Distance One way	Company	Route	Target Product	Distance	Company	Date
Paraguay	Loma Plata - P.J. Caballero	Dairy Product	800km	Choritizer	Asunción - PJ Caballero - Campo Grande	Dairy Product	1,000km	Choritizer	12-'06
	Asunción - Cd. del Este	Dairy Product	340km	Choritizer	Loma Plata - Asunción - Cd. del Este	Dairy Product	860km	Choritizer	9/27 - 28 '05
	Asunción - Encarnación	Dairy Product	400km	Choritizer	Loma Plata - Asunción Encarnación	Dairy Product	900km	Choritizer	10/4 - 10/5
					Gran Asunción Delivery	Dairy Product		Choritizer	9/30 '05
					Asunción City Delivery	Dairy Product		Choritizer	10/14 '05
Uruguay	Florida - Montevideo	Butter, Powered Milk	100km	Conaprole	Rivera - Florida - Montevideo	Long Life Milk	4,800km	Conaprole	9/8 - 9 '05
	Montevideo - Chuy	Butter, Powered Milk	250km	Conaprole	Montevideo - Rocha	Long Life Milk	200km	Conaprole	Several times in LATU
	Montevideo - Fray Bentos	Butter, Powered Milk	300km	Conaprole	Montevideo - Fray Bentos	Long Life Milk, Yoghurt, Cheese	400km	Conaprole	9/5 '05

Source: JICA Study Team

Note): In Paraguay, the transportation environment surveys were implemented by INTN and Choritizer during the absence of the Study Team.

1. Loma Plata – Asunción; 550km (one-way) × 6 times=3,300km
2. Loma Plata – Encarnación; 1,100km (one-way) × 1 time
3. Asunción - Campo Grande (BRA); 1,000km(one-way) × 1 time
4. Loma - Plata Ciudad del Este; 800km(one-way) × 1 time

4.3 Data collection on the Transportation Environment Surveys

The Transportation Environment Surveys have been carried out in two stages. The first stage was developed as a Demonstration Test, using at this time DER-SMART sensors, and studying the return way of Buenos Aires - Aimogasta (La Rioja Province) in Argentina, separated 1,200km each other. On this survey, the products transported were packed with olives.

After that, in July 2005, it was carried out the first effective route survey with Williner company products (dairy products) and using the same type of sensors (DER-SMART).

The studied routes for this company are as follows:

- (1) Rafaela (Santa Fe Province) – Clorinda (Formosa Prov.) – Asuncion (Paraguay)
- (2) Rafaela (Santa Fe Province) – Neuquen (Neuquen Prov.)

After that, in August 2005, a new training program was held in Asuncion (Paraguay) due to incorporation of new type of sensors for the Study (SAVER 3X90), in order to allow the counterpart members of the 4 countries to be familiar with the handling and operation of the new devices.

On this stage of the Project, all the counterpart of the 4 Member Countries finally received the total lot of the measuring devices, so that the field survey activities started with full capacity from September 2005. This is the timing of starting the 2nd Stage of the Transportation Environment Surveys on routes. As result of the activities on this stage of the Study, in the case of Brazil, the surveys covered the following routes:

- 1) Joinville – Salvador (Bahia)
- 2) Manaus – Belem – San Pablo
- 3) Joinville – (through Argentina) - Santiago (Chile)
- 4) Hortlandia – Recife

In the case of Paraguay, the surveyed routes are 6:

- 1) Loma Plata - Asuncion
- 2) Loma Plata – Asuncion - Encarnacion
- 3) Loma Plata – Asuncion – Ciudad del Este
- 4) Gran Asuncion (Urban area)
- 5) Zona del Asuncion (suburban area)
- 6) Asuncion – Campo Grande

For the case of Uruguay, the studied routes are 5:

- 1) Montevideo – Rivera (2 surveys)
- 2) Montevideo – Rocha (2 surveys)
- 3) Montevideo – Fray Bentos

As result of all these surveys, a series of data have been collected by each country. These data have been processed for data analysis and it was obtained a group database.

The JICA Study Team compiled all the collected information into a common database. One copy of this database have been transferred to each counterpart institute during May-June 2006, by sending one unit of Hard Disk Drive (HDD) for each party.

4.4 Data Analysis of Collected Data

The analysis of collected data in the surveyed routes has been developed by the Study members, by applying the procedures recommended by the sensor's manufacturers. For this purpose, it was necessary to standardize the data analysis procedures, so that it was prepared the "Data Analysis Procedure" both in Japanese and English, applicable for DER SMART sensors and SAVER3x90 separately.

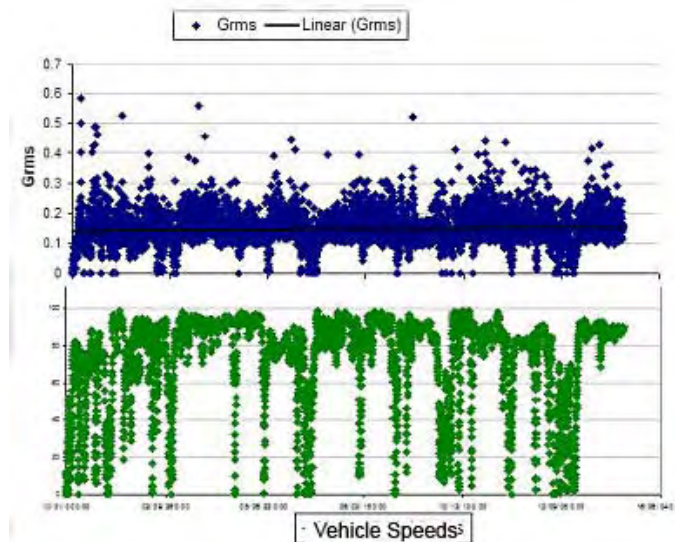
4.4.1 Data Analysis Procedure for DER-SMART Sensors

The main topics of the data analysis procedure for DER-SMART sensors are described below. This procedure has been developed based on the survey of Rafaela (Santa Fe Prov.) – Asuncion (Paraguay) carried out on July 2005, where the surveyed product was dairy products of Williner company.

(1) Truck stopping point identification

Procedure

- 1) By checking the G-S table, the truck stop points are identified and those events are taken out.
- 2) By the table in which the stopping points are eliminated, the Grms – Speed curves are plotted (Fig. 4.4-1).



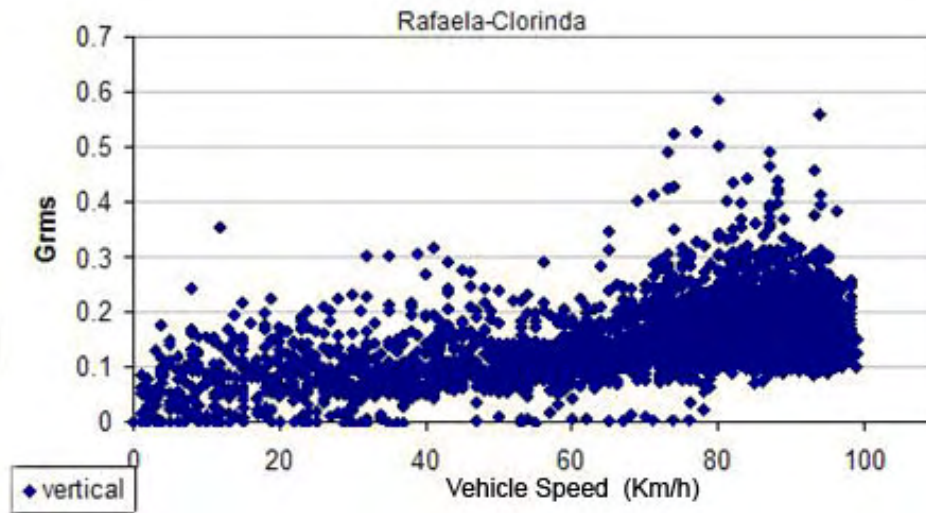
Source: JICA Study Team

Fig. 4.4-1 a) Grms – Time curves, b) Truck speed – Time curves

(2) Calculation of Average and Standard Deviation of Grms

Procedure

- 1) The average and standard deviation of Grms are calculated.
- 2) Having truck speed on x axis, it is plotted the Grms values. This is the correlation of Grms according to the truck speed (Fig. 4.4-2).



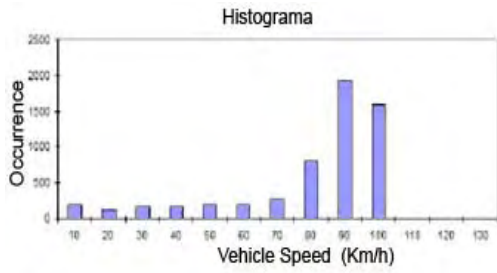
Source: JICA Study Team

Fig. 4.4-2 Grms vs. Truck speed graphic

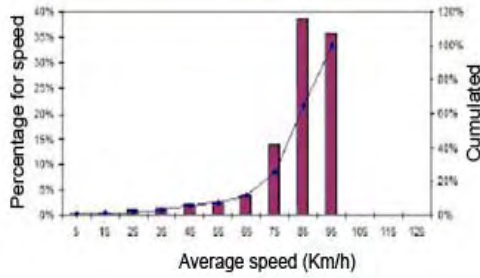
(3) Truck speed analysis

Procedure

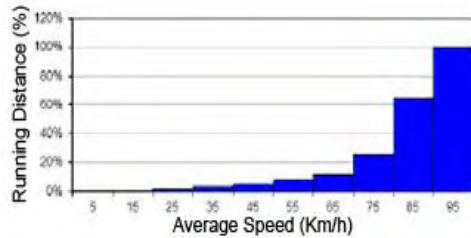
- 1) Based on the truck speed data, a histogram was prepared in order to study the type of route.
- 2) Probability density function was prepared with the calculation of the event occurrence of histogram divided by total number of data.
- 3) Based on the occurrence frequency of a speed within a route segment, the running speed is calculated for this speed, the running distance and the total distance as well.
- 4) By dividing the run distance at certain speed by the total distance, the percentage for each speed against the total distance is calculated.
- 5) In the same graphic, it is shown the speed distribution, the distribution of the running distances and cumulated values. This procedure allows graphic information about the type of route, the traffic status, and the vehicle driving status (Fig. 4.4-3).



Histogram of occurrence vs truck speed



Speed distribution vs average speed

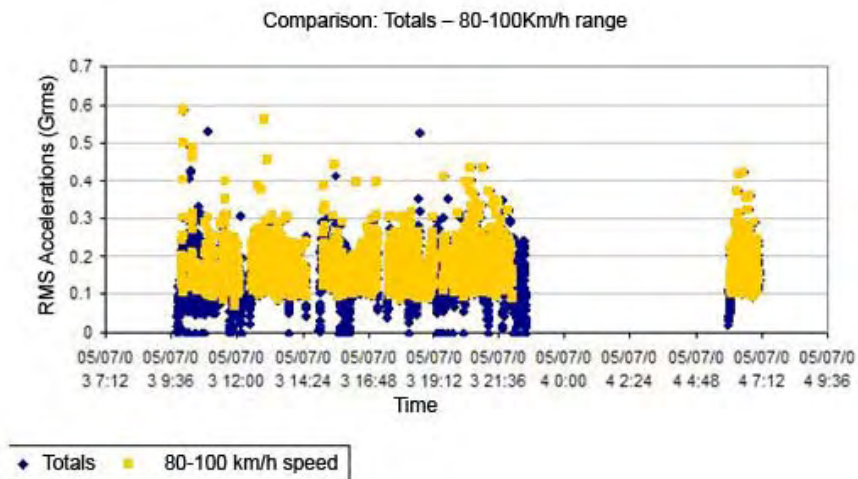


Running distance percentage vs average speed

Source: JICA Study Team

Fig. 4.4-3 Cumulative value on running distance distribution

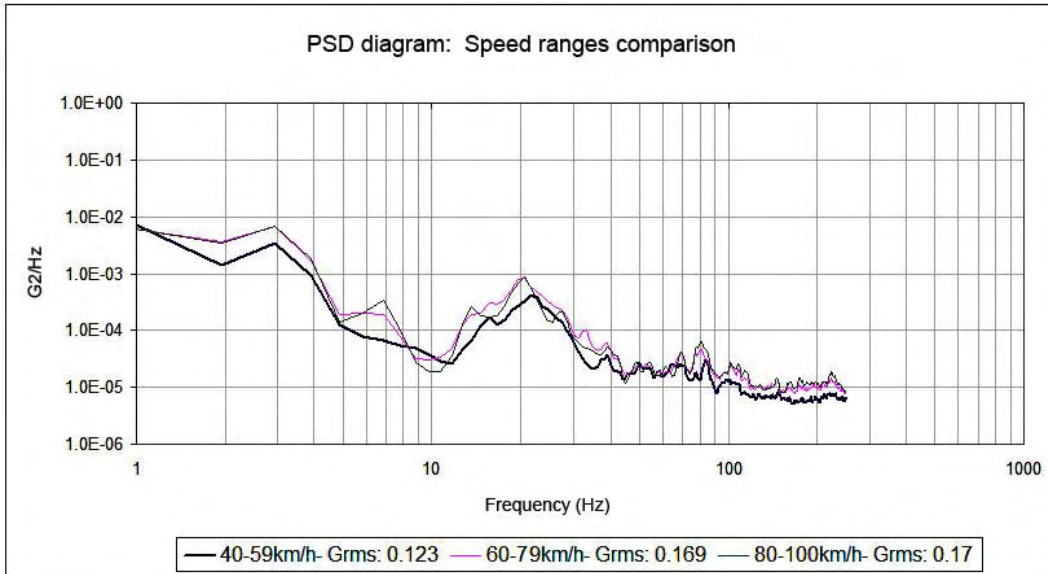
- 6) The Grms values are analyzed graphically, along all the route and they are compared against the range of 80-100 km/h. (Fig. 4.4-4)



Source: JICA Study Team

Fig. 4.4-4 Grms comparison for Total Route and 80-100km/h Level

- 7) The speed range is sub-divided into 3 levels (40~60km/h, 60~80km/h, 80~100km/h), and the average PSD is calculated against frequency for each level (See Fig 4.4-5).



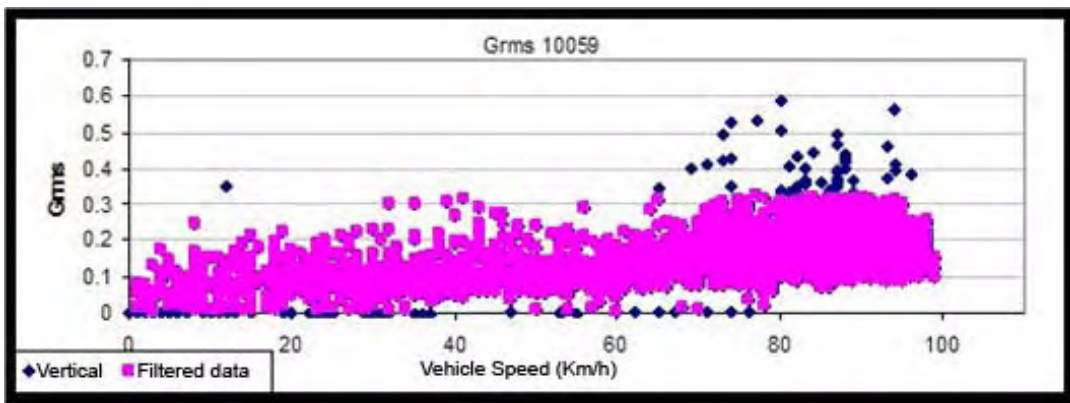
Source: JICA Study Team

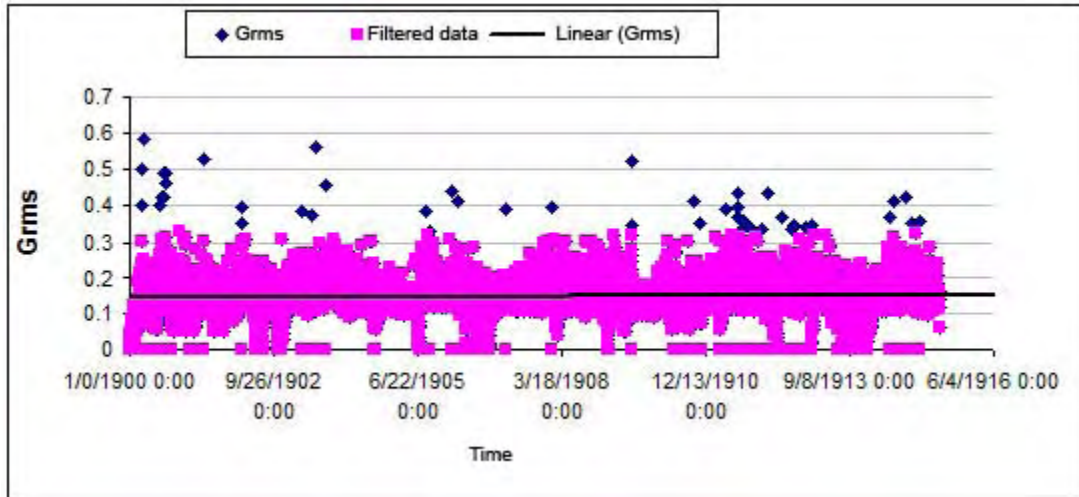
Fig. 4.4-5 PSD Average vs Frequency for 3 Ranges of Speed

(4) Waves analysis separating significant peaks ($>3\sigma$)

Procedure

- 1) Considering the average standard (μ) and the deviation (σ) of the Grms, all values out of the range of ($\mu+3\sigma$) are separated from vibration signals and to be treated as impacts (See Fig. 4.4-6).

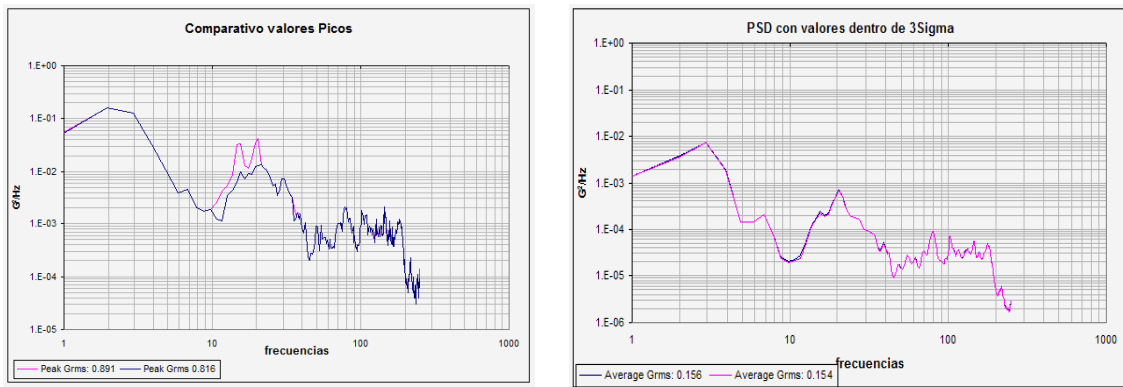




Source: JICA Study Team

Fig. 4.4-6 Grms Values Discarding Extreme Events

- 2) The separated data are analyzed. The wave forms of each point are studied, analyzing if they are isolated cases or repetitive cases within a route segment. The characteristics of each wave are observed. (See Fig. 4.4-7)



Source: JICA Study Team

Fig. 4.4-7 PSD peaks vs frequency for two Grms values

- 3) Map plotting of the events

For plotting of events into a map, the following color codes are applied (Fig. 4.4-8).

- Spot events, segment limits: RED,
- Steps on bridge edge: GREEN,
- Overpass of other vehicles and others spots: BLUE.



Source: JICA Study Team

Fig. 4.4-8 Rafaela-Clorinda route (Argentina)

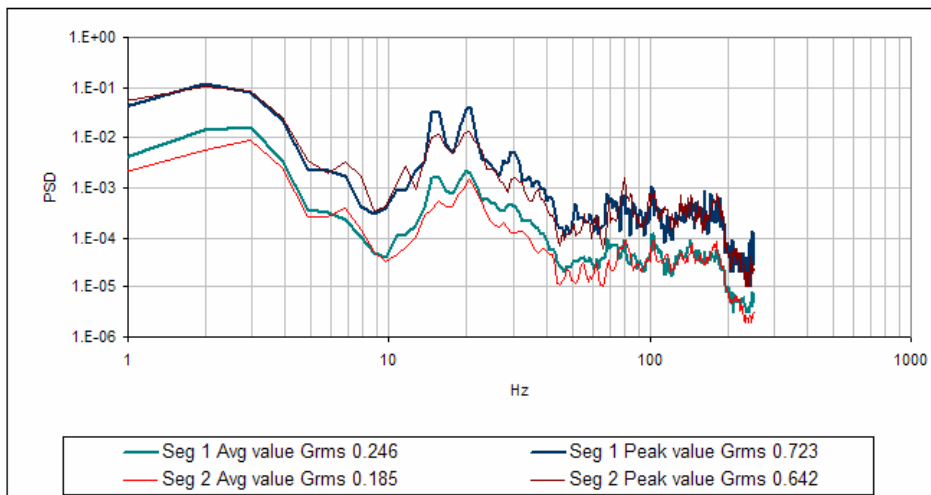
- 4) The impact events are grouped by segments, then analyzed the PSD values.

Rafaela-Asuncion route example (Raf-Clorinda)

- 1) The separated data are shown in Fig. 4.4-6. Since the number of separated data was 2.9% of the total, they did not affect the PSD average. However, they affect the PSD peak for each frequency, showing high values in a range of [10Hz-25Hz] which indicates apparently a response to a natural frequency of the truck structure or the cargo itself (See Fig. 4.4-7).
- 2) The recorded data is checked against manual records taken during the survey, and each point are plotted geographically (See Fig. 4.4-8).
- 3) They were identified 4 segments having high values of G acceleration, nevertheless the events are dispersed:

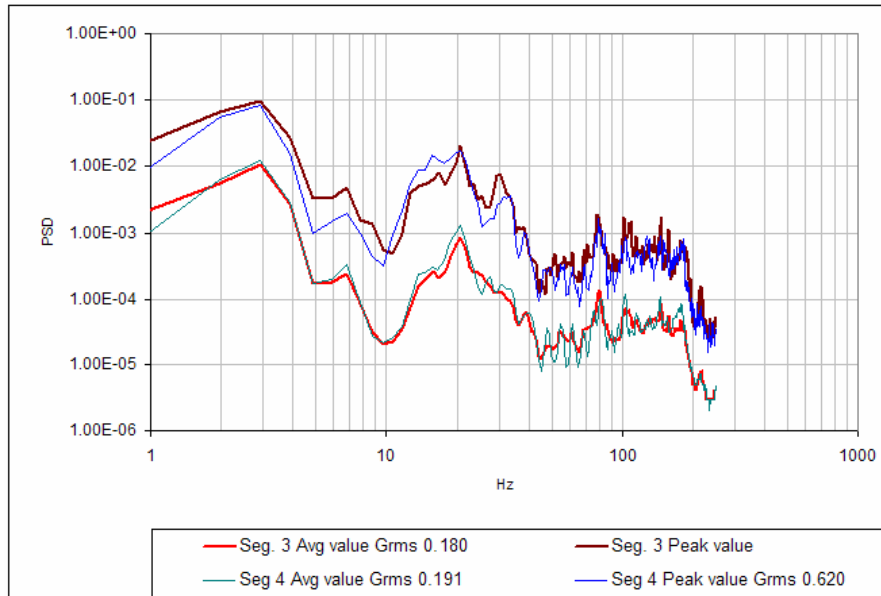
Segment1: Province Route RP70 – located near Colonia La Nueva, events number: 6, segment length 6.6km, average speed: 75 km/h (GPS). In the registered data they were found wave peaks indicating “speed reducing bumps” or “saw tooth”.

- Segment 2: National Route RN11-San Justo city, events number:4, segment length 29km, average speed: 79 km/h (GPS), paving: repaired, route status: medium.
- Segment 3: National Route RN11- Resistencia City-, events number:14; 95km, average speed: 73 km/h, “Eva Perón” port is bridge area and having slope.
- Segment 4: National Route RN11–Mercedes River-, events number: 5, segment length 36.8km, average speed 79 km/h, surface: irregular, bridges and holes in the route.
- 4) The PSD curves were plotted: Segment 1, 2 in Fig 4.4-9 and Segment 3, 4 in Fig. 4.4-10. The Fig. 4.4-9 indicates “speed reducing bumps” and “saw tooth”, and the Fig. 4.4-10 is a segment having bridges. In both cases, the peaks are in frequencies of [2Hz , 4hz] and [15Hz], [30Hz].



Source: JICA Study Team

Fig. 4.4-9 PSD average and peak vs frequency for Segment 1 and 2.



Source: JICA Study Team

Fig. 4.4-10 PSD average and peak vs frequency for Segment 3 and 4.

(5) Site observations

Speed:

From the data analysis, it is possible to infer that the route is suitable for running at high speed during long spans (See Fig. 4.4-3). According to the survey, the 75% of the route was run at speed between 80 km/h and 100km/h. The PSD graphic suffer modifications and the Grms value is increasing along the increasing of speed.

Peak waves analysis, having extremely significant jumps ($> 3 \sigma$):

From the total of data collected, this category covers the 2.9 % of the total.

This percentage does not affect the average PSD value, but it affects the peak value of PSD (curve composed by all the peaks for each frequency), having a remarkable peak on the range of [10Hz-25Hz].

According to the analysis, they were identified 4 segments with a variety of numbers of events and having high accelerations G and dispersedly distributed.

(6) DER Correction Software; Sample Analysis using GPSMap for JPI

The preliminary condition is to have **GPSMap for JPI** installed.

This software will be used to analyze the data

Aimogasta-Charata-A050719-DER-10059 contained in the database.

- 1) First of all, the Table 4.4.1-1 needs to be prepared using Microsoft Excel. From here on out, whenever the necessary data appears, insert them into the appropriate column.

- 2) Then, initiate the program to run the vibration analysis and will maintain opened the analyzed file, 19-07-05-Aimogasta-Charata-10059.DRS. This will prompt open the Table of Acceleration Grade. Besides the DRS file, there will also be files with extension .ppv, .Svd, .THM. It will also contain the DATA.DAT file, as raw data. Notwithstanding, it will include the PSD Total.Svd file.

The text files ---itp, ---ptr, ---utu will be located here as well. If they are not there, these can be elaborated through a text conversion that will be presented below. It must be noted, itp are title/headers, ptr are Grms, and utu are acceleration grade values.

- 3) The corresponding GPS data are within the *19-07-05-Aimogasta-Iguazu-PGS as Aimogasta-Charata-A050719-sn-16-HVS.cnt*. These data is then matched using the **GPSMap-JPI**, which will present the Table of Acceleration Grades with the velocity data. Here, click on the **Text** button and leave a prepared text file of the Table of Acceleration Grades. This will create a new file with the extension ---.Txt.

The above described steps reflect the preparation process.

- 4) First, using the current vibration analysis program, open the Table of Acceleration Grade choosing the conditions (preferences) in which the most amounts of data is available, and proceed to the PSD analysis. As a result, the Grms of the entire analyzed object's data is created. To do this, one must first exclude the unnecessary portions of the data.
- 5) These results will be saved as text files.
To do this, one must click and choose the option icon that appears on the top of the screen. This will access a pull-down menu, from where one can select the option to convert to text format. At this moment, a measurement unit icon will be presented for confirmation; make sure that the acceleration grade is measured in G units.
Once the text conversion is selected, the titles that can be converted will be presented, then choose the option of Acceleration Grade and Grms, and select outputs as data. The output location can be deliberately chosen, but most commonly, these are placed in folders (directories) containing **DRS** files.
- 6) Once the processing is complete, one must confirm that the files identifiable as ---.itp, ---.ptr, ---.utu were created within the assigned output folders.

It is noted as a reference that besides the file types previously mentioned, the PSD data of Maximum and Averages, Temperature and Humidity, and the Oscillation Accelerations are also susceptible to being converted into text files.

Table 4.4.1-1 PSD Analysis of “05-07-19 Aimogasta-Charata”, speed-acceleration

Note: This table must be filled every time when PSD analysis is made, checking data previously.									
Analysis Range (Data Nbr.) : 167~3036									
Area	Ch1			Ch2			Ch3		
	Data Qty	Grms (G)		Data Qty	Grms (G)		Data Qty	Grms (G)	
		PSD-Aver.	PSD-Peak		PSD-Aver.	PSD-Peak		PSD-Aver.	PSD-Peak
Ov.All	2523	0.304	2.04	1531	0.102	0.671	843	0.062	0.374
Alow	2	0.09	0.12	44	0.06	0.15	37	0.05	0.12
Blow	112	0.11	0.35	129	0.09	0.29	68	0.07	0.19
Clow	233	0.24	0.80	52	0.15	0.47	15	0.10	0.26
Dlow	45	0.47	1.44	0	0.00	0.00	1	0.17	0.17
Amid	292	0.19	0.60	873	0.09	0.42	911	0.05	0.27
Bmid	309	0.28	0.86	42	0.19	0.50	11	0.16	0.29
Cmid	137	0.34	0.97	8	0.26	0.49	2	0.34	0.96
Dmid	187	0.49	1.86	2	0.35	0.45	1	0.17	0.17
Ahi	878	0.26	1.00	1290	0.08	0.46	1293	0.04	0.27
Bhi	275	0.34	0.97	3	0.28	0.38	1	0.17	0.17
Dhi	141	0.46	1.61	1	0.32	0.32	0	0.00	0.00
Note: The following table must be filled with “GPS Matched Data” transferred to Excel sheet as Speed-Accel. Table, and sorted by Areas.									
Ch1					Ch1				
Area	Data Qty	Time hr	Distance km	Ave Speed Km/hr	Route type	Data Qty	Time hr	Distance km	% distance
Alow	38	0.07	0.77	10.40	A	1140	2.22	181.30	50.3%
Blow	106	0.21	4.80	23.30	B	686	1.33	95.61	26.5%
Clow	240	0.47	12.38	27.60	C	379	0.74	30.23	8.4%
Dlow	45	0.09	2.67	30.60	D	381	0.74	53.22	14.8%
Amid	270	0.52	30.81	58.00	Total	2586	5.03	471.48	100.0%
Bmid	295	0.57	39.27	68.50					
Cmid	139	0.27	17.85	66.00					
Dmid	189	0.37	24.20	65.90					
Ahi	832	1.62	149.72	92.60					
Bhi	285	0.55	51.54	93.00					
Dhi	147	0.29	26.35	92.20					
Total	2586	5.03	360.38	71.95					

Source: JICA Study Team

- Now access and open **Microsoft Excel** and open the converted text files located within the newly created folders, summarized in one worksheet, and save it as *Aimogasta-Charata-A050719-DER-Acc-Grms-Vel.xls*. This will be Table A.

This file will contain the information regarding the Row Number, Time and Date, Acceleration Rates in three directions and Grms, Velocity, and Location based on GPS. Now, the measuring units of the Acceleration Rate and Grms need to be confirmed.

If the units are in m/sec^2 , divide the values by $9.8 m/sec^2$, which is the Acceleration Rate of the Gravity, and convert the measuring unit to **G**.

As it will be necessary later, the correlation between the absolute values of the acceleration rates and the Grms need to be determined, and should be placed on the column adjacent to the one containing the acceleration rates.

Table 4.4.1-2 Reference values by area, based on vibrations and according to speed and route type (for plain route)

Area	Speed Range	Grms (G)		Acceleration (G)		Grms (m/sec^2)		Acceleration (m/sec^2)	
		Min(<)	Max(\leq)	Min(<)	Max(\leq)	Min(<)	Max(\leq)	Min(<)	Max(\leq)
Alow	0<	0.00	0.06	0.00	0.22	0.0	0.6	0.0	2.2
Blow	Vel	0.06	0.12	0.22	0.43	0.6	1.2	2.2	4.3
Clow	≤ 40	0.12	0.33	0.43	1.20	1.2	3.3	4.3	12.0
Dlow	km/hr	0.33	-	1.20	-	3.3	-	12.0	-
Amed	40<	0.00	0.19	0.00	0.69	0.0	1.9	0.0	6.9
Bmed	Vel	0.19	0.265	0.69	0.96	1.9	2.65	6.9	9.6
Cmed	≤ 80	0.265	0.33	0.96	1.20	2.65	3.3	9.6	12.0
Dmed	km/hr	0.33	-	1.20	-	3.3	-	12.0	-
Ahi	80<	0.00	0.265	0.00	0.96	0.0	2.65	0.0	9.6
Bhi	Vel	0.265	0.33	0.96	1.20	2.65	3.3	9.6	12.0
Chi		-	-	-	-	-	-	-	-
Dhi	km/hr	0.33	-	1.20	-	3.3	-	12.0	-

Note: The relationship between acceleration and Grms is as follows: $Acc=3.6241 \times Grms$
 Source: JICA Study Team

- 8) After this, the PSD Analysis needs to be run based on Table 4.4.1-2, which is done by returning to the Acceleration Rates with Velocities Table (Acc. Table) and pressing the **Auto** button.
- 9) Subsequently, the data selection screen will be displayed. Proceed by making the necessary selections.
 1. First, input the conditions for **Alow**
 - In **Adoption Level**, select the Acc. to $0.0m/s^2$ and 0.
 - In **Analysis interval appointment** select **Entire interval appointment**, and choose **Analysis start Num** and **Analysis end Num** coinciding with the range selected in 3) above.
 - Select **Speed Specifications** and insert the velocity range for **Alow** based on Table 4.4.1-2.

- Similarly, select *Acc Specification* and establish the range for the acceleration rate based on Table 4.4.1-2. Close attention must be paid to the measuring units and choose the corresponding one.
- Once the setups are complete, press the **Execute** button and process the selected data.
- When the processing is complete, return to the Acceleration Table. Here, one must confirm that the appropriate selection was processed, simply by scrolling up and down observing the worksheet.
- To save these conditions, click the Save button. Insert the name for the file where the data will be stored. To do this, a new folder for *Alow* needs to be created and used to save file as *Alow.Svd*.

2. PSD Analysis for *Alow*

- To do this, one must return to the **DER-SMART** vibration analysis program, and open the file *19-07-05-Aimogasta-Charata-10059.DRS*.
 - Open the list of Acceleration Rates on the screen, press the open button, and in the select file window, select the *Alow.Svd* that was saved during step 1 in part 9) and press the **save** button.
 - In the next screen, press the **Initiate (Start)** button.
 - At this point, the data will be set based on the selection conditions of *Alow*. Press the PSD analysis button. The calculation process for the PSD will be performed in waves, and the measuring unit will be in G^2/Hz . Press the **OK** button to begin the analysis.
 - Once the results from the analysis are displayed, confirm the number of data, Grms, etc., and if no problems can be detected, press the **options** button once the necessary data was copied into Table 4.4.1-1, and proceed to converting all the items except for the oscillations of the acceleration rates into text.
 - Create a new *Alow* folder and save the files there. An *Alow.itp* file will be created.
 - Open this file using **Excel**. If all files are selected to be displayed, there will be other files besides the *Alow.itp*, including *Alow.otd*, *Alow.ptp*, *Alow.ptr* and *Alow.utu*. As previously mentioned, the **.itp** are title and headers, **.ptr** are Grms, **.utu** are acceleration rates, **.otd** are temperature and humidity, and **.ptp** are PSD.
 - This is the last step for the *Alow* vibration software analysis.
 - Therefore, to return to the **GPSMAP for JPI**, open the Acceleration Table. In other words, return to step 7).
 - To perform the *Blow* analysis, repeat this process from step 8).
3. The storing of all the text files need to be completed, including all the PSD files up to *Dhigh*. From here on forward, all the processing and editing will be performed in **Excel**, and therefore all other windows and running programs can be closed.

- 10) Roadway Type, Data Quantity based on the Classification of Circulation Velocities, Traveled Distance, Traveling Time, PSD.
1. Finish the **Excel** worksheet 4.4.1-1. The number of data values, maximum and average PSD can be inserted after each PSD analysis for the different classes are displayed.
 2. Perform the analysis solely in the **Ch 1** (vertical) direction; the other directions will be performed depending on necessity.
 3. Confirm the measuring intervals based on the time data. The current study has an established measuring interval of 7 seconds, and therefore the actual travel time can be obtained by multiplying the number of data by 7 (seconds).
 4. To determine the traveling distance for each class, a new table needs to be created by copying the data from Table A. This table will be named “*Worksheet based on Velocity – Grms.*” All the unnecessary data will be eliminated in the new table. The data to be deleted consists of that recorded before the start of the actual measurement, and the data between Num1-166 and Num3037-10000 where there was no variation in the velocity set at 50km/hr because no GPS data was available.
 5. Change the order of the columns so that the absolute values of the acceleration rates Ch1 are next to the Speeds.
 6. Next to the Speed column, place the formula to calculate the traveled distance by multiplying velocity by 7 seconds=0.001944hr, so that with every velocity, a traveled distance can be calculated.
 7. Then, rearrange the table values based on the Speeds data. Based on the reorganized table, classify the velocities in zones of low, medium and high velocities. It is convenient to leave three empty colored rows.
 8. Rearrange the values under the low velocity zone based on the acceleration rate, and classify the zones A, B, C, D, in conformity with Table 4.4.1-2. Insert 3 blank rows with distinctive colors for each zone.
 9. Repeat the previous step for the zones of medium and high velocities.
 10. Use the blank separation rows to insert the summarized data for each zone, which include average velocity and traveled distance in each zone. Insert these resulting values into Table 4.4.1-1. These values will be similar to those obtained during the PSD analysis. There can be variations between the data, but there should be no major differences.
- With the information gathered, Table 4.4.1-1 can be filled, and the composition ratio based on roadway types can now be calculated.

11) Processing PSD waves in each zone.

1. The PSD waves for each zone will now be summarized and the testing parameters will be determined.
2. First, the PSD data which is saved as a text file is summarized into one Excel file. At this point, create a file named "PSD by Zones."
3. Open the ---.ptp files created in step 9) using Excel, orderly from A low to D high. Copy these files in the "PSD by Zones."
4. Use the first worksheet as the general page, and starting on the second worksheet, past the data regarding each zone in all three directions, one sheet per each zone. Identify each created sheet by inserting the name of each zone within the header of each page.
5. Once all the data is copied and pasted, copy the data for the upward and downward directions and those on the Frequency column. Order them by frequency and paste them on the first page (general worksheet). Before, the first worksheet needs to be renamed "General Worksheet Ch1."
6. Once the copy/paste is completed, rearrange the appropriate columns and the following PSD curves will be created.
 - a. Four (4) linear PSD graphs summarized by roadway, A (low, medium, high), B (low, medium, high), C (low, medium), and D (low, medium).
 - b. Three (3) linear PSD graphs summarized by velocity sections, Low (A, B, C, D), Medium (A, B, C, D), and High (A, B, D).

4.4.2 Data Analysis Procedure for SAVER3X90 Sensors

For data analysis process of collected data during the Transportation Environment Surveys, by using SAVER3X90 sensors, it is explained on next pages the procedure according to JICA MERCOSUR process.

JICA MERCOSUR - Data Analysis Procedure (SAVER3X90 case)

The following is the procedure for Data Analysis of vibrations recorded during the Transportation Environment Survey by using the SAVER sensors.

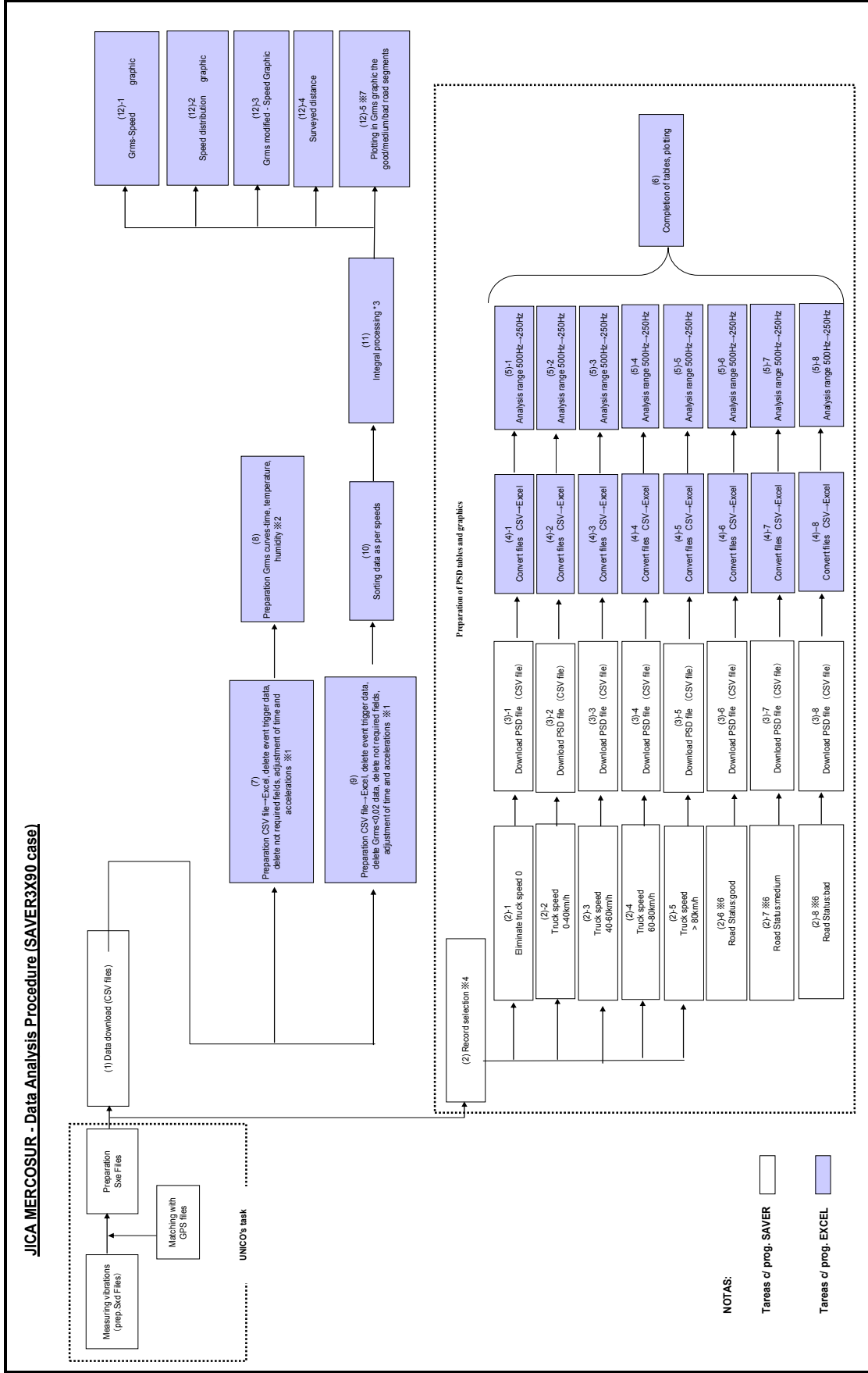
- 1) Applied terminology
Sxd files "Rough Data" files, recorded by the SAVER sensors.
Sxe files Modified data files from Sxd data by SAVER's program, under MS Access format.
GPS files GPS data recorded by GPS system, indicating the truck position, time.

2) Data Analysis works flow diagram

For issuing the request of Data Analysis to Kobe University, basically a Sxe file is transferred, in which they are included the positioning data after complete the data matching of vibration data with GPS data.

Regarding to the data analysis works, they are divided into 2 main activities.

- a) Works by using SAVER programs (mainly to obtain PSD data) and export to an EXCEL file.
- b) Data Analysis works by using EXCEL functions.



JICA MERCOSUR - Data Analysis Procedure (SAVER3X90 sensor case)

NOTES:

- ※1: At the stage of "exporting" data from SAVER's program to an EXCEL file, the time is indicated by GMT and the speeds by miles/hour. These data must be converted into "local time" and "km/h".
- ※2: See please EXCEL sample file.
- ※3: See please EXCEL sample file.
- ※4: The SAVER program is suitable for a fast selection of data, based on required speed values. However, for the deletion of zero speed data, it is carried out by Grms < 0.02 condition.
- ※5: In the case of sampling time of 1ms, the SAVER program calculates automatically the PSD values within a range up to 500Hz. In this case, it is required to make a re-calculation of PSD within a range up to 250Hz, in order to match with DER-SMART system.
- ※6: The PSD values are manually calculated for each route condition (good, medium, bad), based on a previous selection of related route segments and referred to "time records" registered manually during the surveys.
 Since the selection of route segments is made manually, this process requires time. For this reason, this process will be developed only for the route of Brasil (Belem-San Pablo, Sep21-22) ; Joinville-Santiago route and Campinas-Recife route.
- ※7: The plotting process for identify the route status of "good", "medium" and "bad", is made manually, so that it requires time. The data to be processed manually are those indicated in ※6.

Source: JICA Study Team

4.4.3 General Aspects of the Transportation Environment and the Measuring Data

The data that was summarized with the aim to define standard reference values to evaluate the packaging tests. The following is a summary of the observed characteristics.

(1) Differences on road transportation between Japan and MERCOSUR

There still are many damage accidents even though the JIS standards are satisfied. The situation of MERCOSUR is compared with Japanese case as below.

1) Different Vehicle Type

Firstly, from a visual comparison perspective, approximately 80% of the freight transportation means utilized in the MERCOSUR region consist of trailers, whereas it is estimated that in Japan, slightly over 80% of the distribution is done with trucks.

A certain Japanese company tried changing their trucks by trailers, which allow a larger volume of freight transfer per trip, to improve the transportation efficiency, but this lead to an increased number of damaged goods. A study was conducted to determine the causes, and it was discovered that there was a high difference in the emitted vibrations between the two means. At that time, the problem was resolved by changing the suspension types on the trailers, adopting an air suspension.

The vehicular inspection system in Japan is such that it incurs high maintenance costs to older vehicle models to satisfy the regulations in place. On the other hand, newer vehicle models abiding by the low gas emission regulations enjoy tax exemption advantages.

During the execution of the transportation tests, performed under the scope of the project at hand for the JICA development study, there were situations that arose impeding the gathering of data due to breakdowns and repairs on the vehicles utilized for the testing.

2) Freight's (Cargo's) Conditions

From what was observed, with the exception of large freight such as those with electrical household appliances, the small and medium ones, which represent the majority of the transported freight volume, were placed on pallets and set in place with elastic film to avoid their displacement and disarrangement. The handling during the loading and unloading of the freight is primarily done with forklift trucks.

The dimensions of the pallets employed by the companies that participated in this study correlate to the size of the loading bed of the trailers and have practically no unoccupied space. Maybe due to this geometry, the van type transports do not require stabilizers to

avoid the disarrangement of the cargo. When loading refrigerators onto the loading bed, these are tied with ropes and covered with cloths.

Even in Japan, there has been an increase in the use of pallets to reduce the cargo loading and unloading time, but the trends are still low. The system of cargo transfer on pallets provides stability to avoid disarrangement and improve the loading ratio, although it has its disadvantages when it comes to impacts during their handling.

The loading ratio for those products of high specific weight, such as foods, is almost at the maximum levels, leaving minimal space on the upper parts of the transport. The products with low specific weights, such as refrigerators, are loaded to the maximum volume capacity, but it is estimated that their specific weight does not reach 60%. This is similar to Japan.

In general, the lower the loading ratio, the higher the vibrations felt on the loading bed.

3) Traveling Distance and Transportation Conditions (Circulation)

In Japan, the distance between the large consumption centers such as Tokyo, Nagoya and Osaka is between 600km to 700km, and therefore most of the time, the transportation distance for each trip is less than 1,000km. Even the longest trips are considered to be around 2,000km, whereas in the MERCOSUR, the international transportation distance can be greater than 3,000km. In Argentina and Brazil, even some domestic trips exceed 3,000km in distance.

Given this situation, most of the traveling is done on highways for long periods of time, and therefore the majority of the recorded average speeds surpass 80km/hr. Given that the kinetic energy of the entire transport increases proportionally to the velocity squared (v^2), given constant conditions to the roadway, the vibration produced on the transport's loading bed also increases proportionally to the vehicle's velocity. From this, it can be assumed that the vibration levels in the MERCOSUR are greater than those experienced in Japan.

Nevertheless, the transported distances is equal to those conducted in the United States or Europe, and therefore the causes that produces higher stress levels than those contemplated in the ISO and ASTM testing norms must be determined.

4) Driver's Skill and personal character

In practically, all trips performed as part of this study, there has been an assigned chasing vehicle with members from the study team to make observations of both the roadway conditions as well as the traveling itself. All vehicles were carefully operated by expert drivers, all excellent people and proud of their profession. Certainly, there are registries of driving speeds exceeding the ones verified during a normal trip once the participants took separate directions, and the drivers went to spend the night in the trucks in the parking lot,

and the remaining of the team spent the nights at hotels; but it should be noted that there has also been parts where the truck and the chasing car had to travel in very low speed, forming a single file.

Based on the collected data regarding the relation between the traveling velocity and the magnitude of the generated vibrations, it is observed that there are various sections of the trip where the traveling velocity surpasses 100km/hr, but the levels of vibrations are significantly lower compared to other sections traveled at lower velocities. It can be assumed that the drivers will travel at high velocities only in sections where the roadway conditions present a certain level of security to allow the higher speeds without causing major impacts or vibrations.

5) Roadway Surface Conditions and Curves

Currently in Japan, with the exception of mountainous regions without human settlements, practically all roads are regularly maintained and repaired, and there are no roads with poor surface conditions.

In the MERCOSUR region, probably due to its extensive territory, there are large sections of roadway where the maintenance work is not reached, and when traveling these sections, the vehicle produces high levels of vibrations.

Even so, it is considered that the maximum level of vibration produced during roadway transportation in Japan is comparable to those observed in the MERCOSUR. The problem consists on the frequency in which these high vibrations are observed.

If the same trailer were to be utilized in Japan and the MERCOSUR, the maximum observed vibration levels will be the same in both, but it is estimated that the number of occurrences of such maximum values will be very different.

The main reason causing these differences are the roadway's surface conditions and the traveling velocities.

The curves of the roadway also affect the traveling velocity. In Japan's case, the traveling velocities are obviously limited to the roadways with short tangent sections and their high number of continuous curves.

On the other hand, given the vast territory of the MERCOSUR region, its roadways have straight tangents for hundreds of kilometers, incomparable to the tangent sections that may be found in Japan. As such, and with the low traffic volumes, there is a satisfactory situation to travel at high velocities. Even with the poor roadway surface conditions, if the wheel is in safe hands, it seems that high velocity travel can be done without problems.

4.5 Damages on Target Products and Damage Index

Damages on target products and packaging have been studied on transported cargoes from Brazil to Chile, during the Transportation Environment Survey. They were home refrigerators (capacity: 310L, truck loading capacity: 142 units). The route stretch and conditions have been indicated in the study content described above, so that on this section it is described the results of the cargo visual inspection on the arrival warehouse at Chile side.

- (1) Product Inspection: Since the packaging was not allowed to be opened, the full evaluation could not be done.
- (2) Packaging inspection: The cargo was only inspected visually, together with the persons in charge of reception of the cargo, due to the lack of inspection basis criteria, to verify if the packaging is good or bad. The results obtained from this inspection are described below.

Table 4.5-1 Damaged units quantity

Total inspected units		Good	Bad
Vertical position refrigerators	94	90	4
Horizontal position refrigerators	48	2	46
Totals	142	92	50

Source: JICA Study Team

Within the damaged units indicated in the table above, they were identified some of them which supposedly they were damaged at the time of delivery at factory.

Cracks on packaging EPS: 4 units

Damages on shrinkable film: 17 units

Some units were transported on horizontal position (on the upper side layer) for increasing the load capacity of the truck, but according to the result of the table above, some problems can be aroused under the point of view of the packaging design. This means, the loading of the units to horizontal position is made by one man standing on the vertical units, so that the packaging will be damaged. Furthermore, the horizontal units also are suffering the vibration transmitted during the transportation, which must be taken into account at the stage of design.



Corner support moved at the back side of truck.
EPS edges are slightly damaged.



Horizontal position units loading.
Cargo and personnel under dangerous procedures.



Cargo moved during transportation. EPS slightly deformed due to cargo displacement for 8cm.
Source: JICA Study Team



Shrinkable film meltdown. Film touching a portion of refrigerator.

Fig. 4.5-1 Cargo arrived at destination and damages observed

4.5.1 Status of Damages of Packaging

For the analysis of the damages of packaging based on collected information during this Study, it was observed some difficulties as follows:

- (1) The information is coming from several sources, but there are no systematic data gathering for statistical analysis.
- (2) In case of products to be sold commercially, it is not possible to carry out an exhaustive study since it is not possible to open the packaging one by one.
- (3) The information can not be published, due to commercial confidentiality rules, even working with cooperating companies.

Considering these sensible items, the data of products having packaging damages were summarized on the following table, including the detail of damages observed in order to study the improvement of packaging.

Table 4.5.1-1 Packaging defects information

Product	Damage	Possible origin	Source
Electric refrigerators	Cracks on external side of EPS	- Loading / unloading - Truck sudden stop - EPS molding	Trace study
	External film damaged	- Loading / unloading - Truck sudden stop	
	Discontinuity on films	Shrink procedure	
	Cooling gas leakage	Tubing welding – Vibrations during Transp.	Company
	Product base damaged	Impacts during transportation	Measured in lab
Home appliances	Carton box crushed	Storage	Trace study
Common goods	Carton box crushed	Stacking during transportation	
Liquid medicine	Leakage of liquid	Compression during transportation	Trace study
Edible oil	Oil leakage (seal failed)	Compression during transportation	Company
Dairy products	Tearing of seal material of containers	Compression during transportation	
	Lack of sealing on material	Quality of the sealing material	

Source: JICA Study Team

4.5.2 Economic Loss due to Excessive Packaging Design

The excessive packaging of industrial products are the result of inadequate considerations of external loads of distribution environment, or, an excessive protection applied to the product (product + packaging) against those external loads. In other words, the lack of studies of external loads, resistance of the product or packaging material, or real cases of oversize (explanation of gift wrapping / packaging is omitted).

As an example, it can be analyzed the case of refrigerators packed with EPS, as observed in MERCOSUR countries.

The EPS is a material which is required some properties such as: as cushion material during the impacts of drops during the cargo handling, protection against vibrations during transportation, and protection of the goods against crushing during the stacking of the cargoes.

The cushioning material: The EPS requires enough area and thickness in order to get the necessary resistance against drops.

The following are some of the causes which lead to an excessive packaging.

- (1) Calculation error of the drop height from usual cargoes.
- (2) Lack of study about the mechanical resistance of the product itself.
- (3) Design errors for the cushioning (quality of the material defects)

Protection against vibrations:

The vibration characteristics of the packaged cargo, which is determined by the thickness and area of EPS material – supporting and fixing the product – and the weight of the product, could be amplified during the transportation process transmitting the vibrations to the product, so that it can exceed the allowable vibration level of the product and then producing damages. In this case, the causes of excessive packaging could be centered in the following items.

- (1) Lack of evaluation of vibrations, originated by the excessive thickness and area of EPS material.
- (2) Lack of study of the vibration resistance of the product.
- (3) Calculation error of vibrations aroused during the transportation.

Crushing:

The EPS must be sized (thickness and area) in such way that it can resist the weight of the cargo during the time of storage. In this case, the cause of excessive packaging is an incomplete evaluation for EPS Creep characteristics.

As described above, due to an non adequate values of thickness and area of EPS material, the package results on a oversized design with an increased external dimensions.

Furthermore, it is added the problem of lack of precise data of the transportation environment. As result of all of these, the cost is increased due to materials, processing, transportation up to the end of user, loading / unloading, so that even in the case that the material and processing costs are relatively low, the total distribution cost as a whole will be completely “in red”.

4.5.3 Economic Losses due to Damages on Products

As an example, on the following Table, it is shown the case of damages observed on transported goods, i.e. refrigerators, analyzed during the study of home appliances.

Table 4.5.3-1 Break down of defects on product (refrigerator)

Failure	Percentage (%)
Failure on door adjustment	0.46
Failure on electrical wires	0.42
Failure on door right angle	0.28
Failure on drain system	0.27
Failure on doors due to impacts	0.13
Failure on packaging	0.03
Others	0.33
Total	1.92

* The percentage is an incidence rate of defects out of 17,000 inspected units.

Source: JICA Study Team

The total 1.92% defects observed at the end of the distribution represent a high value from production point of view. Looking the details of type of defects, it can be seen that the 25% are related to the doors problems. It can be guessed that this is due to the displacement of the door originated by the impacts produced by vibrations.

From this information, it can be related to the loss of profit due to reduction of value due to replacement of parts, spending for non-charged repair works, reduction of commercial value and loss of quality of the product. It must be remarked that the author could not obtain the exact quantity of damaged products during the Study.

Regarding to the damages prevention measures, it must be analyzed the type of damages, and the system of validation of the product / packaging for the design of packaging as well.

We are sure that, all the measurements, data analysis, and determination of the Reference Guideline for Packaging Tests etc developed during this Study, will have a practical application.

Chapter 5 Data Collection and Data Analysis of Transportation Environment Study

Chapter 5 Data Collection and Data Analysis of Transportation Environment Study

As a part of the current JICA Study, the Demonstration Test of Transportation Environment Study was performed in February 2005 in Argentina. After that, the collected data related to the transportation conditions, intensively executed by each member country of MERCOSUR, were stored as “raw” data, following the classification method agreed between the JICA Study Team and the members of their counterpart institutions, at the time of the presentation of the Progress Report. Following this stage, the analytical work was conducted in compliance with the JICA MERCOSUR (SAVER3) analysis methodology, to establish reference values as standards to evaluate packaging through tests. This task was undertaken by the JICA Study Team and their counterparts, coordinated by INTI Argentina as the MERCOSUR Coordinator. As a result of this coordinated effort, the JICA Study Team finalized on setting the "Reference Value for Evaluation of Packaging Tests" (preliminary version).

5.1 Construction of the MERCOSUR Database

Introduction

Regarding to the construction of the MERCOSUR database, a data classification method has been issued and agreed upon at the stage of the Progress Report, at the meeting of the four (4) countries on February 16th 2006 (see Fig. 5.1-1). However, it is considered that there is the difficulty of directly taking upon the construction of this database, because of insufficient capacity of the existing counterparts' computer systems on both hardware and software, and the lack of human resources for the task. For that reasons, it was decided to explain the general guideline in this chapter, which will be complemented in detail in the Chapter 10.

The database, containing information about collected data, result of data analysis, numerical information and graphics (hereinafter “informative resources”) developed by the “Study of Improvement of Packaging Technology for Merchandise Distribution in MERCOSUR” integrated by Argentina, Brazil, Paraguay and Uruguay, will become an important source of information regarding improvement techniques for transporting and packaging of products within the region once it is placed on the Internet Website for public access.

5.1.1 Use of the Database

As the final users of the database, two main types of users have been defined, and to be considered for the construction of the database for Web site.

- 1) Passive users, whose main objective is the sole acquisition of information, for example, for the study of specialized knowledge.
- 2) Active users, seeking information and graphics for managerial, educational or investigative purposes that are provided to the public via the Internet Website.

The use case 1) is similar to any Internet Web Page, whereas the data corresponding to 2) will require characteristic properties of a database. In this case, the provider of the information must prepare high quality data and validate to be used as a reliable source. Also, in the use case 2), the informative resources open to the public use may be utilized as secondary sources, in other words, the information may be downloaded and used as presentational material in seminars and conferences as visual aides in form of films, posters or prints, CD-ROM, and even link to other websites. The database may be a non-profit source of information for investigative or educational purposes, or, it can be commercialized. Regardless of the case, the copyright must be properly referenced throughout its use.

5.1.2 Group of Users and Correspondence Needs

The informative resource database for the field of packaging technology can be used on several ways, and the type of users would be diversified also. The published information on the web can be accessed by a wide variety of users. These users may also issue questions, comments and requests regarding the provided information, and therefore a mean to respond to such demand must be defined.

5.1.3 Useful Database

The important thing is to “construct something that is truly useful.” A mean or vehicle is required, to transmit the information, and the user will acquire the information through the mean deemed most user-friendly. Placing the information in Web format for public access only makes sense if the provided information could not be given through the currently conventional means of communication. It is obvious that a database will not be completed before its construction is finished. In order to maintain the usefulness of a database, it is required a constant work, not only to update and correct the data, but also working to address the solicitation and comments of its users.

5.2 Aspects to Be Considered for the Database Development

5.2.1 Database Structure

(1) Information Administration for Non-Specialized and General Public Users

The database can be accessed by the general public, therefore their structure cannot account solely on the specialized sector. Wherever possible, the organizational design, menu and content, must be oriented for both types of users. It would be beneficial to design separate menus for those “Specialized” and “General Public” users. The important aspect is to consider the accessibility from the eyes of the users of the database.

(2) Database as a Secondary Source

Anyone may access and download the information placed on the Web. To accomplish this, the users must indefinitely obtain the authorization from the author of the work to be able to access and utilize the information.

(3) Naming and Location of the Files

While elaborating the database, close attention must be paid to the file naming criteria and their location. In general, any Website, once uploaded and opened to the public, it must be continuously updated which makes it essential to have a consistent file name and location from the conception of the database. Once placed on the Web, it is not convenient to change the location of the files because the **html** files are used by the Internet search engines to browse its contents, and most users will access the site through them. Changing file names and location may not only cause erroneous links, but it may also complicate the search engines browsing capabilities, therefore reducing accessibility and functionality of the Web Site.

Special attention must be paid for a database with large volume of information, such as the one at hand for packaging technologies for transportation, but this holds true for any Web Page in general. Regarding the location of the files, it is convenient to place the informative resources collected from the survey field, such as the images (maps, photographs of road conditions, etc.) and the numerical and text information, including the results of the analysis, to be stored in different directories (or folders). If a directory (or folder) contains hundreds or thousands of files, it makes their handling quite difficult. Therefore, it is convenient to have a previously agreed maximum number of files per each directory, and once that limit is reached, a new directory shall be created.

5.2.2 Navigators and Search Engines

(1) WWW Browser as Database Browsing Software

There are some databases available through the internet which requires a particular web-browser, but in general, most of these sites can be viewed through mainstream WWW browsers, such as Netscape, Internet Explorer, etc. It is convenient that the database published on the web will be accessible with any mainstream browser and not limited to a particular version or program.

(2) WWW Browsers, HTML Files, and Search Engines

A database that can be accessed through WWW browsers means that the final output format (layout) is controlled by the HTML (hypertext markup language) files. However, there are two types of data published on the web:

- (a) The main database is controlled through a specific program, and in order to cover the needs of each user accessing through the web, the program will automatically create a HTML file with the inquired information.
- (b) All the data is located from the beginning on the server in the form of HTML files.

In this case, all the files need to be connected and unified to allow the search engines to gather the necessary information for its searches.

5.2.3 HTML File Design

(1) Avoid Potential Browsing Software Errors in Perception

HTML is a simplified language based on the SGML (Standard Generalized Markup Language) adopted as a standard by the ISO 8879. The SGML in itself an extremely complicated language, and therefore for practical reason, a simpler version known as HTML is used.

To avoid functionality issues, it is preferable to elaborate a web site using generalized HTML format, practices that have been in place and have been tested for several years, and preclude the use of newer and more complex functions that may generate confusion among the users.

(2) Needs for Metadata

Looking the large number of published information on the web over the last few years, sometimes it is complicated to obtain matching search results by an Internet even using reliable search engines. To address this issue, presently on the Internet world it is recommended to insert

a key-word (metadata) which allows the identification of the content within each HTML file. Metadata is defined as a data of the data, in other words, information regarding each piece of data.

5.2.4 Information Quality Maintenance on Laboratory Test and the Roadway and Transportation Conditions

The most important aspect is the level of utility of the information that will be made available to the public.

(1) Providing High Quality Images

There are large numbers of pages containing images (photographs, etc.) that are placed with the sole purpose to be displayed on the screen. These images can be amplified only to a 2x2 to 4x4 ratio. Also, the images' resolution is low and not adequate for printing. This occurs because the printed image's resolution is very high (greater than 600 dpi) compared to the screen's resolution of 72 dpi. To obtain printable images, the file needs to be accommodated for at least 8x8 to 16x16 ratios to the resolution on the screen. To obtain such resolution, the photographs or image sources must be passed through a scanner and set its resolution to a setting equal to or higher than the printed source, in other words, at least 600 dpi.

(2) Image's Objectivity

If the images are going to be published on a website for general use, they must be visually attractive. To obtain this, in most cases, even in photographs of nature, retouching may be required.

(3) Clarity and Color

There are cases in which the photographs need to be altered in its appearance from the moment the photograph is taken until the film is developed and digitized, and in some cases manipulation of the colors, as in microscopic images.

5.3 Elaboration through the Publication of the Database

5.3.1 Checking Grammar and Links

Once the web page is set up, an exhaustive checking process must be undertaken reviewing the content of each HTML file before they are published on the web. In other words, the precision of each link to texts and images, internal and external to the page, and as well as the logistic grammar of the HTML text need to be reviewed.

5.3.2 Correcting Search Engine's Perception Errors

In many cases, the output layout (presentation on the screen) of the HTML files could be viewed differently, depending on the Web browser used. This aspect must be carefully considered while creating the HTML files, but these must be revised once the varying displays are checked on the different browsers and make the necessary adjustments to obtain the most homogeneous layout possible.

5.3.3 Advantages and Disadvantages of the DNS (Domain Name Server) Reference Function

Users would logically prefer obtaining the queried information as soon as possible from the accessed web server. The website server administrator desires to acquire the location and the number of users from where the user accesses to gain a better understanding of the types of utilizations of the server. The DNS has the function to control the information regarding the Websites connected to the Internet system. The reply may be delayed depending on the use of these reference functions. The selection depends on the reference or the DNS from which the web server is created. That is the reason why it is necessary to confirm the level of delay in the response when accessed from outside.

5.4 After the Publication of the Database

5.4.1 Methods to register the Website

It is necessary to reach a level in which any person from around the world knows where this type of information can be obtained by putting to use any computer web browser connected to the internet. The two most common ways to universally promote a website's existence on the internet are:

- (a) Request the search engines to collect information on the database. (For example, Google, Alta Vista, Infoseek, etc.)
- (b) Register the database to directory services (For example, Yahoo)

Another method is requesting the research institutions with websites already in place to insert links to the newly site to be published from their homepage.

5.4.2 Control and Maintenance of the Source Server

(1) Preparations for Control and Maintenance: Short Term Issues

Once the server is set up, it must be attended to and coordinated in several aspects to allow a continuous administration of the information. In the short term, the server must be functional 24 hours a day throughout the entire year. For websites with specialized focus, its' contents need to be aimed, whenever possible, not at a national level only, but an international one. In this case, it is desired and possible to have enough demand for 24 hours a day throughout the whole year. It is recommended to have an automatic recovery system to obtain a quick recovery in the case of electrical power troubles, and also to have a back-up machine for up-to-date back up of the server in case of any source server malfunction.

(2) Preparation for Control and Maintenance: Long Term Issues

1) Ensuring the permanence

The permanence of the control and maintenance of the information on specialized fields such as the packaging technologies is permanent.

2) Data Recollection Reply to the Search Engines

When a database (a website) is opened to the general public, it is registered with the search engines to promote its' existence around the world. These engines start accessing the server to collect data. In this case, the search only requires textual data (html files), and therefore the search engines do not access image files and limit themselves to downloading

only html files. This allows to easily distinguishing searches pertaining to “search engines” and those from the other people (users).

Still, this data collection is not only performed by the mainstream search engines such as Google or Alta Vista, etc. In the last few years, research institutions and private companies started creating search engines to gather data with different objectives. These search engines access and collect the information of different sites without having registered with the site’s server, through links created at other sites or from the information collected from other general search engines.

While the search engines are collecting the data, the reply signal to other access points become extremely slow, and sometimes even the connection might get lost. While this is rarely the case, if these circumstances arise, access to the search engines will be denied using server program’s function, or simply contact the search engine’s administrator to interrupt the data collection.

5.4.3 Issues to attend to during Data updating

One method of constructing a web server is to start only with simple files, then add and update the data gradually. In the matter at hand, the data and analysis pertaining to the Transportation Environmental Study conducted as part of the Packaging Technologies Improvement Plan already has a considerable volume, and will increase and accumulate even more in the future.

(1) Avoid File Relocation and Renaming

It is convenient having the files categorized in different directories based on type and content, and also on sub-directories, in order to make easier the data searching. After the launching of the database to the public, the data from the site is collected by search engines, and most of the users will access the server based on the information captured by these search engines. If the files to be found by these search engines are then unnecessarily moved or renamed, there is a risk of fail, wasting an opportunity to promote the site’s existence given that there will be inaccessible to the user. Because of this, it is necessary to study carefully the placement of the files during the initial stage of the site’s construction, in such way to allow the creation of new directories and sub-directories when the number of files increases, by avoiding the relocation and renaming of the existing files.

(2) Avoid Changing the Server’s Address

The Domain Name Server (DNS) should never be changed. If an unavoidable circumstances arise, such as changing the server’s administrator or institutional reorganization,

and the change is necessary, the central information must be accessed to implement a transition mode (old domain – new domain) to allow the access to the previous domain as well.

5.4.4 User Interaction

The most important characteristic of the information on the web, what makes it different from the other known means of mass communication, is the bilateral flow. This means that at the moment a database is going to be published, it does not only provide information, but it also requires a system to receive opinions, comments and solicitations from its users. This interaction will serve to improve the database and turn it into a more practical and useful tool.

(1) Reply to Solicitation of the Users

The basic objective of a database publishing these informative resources is to allow its public use, and therefore the main request from its users can be assumed to be requesting permission to use the published data and images as secondary sources of information.

In this case, it is not convenient to allow the visual images to be utilized without the author's consent, even to investigative and educational institutions. Everyone must request the author's consent prior to its use. To do this, it would be convenient to have a web page within the site explaining the author's rights (copyright) process to request the information use.

It is necessary to verify such permission even stricter for solicitations from private companies with commercial objectives. Different from educational or investigative institutions, the consent agreement must be made on written paper, not limiting itself to electronic communication.

(2) Use of Internet Discussion Board

As the number of users increases, it is also possible to receive consultations and opinions regarding similar contents. In this case, replying to each of these individually will become unmanageable, which makes it convenient to open a Frequently Asked Question page, where all the received consultation from the users is summarized, or even have a page set up in an open Internet discussion board, where all the received consultation will be published along with each individual response. This will eliminate the need to reply various times to the same questions.

5.5 Regarding the Author's Rights (copyright)

The objective of the informative resources database is to have information useful in the fields of packaging technologies, transportation of packaged freight and related fields. If the number of active users of the database increases over time, it can be said that the objective of the database has been achieved, and that it has become an indispensable tool in this field of study.

Still, the worrisome issue is regarding the author's rights. It is satisfactory to have the site used, but it is not convenient to have its contents used without the consent of the author. Unless it is explicitly stated on the material to be published that it may be freely utilized without previous authorization, the user must always solicit the author's authorization for its use.

Also, even if the material explicitly states its free use without previous authorization as mentioned above, that does not imply that the author's rights are voided, and therefore if the user intends to use such material for conferences, documents, presentations or other public sites, the user must clearly state the source of the information.

5.5.1 Clarification for the Author's Rights/ Utilization Guide

While considering the users, it is beneficial to explain the author's rights. Even if the user intends on using images or data presented at the site, if the procedure to obtain authorization for its use is not clearly stated, the user might desist its use. In other words, it is convenient to have a reference explaining the author's rights (terms of use, forms for solicitation for authorization, etc.) also to motivate the active use of the informative resources administered at the site.

Also, as previously stated, most of the users will access the site through search engines, and therefore they will not always access the site through its homepage, and rather go directly to the page where the searched key word appears. Because of this, it would be illogical to place the terms of use only on the main menu (portal homepage) but it will also have to be presented in all the pages containing data and images that may be utilized as secondary sources (This does not mean that the terms of use need to be displayed in detail in all the pages, but would rather have a separate copyright page that may be accessed from all the pertinent locations.).

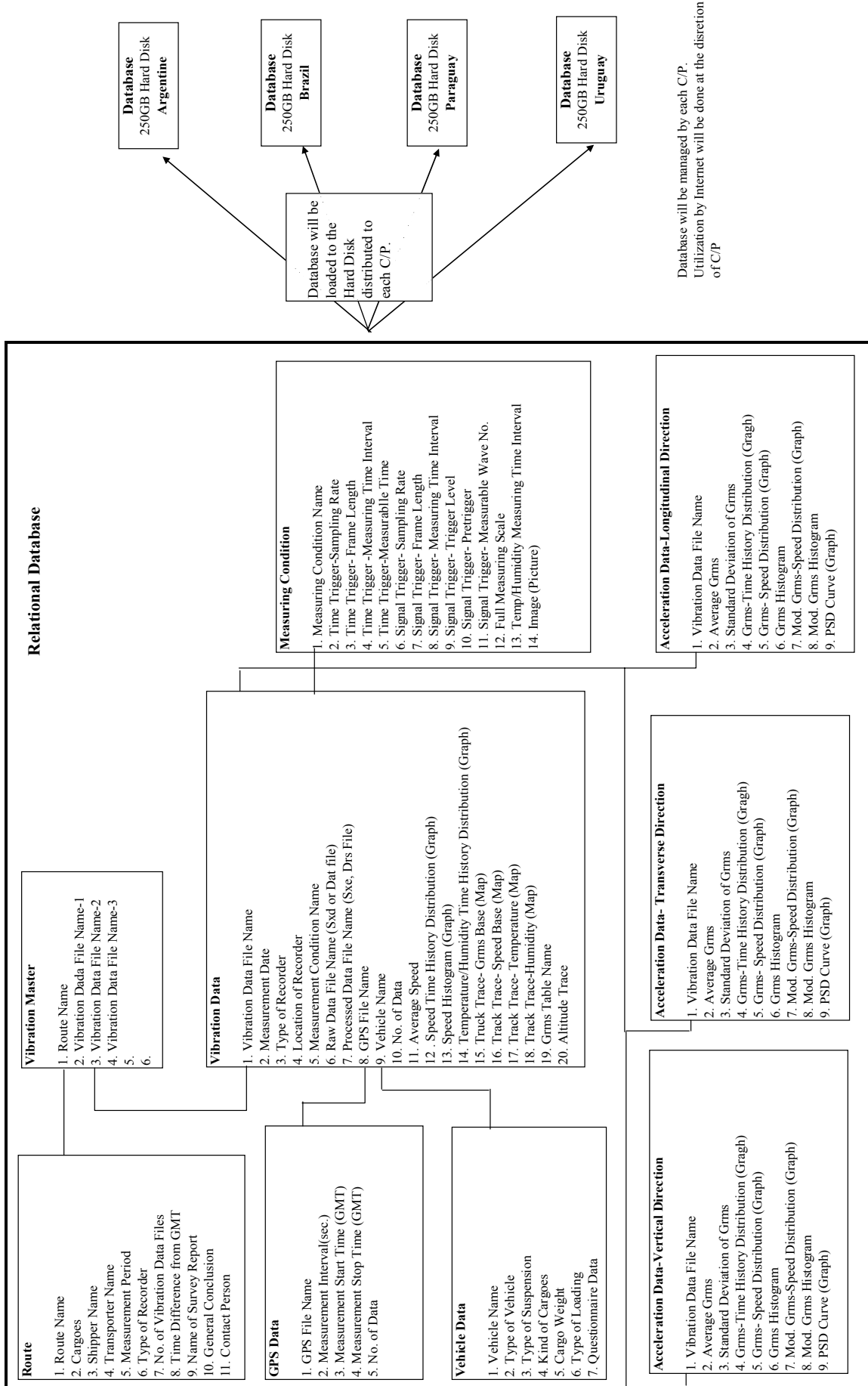
This will greatly reduce the illicit use of the database's content.

5.5.2 Free-of-charge or with charge

In general, when someone wishes to utilize something, a tariff must be paid to the person or entity to which the resource's copyright is registered to. But in the case for database information from public investigative institutions, where the registered information was obtained and processed with public financial resources, its use should be strictly free-of-charge. In the case

where its use will be charged (especially for commercial usage), it is necessary to obtain the pertaining authorization from the supervising governmental entity.

JICA MERCOSUR / Database Structure (Draft)



Source: JICA Study Team

Fig. 5.1-1 Database Structure (Draft)

Chapter 6 Establishment of the "Reference Guidelines for Packaging Tests"

Chapter 6 Establishment of the "Reference Guidelines for Packaging Tests"

The details of the methodology to determine the Reference Guidelines for Packaging Tests were discussed at the Joint Meeting of the 4 Countries held on February 16, 2006 (in Campinas, Brazil). There, it was agreed that said "Reference Guidelines for the Evaluation of Packaging Tests" would be applied by classifying routes into different "grades" based on their conditions. The establishment of reference guidelines is a pending activity that will be performed based on the results of the analysis of the data collected during the Transportation Environment Surveys, depending on the applicable techniques and methodology.

Table 6-1 Reference Guidelines for the Evaluation of Packaging Tests (Example)
Type of route corresponding to each Grade

Grade	A (good)	B (medium)	C (bad)	D
Grade 1	100%			
Grade 2	80%	10%	10%	
Grade 3	60%	20%	20%	
Grade 4	40%	30%	30%	
Grade 5	20%	40%	40%	

Source: JICA Study Team

6.1 Procedures for the determination of the reference guidelines for the evaluation of packaging tests

Regarding the activities performed during the 3rd year of the Study, the JICA Study Team proposed a draft of the procedures for the determination of the "Reference Guidelines applicable within the MERCOSUR" – as described below – based on the results of the analysis of the collected data and as mutually agreed at meetings held with the Counterpart institutes and for the presentation of the Progress Report. Besides, when planning the activities to be carried out during the 3rd year of the Study during the training course held in Japan on March 29, 2006, the Coordinator of the Counterpart institutes (INTI of Argentina) proposed a route classification method based on the combination of PSD curves per route category and comparative curves pursuant surveys carried out by the National Traffic Department (*Dirección Nacional de Vialidad*) of the Argentine Ministry of Transport. This methodology is compatible with the route evaluation procedure for the determination of reference values proposed by the JICA Study Team. Therefore, the mentioned proposal was accepted and implemented as part of the general procedure in order to proceed with the study.

Procedures for determining the Reference Values for the MERCOSUR

In the Progress Report (March 2006), the JICA Study Team proposed the following classification of routes in order to define the reference values for the evaluation of packaging tests.

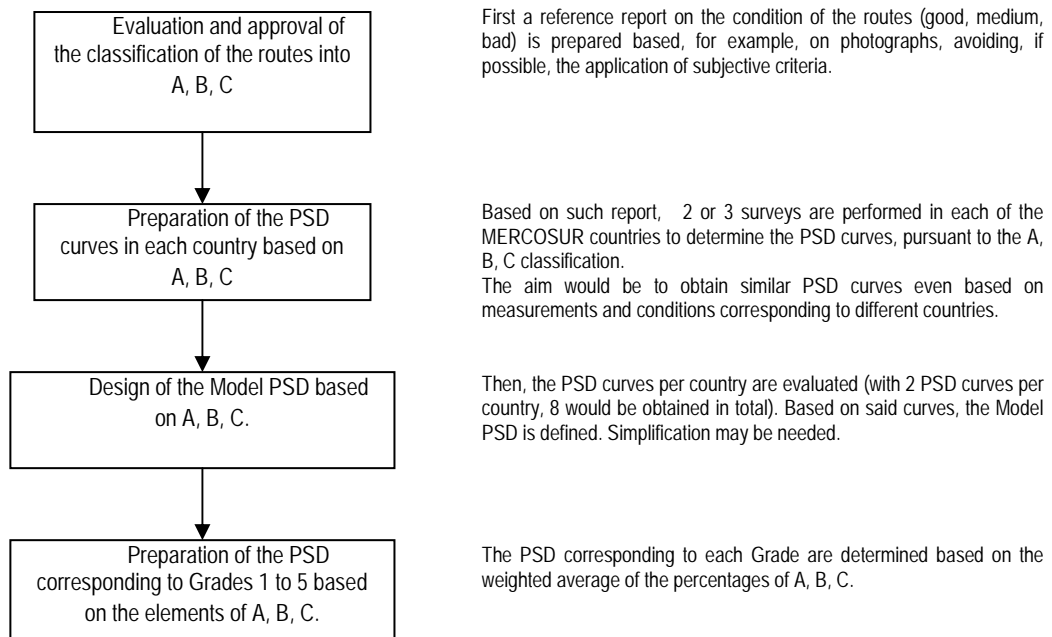
Classification for the evaluation of packaging tests (Example)

Grade	Type of route and % composition			
	A (Good)	B (Medium)	C (Bad)	D
Grade 1	100%			
Grade 2	80%	10%	10%	
Grade 3	60%	20%	20%	
Grade 4	40%	30%	30%	
Grade 5	20%	40%	40%	

However, the percentages for each column, A, B, C, should be fixed based on the actual conditions of the MERCOSUR routes, so the values shown in the table are not mandatory. This issue should be analyzed in the future. Similarly, grades 1 to 5 indicated in the table are not final, but will be determined upon a detailed analysis between the Counterpart institutes, aiming at finding an adequate classification.

The main issue is to determine the approach to define the classification of routes into A (good), B (medium), C (bad) how to link such classification to the condition of the routes so as to later define the "Model PSD".

The following is a brief overview of the procedure applicable to determine the reference values for Packaging Tests.

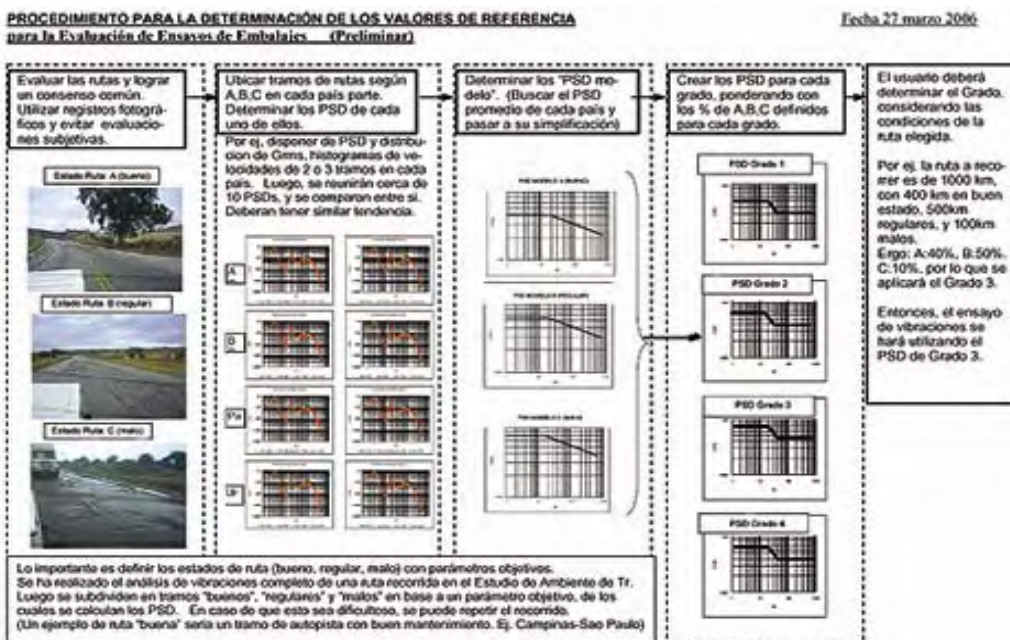
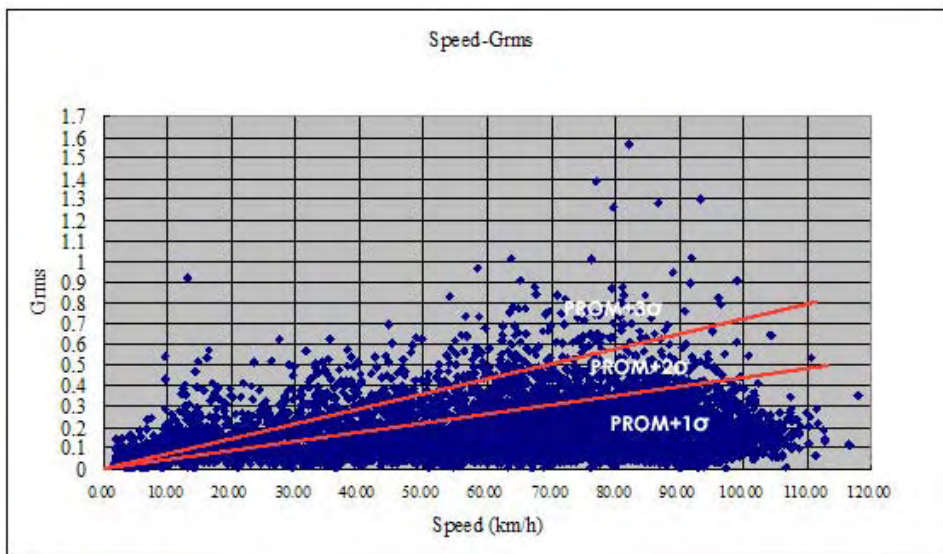


The following is the determination of each A, B and C category.

The following energy scatter diagram represents the Grms curve vs. speed where σ is the standard deviation. A hypothesis is established considering the following:

- Average value + σ = A (good)
- Average value + 2σ = B (medium)
- Average value + 3σ = C (bad)

From these figures, the (Average values + σ) are taken and the pertinent PSD curve is calculated. The same applies to obtain the + 2σ and + 3σ averages, calculating the respective PSD curves. Then, these PSD curves can be compared against the "Model PSD" indicated above. If both PSD are similar, it can be said that reference values can be calculated based on the Grms curves.



Source: JICA Study Team

Then, the surveys continued through Workshops, based on a concept mutually agreed between the counterpart institutes of the 4 countries.

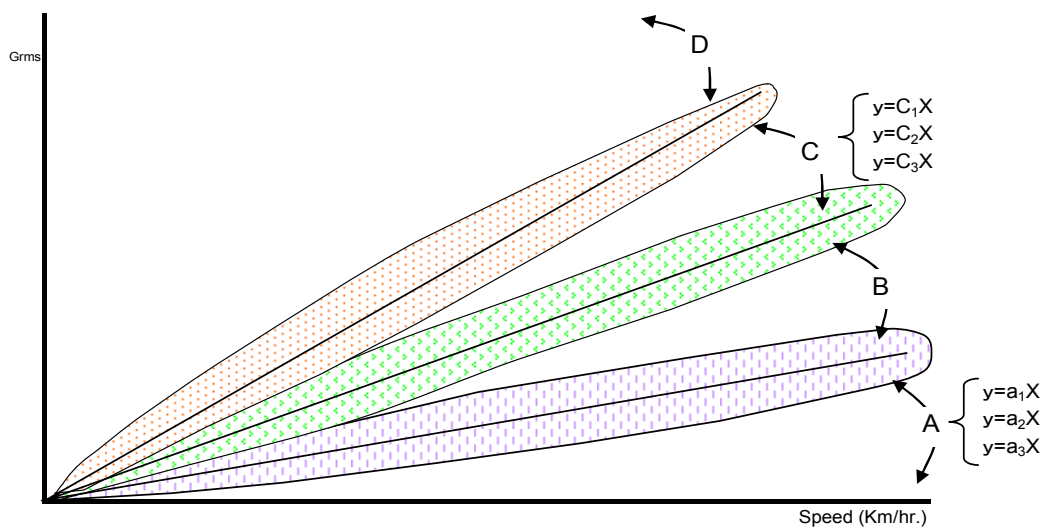
(1) Route classification based on their conditions

- Determine the classification of route segment as A, B, C, D based on photographs
- Evaluation based on manual records made during the Transportation Environment Surveys
- Evaluation based on existing standards issued by Transportation Ministries or Traffic Departments
- Evaluation based on public reports on the condition of the routes, transitabilidad, reports on traffic conditions from the Traffic Department

(2) Preparation of energy scatter diagrams (Grms vs. Speed)

Based on the results of the Transportation Environment Surveys, a diagram is designed with A, B, C and D lines as indicated in the figure below.

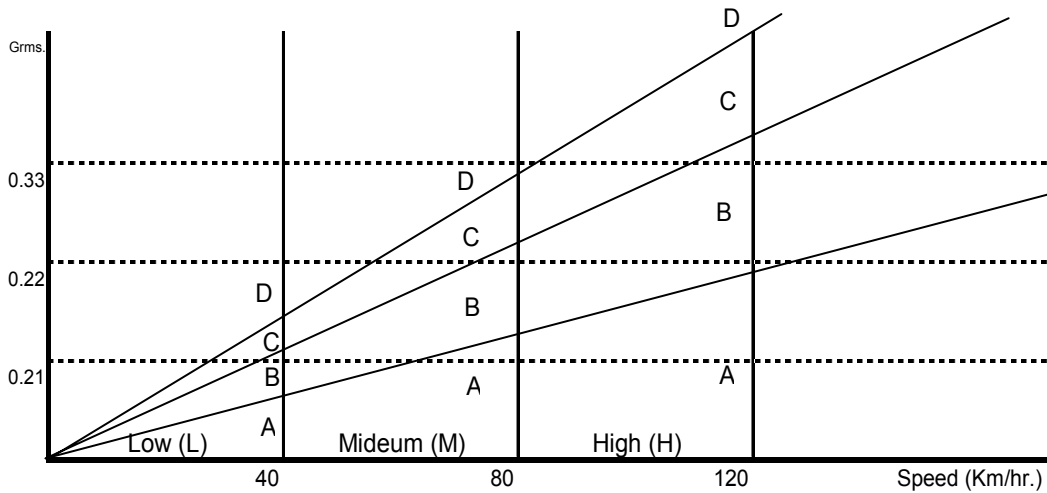
Note: Some difficulties in the classification of routes were identified during the surveys of Brazilian routes carried out by Brazil (CETEA). I.e. a fourth category, "D", was established (subject to stricter conditions) after filtering the data indicating energy values over Grms = 0.33. After several discussions, the addition of the D category was mutually agreed.



Source: JICA Study Team

Each route was analyzed based on this graph so as to determine the percentage values corresponding to A, B, C, and D.

(3) Preparation of the PSD vs. truck speed diagram with speed ranges



Source: JICA Study Team

The area of the Grms vs. Speed energy scatter diagram is divided into 12 sectors, based on speed ranges (L: low, M: medium, H: high) and the trapezoidal sub-areas resulting from the straight lines that define the A, B, C, and D sectors are determined. Based on this criteria, surveys were designed to be carried out through Workshops. As result, the Counterpart institutes prepared a technical proposal as described in the graphs of clause 6.2. Then, the JICA Study Team performed an analysis and evaluation. Based on the results of such analysis, a draft of the "Reference Values for the Evaluation of Packaging Tests" was issued. Besides, further studies were carried out by the counterparts from each country analyzing, among other things, the collected data and the classification of the routes, etc.

(4) Data gathering, data analysis, verification procedures – Example #1

Until now, to determine the "Reference Guidelines for Vibration Tests for packaging evaluation", during site surveys, several route stretches, each representing a "route condition" were taken as a reference, data was taken from said stretches and then processed and analyzed to prepare the base PSD curve for each type of route.

Afterwards, an estimation of each type of route was made for the route under study, and based on that information, the base data were combined and determinations were made.

However, in the Transportation environment survey carried out in this JICA Study, the data was collected in prefixed and uniform time periods to determine the bases to establish the reference values for testing. This allowed the collection of more data than that obtained under conventional methods. To take maximum advantage of the information that may be obtained from this, new methods for the determination of reference values had to be developed.

1) Field data collection

[1] Data is collected using field sensors for transportation environment surveys equipped with high capacity memories which record vibrations, impacts, temperature, and moisture in fixed time frames. To such end a "timer" was installed beforehand.

Besides, to know the time, the geographic position and speed of the truck a GPS was connected. The geographic information and the information from the sensors were synchronized.

As to the registration of other information related to the survey, data is taken at the point of departure and destination, the type of vehicle, the origin, the type of cargo, the volume of the cargo, information related to the driver, such as years experience, etc., recording all this information in forms specially designed to this end.

The sensor records data recording in short periods of time ("beeps") approximately 1 second apart, each time the device triggers. Within these periods, the device reads specific information per millisecond, for a total of 1024 milliseconds, creating an information package that is stored in the memory as a "frame". This process is carried out to then allow a frequency analysis of the triggers. This process is repeated in prefixed time periods as indicated above "triggering at fixed times".

[2] Once the field data is collected, the sensor and GPS information is also entered in a PC. Afterwards, the data is matched using the time schedule parameter.

2) Data analysis

[1] As to the total distance covered by the surveyed routes, a general verification of the stretches is made (using the matched data) and the times and general conditions of transport through: GPS data mapping, speed variations analysis, accelerations and Grms acceleration (and information collected manually during the study).

[2] Also, quantity determinations are made applying statistic calculations, determining the frequencies of speed change and the distribution of Grms values according to speed.

[3] Based on the foregoing, the data of the database is exported to an Excel sheet and with the graph function, the Grms acceleration energy scatter graph is prepared based on truck speed (Grms versus speed).

[4] From this Grms distribution graph, the PSD curve representing values is determined, and the best PSD percentage combination to cover the different route conditions can be estimated.

At this point, the following hypotheses are made and certain rules are fixed.

- a. For route stretches in the same conditions, the greater the vehicle speed, the greater the Grms values.

The dynamic energy of the vehicles is proportional to the square of the vehicle speed.

If these aspects are taken into account, the increases should appear in the graph as quadratic curves. However, in this study, the increases are linear, due to the following reasons.

- As regards high speed route stretches, the oscillation frequencies shifted to the high frequency band, and within the components of each oscillation, those of a high frequency increased.
- Due to the development of vehicle suspension, the high frequency components of oscillations are mitigated.
- Based on these multiplying effects, it can be assured that increases would be almost linear.
- Nonetheless, all these aspects are main points that have to be verified.

- b. Routes are classified into 4 different types (according to their condition): A good, B medium, C bad, and D extremely bad.

In the case of “extremely bad” routes, the oscillations are not those usually called Random oscillations, but more likely “impact” oscillations. In this case, upon an statistic analysis and multiplying values times 3, 1 the possibility of having accelerations exceeding the 1G value within the frames gathered is almost 1. This is why, the information above and below Grms 0.33 has been subdivided.

However, this should be furthered reviewed, given its limited relevance to the analysis.

In other words, type D routes include vibratory waves, therefore the form of the wave in the PSD curve would be very different if compared to types A, B or C.

Actually, this limit value should be determined upon a more detailed analysis, to find out the actual value where such a limit occurs (between vibrations and impacts).

- c. Here the Grms graph areas are determined, corresponding to routes type A, B and C.

Determination of area A:

Within the covered route, the stretches classified as good were selected. From the data collected and taking the time schedule as a reference, the applicable data was selected and taken as the basis of a “good route”.

¹ Note: Obtained by applying the standard deviation concept and the formula: $x \pm 3\sigma$

This information is exported to an Excel sheet and by using the data processing; a dividing line is drawn passing through the origin of the graph, showing the slope of the line.

However, there is the possibility that, even being a “good route”, data corresponding B, C or D routes could be found. On the contrary, in “medium” routes or “bad” routes, A type conditions could be found. Therefore, the area of the graph below the straight line drawn up is “Area A”.

Determination of area C:

Afterwards, the stretches classified as “bad” are selected, and the same procedure is applied. A straight line passing through the origin of the graph is drawn up, with its applicable formulae, showing the slope of the line.

Here, the area above the straight line is area C.

Determination of area B:

Based on the above, the distribution graph will have 2 straight lines and 1 horizontal line, defining 4 areas. Three areas have been already named D, A and C. The remaining area will be called area B.

d. Division into speed ranges

From the distribution graph, it may be observed that in the routes with too many irregularities vehicles cannot move at a speed exceeding 40km/h. Besides, if the route is good, trucks tend to move at their maximum speed (except for a specific cause), so, if the speed is reduced, there must be a reason.

Therefore, a hypothesis has been established that these aspects would be somehow shown in the applicable PSD curves.

This is why speeds are divided into 3 groups: low speed ($V < 40$ km/hr), medium speed ($40 < V < 80$ km/hr), and high speed ($V > 80$ km/hr).

As a result, the graph is divided in a total of 10 to 12 areas.

Each of them have the following denominations.

A-low, A-med, A-high, B-low, B-med, B-high, C-low, C-med, C-high, D-low, D-med, D-high.

3) Determination of the PSD graph for each area and calculation of distances covered.

[1] Data from the SAVER sensor

SAVER sensor data maybe collected and processed using the ACCESS program.

Therefore, if the program is available, the above mentioned data is collected and, the whole

information is classified according to the different areas, based on the parameters of the straight lines limiting the areas:

(A-low, A-mid, D-mid, D-high)

The information grouped by area is processed and set as an Sxd file. Putting these files through the SAVER sensor program, with the conventional method and successively, the followings are obtained: the Summary PSD for each area, the average speeds and the equivalent total distances covered.

[2] DER SMART sensor

In the case of the DER sensors, the division into areas within the Grms field is quite difficult due to the configuration of its programs. Besides, the collection of data following a straight function is also difficult. Consequently, in order to achieve a processing similar to the one above described, the following would be necessary:

- Once the matching of data with the GPS information and the following data analysis is concluded, said data is exported to an Excel sheet, the Grms versus speed energy scatter graph is showed and the division in areas A, B, C, and D is made.
- Afterwards, following the hypothesis that the maximum acceleration values within the frames may reach values close to (Grms x 3), the Grms of the graph are multiplied by 3, and these values are considered accelerations (maximum values per frame).
- Additionally, this data is converted to a similar rectangle. The vehicle speed and acceleration values are recorded on this rectangle.

In this step, the whole distance covered and the average speeds are calculated using an Excel sheet, and based on the data of groups A, B, C and D previously recorded.

- Going back to the steps for data analysis, the acceleration sheet containing the vehicle speed is open.
- Here, the data selection screen appears and the vehicle acceleration and speed data recorded before are separated. With this data the PSD analysis is carried out. At this point, the number of samplings is verified and recorded.
- Based on the above described steps, the total distances per area and the PSD by approximation may be calculated.

Proposal of the JICA Study Team

All the data and the applicable data analysis gathered during the transportation environment surveys carried out in the 4 countries were entered in hard drive disk (HDD), delivered to each of the 4 countries in May, 2006, so that each counterpart would have a common database. On this occasion, meetings were held to explain to each country the work schedule for 2006. Since this database includes all the data for the 4 countries, and is integrated into a single data system, including the analysis carried out, Grms versus Speed energy scatter graph will be prepared to cover the whole MERCOSUR so as to analyze it and make the first conclusions. This Grms-Speed energy scatter graph will include the data corresponding to the selected routes of the 4 countries, totalizing 30,000km, as a result of the transportation environment survey. The graph will also show the main routes used at present to carry the target products selected in each country. The advantage of this survey is that it will show the general situation of the MERCOSUR in this area. In a later stage of this Study, the counterpart institutes of each country may continue their own route surveys, carrying out the applicable analysis and then, by means of these graphs, drawing up the respective comparisons to the main graph of the MERCOSUR, so as to be able to directly assess the trends and position of its country in respect to the MERCOSUR.

Regarding to this proposal, the INTI of Argentina, INTN of Paraguay, and LATU of Uruguay have been developed activities on this line, on each institutes.

(5) Collection of data, analysis and verification method (mainly considering Brazilian routes) - Example #2

Taking the vibration data of the truck loading platform in Brazil obtained in this Study, the vibration spectrums for random vibration surveys were calculated. This will be used in the household fridge packaging evaluation surveys.

As a result of these calculations, a general overview of the representative routes for distribution between Brazil and Argentina could be visualized, obtaining the spectrums of the Random vibration surveys applicable to these routes.

The calculation results of a representative route are shown below.

1) Measurements

The impact digital sensor is connected to the GPS. It permits the collection of a great quantity of data for very long routes.

If the devise is set to take 1 frame per second every 7 seconds between takes, the whole data for 1 day can be collected.

Taking the information from each frame, it is possible to read speeds and vibrations.

2) Data Collection

Collecting data from a long route, monitoring the condition of its surface and gathering a great volume of information is not an easy task. That is why analyses are made by means of a distribution graph of those signals (acceleration G) per vehicle speed, see Fig. 6.1-1. Using this, the condition of the route may be compared with the visual information previously gathered.

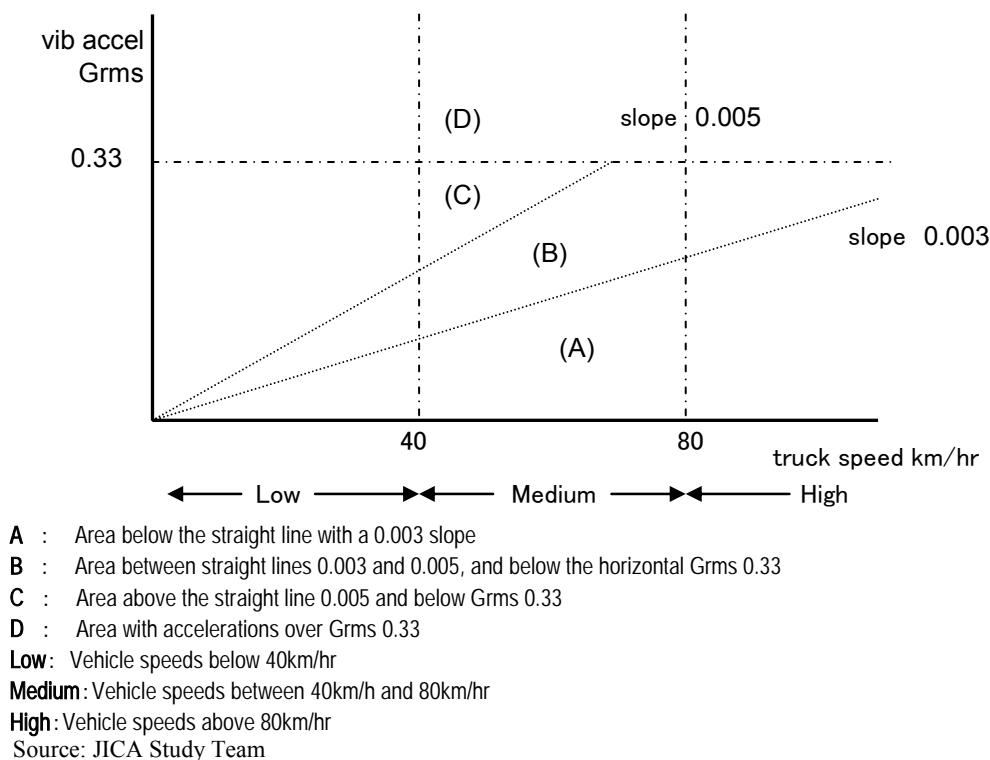


Fig. 6.1-1 Visualization of the condition of the route

It is estimated that the characteristics of the vibration spectrum of each of the areas defined in Fig. 6.1-1 are included, so this classification was taken as a basis. From the PSD calculation of each area, a single PSD curve for tests was obtained.

3) Data analysis

a. Classification per speed and acceleration levels

As shown in Fig. 6.1-1, 4 divisions per acceleration and 3 divisions per speed were made, in a total of 12 areas. The data of those 12 areas was collected, and the average PSD of the total data was calculated using the software of the recording sensors.

b. PSD graphs for each area

From the data exported from the average PSD per area, the following parameters were calculated:

- (1) Quantity of data recorded
- (2) Average speed value corresponding to each entry
- (3) Grms value for a required vibration oscillation number band

The time of data recording may be calculated, from the reading period previously set in the sensor. The transport times can also be determined from that, based on the total quantity of data (in the case of Fig 6.1-1, it is 5 seconds/entry).

In turn, from the average speed, the distance covered per area may be calculated.

Once the general Table is drawn up with this information, the data is rearranged based on Grms values (Table 6.1-1).

The Grms are calculated by including the “exported” PSD values through the frequencies per area and taking the square root.

Mathematically, it is expressed as follows:

$$\text{Grms} = (\sum ((\text{PSDi} + \text{PSDi} + 1) / 2 \times \Delta f))^{1/2}$$

Table 6.1-1 Data per area

Area	Grms Medium Accel.	Entry Number	Time covered 5sec hr	Load tons	Route surface condition	Average speed km/hr	Distance km
Dlow	0.377394	46	0.0638			29.588	1.89
Dhi	0.366155	1562	2.1694			89.091	193.28
Dmed	0.363847	447	0.6208			66.750	41.44
Bhi	0.263730	1147	1.5930			86.002	137.01
Cmed	0.243932	323	0.4486			47.431	21.28
Bmed	0.211402	2073	2.8791			61.808	177.96
Ahi	0.192818	3612	5.0166			87.247	437.69
Amed	0.173857	1007	1.3986			67.220	94.02
Alow	0.173857	225	0.3125			26.204	8.19
Clow	0.170109	669	0.9291			23.322	21.67
Blow	0.110293	616	0.8555			29.404	25.16
total		11727	16.287				1,159.5

Source: JICA Study Team

The data indicated in Table 6.1-1 apply to a day long survey of the Campinas-Recife route (Brazil). The table shows the information corresponding to a 1160 km route and the 16 hours traveled.

The Grms and distances covered in each of the areas vary.

If the vibration levels representing all the stretches could be transformed into hours, the testing conditions of that stretch could be obtained.

As regards criteria, the traditional MIL² standard was used, the MILSTD-810 was taken as a reference and data was processed as follows:

c. Calculation method for PSD with compressed time as from the validated average PSD.

First, the process will be explained based on the fatigue curve (S-N curve) of materials, to ease calculation processes. In the fatigue curve, if loads are replaced by “vibration accelerations”, and the number of repetitive oscillations are replaced by the hours covered-testing hours, the relation showed by the curve is maintained, such as it is shown in Fig. 6.1-2. Mathematically, it is expressed as follows:

$$(W_1/W_0)^M = T_0/T_1 \quad (1)$$

W : Level of tests

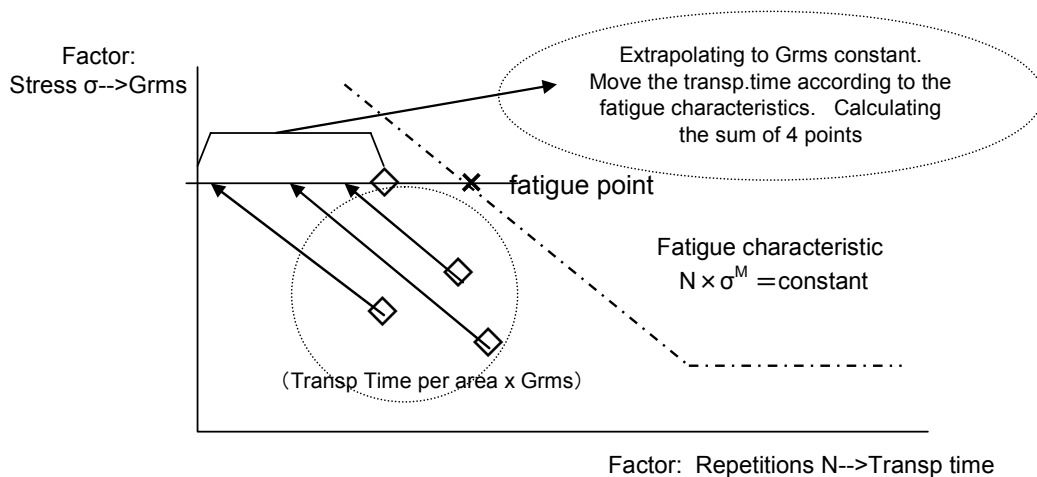
T : Time elapsed – Testing time

M : Material constant (usually 4)

Here, the following ratio is considered $W_1/W_0 = \alpha$, amplification factor,

And the ratio $T_1/T_0 = \lambda$, is:

$$\alpha^M = 1/\lambda \quad (1)$$



Source: JICA Study Team

Fig. 6.1-2 Validation Criterion

² Note: Standards of the USA Ministry of Defense usually called MIL Standards. They can also be applied to civilian uses.

Continued Table 6.1-1, values calculated according to Table 6.1-2

Table 6.1-2 Calculation Table

Area	Medium Accel. Grms g's	Time elapsed hr	Amplif factor	Time factor with M=4	Grms compens g's	Time compens hr	T Factor for 1hr	Time compens2 hr	amplif2 Factor	Grms test g's
Dlow	0.377	0.064	1.000	1.000	0.377	0.064	0.268	0.017	1.390	0.524
Dhi	0.366	2.169	1.031	0.886		1.922		0.516		
Dmed	0.364	0.621	1.037	0.864		0.536		0.144		
Bhi	0.264	1.593	1.431	0.238		0.380		0.102		
Cmed	0.244	0.449	1.547	0.175		0.078		0.021		
Bmed	0.211	2.879	1.785	0.098		0.283		0.076		
Ahi	0.193	5.017	1.957	0.068		0.342		0.092		
Amed	0.174	1.399	2.171	0.045		0.063		0.017		
Alow	0.174	0.313	2.171	0.045		0.014		0.004		
Clow	0.170	0.929	2.219	0.041		0.038		0.010		
Blow	0.110	0.856	3.422	0.007		0.006		0.002		
		16.288				3.728				

Source: JICA Study Team

- (1) The areas and average Grms values are taken from Table 6.1-1 literally.
- (2) Calculation: amplification factor = (Grms max) / (Grms of the area)
- (3) Calculation: time factor = 1 / (amplif fact.)⁴
- (4) Calculation: compensated Grms = (medium Grms) × (amplif. factor)
- (5) Calculation: compensated time = (time elapsed) × (time factor)
- (6) Calculation: aggregation of all compensated times

With the previous calculation, the distances covered for each area and the Grms maximum value are summed up.

In this example, for Grms = 0.377, the compressed time is 3.78 hs. Afterwards, considerations may be made for calculation of test times of 1hr, 2hr, or 4 hr etc. As an example, the compensation for 1 hour-times will be explained here, such as it is indicated in the last right column of Table 6.1-2.

- (7) Calculation: Time Factor = 1 / (sum of compensated times)
- (8) Calculation: Second time compensation = (T1 factor) × (compensated time)
- (9) The following is verified: if the sum of compensated times is equal to 1 hr.
- (10) Calculation: Amplification Factor = 10^{exp (-10 log₁₀ (Time Factor) / 4)}
- (11) Calculation: Grms ens = (Grms compensated) × (Amplif Factor)

Pursuant to the above, for Grms=0.377 and a testing time of 3.78hr, with a value of Grms = 0.524, time can be compressed to 1hr.

To calculate other testing times, the data applicable to the above indicated formula (7) must be used. Below, the test acceleration spectrums are explained.

Table 6.1-3 Calculation Table for PSD Test (1)

Freq Hz	Measured PSD Dlow	Measured PSD Dhi	Compensated PSDD Dhi	Measured PSD Dmed	Compensated PSDD Dmed
1.95	7.800E-03	7.820E-03	8.308E-03	9.615E-03	1.034E-02
2.93	1.867E-02	1.916E-02	2.036E-02	2.314E-02	2.490E-02
3.91	7.985E-03	1.167E-02	1.240E-02	1.126E-02	1.212E-02
4.88	1.681E-03	1.640E-03	1.743E-03	2.042E-03	2.196E-03
5.86	9.358E-04	7.529E-04	7.998E-04	1.250E-03	1.345E-03
6.84	9.402E-04	1.241E-03	1.319E-03	8.361E-04	8.995E-04
7.81	1.258E-03	1.011E-03	1.074E-03	5.818E-04	6.259E-04
8.79	9.522E-04	3.681E-04	3.910E-04	4.106E-04	4.417E-04
9.77	8.791E-04	2.612E-04	2.775E-04	3.657E-04	3.935E-04
10.74	8.698E-04	2.267E-04	2.408E-04	4.602E-04	4.951E-04
11.72	7.365E-04	1.901E-04	2.019E-04	6.070E-04	6.531E-04
12.70	7.359E-04	2.522E-04	2.679E-04	7.109E-04	7.649E-04

Place as many columns as areas in table 6.1-2

Copy PSD values measured according to "exported" data

Source: JICA Study Team

Table 6.1-4 Calculation Table for PSD Test (2)

Measured PSD Blow	Compensated PSDD Blow	μ(f) Average	σ(f) SD	Compensated PSD	PSD ens 1hr
5.617E-04	6.577E-03	6.124E-03	2.579E-03	9.218E-03	1.780E-02
2.137E-03	2.502E-02	1.950E-02	7.938E-03	2.902E-02	5.603E-02
1.632E-03	1.911E-02	1.454E-02	9.998E-03	2.654E-02	5.124E-02
3.538E-04	4.142E-03	3.391E-03	2.098E-03	5.909E-03	1.141E-02
1.497E-04	1.752E-03	1.547E-03	9.369E-04	2.671E-03	5.157E-03
1.034E-04	1.211E-03	1.099E-03	4.645E-04	1.656E-03	3.198E-03
8.896E-05	1.042E-03	8.535E-04	4.887E-04	1.440E-03	2.780E-03
7.834E-05	9.172E-04	5.522E-04	3.142E-04	9.293E-04	1.794E-03
5.189E-05	6.076E-04	3.959E-04	2.620E-04	7.103E-04	1.371E-03
3.246E-05	3.800E-04	3.563E-04	2.412E-04	6.457E-04	1.247E-03
2.909E-05	3.406E-04	3.760E-04	2.306E-04	6.528E-04	1.260E-03
2.932E-05	3.432E-04	4.301E-04	2.272E-04	7.027E-04	1.357E-03

Calculate until the row of the lower limit of frequency

Source: JICA Study Team

(12) Calculation: compensated PSD=(amplification factor Table 6.1-2)²× measured PSD

(13) Calculation: all spectrums per area.

(14) Calculation: after calculating all areas, the average spectrums applicable to vibrations per each area.

(15) Calculation: the Standard deviation, such as item (14) above.

(16) Calculation: compensated PSD=(Spectrum prom)×1.2 (spectrum standard deviation)

This is how the test spectrum is calculated for the whole track. Besides, for the PSD Test of 1hr we have:

(17) Calculation: 1 hr PSD Test =(1hr amplification factor of Table 6.1-2) 2×(compensated PSD item16)

(18) Taking the data from the frequency column, the compensated PSD and the 1hr PSD may be plotted to draw up the spectrum graph.

d. Method to create the PSD

Transportation environment surveys in Brazil were carried out in 4 routes using household appliances supplied by 2 companies. Considering the data collected, the PSD intensities will only be known after comparing the vibration levels, once calculated the testing times and distances. As a first approach, calculations were made by temporarily setting the vibration levels and testing times, as follows:

- (1) Define the PSD taking into consideration for 4 days stretch, representing the route.
- (2) Take 500km-stretches and determine 1hr tests with average vibration values.

e. PSD evolvent curve

To show the PSD curve in the vibration test equipment, based on the calculations showed above, a broken-line graph should be drawn up considering the characteristics of the resulting curve. To this end, the following aspects should be taken into account:

- (1) The PSD evolvent curve should be drawn up by making the pertinent calculation verifications, so that the Grms resulting from the calculation based on the PSD evolvent curve would be similar to the original Grms.
- (2) At the same time, the displacement and speed levels calculated with the envelope curve should be lower than those admitted by the test devise, based on the usual curves.
- (3) Besides, the values cannot exceed the F maximum force of the vibration load of the vibration equipment.

$$F=1/3(\text{Grms}) \times (\text{weight of the sample} + \text{equipment dynamic load})$$

In case the above mentioned 3 conditions are not fulfilled, the testing time should be extended and the calculation repeated so that the Grms value would not exceed the indicated value.

4) Points to be considered in the future

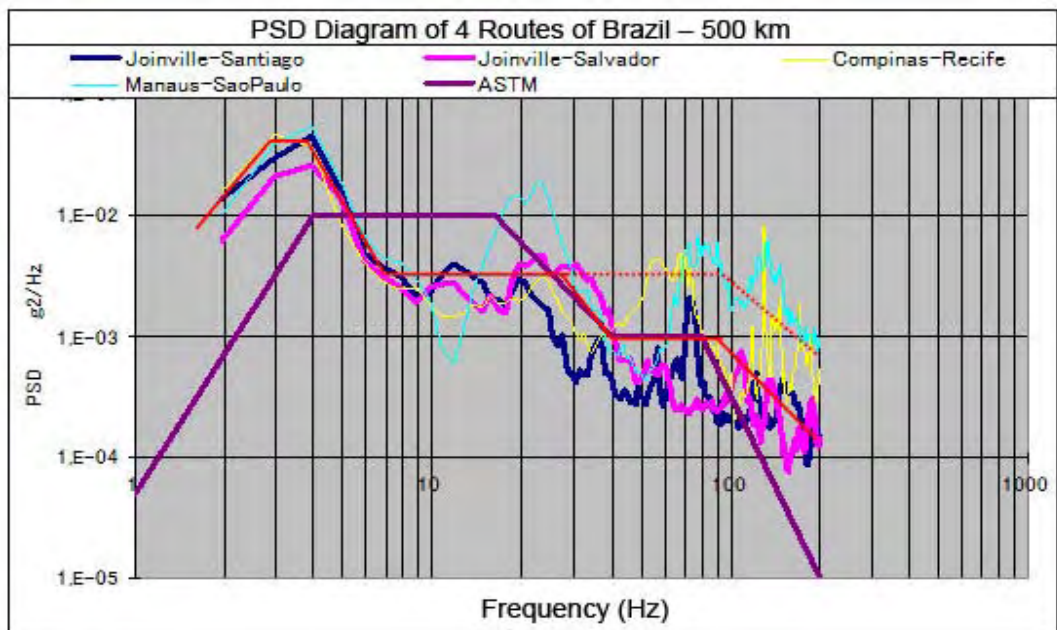
Up to now, we have explained one of the ways to create the Reference Guidelines for Random Vibration Tests of vehicle on the road.

Other points should be analyzed, such as treatment of the data collected etc., but the above is only limited to the reproduction of vibrations in the testing equipment.

As regards the administration of the information collected, the procedures for the planning and verification of tests should be implemented. For example, an effective data control system should be developed, as well as a tool for the determination of effective reference values, based on the size of the different products, the capacities of the testing equipment, the size and type of the vehicles used to transport the goods.

5) Calculation procedures – Examples

The PSD curves calculated based on the data obtained in the 4 Brazilian routes, are the following:



Source: JICA Study Team

Fig. 6.1-3 Case A: Comparison of PSD curves in Brazilian representative 4 routes (reference: 500km distance, testing time 1 hr)

Details of Case-A:

- (1) The PSD corresponding to a 500km stretch, representative of each of the routes, is calculated, and in turn, it is converted into the test curve for a 1 hr period.
- (2) The ASTM curve shows the truck curve, according to the data of the field study.

In the case of CETEA, this PSD curve is the one frequently used in tests using household fridges, and applied in 6-hour vibration tests.

- (3) The red continuous and pointed line is the evolvent line. Both lines show the differences among the 4 routes.

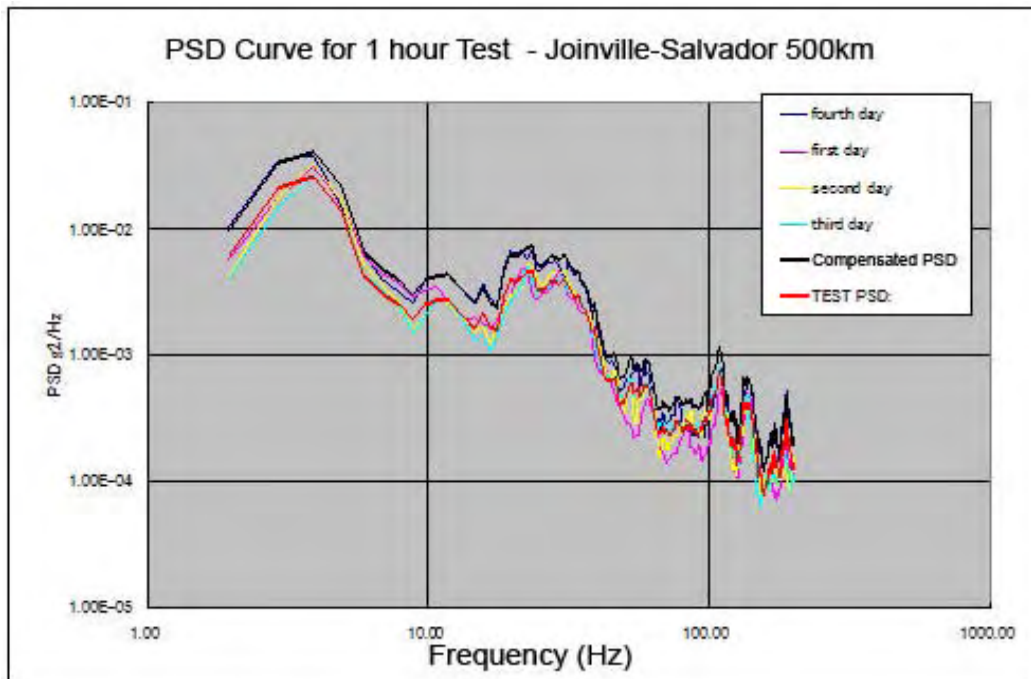
In order to calculate the duration of the test, the 500km may be taken as a reference, and then the proportional value of the route to be analyzed can be calculated.

For example, if for a 3000 km track, the test lasts 6 hours, it can be compared with a 6-hour long ASTM test.

Observations:

- The area below 5Hz, if the ASTM curve is considered, does not cover the required level. In the area between 5 and 20Hz, the situation is reverted.
- In two of the Brazilian routes, high PSD values are observed in the area between 40Hz and higher.

Based on the above description, it may be inferred that with the conventional curve used so far, the test below 5Hz and above 40Hz could not be neither covered not tested.



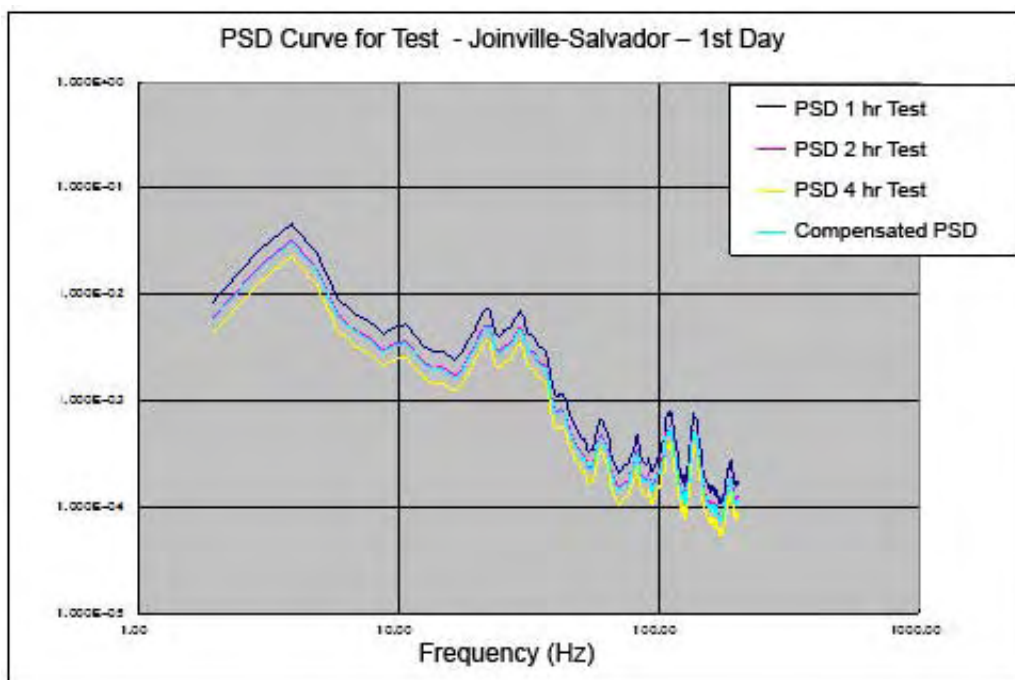
Source: JICA Study Team

Fig. 6.1-4 Case-B: Comparison of PSD curves in Brazilian representative routes (converted to ref.: distance 500km)

Details of Case -B:

- (1) This is a 2800km route and it was covered in 4 days. The 4 curves corresponded to each day, and they were drawn up by converting the data from an equivalent 500km-route.
- (2) The thick black line indicates the total PSD representing the 4 days.
- (3) In turn, the red line shows the PSD curve for the whole 4 days and converts the 500km into a 1 hour test.

	Distance (km)	Time (hr)
Day 1	899	13.3
Day 2	863	15.2
Day 3	812	14.0
Day 4	229	5.1

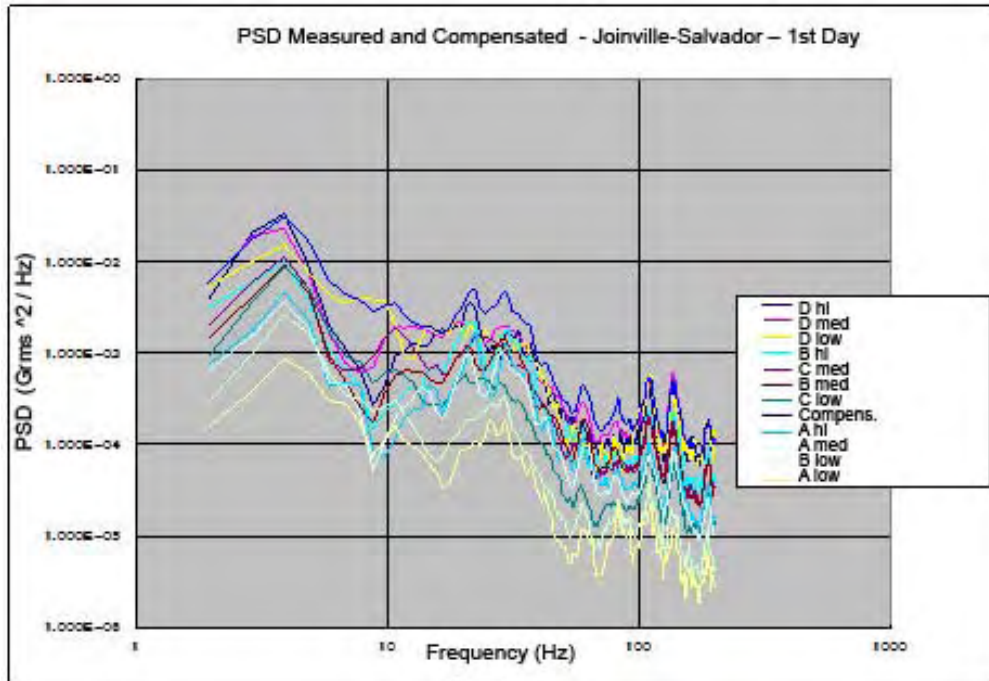


Source: JICA Study Team

Fig. 6.1-5 Case-C: Comparison of PSD curves in Brazilian representative routes (PSD Test Curve)

Details of Case -C:

- (1) The PSD applicable to the first day is shown.
- (2) The PSD Test Curves for 1, 2 and 4 hour tests are shown.



Source: JICA Study Team

Fig. 6.1-6 Case-D: Comparison of PSD curves in Brazilian representative routes (PSD curves pursuant to speed range)

Details of Case-D:

- (1) As a result of dividing the (Grms) graph in areas, the PSD curves representing each area are shown here.
- (2) Each curve of each of the areas is processed for its compensation and the PSD Test Curve representing all the areas is obtained.

6.1.1 Dropping Tests

Most cargo impact stress during the transport process occur during handling whether by impact or dropping, therefore impacts due to transportation are minimum. That is to say that the human factor is the main cause of impact.

Therefore, load impact ratio will vary to a great extent according to weight, concluding that loads between 5 to 15kgs tend to suffer the hardest impacts.

On the other hand, impacts and droppings may also vary pursuant to other factors, such as the length/width of the cargo, the center of gravity, etc.

If compared to the external weight effort in respect of the product, damages due to impact are considerably higher, and more frequent. This is why drop tests are so important, within the series of tests carried out on packed cargos.

The drop test regulations applied in Japan are two:

- JIS Z0200: General Rules for Evaluation Tests on packed cargo

- JIS Z0202: Methodology for drop Tests on packed cargos

JIS Z0200 standard defines the parameters for tests such as dropping heights, sequences and number of tests. Standard JIS Z0202 defines the conditions of the equipment to be used in the tests.

For example, in method B of JIS Z0202 standard, in case a packed cargo is subject to impact tests, the equipment required as is specified in JIS Z0119 standard "Methodology for Impact Tests, for the design of Packaging".

To perform the drop tests, there are available 3 methods:

- Free fall: Products are dropped in the air.
- Fall on corners: The cargo is placed on a platform leaned on one of the corners and dropped to fall on the other corners.
- Impact Method: Using the impact test equipment.

(In this Study, the tests are carried out based on the conditions described in Chapter 7 of this report, using the equipment from the labs of the counterpart institutions and taking samples of the 2 types of "target" products previously selected.)

Regarding to the determination of the Reference Values, they are described in the Chapter 3, clause 3.2.6.5, so that it can be used as reference. However, regarding to the actual data gathering, is necessary a well coordination between all the participants and specially the criteria and the thinking of the managing personnel of the group working for the survey, about how to use the data.

Regarding to the survey of cargo handling, the following aspects must be considered: if the survey will be done openly or confidentially, if both, how to solve the differences aroused in gathered data between one or other method, if data can be used for the determination of the reference value, can the data be useful for the development of the operation environment, the selection of mechanical devices of the works and their maintenance, etc. Depending on the deep comprehension of all these factors, the information emerging from surveyed data could change drastically.

6.1.2 Vibration Tests

Vibration tests are used to assess if the packaging or product is duly protected against damages that may be suffered by oscillations during transport, that may be caused by the means of transport itself (truck, van, vessels, aircrafts, etc.). To that end, vibrations are applied to the cargo under certain conditions and the behavior of such cargo (or product) is then analyzed. As regards the damages due to vibration, they may vary due to the following: the fatigue of materials due to component resonance phenomena, damages due to internal impact between components, lack of adjustment of linking elements such as screws, damages or scratches due to

friction with the packaging or the product, flattening of the boxes due to the effort made by dynamic phenomena due to vibration. These are the reasons why the damages and the causes of such damages do not always coincide if compared to those observed in the drop tests.

The aim of vibration tests is to basically reproduce the real transportation environment, with the purpose of establishing testing conditions equal the real ones.

New trends in packaging design help to adjust the packaging to protect the cargo against impacts at the minimum required limit, reducing the margin of protection of the cargo against vibration. For this reason, it's becoming more necessary to further study the levels of protection against vibration, based on the applicable tests to verify packaging under these conditions.

Within the dynamic efforts the cargos are subject to during transportation, handling impacts are low, in the order of 1 digit percentage on the total cargo. This is why, in case the load is barely protected against vibration, the possibility of damage during transportation is high, being necessary to perform thorough vibration tests.

Standards for vibration tests in Japan are 2:

- JIS Z0200: General Rules for Evaluation Tests on packed cargos.
- JIS Z0232: Methodology for vibration tests on packed cargos.

The first standard specifies the vibration levels the cargo is subject to, and the duration of the test. The second standard sets forth the specifications of the equipment used in the test.

(In this Study, the testing conditions were set based on the results of the analysis of data collected in the transportation environment surveys, using the previously selected "target" products, performed in the labs of the counterpart institutions)

Until now, the reference values for transportation vibration tests were normally determined following this procedure:

- 1) Routes were classified in several categories.
- 2) Some route stretches of each category were selected. The surveys of these stretches were prepared.
- 4) The typical PSD for each type of route was defined.
- 5) As regards a new route to be studied, a weighted average calculation of each type of route was made to evaluate the whole route (% for each type).
- 6) Taking into account these percentages and the level of possible damages due to accumulated fatigue in materials during transport, the PSD per type of route were combined and the standard curve was determined (But, the PSD curve patterns should be similar. If there are significant differences, new testing conditions should be defined, as many as different patterns).

In the past, the procedure applied to define the standard PSD consisted in discussing the criteria on how the routes would be divided, classifying them by photographs and exchanging information among the study teams and counterpart institutions.

However, the transportation conditions in each country are different, and it has been difficult to establish a basic common criterion for the classification of routes.

On the other hand, memories have more capacity so data can be collected over a uniform percentage (20%) of the total.

I.e., the information on type of route, structure, etc, that until now was only hypothetical, can now – thanks to all the information collected – be directly evaluated, being highly reliable.

Besides, for the reference PSD per type of route all the information gathered from similar stretches classified into the same category can be used not considering the first one as a “model”. Therefore, the data is now more accurate.

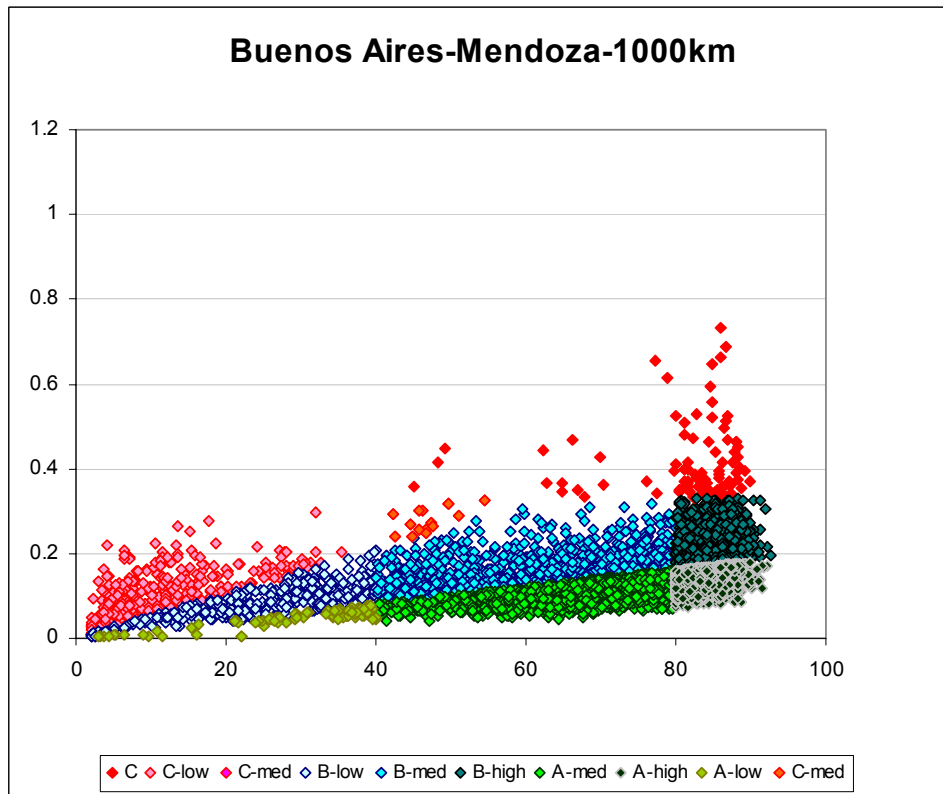
The application of GPS data has permitted the monitoring of routes and the analysis of data with an unprecedented accuracy. Nevertheless, new procedures had to be designed to process all this data. One of these procedures is the one used to classify the data collected according to the type of route. Another important aspect is the availability of the data analysis function within the programs provided by sensor manufacturers.

6.2 Reference Guideline for Packaging Tests, for Evaluation

6.2.1 Validations up to the date of the Interim Report

Based on the mutual agreement about the methodology for the determination of the "Reference Guideline for Packaging Tests, for Evaluation", reached during the Joint Meeting of 4 member countries, in the occasion of issuing the Progress Report of this Study, (as stated in the Work Plan for the 3rd year of the Study), a series of discussion meetings have been developed. As result of the activities of the Study, through Work Shops, they were obtained energy scatter diagrams i.e. "Grms vs Speed" and "PSD" diagrams for each transportation survey made on routes of each country. The information are ordered sequentially as: Argentina, Brazil, Paraguay and Uruguay.

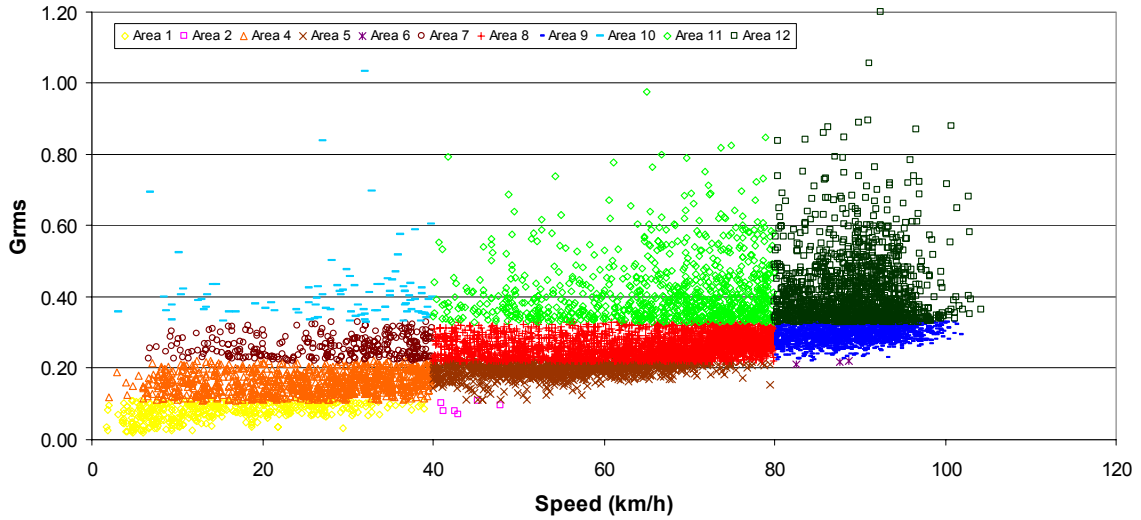
(1) Diagram of Grms vs truck speed – Argentina



Source: JICA Study Team

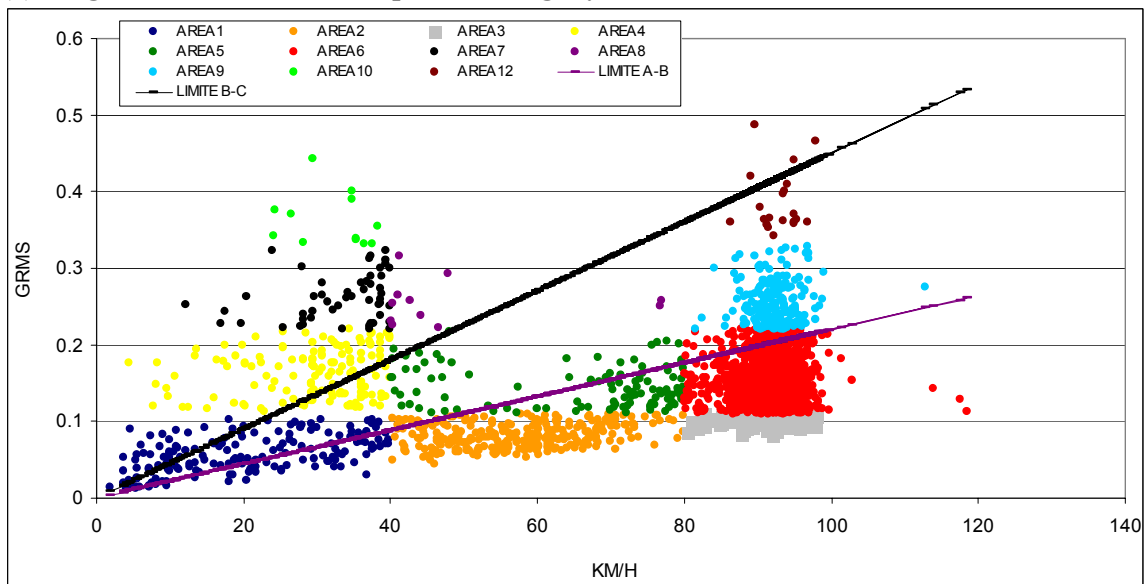
(2) Diagram of Grms vs truck speed – Brazil (Campinas-Recife)

Campinas - Recife 24/10/2005



Source: JICA Study Team

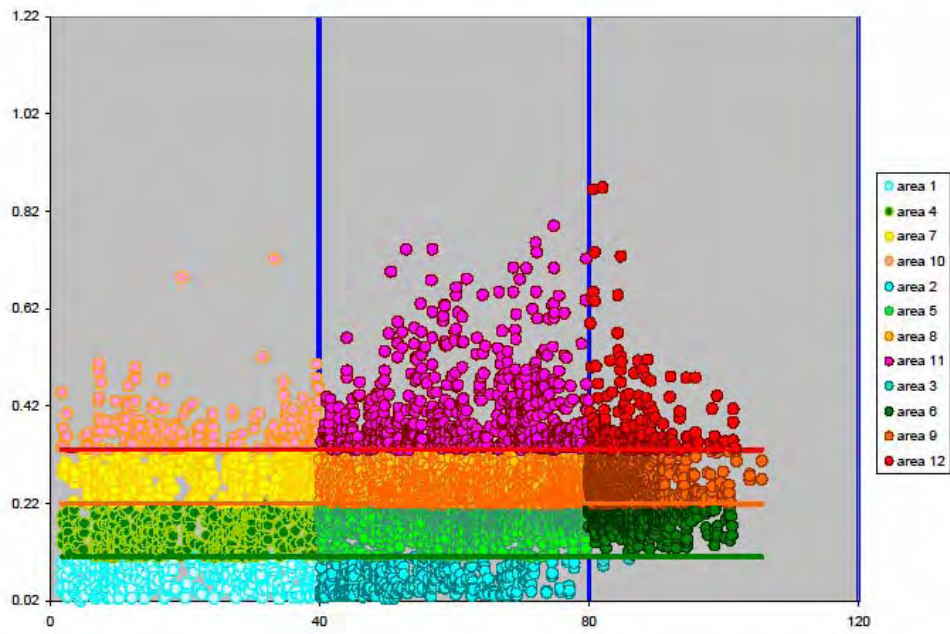
(3) Diagram of Grms vs truck speed – Paraguay



Source: JICA Study Team

(4) Diagram of Grms vs truck speed – Uruguay (Montevideo Rocha)

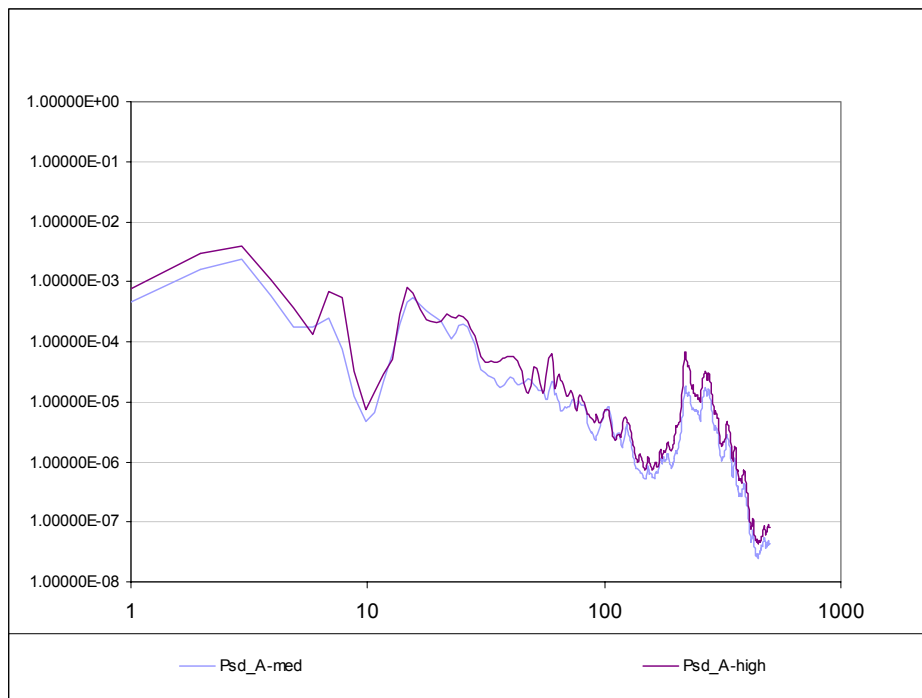
Mvd - Rocha C 06-06-12 Saver 75



Source: JICA Study Team

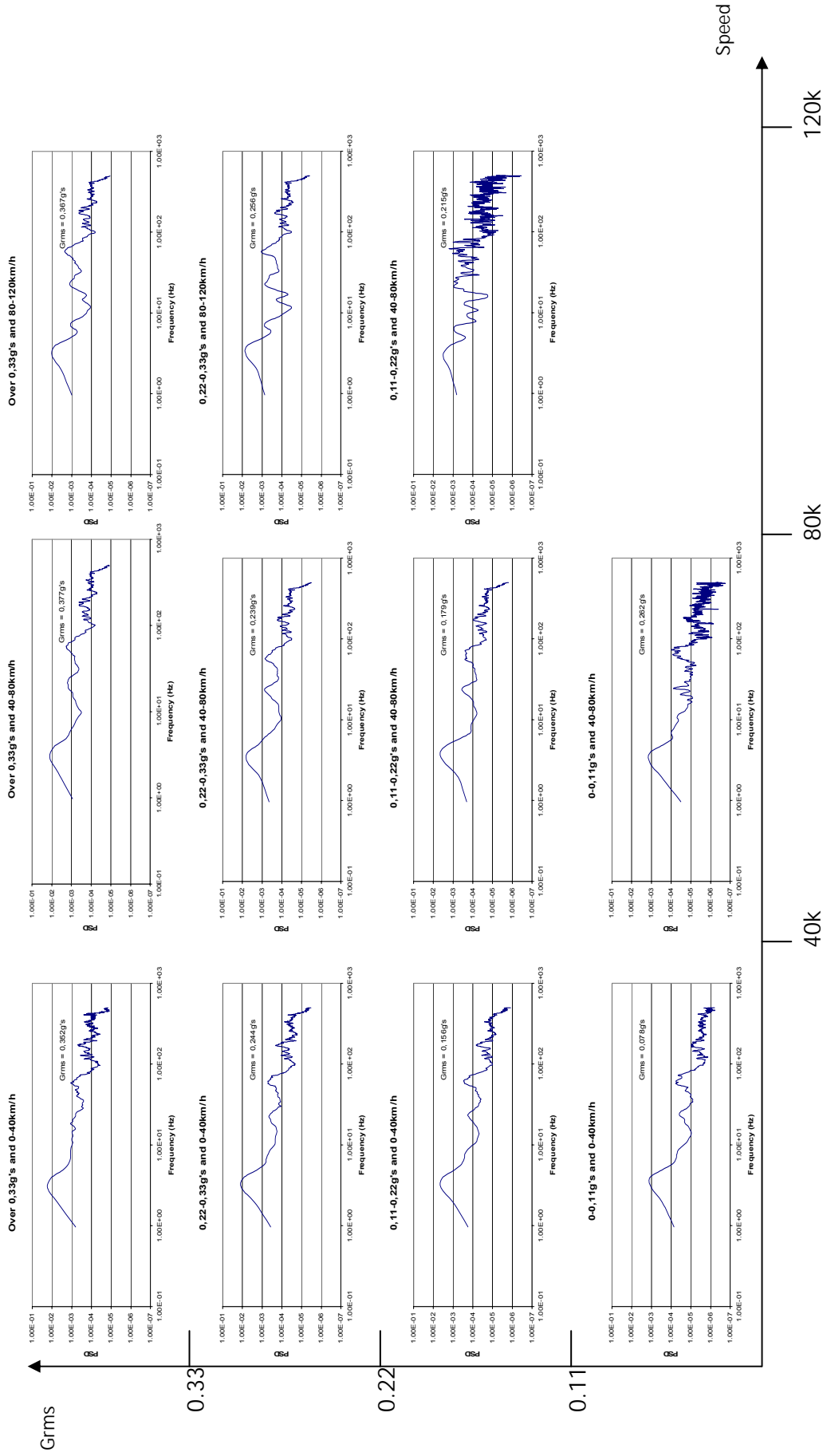
Based on the above Grms distribution diagrams, the associated PSD diagrams have been prepared, for each country.

(1) Argentina: Buenos Aires – Mendoza



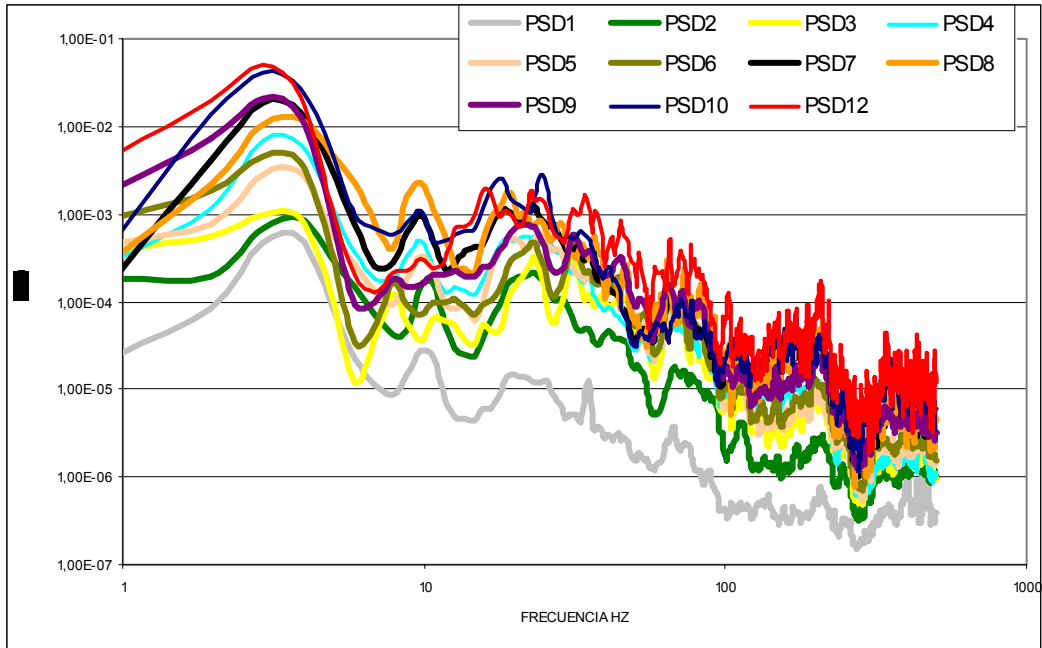
Source: JICA Study Team

(2) Brazil : Campinas – Recife



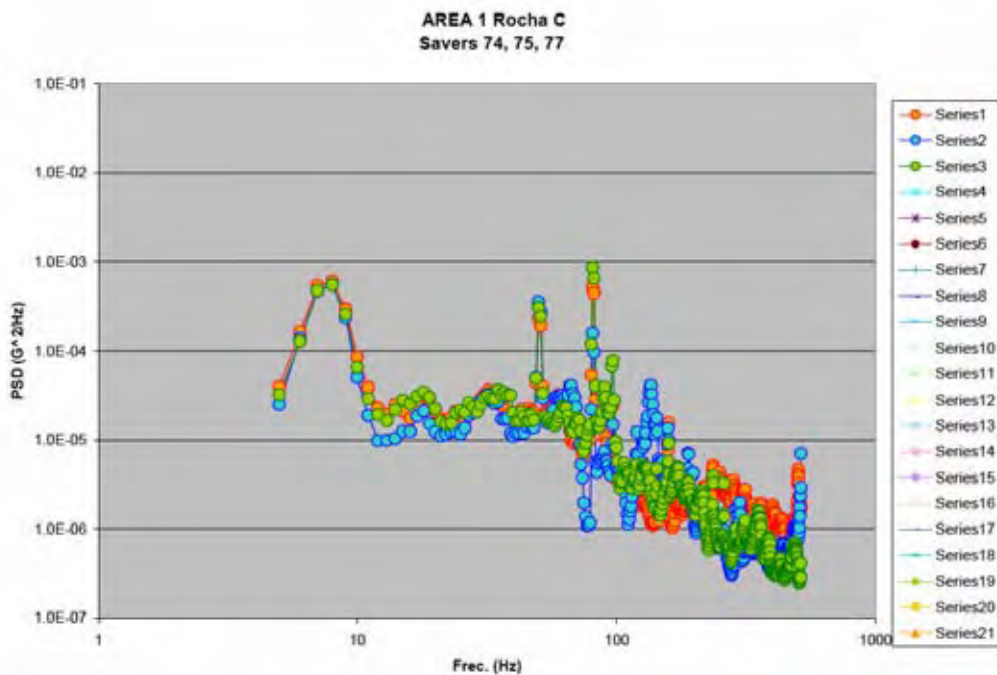
Source: JICA Study Team

(3) Paraguay: Diagram of PSD for the twelve areas



Source: JICA Study Team

(4) Uruguay: PSD Diagram route: Rocha C – Area 1



Source: JICA Study Team

Also, others studies have been developed for the preparation of the "Reference Guideline for Packaging Tests, for Evaluation" at MERCOSUR level, by using the route classification by Grades, according to route status.

6.2.2 Validation of the "Reference Guideline for Packaging Tests, for Evaluation" at country level, and at regional level by data combination

During the verifications of the PSD diagram in the Study, as stated in the Chapter 6, clause 6.1 of this report, following characteristics have been confirmed, based on the route classification by route types, and from the gathered data from the surveys.

- (1) Truck structures (multiple type of structures used, different types of engines, suspension, number and position of axles etc.)
- (2) Characteristics of vehicle driving methods
- (3) Variety of route conditions, specially for long distance routes
- (4) Variety of the cargo arrangement in the vehicle
- (5) Characteristics on the distribution system (within urban areas)

Based on this analysis, the following tests have been incorporated and based on their results it was decided to establish the guidelines for the preparation of the "Reference Guideline for Packaging Tests, for Evaluation"

- (1) Vibration Tests (conventional)
- (2) Bouncing Tests
A partial portion of this test can be replaced by the following.
- (3) Repetitive Impact test (The excess portion of above is tested by impact test equipment or, dropping tests by applying repetitive method)

Based on the studies developed within the frame of this Study, up to the date of the Progress Report and the Intermediate Report, they represent the results of exhaustive analysis of gathered data during the Transportation Environment surveys of the routes of each country. The next validation have been made considering the best route for drawing up the Common Reference Guideline for MERCOSUR. This Reference Guideline has been developed under limited conditions of time, number of selected routes taken as reference, and type of products transported.

6.2.2.1 Discussion items for drawing up the "Reference Guideline for Packaging Tests, for Evaluation"

Regarding the drawing up of the "Reference Guideline for Packaging Tests, for Evaluation", several items have been subject to discussions, as follows:

- (1) General criteria for the basic concepts for a MERCOSUR standard.
- (2) Route selection as reference in order to validate the MERCOSUR Standard.

- (3) The combination of data gathered in the 4 member countries, and their analysis.¹ Their advantages and calculations development.
- (4) Definition of PSD curves for packaging tests, and the conditions for the tests according to the selected cases.

6.2.2.2 Detail discussions and conclusions

(1) General criteria and basic concepts for a MERCOSUR standard

- 1) The MERCOSUR standard will consider as reference the most recent data gathered from the developed Transportation Environment Surveys. However, each MERCOSUR standard can be continued in their own development through future revisions of the document, based on new route surveys in each country.
- 2) This MERCOSUR standard will have as area of application, the member countries of the MERCOSUR. The data to be taken as reference have been divided into two groups – above and below 0.33 Grms- taking into account the results of data analysis of data having very high acceleration values, such as the case of some data gathered in Brazil.
 - a. The data equal or below 0.33 Grms are evaluated by Vibration Tests.
 - b. The data above 0.33 Grms are evaluated by the Bouncing Tests.
(A portion of this test can be replaced by repetitive impact tests)
- 3) For vibration tests, this standard will consider two types of products for the tests, depending on the characteristics of the product.

Pattern-A: Products subject to damages due to fatigue of the materials (mainly industrial products).

Pattern-B: Products subject to damages due to friction (mainly food products)
- 4) The frequency ranges for each pattern are defined as follows:

Pattern-A: 5 to 100Hz

Pattern-B: 3 to 50Hz
- 5) The overall “PSD Curve for Tests”² of packaging is defined as the resultant of applying all the “PSD Summary curves”³ of all the 4 member countries.
- 6) The PSD Curve for Tests for Pattern-A must be drawn so that the lines are closer as possible to the peaks of PSD Summary curve. The reason of this is because, the products subject to damages due to fatigue are under tests, they can be subject to vibrational stress larger than the actual transportation conditions, due to the application of that simplified PSD curve. Consequently, if the test conditions are different from the physical

¹ NdT: From data combination, it is obtained the so called “PSD Summary” curves.

² NT: PSD Curve for Tests: A broken line in PSD diagram, applicable for laboratory test.

³ NT: PSD Summary curve: The PSD Curve resulting from combining a group of PSD curves.

requirements of the actual transportation, the results to be obtained in the test also would be very different from those under actual transportation.

On the contrary, the tests for Pattern-B are centered in reproducing the abnormal conditions. Since the friction is associated to vibrations, the important point is that the Curve for Tests must be drawn close to the Summary Curve in the zone of low frequencies. But for the high frequencies, there are no major difficulties to apply a simplified curve, instead.

- 7) The final PSD Curve for Test will have a margin of $\pm 3\text{dB}$, so that the expected PSD Curve of actual test must be plotted within this band. It is planned to carry out the verification if the lab test equipment (vibration Test machine) can generate the test conditions according to this PSD curve for Test, by INTI (Argentina).

(2) Reference route selection from surveys, for MERCOSUR common standard

The selection of the reference route for MERCOSUR standard is based on the following criteria.

- 1) All the surveyed routes up today have been verified (Transportation Environment Surveys) and a combination of pair of routes from different countries have been set. The verifications have been done for a total of 52 combinations (pairs).
- 2) Once analyzed the characteristics of all pairs of routes, they were selected the most representative of each category, this means, "good", "medium", "bad" routes. The selected pairs of routes are as follows:

Good: BsAs – Rosario (AR) + Montevideo – Rivera (UY)

Medium: BsAs – Mendoza (AR) + Loma Plata – Asuncion (PY)

Bad: Aimogasta – Iguazu (AR) + Belem – Sao Paulo (BR)

Note: The route combinations (pairs) indicated above, does not necessarily represent the actual route for transportation. These combinations are representative ones for each route category.

(3) Data combination and analysis of gathered data at 4 member countries

- 1) The data of a pair of route is analyzed. Then, all data above 0.33 Grms are eliminated.
- 2) The value of Grms is determined and also the test duration based on the data analysis of remaining data.
- 3) The Grms values of each route constituent of the pair have a variety. For calculating the test duration, it is necessary condition that all Grms must be uniform, so that Grms levels of each route must be properly adjusted. That is the reason to make compensation, taking as reference value the Grms maximum.

A Time Factor M is applied, which has defined values depending of type of products: M=4 for industrial products, and M=2 for food products.

- 4) Furthermore, the duration related to these data are adjusted by means of another Grms compensation, so that the time of test is compressed. The test duration can be selected from the following values: 1hr, 1.5 hrs, 2 hrs. For this purpose, it was determined that the test must be conditioned so that the accelerations must not be beyond 0.9 G.
- 5) All the Grms data beyond 0.33 Grms can be analyzed by calculating the number of events for the entire route, based on "time trigger" setting and number of signals gathered. From here, it was determined that precisely this number will be the number of impact to be applied to the sample. This means, the number of jumps on the Bouncing Test. The conditions for the Bouncing Test are 10Hz frequency, 1.1 G acceleration.
- 6) By calculating the time of test, if this is below 5 minutes, the related time will be a continuous test of 5 minutes.
- 7) In the case that the test time is above 5 minutes, the excess value can be tested by repetitive shock test by using the impact test apparatus, or the drop test equipment. These repetitive shock tests will be carried out under the following method: in case of applying the impact test apparatus, the speed on the sample is 1.4 m/sec; or in case of free drop test, the drop height will be 10cm. Also, the number of impacts for the repetitive shock test will be 1 impact for each calculated period of 10 minutes.

(4) Definition of PSD Curve for Tests (Standard Curve)

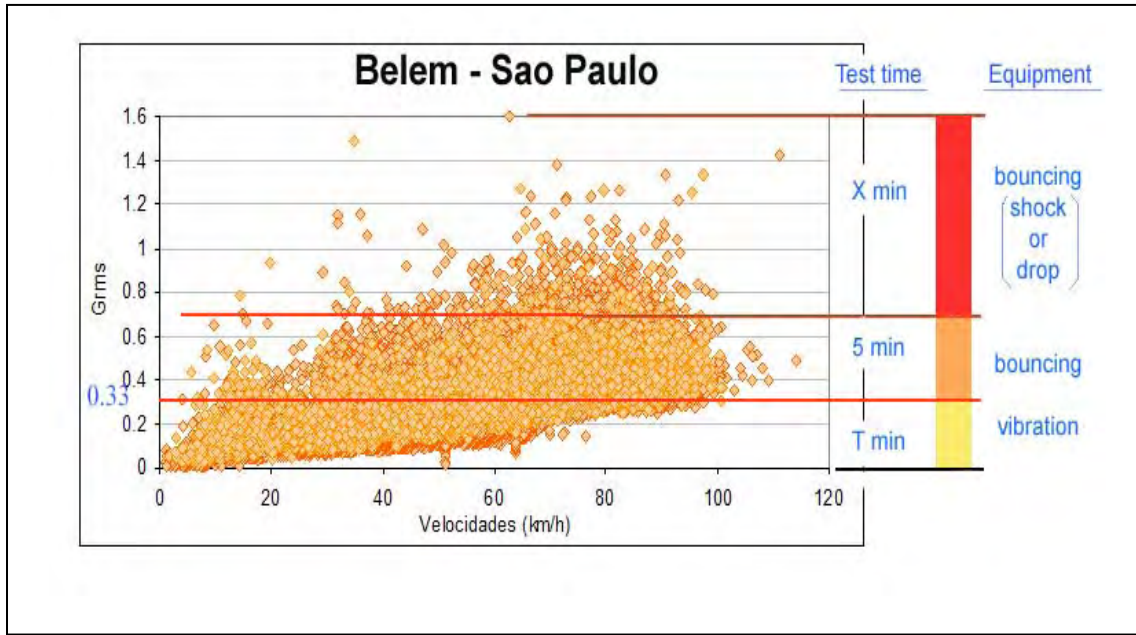
- 1) Next, it is determined the PSD Curves for Tests.
- 2) In the case of industrial products, they are suffering the accelerations. In the case of food products, the containers are subject to the effects depending on the frequency band. Consequently, it is necessary to determine the PSD Curve for Tests, taking into account the type of products to be tested.
- 3) Therefore, for the PSD curve for tests, the following two curves are defined:
 Pattern-A: 5 to 100Hz (mainly for industrial products)
 Pattern-B: 3 to 50Hz (mainly for food products)
- 4) The Final PSD Curve for Test is determined by compensated Grms curves for the time compression, considering the container-packaging of each type of product and the frequency ranges.

6.2.3 Results of validation of the Reference Guideline for Packaging Tests, for Evaluation

The general summary of the "Reference Guideline for Packaging Tests, for Evaluation" are described in the Clause 6.3.3 of this report. The guideline and logic process applied in the Clause 6.2.2 are indicated by the following figures. Furthermore, the validation was conducted

by reanalysis of classified 52 combination data from the Transportation Environment Surveys. The sample calculation and route data figures are shown as follows, and described the leading procedure to the "Reference Guideline for Packaging Tests, for Evaluation" of the MERCOSUR.

Example: Testing Method for a bad conditions route



Source: JICA Study Team

Fig. 6.2.3-1 Grms diagram of a transportation survey, divided into 3 sections

Table 6.2.3-2 Comparison calculation data of surveyed routes (example)

COMPARACION DE RUTAS DE ESTUDIO

Comparison of Target Routes	Routes	Div datos	Cant datos	Vel prom	Horas rec	Hs datos	Distan	Travel Distance km	Data Time hr	Dist Datos	Grms prom	Val calculado ejecucion			TEST PSD		
												g/s	cm/sec	mm	1hr	2hr	4hr
	Route Section	Number of Data	Mean Speed km/hr	Travel Time hr	Data Time hr	Travel Distance km	Distance km	Ave. Grms g/s	g/s	cm/sec	mm	1hr	2hr	4hr			
Buenos Aires-Mendoza	C	99	81.5740	0.1657	0.0282	13.5135	2.2971	0.4104	0.3662	25.7994	25.0995						
	C-low	395	10.6130	0.6610	0.1124	7.0148	1.1924	0.1011	0.1073	6.8514	6.1270						
	B-hi	2200	84.5730	3.6813	0.6258	311.3414	52.9239	0.2104	0.2018	11.5175	10.4642						
	B-med	1082	64.6930	1.8105	0.3078	117.4297	19.9105	0.1682	0.1643	8.4442	7.5010						
	B-low	405	25.7860	0.6777	0.1152	17.4752	2.9705	0.0849	0.0896	4.9617	4.3872	0.3321	0.2793	0.2348			
	A-hi	2360	84.1000	3.9491	0.6713	332.1165	56.4554	0.1389	0.1343	6.2621	5.6631						
Montevideo-Rivera	A-med	1740	68.8790	2.9116	0.4949	200.5481	34.0905	0.1060	0.1043	4.6802	4.2391						
	Σ	8281		13.8569	2.3555	999.1393	169.8404										
	D-hi	818	87.8784	1.3688	0.2327	120.2868	20.4472	0.4658	0.3773	9.1502	6.2772						
	D-med	608	68.1093	1.0174	0.1729	69.2935	11.7790	0.4669	0.3524	9.0790	6.3127						
	B-hi	442	85.4946	0.7396	0.1257	63.2329	10.7488	0.2883	0.2636	5.9716	4.4555						
	C-med	382	58.8977	0.6392	0.1087	37.6482	6.3997	0.2769	0.2417	5.8344	4.0097	0.4747	0.3992	0.3357			
Loma Plata-Asuncion	B-med	406	68.9554	0.6794	0.1155	46.8465	7.9633	0.2286	0.2118	4.9229	3.8451						
	C-low	333	22.2607	0.5572	0.0947	12.4041	2.1085	0.1689	0.1420	3.8267	2.3695						
	Σ	2989		5.0016	0.8602	349.7120	59.4464										
	D-med	107	56.3021	0.1790	0.0304	10.0807	1.7136	0.5104	0.4455	7.1174	5.3043						
	D-low	166	32.5317	0.2778	0.0472	9.0364	1.5361	0.5027	0.4201	10.9460	7.2343						
	D-hi	1341	90.2330	2.2439	0.3814	202.4774	34.4185	0.4363	0.3307	11.1111	9.1214						
Loma Plata-Asuncion	B-hi	2745	90.1004	4.5933	0.7808	413.8581	70.3604	0.2564	0.2190	7.6752	6.3538						
	B-med	435	64.9690	0.7279	0.1237	47.2909	8.0388	0.1811	0.1561	4.6398	3.6892	0.4838	0.4068	0.3421			
	A-hi	833	90.0940	1.3939	0.2369	125.5809	21.3471	0.1740	0.1625	5.3605	4.7120						
	C-low	246	21.5107	0.4116	0.0700	8.8547	1.5052	0.1687	0.1526	5.6081	3.8581						
	A-med	244	61.6445	0.4083	0.0694	25.1690	4.2784	0.1143	0.1075	2.8574	2.3499						
	Σ	6117		10.2358	1.7399	842.3482	143.1880										

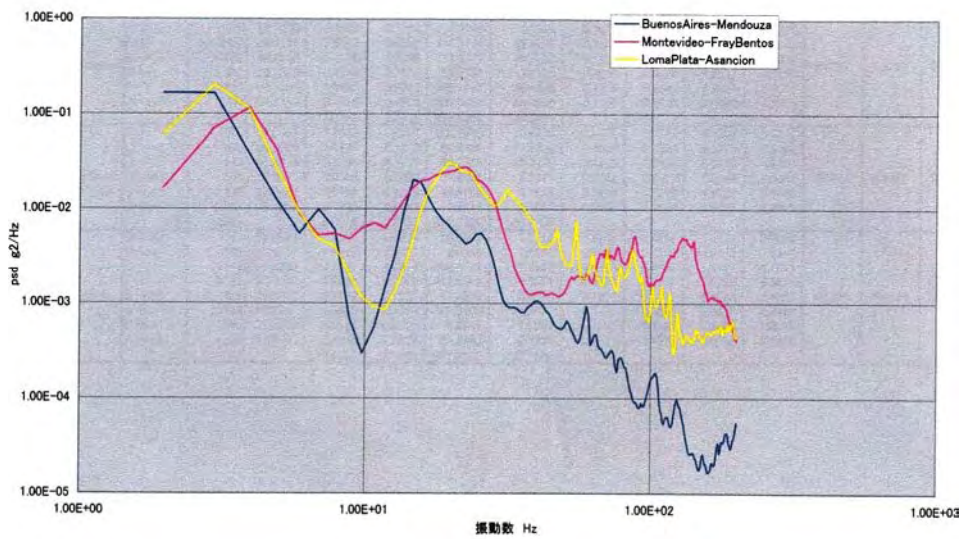
Source: JICA Study Team



Bs.As -Mendoza Grms:0.211		Aimogasta-Iguazu Grms=0.262		Rosario-Bs.As- Grms 0.19	
Km	1100	Km	1600	Km	265
M=2	M=4	M=2	M=4	M=2	M=4
7.6h	5.4h	14.7h	12.4h	2.3h	1.7h
Grms>0.33	D	D	D	D	D
	99	1389		26	

Source: JICA Study Team

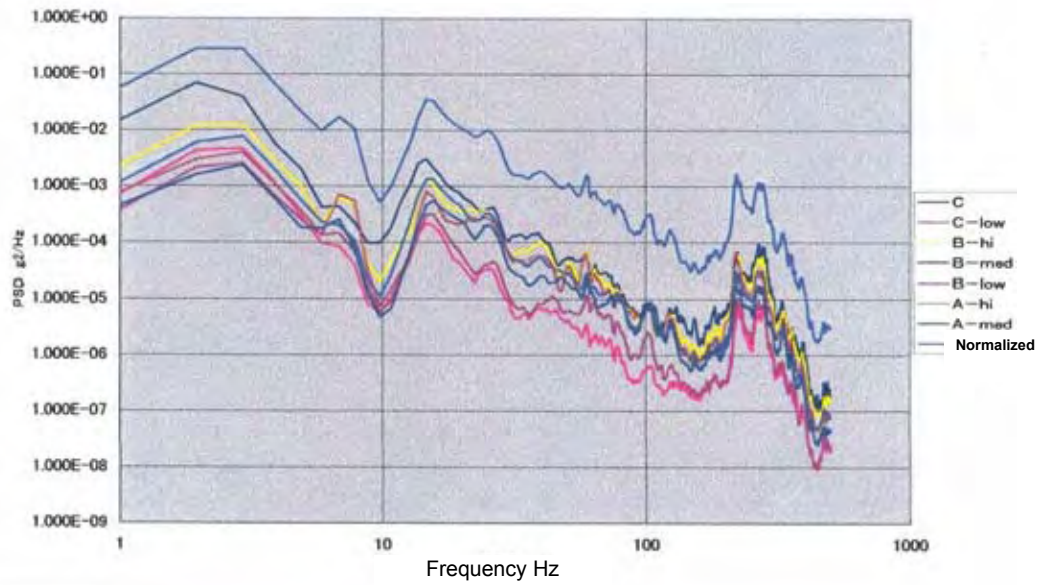
Fig. 6.2.3-2 PSD curves for Argentina's routes



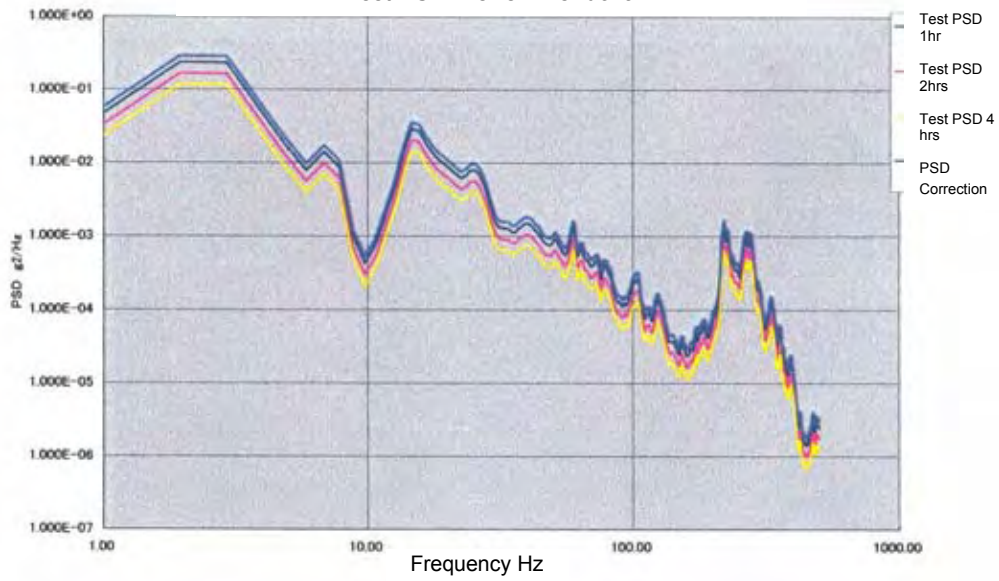
Source: JICA Study Team

Fig. 6.2.3-3 PSD curves-comparison of routes : 2 hrs test time

Actual PSD and Normalized: BsAs - Mendoza



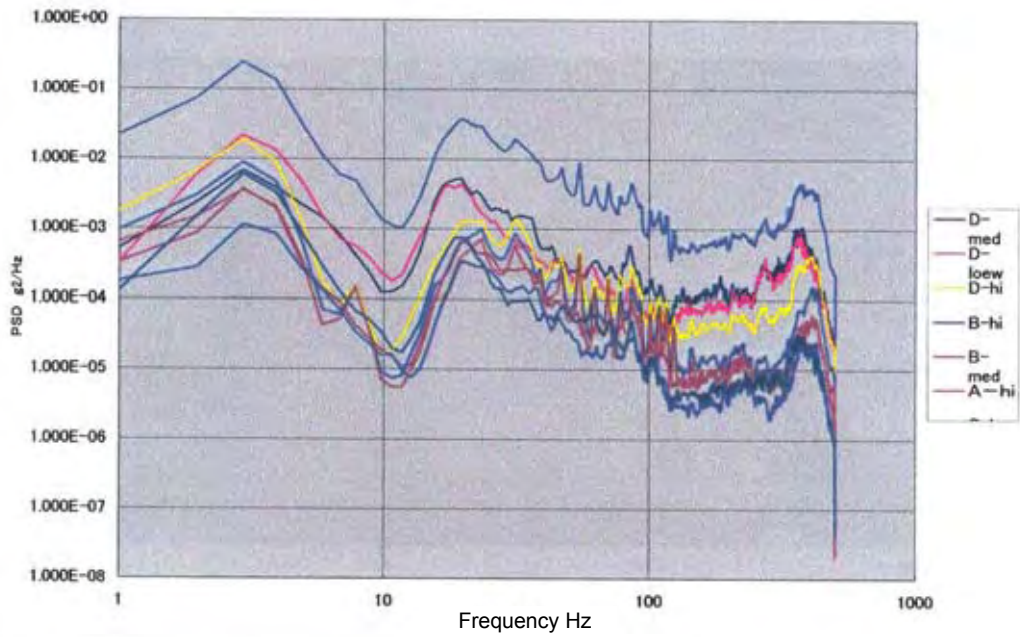
Test PSD: BsAs - Mendoza



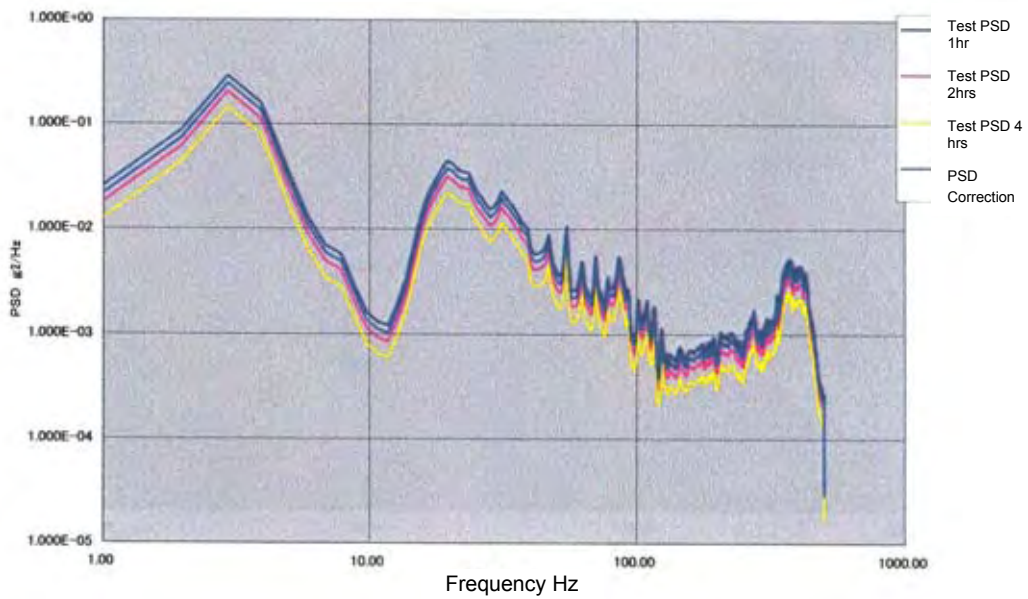
Source: JICA Study Team

Fig. 6.2.3-4 Measured PSD and Compensated PSD curves (BsAs—Mendoza route, AR)

Actual PSD and Normalized PSD: Paraguay

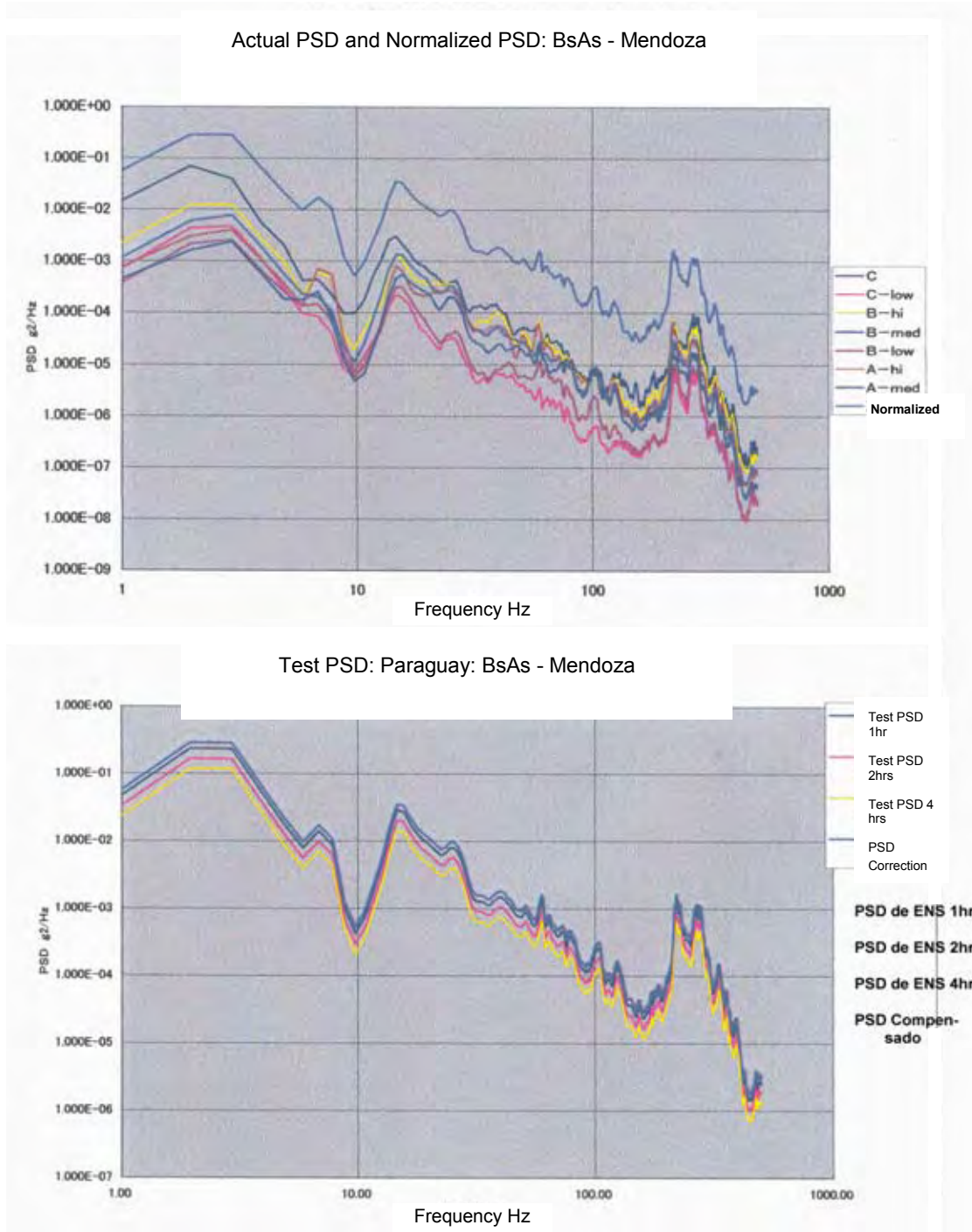


Test PSD: Paraguay



Source: JICA Study Team

Fig. 6.2.3-5 Measured PSD and Compensated PSD curves (PY)



Source: JICA Study Team

Fig. 6.2.3-6 Measured PSD and Compensated PSD curves (Montevideo—Rivera, UY)

Table 6.2.3-3 "Reference Guideline for Packaging Tests, for Evaluation" (preliminary)

MERCOSUR - TEST CONDITIONS TABLE

Test	Section	Distance (km)	Vibration				Bounce time	10cm Drop number	
			Patern Grms(G)		Test time(h)	Test Grms (G)			
			M:2	M:4		M:2			M:4
Level 1 Bad	Aimogasta - Iguazu & Belem - Sao Paulo	4651	0.261	0.278	1	1.23	0.53	5 min	24
					1.5	1.00	0.48		
					2	0.87	0.45		
					3	0.71	0.41		
Level 2 Medium	BsAs - Mendoza & Loma Plata - Asuncion	1522	0.243	0.231	1	0.70	0.36	5 min	1
					1.5	0.57	0.33		
					2	0.49	0.30		
Level 3 Good	Rosario - BsAs & Motevideo - Rivera	501	0.236	0.24	1	0.41	0.29	5 min	1
					1.5	0.33	0.26		
					2	0.29	0.25		

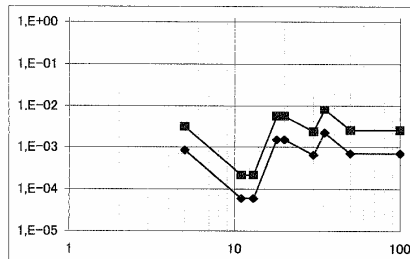
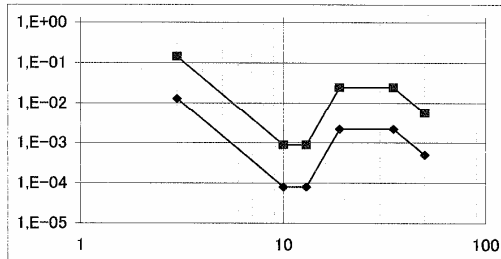
*1) Order of Test 1: Vibration, 2: Bounce, 3: 10cm Drop
 *2) Bounce test : 10Hz, 1.1G
 *3) Shock test : 10cm drop or shock machine test (1.4m/sec)
 Source: JICA Study Team

Table 6.2.3-4 Test Conditions for Packaging, for MERCOSUR (Level 1)

MERCOSUR - TEST CONDITIONS TABLE

Oct 22 2006

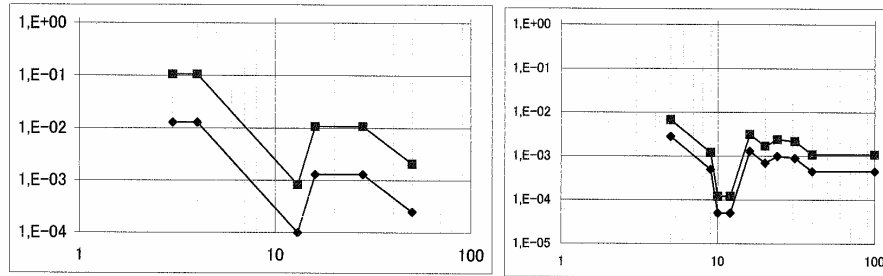
Level 1	Bad	11,14	3,63
M:2	Grms:0.261	Grms:0.87	Grms:0.271 Grms:0.53
Freq (Hz)	G ² /Hz	G ² /Hz	G ² /Hz G ² /Hz
3	0.013	0.14482	0.00085 0.00309
10	0.00008	0.0008912	11 0.00006 0.00022
13	0.00008	0.0008912	13 0.00006 0.00022
19	0.0022	0.024508	18 0.0015 0.00545
35	0.0022	0.024508	20 0.0015 0.00545
50	0.0005	0.00557	30 0.00065 0.00236
			35 0.0022 0.00799
			50 0.0007 0.00254
			100 0.0007 0.00254



Source: JICA Study Team

Table 6.2.3-5 Test Conditions for Packaging, for MERCOSUR (Level 2)

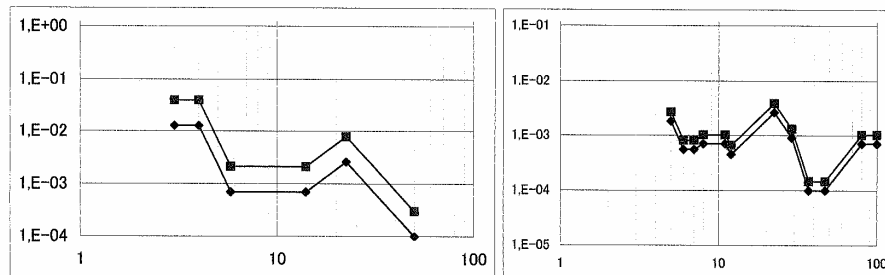
MERCOSUR - TEST CONDITIONS TABLE				Oct 22 2006			
Level 2	Medium	8,315		M:4	2,42		
M:2	Grms:0.243	Grms:0.7		M:4	Grms:0.23	Grms:0.36	
Freq (Hz)	G ² /Hz	G ² /Hz		Freq (Hz)	G ² /Hz	G ² /Hz	
3		0,0128	0,106432	5	0,0028	0,00678	
4		0,0128	0,106432	9	0,0005	0,00121	
13		0,0001	0,0008315	10	0,0005	0,00012	
16		0,0013	0,0108095	12	0,0005	0,00012	
28		0,0013	0,0108095	16	0,0013	0,00315	
50		0,00025	0,00207875	20	0,0007	0,00169	
				24	0,001	0,00242	
				31	0,0009	0,00218	
				40	0,00045	0,00109	
				100	0,00045	0,00109	



Source: JICA Study Team

Table 6.2.3-6 Test Conditions for Packaging, for MERCOSUR (Level 3)

MERCOSUR - TEST CONDITIONS TABLE				Oct 22 2006			
Level 3	Good	3,02		M:4	1,46		
M:2	Grms:0.236	Grms:0.41		M:4	Grms:0.24	Grms:0.29	
Freq (Hz)	G ² /Hz	G ² /Hz		Freq (Hz)	G ² /Hz	G ² /Hz	
3		0,0127	0,038354	5	0,0018	0,00263	
4		0,0127	0,038354	6	0,00055	0,0008	
5,8		0,0007	0,002114	7	0,00055	0,0008	
14		0,0007	0,002114	8	0,0007	0,00102	
22,5		0,0026	0,007852	11	0,0007	0,00102	
50		0,0001	0,000302	12	0,00045	0,00066	
				22,5	0,0026	0,0038	
				29	0,0009	0,00131	
				37	0,0001	0,00015	
				47	0,0001	0,00015	
				80	0,0007	0,00102	
				100	0,0007	0,00102	



Source: JICA Study Team