Minutes of the Transport Stresses Working Group of the Committee for European Environmental Engineering Societies Held on 20th September 2001 at the Hotel Britannique, Naples, Italy

Present at the Meeting of the Transportation Stresses Working Group (TSWG) were;

Mr B. Belotti	AITPA
Dr U. Braunmiller	GUS
Mr M. Dumelin	SSEE
Mr T. Geise	PLOT
Mr R. Hansson	SEES
Mr G. Jansson	SEES
Mr M. Juntunen	SEEF
Mr J. Siren	SEES
Mr R. Sjoborg	SEES
Mr. D. Richards	SEE (Chairman)
Dr K Zieghan	GUS

Matters Arising

Apologies were received from, Mr T. Trost, J. Moriceau, Dr P. Dehombreux & Mr E. Furrer. The group welcomed four new members.

A list of TSWG members, including corresponding members, was circulated. As usual this list is attached to the minutes as Attachment No 1.

Unlike several recent meeting this was of the full duration. The meeting observed that this allowed greater technical discussion to occur.

Systematisation of Measurement Methodologies

CEN TC 261 . It was reported that no meetings of this group had occurred since the last TSWG although a meeting of the ISO shadow group will occur shortly.

DIN 30787. For the benefit of the new members of the group Ulrich explained the background to this standard. He explained that about half the document is now finished and the other half was issued as DIN "yellow" pages. As this document contains unique information it was been offered to several International standards agencies. To this end it was in the process of been translated into English. A possibility of a workshop based around this standard had been voiced at the previous meeting. The group supported this and it is proposed to include this at the next meeting. A proposed agenda is included as Attachment No 2.

IEC TC104. David Richards reported no meeting had occurred since the last TSWG meeting.

STANAG 4370. Marcus reported that he had attended the last meeting of the NATO updating this military standard. He gave a brief account of progress.

Mil Std 810F It was reported that the first amendment was now on the web site.

Miscellaneous. A number of ad-hoc items were addressed. These included;

> Karl mentioned work by the BAM organisation (based in Berlin) to define tie down systems and forces for transportation purposes. He indicated that BAM were proposing a "open table" discussion on this subject.
>
> The status of the vibration test proposed for the UN "orange" book (requirements for transportation of dangerous goods). Although the recent test had been proposed by Spain, essentially the same test had been proposed several times previously by the US. It had been rejected several times previously and

most of Europe were against the tests inclusion. An EU directive aimed at better protection of dangerous goods was currently been looked at by a sub-committee of CEN TC 261. This group was looking at enhancing the "orange" book.

Technical Papers

Working Practices

Discussions occurred on the possibility of the group generating a "working practices" document on the subject of deriving environmental and test severities from measured data. Little advice on this is currently available yet they represent critical steps in establishing the capability of equipment, products and packages. It was agreed that the group assemble initial contributions for such a working practice. To this end several actions were placed for the members to supply the following initial contributions on the following techniques;

Goran	His method
Ulrich	The DIN methodology
Markus	New ACETP
Marrkku	FDS/MRS
David Richards	Probability Density Approach
Thomas Trost	?

Future Methods of Transportation Testing. A paper presented at an earlier meeting was revisited and a brief discussion ensued on the use of shock on random vibration tests. It was suggested at the previous meeting of the possibility of CEEES looking at the feasibility of a range of combined shock and vibration tests, with the intent of submitting a New Work Item Proposal to ISO/IEC. The group decided to continue with this. For the new members of the group the previous paper is included here as Attachment No 3.

Round Robin Exercise & Monograph. The chairman once again apologised that this was not yet complete. However, he explained that it would now be difficult, if not impossible, to generate a fully electronic copy of this document. It was agreed that a paper only document be issued. Markus said that the SSEE were still working on the 2nd exercise. Marrkku gave presentation on his work on the 2nd exercise which promoted a useful discussion.

Standards Report. At a previous meeting it was suggested that the TSWG attempt to produce an overview of European and International work currently underway relating to transportation stresses. Mainly due to lack of time at previous meeting this item had not been progressed. Lead by Karl an attempt was made to create an overview the meeting. This is included here as attachment No 4. Could the members not present please review this before the next meeting.

Any Other Business

Markku raised two issues;

He reminded the group that at the previous meeting Ulrich had suggested that the Objectives, Terms of Reference and Aims of the group be reviewed. He had also suggested the possibility of a change of name of the TSWG. *(Chairmans note: although not progressed at the TSWG it was addressed at the main meeting the following day – see minutes of that meeting)*

He remained the group we need an EU project – any ideas?

Next Meeting

The date of the next meeting of the TSWG is planned for 21st February 2002 in Brussels. The meeting will be preceded by the workshop.

Attachments

1 Names and Addresses of TSWG Members
2 Proposed Workshop Agenda
3 Paper on Future Methods of Transportation Testing
4 An Overview of European and International work

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Proposed Workshop Agenda

Distribution Environment and Transportation Loads – a Key Factor for Safe Cargo Handling

February 22nd , 2002 Brussels, Belgium

Program

8.30 h	Registration
9.00 h	Welcome and Opening of the Meeting
	Dr. Karl-Friedrich Ziegahn, President of CEEES
	David Richards, Chairman, CEEES Technical Advisory Board on Mechanical Environment
9.20 h	The Distribution Environment – a Key Factor for Saving Costs, Customers Satisfaction, and Environmental Protection
	Dr. Karl-Friedrich Ziegahn
10.00 h	European Policy and Strategies on Safety of Transportation
	Possible EU Commission
10.30 h	Transportation as an Issue for Standardization
	Possible CEN Headquarters, Brussels
11.00 h	Coffee Break
11.20 h	Mechanical Transportation Environment
	David Richards, Hunting Engineering, UK
11.40 h	Measuring Transportation Stresses – the New German Standard for Measurement Techniques (DIN 30 787)
	Ed Furrer, DIN NAVp Working Group 1.4 “Requirements and Testing for Packaging”
12.30 h	Lunch Break
14.00 h	Measurement Equipment for Determination of Transportation Loads - Examples
	Kuschel?, SMD Hybrid Technik, Dresden, Germany
14.30 h	Recent Research Results – The SRETS Project on Transportation Stresses
	Thomas Trost, Pack Forsk, Sweden
	Dr. Ulrich Braunmiller, Fraunhofer ICT, Germany
15.00 h	Coffee Break
15.20 h	Climatic Influences during Transportation

	Jacques Mauriceau?, France
15.40 h	Practical Experiences – How to Handle Transportation Loads, How to Avoid Cargo Damage
	Belgian Shipping Company
16.00 h	Open Discussion
16.30 h	Closing Remarks
	David Richards
17.00 h	End of the Workshop

Who Should Attend

Manager and engineers in the field of cargo shipping, researchers

on transportation loads, representatives of insurance companies,

packaging experts, professionals in standardization

Registration

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Registration is handled on first-come / first-serve basis. Number of participants will be limited.

Registration Fee

Euro 95,- including lunch, coffee breaks and hand-outs

Euro 65,- Participants from CEEES member societies

Conference location

To be announced as soon as possible

Future Methods of Testing for Transportation Stresses

Background

1. As part of the SRETS project the participants had to decide on the testing methodology for which the test schedule were to be developed. This involved considerable discussions on whether to adopt existing or likely future methodologies. However, the SRETS group was not the most appropriate forum to identify future methodologies which may have advantage to simulating transportation stresses. It was suggested at the last CEEES meeting of 1999 that the TSWG may be a more appropriate forum. This draft note is intended as the basis for discussions.

Summary of Existing capabilities

2. Many existing shock and vibration test procedures originate from a time when few other options existed. Unfortunately, (or fortunately depending upon your point of view) most of these are still in common use. Somewhat of a catch 22 situation seems to exist, national / international standards do not include new procedures because insufficient people require them, however, uses do not call for them because there are no standards which require them.

a. **Shock**. Many shock test procedures used today are fundamentally the same as those used 50 years ago. The basic design of the shock test facilities these procedures relate to also remains largely unchanged. However, in recent years advances in computing power has allowed the ability to control shock tests on electro-dynamic or hydraulic vibrators. The ability to control shock testing has been accompanied by the wider availability of long stroke electro-dynamic vibrators as well as the increased frequency bandwidth of hydraulic systems. Although test procedures exist which allow use these new facilities, a common theme of these is that they attempt to replicate the older tests. Unfortunately these older tests are not ideally suited to application on electro-dynamic or hydraulic vibrators. Nor are they necessarily representative of actual conditions.

b. **Vibration**. The introduction of digital vibration control systems in the mid 1970's swept away most of the older analogue systems. In the early days of digital vibration control systems available computer power limited loop cycle time and the complexity of the control process. Since then computing power has risen by several orders of magnitude, yet for most applications we are mostly still undertaking the same type of broad band random vibration test.

c. **Loose Cargo (or bounce)**. Although not always undertaken today, the test machines mainly used for this test are mechanical vibration generators based upon motor driven cams. A few hydraulic systems exist, but again they are expected to replicate the older test rather than one more suited to their capability or actual conditions.

d. **Bump**. Although this test still exists in several national / International standards, it is rarely now considred as an environmental simulation test. Essentially the bump test induces repeated half sine pulses on an equipment. The bump test machine is usually able to undertake a programme of such shocks frequently involving many hundred. Originally the intent of the bump test appears to have been to reproduce the effects of bounce on equipment when the package was not available.

3. Two generic reasons exist for wanting to adopt improved testing methodologies for testing packages and equipment against transportation stresses. One of these is to reduce costs the other is to allow the test to more accurately replicate actual conditions. Reducing test costs may be achieved by minimising the duration of testing, reducing the number of times an equipment has to rigged on the test facilities and/or reducing capital equipment costs.

Improvements Identified by SRETS

4. The Part EU funded project known as SRETS identified a number of ways by which current simulations of Transportation Stresses could be improved. SRETS identified several different testing methodologies, all of which were restricted by current facilities.

5. **Increased Crest Factor**. The "real world" vibration transportation data identified by SRETS indicated that the vibration crest factor of 3 used in testing, was exceeded. Attempting to envelope peak accelerations whilst adopting a limited crest factor had the potential to result in overtesting. In theory increasing test factor is possible with existing control equipment. However, crest factor is rarely increased above the value of 3, indeed, there is some evidence it is reduced to permit some tests, such as that in Mil Std 810E, to be achieved. In support of the SRETS work it was shown that within the current control methodology a crest factor of 8 to 10 could be achieved and still maintain a credible gaussian distribution. An argument for not increasing crest factor is that larger vibrators and associated amplifiers would be required. However, this is not entirely the case, for example an increase in crest factor to 6 would not require twice the vibrator/ amplifier capacity.

6. **Varying rms Profile**. In reality amplitudes are related to vehicle speeds. A testing strategy particularly suitable for reliability of fatigue type simulations would be to undertake the vibration test at several different levels. On most test equipment this can only be practically achieved currently by undertaking several discrete tests. SRETS proposed several ways by which a variable amplitude test could be achieved. These were mostly intended to match a particular Amplitude Probability Density profile. Realistically current vibration controllers increase test amplitude in discrete steps. Allowing the user to programme an amplitude / time should be a relatively simple change to the software.

7. **Loose Cargo Testing on Vibrators.** The SRETS work indicated that a significant number of agencies were simulating transportation tests on equipment by replicating actual restraint conditions. In many cases this resulted in the equipment "bouncing" on the vibration table when test excitations were applied. Currently such restraint methods are not permitted in IEC 60068, mainly because test reproducibility cannot be ensured. Some debate occurred as part of the SRETS work as to whether current vibration test control methods are able to cope with the impacts that occur when the equipment is "bouncing" on the vibration table. Practical experience indicates that some bouncing can be tolerated without upsetting the control loop. However, the extent to which this is possible and the likely consequences seem to be unknown.

Improved Methods Available but Not Widely Used

8. A few procedures exist today which would permit both cost reduction and/or improve the simulation of road transportation stresses. However, some of these are either little used or not used in a manner allows their full potential to be achieved.

9. **Shock Response Spectra.** Although some procedures for testing against Shock Response Spectra exist they are not often used for simulating the shocks that arise from transportation. This seems to be the case even though the available SRS test procedures offer some advantages. Using an SRS description an oscillatory waveform can be adopted, which is closer the type of transient waveform experienced during transportation. An oscillatory waveform can be undertaken on a vibrator provided a compensation pulse is included. This can save setting up time on a separate shock facility. The oscillatory waveform is also applied in two senses, saving test time. Additionally, the current SRS test procedures adopt tolerances of around double those specified for basic pulse tests. Few SRS test software allows a programme of shock severities and durations to be easy applied.

10. **Large Displacement Excitations.** Not really an improved method but rather improved facilities. The transportation vibration environment can contain significant low frequency contributions, particularly from poor road surfaces. These result in significant displacements which can easily go beyond the capability of electro-dynamic vibrators. Two inch stroke vibrators are now becoming common place, however, some test specifications (notably Mil Std 810E) still requires displacements even beyond this capability. The ability to control hydraulic shakes over the required frequency range is starting to emerge as a potential solution.

Emerging Tests Methods

11. A number of tests methods particularly applicable to transportation stresses have been postulated in recent years. However, few of these have been taken up by either National / International specification or suppliers of test control software.

12. **Control of Skewness and Kurtosis**. Current vibration control systems create random time histories which match a specified PSD. Steinwolf has proposed a procedure to extent this to generate a time history which also matches specified skewness and kurtosis properties. A time history with a kurtosis greater than 3 would constitute a better simulation of actual conditions than the existing process. Whilst, the Steinwolf process would currently significantly increase the loop time of the vibration controller, improvements in computer speed will soon mitigate this limitation.

13. **Embedded Shocks**. Embedding shocks within a vibration test has been undertaken by several agencies in the past. However, this was mostly achieved by replaying a recorded time history into a vibrator. This tends to be a difficult process and does not lend itself to wide spread use. Several workers have suggested approaches by which the existing random generation process is modified (usually by adjusting phase values) to create a shock embedded with the vibrations. A programme of shocks within otherwise random vibration, especially if the crest factor is increased, is more representative of the real world transportation environment, than applying vibration and shocks separately.

14. **Multi-axis Control**. The ability to undertake tests in multi-axes has been proposed for some years. It is already available for low frequency conditions mainly using hydraulic excitations methods. Some facilities already adopt multi-axis control for testing packages, particularly on hydraulic vibrators. However, the general purpose multi-axis system is still not available.

D.P. Richards
28 February, 2000

An Overview of European and International work

Group / Standard	Connection with CEEES Working Group	Other Connections
ISO – Analysis		Kjell Ahlin
ISO – TC 122	Thomas Trost	
ISO - Railway		
IEC TC 104	David Aad Marrkkus Marku	Trygreve Hell
CEN TC261	Ulrich Thomas	
DIN 30787	Ulrich Karl	Ed Furrer
BSI	David	
UN Orange Book		
Mil Std 810		Skip Connon
Nato Standard - AC310	David Markus	
Nato Standard - AC301	David Markus	Peter van Harmelen
Nato Standard - ITOPS		