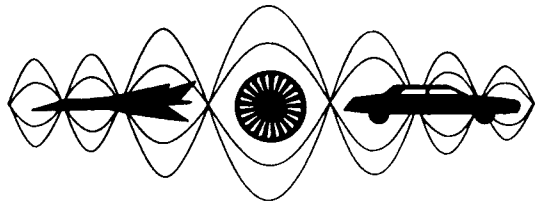

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CLASSIFICATION OF THE ORIGINAL MEASURE AND MEASURING DEVICE DUE TO THEIR SENSITIVITY TO VIBRATIONS AND OTHER LOADS DURING TRANSPORTATION

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SUMMARY

The transportation of original measure (OM) and measurement devices (MD) is frequently performed by motor vehicles.The unusual conditions wich occur due to vibrations, and temperature impact loads, as well as other disruptions during transportation have influence on the metrological characteristics of OM and DM.

Due to this fact, and in the desire to choose, that is, design a motor vehicle for the transportation of OM and MD, there has been made classification of OM and MD according to their sensivity to vibrations and other loads, as well as to the method of packing of same and storage facilities in the vehicle, all for the purpose of securing the preservation of the metrological characteristics in transportation.

Introduction

The extraordinary conditions which, due to vibrations, shock, temperature and other disruptions, occur in transportation of measuring device (MD), have significant influence on the metrological characteristics of these devices and the original measure (OM). Every, even the slightest, disruption of the normal conditions may have, as a consequence, the change in the numerical value of the original measure or, from time to time, its destruction. However, with great probability, there could on the basis of experiments - research and the experience of the metrologist - be estimated as the expected numerical value deviation of the metrological devices characteristics exposed to certain types of incidents, such as vibrations, impacts, thermal shock, etc. To illustrate these facts, there are examples in literature, namely:

For Weston's cells, as one of the most sensitive elements to transportation conditions, authors (1) and (2) indicate results of experiments, supplemented by additional knowledge:

- if the temperature of Weston's element gradually changes from 25°C to 30°C, its voltage will reach its rated numerical value with a deviation of less than 1V, but only after two days of standstill at the temperature of 30°C.The cooling process, on the other hand, will manifest a considerably faster response, so that the voltage will be back to the initial numerical value with the same deviation, after only 15 hours. Hysteresis occurrances and described time response manifest various reactions in different cases of Weston's cells performance;

- the vibration testing with accelerations of 1g and frequencies of 100Hz show only slight effects. It follows that at higher frequencies, there can be observed more significant changes, up to 100MV, while at acceleration of 1g and the frequencies of 100Hz, these changes will range from a few MV, to several tens of MV, depending on the subject cell. There is only a few minutes relax time from high frequency incidents, while the

changes caused by impacts and long-term low frequency vibrations, or quivers, take several days to lose effect. There are even known very frequent voltage changes of certain cells;

- impacts are especially unpleasant. For example, impacts from 10g to 40g, lasting between 6 and 18ms cause changes in voltage from only several MV several tens of MV. Having in mind that in land transportation there could occur impacts up to 20g, Weston's cells are packed for transportation in special boxes with independent elastic supports; additional very carefull packing in extra safety soft padded wrapping is used;

- low temperatures cause the freezing of cells, while high temperatures cause changes in the chemical composition of the amalgam. Therefore, the most frequently determined extreme range of tolerable temperature changes are from +4^{o}C to +40^{o}C, in order that there should not occur more permanent damage to the cells.

- in transfer of standard Fluke 731 and HP 735, there are known to occur step changes in voltage, ranging to even several tens of ppm, which could not be with certainty accounted for as the consequence of vibrations or impacts in transfer, since similar changes sometimes occur in normal laboratory conditions as well. Recent transfer of standard Fluke 732 has proved to be more reliable in every respect, with changes of only 0.1ppm being typical. They are considerably more suitable for transfer of voltage measure in respect of inter-laboratory improvements than are Weston's cells, especially the stationary type (3).

The resistor original measures are extraordinarily sensitive to pressure and impacts changes. The normal atmospheric pressure changes could cause variation in resistance even upto 50ppm, and the same variation could be caused by an impact of 5g. A relax time of 4-5 hours is typical in both cases.

Considering temperature changes, hysteresis incidents occur in all devices.

For the wide range of different original measures and measuring devices which require transportation, it is difficult to provide precise criteria for their classification in respect of transportation conditions' sensitivity.

In this study there has been made an attempt to do so, setting the following groups of OM and MD in respect of sensitivity:

- group A - very sensitive OM and MD;
- group B - moderately sensitive OM and MD;
- group C - hardly sensitive MD.

Classification of the original measure and measuring devices according to their sensitivity to vibrations and other loads during transportation

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Sensitivity to vibrations

As already emphasised above, the OM and MD transported according to their sensitivity to vibrations, can be divided into three groups.

Group A - very sensitive OM and MD
Impacts up to 14.715 m/s^2 (1.5g)

Name	Manufacturer	Type
Laser Measurement System	HP	
Original Measure Capacity	GR	1408
Original Measure - Voltage DC	Guildine	9150, 91540
Original Measure - Voltage AC	Fluke	540 B
Electro-meter	Keithles	610C
Voltage (Thermal) Converter	Fluke	540, A - 55
Voltage (Thermal) Converter	Ballantine	1600, 440
Voltage (Thermal) Converter	HP	8400, 11000
Original Measure - Voltage DC	JRL	106, 368
Transfer - Standard VDC	HP	735
Kelvon-Varley Dividor	Fluke	720
Original Measure Air Lines (Routes)	GR	900
Rubudijev Original Measure	HP	5065
Transfer - Standard VDC	Fluke	731, 732
Original Measures - Voltage DC	Cambridge	44113
Thermal Converter-Watt Meter Head	HP	8480
Frequency Original Measure	HP	5340
Synthesizer Signal Generator	HP	8670
Alternator Calibrator	Harris PRD	915-B

Group B - Moderately sensitive OM and MD
Impacts up to 29.43 m/s^2 (3 g)

This group consists of a large number of OM and MD; most of the OM and MD from this group have been selected for transportation. Therefore, they could not be individually listed as the OM and MD of group B, as it had been done in the case of group A, but it could be simply stated that these are all OM and MD which have been selected for transportation, but for those OM and MD which have been indicated in groups A and C.

Group C - hardly sensitive - impacts up to 78.48 m/s^2

This group consists of those OM and MD which are not noticably sensitive to vibrations and impacts in transportation, namely:

- Multimeters and universal instruments, of various types;
- Capacitive, resistive and inductive decade boxes of minor precision;
- Indicators and digital electrical instruments and frequency meters of less precision (class 0.5 and less reliable), with the exception of Wattmeters for high frequencies which are a part of group B, regardless of their precision;
- Impulse generators, oscillators and function generators with less precision (mostly from the group of working measures in some laboratories);
- Oscilloscopes and registration instruments of less precision and sensitivity;
- Measurement platforms (LRC), compensators ("potentio-meters" or adjustable resistors), devisors and calibrators of less precision;
- Acustic, microwave and high frequency measuring instruments of less precision;
- Original measures of length, angle and roughness of all kinds;
- Measuring devices for flows, pressure measuring devices and hydrometers, and accelerators of less precision and sensitivity;

- Filters, measuring boosters, various resistors, capacitors, inductive instruments, diodes (electrodes), microphones and other elements of less precision and sensitivity;
- Original measures for pressure, force, and swing moment, of less precision and sensitivity;
- Receivers, transmitters, attenuators, wave transfer devices, normalizers, and signal analyzers of less precision;
- Calibrators, various measurement plates, length measuring indicators, micrometers, length measuring devices and spirit-levels of less precision and sensitivity.

The influence of other types of loads on the original measures and measurement devices

Besides vertical acceleration, transversal acceleration also has influence on the original measure and measuring devices in transportation, which at platform floor level of the superstructure frequently rises up to 25%-50% of the vertical; with overall large loads, the existance of angular oscillations could be considerable. For the calculation of comfort of transportation of OM and MD, the middle square longitudinal and transversal acceleration on the platform can be used, besides the middle square longitudinal - angular and transversal - angular acceleration.

In the more complex cases, the safe transportation of the measuring devices depends not only on acceleration, but also on the frequency of the system. This holds if the OM and MD, which are being transported, are represented as a system with its own frequency, which is within the range of the spectra of the superstructure. As the frequencies of the transported objects - measurement devices - may be varied, the determination of any general demands whatsoever in respect of the acceleration spectre and the development of appropriate indicators of transportation comfort can not be possible.

The vertical accelerations are varied at different points of the superstructure.

As mean indicator, there could be used the acceleration at the middle point of the platform superstructure, or above the rear axle of the vehicle, which is usually concentrated near the middle point.

The dynamic loads sharply increase under bouncing and other impacts against the bottom of the transported objects.

In order to prevent the bouncing of the transported objects, the maximal vertical acceleration of the platform should not exceed 9.81m/s^2 (1g); therefore, the mean square acceleration should not exceed 3.0 m/s^2. The maximal deceleration on intense use of breaks, at the maximum tread point (0.8) and wheel block, amounts to a=g=08g or 8m/s^2.

The packing of OM and MD for transportation purposes and protection against damaging impacts and vibrations

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There could be implemented two methods of packing of original measure and measurement devices for the purpose of their transportation and protection against damaging impacts and vibrations, namely:

Groups A and B-very, and moderately sensitive OM and MD:

a) packing of original measure and measuring devices in the vehicle in prepared boxes isolated from vibrations;

b) packing of original measure and measuring devices in specially designed box containers which are isolated from vibrations;

c) packing of original measure and measurement devices in boxes and containers.

Group C - hardly sensitive MD:

a) packing in boxes of wavy/uneven carboard and their storage on racks/shelves;

b) packing in boxes of wavy/uneven carboard and their storage on racks/shelves with fixations (fasteners).

c) packing in separate boxes specially made for them, storage on rack/shelves and other for that purpose assigned places on the floor with fixation.

In the study, there has been made both an analysis and classification of OM and MD according to:

- sensitivity to climate conditions;

- necessity of power supply of OM/MD in transportation;

- volume(mass) and overall size of the OM and MD.

Conclusion

On the basis of the enclosed classification, it is possible to design the superstructure of the vehicles for the original measure and measuring devices' transportation - and at the same time protect their work characteristics.

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