RESOURCE MANAGEMENT

A proposal for targeting weighing and measuring devices to optimize local metrology authorities' resources

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Introduction

This paper describes the attempt, on the basis of the imminent changes in the Italian provisions concerning the periodic inspection of weighing and measuring devices, to introduce a continuous monitoring system of devices located in the Legal Metrological Authorities' (LMA) jurisdictions.

The objectives the authors aim to achieve are to:

- optimize the resources allocated to LMAs;
- increase inspectors' efficiency and productivity;
- increase the effectiveness of administrative and enforcement actions;
- better protect "honest" businesses; and
- better protect consumers.

In order to achieve satisfactory levels of effectiveness, it became clear that technical and logistics tasks, such as monitoring weighing and measuring devices on a continuous basis (*targeting*) [1], should not be dissociated from a number of other supporting activities, such as:

- training and refresher courses for inspectors;
- promotion of programs and media contacts;
- office automation; and
- technological support.

The experimental *Targeting Plan* is presently restricted to two typical types of weighing and measuring devices subject to legal metrology control:

- small and medium capacity nonautomatic weighing instruments (NAWI); and
- vehicle fuel dispensers.

Definitions

For a better understanding of what follows, some basic definitions are given:

Compliance:
Status of an instrument meeting the requirements set out by regulations.

Non-compliance:
Status other than that of compliance.

History of good or poor compliance:
Control to verify whether or not the characteristics of compliance are preserved.

Excellent user:
User with a good compliance history.

Poor user:
User with a poor compliance history.

Standard inspection frequency:
Inspection performed according to the law by a Weights and Measures Department, on the basis of types of device. Inspections are to be performed during normal office hours.

Increased inspection frequency[2]:
Inspection performed at more frequent intervals than standard inspection, usually to follow up cases of previous non-compliance.

Users database:
Computerized list of all devices in the area, which enables the LMA to retrieve device users by means of several search keys.

Targeting

The targeting procedure consists of monitoring devices on a continuous basis through inspection; the aim is to penalize users who make use of devices with a poor compliance history. This should allow for human resources to be optimized and result in a reduction in the effective rate of non-compliance.

The device users are divided into two groups: the "excellent" and the "poor". The first category is further sub-divided on the basis of the number of instruments used in the business.

The inspection frequency is variable and is based on the different histories of compliance and other factors related to the instruments such as manufacturer, type, capacity, instructions for use, environmental conditions, etc.:

- the "excellent" users' devices are subjected to *standard* inspection frequency;

- the "poor" users' devices are (conversely) subjected to an *increased* inspection frequency. Normally, users are removed from this list only after successfully passing two consecutive inspections.

The need arises, for users that remain on the "poor" list or those that systematically re-enter it, to thoroughly investigate the reasons behind any case of non-compliance, in order to take appropriate action to reduce or prevent such factors from reocurring.

For those "excellent" users having many instruments, a two-stage inspection is carried out.

The **first stage** consists of an inspection of a random sample of the instruments used, preceded by a visual inspection of all the devices to verify the fulfillment of the formal requirements. For example, for a service with more than five fuel dispensers or for points of sale using nonautomatic weighing instruments with more than ten devices, the inspector respectively tests only five fuel dispensers or ten weighing instruments.

The **second stage** consists of an inspection of *all* the devices used. However, if the first stage was successful then it is not necessary to proceed to stage two, which shall only be performed if either of the following conditions occur:

a) one device is found to be outside the maximum permissible errors;

or

b) the mean of the calibration errors is less than the acceptance criterion.

Targeting procedures and acceptance methods are described in Annexes 1 and 2.

Training

Training and refresher courses for inspectors require considerable local authority investment, but distinct advantages do result from such investment: better trained inspectors perform higher quality inspections, which result in a reduction in the number of errors in the field and reduced user complaints.

Training also increases inspector productivity, thus reducing the likelihood of accidents at work, gives more credibility and hence increases professionalism.

Training would be supplemented with formal courses lasting at least ten days a year, duly recognized on a national scale by means of a certification method [3].

On the job training is no substitute for formal training, but it does complement and reinforce formal training. "Train the trainer" courses will be needed which allow know-how to be spread among the inspectors.

Promotion programs and media contacts

The promotion programs will be directed at improving voluntary compliance of users through industry training and raising consumer awareness by a variety of educational initiatives:

- lectures promoting the programs to businesses;
- advertising campaigns aimed at consumers and directed towards the concept of "enlightened" purchase of goods;
- educational competitions for which a prize is awarded to the best ideas in the field of consumer protection;
- creation of web pages; and
- instigation of toll-free phone numbers for consumer complaints.

Office computerization

To ensure efficient progress it is absolutely necessary to set up a database of users so that every element that could contribute to making the administrative action more effective can be easily identified. Examples of forms that could serve as database records are given in Annex 3.

The use of data processing media will help particularly in implementing targeted inspections: the reports will identify which users have to be inspected on the basis of the last inspection date and based on compliance history.

The reports will periodically take a "photograph" of targeting activity, identifying both the percentage of inspected "locations" and the impact on the territory.

In Italy, the *InfoCamere Eureka Plan* (in its development phase) attempts to provide a medium suitable for the needs of a modern of legal metrology service; it would be advantageous to develop it as a global tool for all the fields of competence of service.

This plan should then provide for a section dedicated to the traceability of working standards to national prototypes of weights and measures units.

For an efficient implementation of such targeting strategies, it could be opportune to develop an "ad hoc" database so as to render inspection easier in the device field as well as the preservation of data concerning the inspection [4].

Technological facilities

The use of new technologies, applied to the inspections, results in noticeable advantages both in the field of job safety and in the effectiveness and efficiency of inspectors.

The most obvious advantage stemming from the utilization of new technologies is related to the reduction in the time required to carry out inspections, which has a beneficial effect on the costs that the sellers pass on to consumers.

It would be sensible to utilize a fleet of motor vehicles to perform verifications, but such a fleet would have to be equipped with working standards to optimize the verification activity.

Authors' comments

The principles explained should be taken as being subjective and open to suggestions for changes in line with the actual conditions in which each individual metrological service works.

It is a subjective management choice to implement a policy in order to achieve best results in the field; of particular importance is the division of non- compliance into classes showing defects defined as "fatal" and those defined as "tolerable".

It is management's responsibility to set out the user classification methods based on the number of reverifications of instruments between two successive periodic verifications (for example an excessive number of reverifications due to "fatal" defects could truly indicate poor instrument performance, or worse still, could be a sign of intentional tampering with the instrument).

In order to ensure better optimization of human resources, it could furthermore be appropriate to separate the area into territorial jurisdictions for different inspectors and also fix the relevant fields of competence.

In summing up, this proposal is an attempt to introduce a notion of "statistical thinking" into the field of legal metrology, traditionally resistant to this idea.

Annex 1

In order to better understand what follows, the definitions below are used:

"b" Category: the whole set of "excellent" users who use not more than 10 weighing devices ($n \leq 10$) or not more than 5 fuel dispensing devices ($n \leq 5$)

"B" Category: the whole set of "excellent" users who use more than 10 weighing devices ($n > 10$) or more than 5 fuel dispensing devices ($n > 5$)

"C" Category: the whole set of non-conforming users

V: Inspection phase at which only formal requirements are evaluated

E: Inspection phase at which metrologically relevant characteristics (accuracy, repeatability, etc.) are evaluated

E%: Inspection phase at which only a sample of the users' device population is tested with respect to metrologically relevant characteristics

M: Evaluation of the above-mentioned sample by means of the acceptance criteria (depicted in Annex 2)

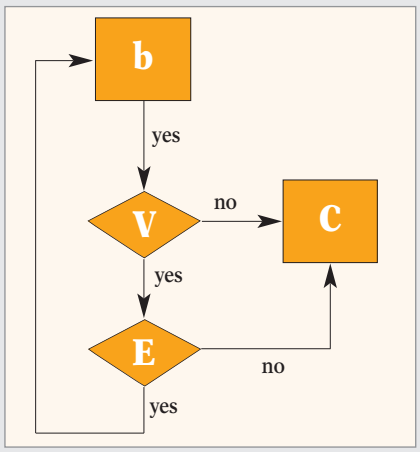
The inspection starts by considering the user's compliance record. To achieve compliance records which effectively depict the real operating conditions, it is necessary, initially, to inspect all the devices by considering both the formal and the metrologically relevant requirements. So the whole user population will be classified in one of the three categories "b", "B" or "C".

(1) "b" Category users shall be submitted to 100 % device inspections: in the case of a positive result for every device relating to both V and E phases, a user shall still be considered as an "excellent" user; otherwise he or she shall be considered as a non-conforming user (see decisional flow chart "b").

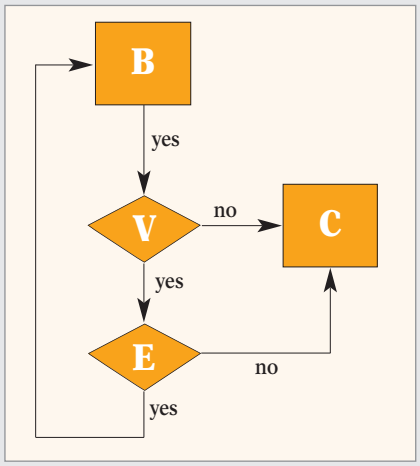
(2) "B" Category users shall be submitted to reduced device inspections: a sample shall be randomly drawn from the device population and inspected. If a user passes the V, E% and M steps, he or she shall be considered as an "excellent" user; if he or she fails the M step, then he or she shall be submitted to a 100 % device inspection as described in (1) above; if he or she fails the V or E steps, then he or she shall be considered as a non-conforming user (see decisional flow chart B).

(3) "C" Category users shall always be submitted to 100 % device inspection. In the case of a positive result in respect of both the V and E steps, the user shall be considered as being non-conforming except when he or she shall be upgraded to the "B" or "b" Category according to the number of devices he or she uses. In the case of a negative result, the user shall still be considered as a non-conforming one (see decisional flow chart C).

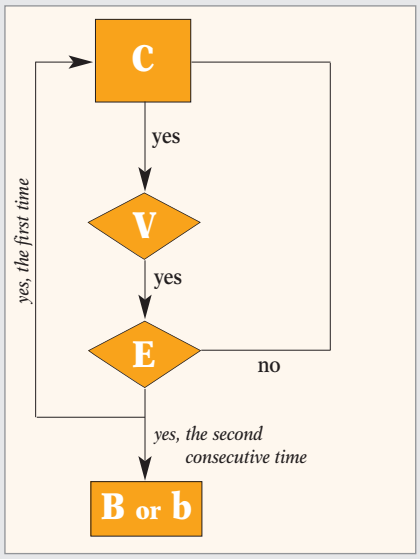
Decisional flow charts



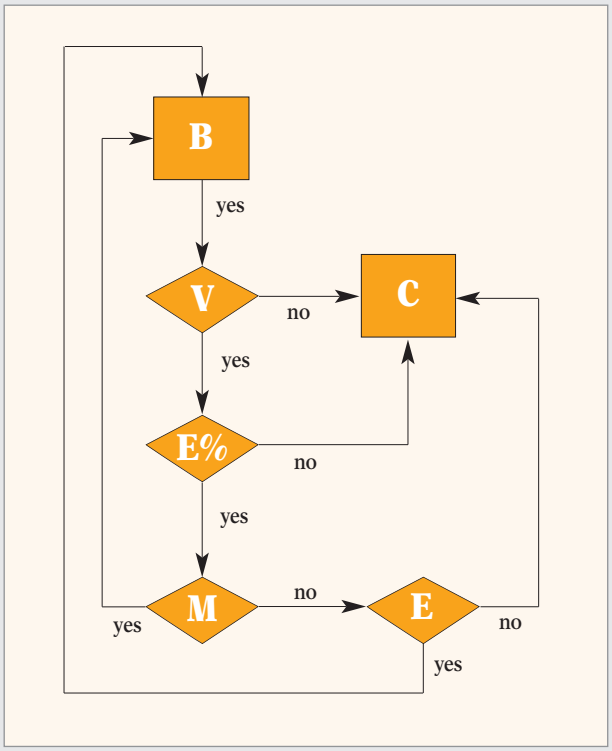
After repair and periodic verification for b Category



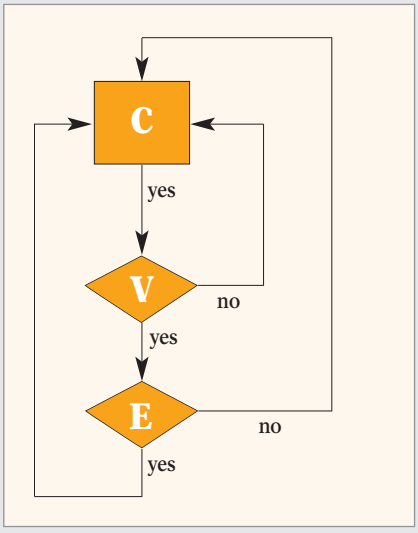
After repair verification for B Category



After periodic verification for C Category



After periodic verification for B Category



After repair verification for C Category

After-repair verification targeting procedure

With regard to after-repair verification, an inspection of the devices for which a repair was needed is carried out.

Apart from the users' conformance history, steps V and E shall be carried out in succession; in the case of a positive result in both these steps, a user shall remain in the original category (see the decisional chart), but in the case of a negative result for one or more of the two steps, the user shall be deemed to be non-conforming.

Human resources allocation

The time elapsed between two successive inspections ("T") is linked to the user's device compliance history: "b" and "B" Category users shall be inspected at the normal inspection frequency, conversely "C" Category users shall be inspected at the increased frequency.

In order to better allocate the human resources available within several jurisdictions, when an after-repair inspection is needed in the time period between 0.5 T and T, an overall inspection shall be carried out as a periodic inspection for every device at the user's location by way of exception to the terms of the inspection validity period.

Annex 2

Two-stage inspection acceptance criteria

With regard to the acceptance variable criteria the following definition is given:

Variable: ratio (x) between the absolute error found and the maximum permissible error (mpe):

x = (absolute error found)/ mpe.

A device population to be inspected shall be subjected to a statistical analysis by using a sampling plan having the following property:

Property: a device population having 1 % of devices below the mpe must have an acceptance probability of 95 %.

To perform the statistical analysis a working hypothesis has been considered as reported below:

Working hypothesis: the variable distribution is considered as a normal distribution with zero mean and such a standard deviation value that the above-quoted definition of "property" is true.

Moreover, on the remaining points of the operative curve (OC) which describes the sampling plan, the standard deviation is deemed to be constant. The reasoning behind this assumption is that usually the error spread depends on the kind of devices to be verified and thus the variance around the average error is generally known; conversely, the average error does depend on calibration operations which are being performed on the device population to be inspected. The situation is as defined in Fig. 1.

Weighing devices sampling plan

For weighing device populations having more than 10 items, a sample of 10 from the whole population is drawn.

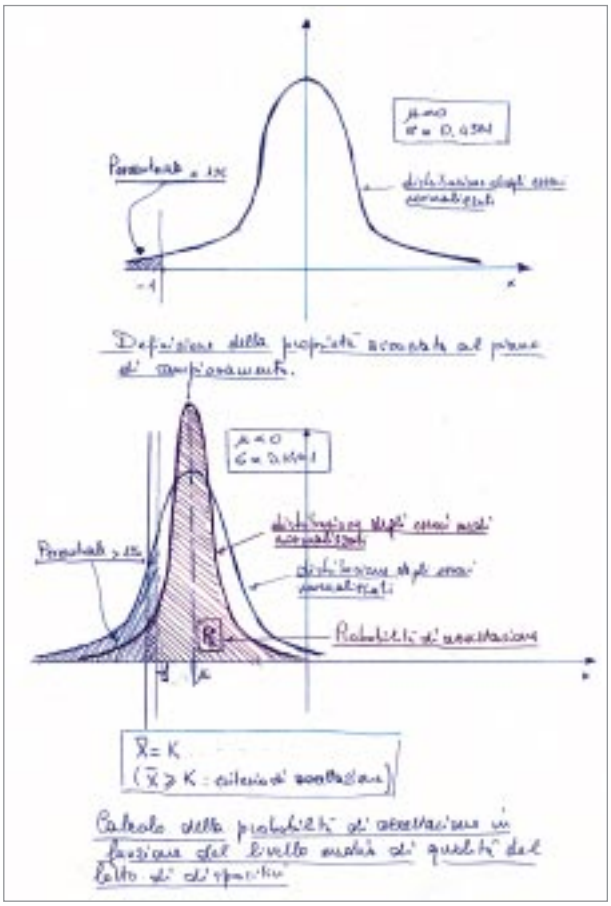


Fig. 1

Annex 3

RETAIL FUEL DISPENSER SURVEY PROGRAM - G.Ardimento - U.P.M. NAPOLI

Record No.: _____ BP: _____ FP: _____ Reg.BP: _____
IMPIANTO: _____
Gestore : _____
Ubicazione: _____

SUPER												
matricola			matricola			matricola			matricola			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

SUPER SP E MIX												
matricola (sp) (mix)			matricola (sp) (mix)			matricola (sp) (mix)			matricola (sp) (mix)			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

GASOLIO												
matricola			matricola			matricola			matricola			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

NOTE: _____

Record No.: _____ BP: _____ FP: _____ Reg. BP: _____
IMPIANTO: _____
Gestore : _____
Ubicazione: _____

SUPER												
matricola			matricola			matricola			matricola			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

SUPER SP E MIX												
matricola (sp) (mix)			matricola (sp) (mix)			matricola (sp) (mix)			matricola (sp) (mix)			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

GASOLIO												
matricola			matricola			matricola			matricola			
data richiesta			data richiesta			data richiesta			data richiesta			
A	OA	F	A	OA	F	A	OA	F	A	OA	F	
data verifica			data verifica			data verifica			data verifica			

NOTE: _____

pag. _____

The mean variable value x_m has to meet the acceptance criterion $x_m \geq -0.224$ and the OC relating to this criterion is set out below:

AQL*	P_a**
1 %	95 %
5 %	31 %
10 %	5 %
25 %	0.02 %
50 %	0 %
.....	.....

Fuel dispensers sampling plan

With regard to fuel dispenser populations of more than 5 items, a sample of 5 from the whole population is drawn.

The average relative error value x_m (expressed per thousand) has to meet the acceptance criterion

$x_m \geq -0.63$ (per thousand).

The OC relating to this criterion is set out below:

AQL*	P_a**
1 %	95 %
5 %	54 %
10 %	24 %
25 %	2 %
50 %	0 %
.....	.....

Notes:

* AQL: Acceptable Quality Level (i.e. the percentage of non-conforming devices in a batch)

** P_a: Acceptance Probability of the batch under inspection given the corresponding AQL value in the table

References

[1] City of Seattle Consumer Affairs Unit: Weights and Measures Inspection Plan (1997)

[2] NIST Handbook 130: Uniform laws and regulations in the areas of legal metrology and engine fuel quality-examination procedure for price verification

[3] OIML D 14 (1989): Training of legal metrology personnel - Qualification - Training programs

[4] Jim Truex: Legal Metrology for the Americas Workshop

[5] Leavenworth-Grant: Statistical quality control, McGraw-Hill

[6] NCWM Course 302: Retail motor-fuel dispensers and consoles ■

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