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Equipement mobile
pour la vérification de ponts bascules routiers

Mobile equipment
for the verification of road weighbridges

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ORGANISATION INTERNATIONALE
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OF LEGAL METROLOGY

Français

EQUIPEMENT MOBILE

POUR LA VERIFICATION DE PONTS BASCULES ROUTIERS

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Note: Cette brochure est une synthèse des informations disponibles au BIML sur le sujet traité. Elle a pour seul but de servir de guide et n'a aucun caractère officiel.

English

MOBILE EQUIPMENT

FOR THE VERIFICATION OF ROAD WEIGHBRIDGES

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Note: This brochure constitutes a synthesis of the information available at the BIML on the subject. It is intended mainly for guidance and has no official character.

EQUIPEMENT MOBILE

POUR LA VERIFICATION DE PONTS BASCULES ROUTIERS

Capacité de charge nécessaire

La vérification de ponts-bascules routiers s'effectuait au début en utilisant un grand nombre de poids de 20 kg qui étaient transférés à la main sur le tablier de la bascule. La capacité de cette méthode était bien entendu limitée à quelques tonnes seulement.

Plus tard on a introduit l'utilisation de masses spéciales, en forme de cylindre ou parallélépipède, allant de 250 à 500 kg, ainsi qu'un matériel approprié pour leur transport et manipulation. Cette dernière se faisait en général à l'aide d'une grue ou d'un palan, monté sur un camion et servant à décharger et à charger les masses. Afin d'amener celles-ci aux emplacements désirés sur le tablier du pont-bascule, les masses cylindriques peuvent être roulées, alors qu'il faut avoir recours à un chariot spécial pour les masses en forme de parallélépipède. Quelques services de métrologie utilisent dans ce but également la grue du camion. Ceci exige une certaine flexibilité dans les possibilités d'utilisation de la grue.

Le but de la plupart des services est d'accroître la capacité de vérification jusqu'à la portée maximale des ponts-bascules. Ceci n'est cependant pas toujours facile compte tenu des limitations imposées par le transport routier. La charge admise par les camions utilisés est en général inférieure à 12 000 kg alors que le camion peut peser vide entre 8 000 et 12 000 kg. Les remorques utilisées peuvent souvent porter des charges plus lourdes, allant jusqu'à 20 000 kg.

Un pays [8] utilise des camions très courts de façon à permettre d'en placer plusieurs en travers sur le tablier et ainsi accroître la capacité.

La charge totale produite par des masses étalonnées doit, aujourd'hui, de préférence atteindre au moins 20 000 kg. Des vérifications à une charge plus élevée peuvent être effectuées par une méthode d'extrapolation en utilisant le camion ou la remorque, ou les deux, comme charges additionnelles. Un service de métrologie [12] utilise comme charge additionnelle un réservoir d'eau. Cet équipement permet d'atteindre une très grande capacité totale (60 000 kg y compris masses, remorque et eau). Le réservoir d'eau n'est en général rempli que lors de l'utilisation à la capacité maximale, à l'arrêt, et nécessite la disponibilité sur le lieu de la vérification d'un branchement d'eau à fort débit. Dans bien des pays il suffit de disposer d'un équipement de vérification d'une capacité de 40 000 kg compte tenu des conditions et réglementations routières.

Choix du matériel de transport et manipulation des masses

Un service de métrologie qui projette de faire l'acquisition d'un nouveau matériel de vérification de ponts-bascules routiers doit tenir compte des points suivants:

MOBILE EQUIPMENT FOR THE VERIFICATION OF ROAD WEIGHBRIDGES

Required test load

Historically heavy weighbridges were first verified by a step by step method using a great number of 20 kg weights which were placed by hand on the weighbridge platform. The capacity of this method is of course limited to a few tonnes.

Special cylindrical or rectangular weights in the range from 250 to 500 kg were later introduced together with suitable transport and handling equipment. The latter usually consisted of a crane or hoist mounted on a lorry for unloading the weights. In order to bring them to the desired location on the weighbridge platform cylindrical weights can be rolled whereas rectangular weights have to be moved using a special cart (dolly) or a small trailer. Some metrology services also use the crane to bring the weights to the desired place on the platform. This, however, depends on the flexibility of the crane.

The goal of most services is to increase the calibration capacity to the full load of the weighbridges. This is not always easy from the point of view of road transport. The load carrying capacity of the lorries used is usually less than 12 000 kg whereas the lorry itself may weigh empty between 8 000 and 12 000 kg. The trailers used may often carry quite high loads, up to 20 000 kg.

One country [8] uses very short lorries of which several can be placed crosswise on a big weighbridge to increase the testing capacity.

The total load produced by calibrated weights should preferably reach 20 000 kg at least. Tests at higher loads can then be made by a differential method using the lorry or the trailer, or both, as additional loads. One metrology service [12] uses, as an additional dead load, a tank filled with water. This equipment allows to reach a very high total capacity (60 000 kg at full load including weights, trailer and water). The water tank is generally only used at highest load, when stationary, and requires the availability of a high-speed water filling facility at the test site. In many countries a weighbridge test facility with a capacity up to 40 000 kg may, however, be sufficient taking into account the conditions of the roads and the traffic regulations.

Choice of transport and weight handling equipment

A metrology service which is planning the procurement of new calibration equipment for road weighbridges should pay attention to the following points:

1. Le nombre de ponts-bascules qui doivent être vérifiés annuellement, leur portée, distribution géographique, dimensions de tabliers, accessibilité du lieu et du tablier même, etc. (il est préférable d'établir un inventaire détaillé).

2. La charge maximale admise par essieu sur les routes d'accès.

3. La masse maximale admise par la réglementation routière pour l'ensemble chargé camion-remorque.

4. Les possibilités de maintenance de l'équipement mobile.

5. Sécurité du personnel manipulant les masses (certains dispositifs de déchargement peuvent à ce point de vue ne pas convenir).

Les deux derniers points sont particulièrement importants lors du choix du matériel approprié. Il est fortement recommandé que les camions, grues ou chariots élévateurs soient d'un modèle couramment employé dans le pays de façon a permettre aisément leur réparation ou leur remplacement.

Depuis la publication de la Recommandation OIML R 47, il est devenu plus courant d'utiliser des élévateurs hydrauliques à fourche pour la manipulation des masses de vérification. Ces dernières doivent alors avoir une forme permettant le levage et le déchargement par les lames de fourche. En d'autres termes, le choix de l'élévateur à fourche et la forme des masses doivent être coordonnés.

Le grand avantage de ce mode de manipulation est que le camion de transport n'a pas besoin d'être construit spécialement mais peut être d'un type courant et servir également à d'autres usages ou simplement loué pour la vérification à entreprendre. L'utilisation de plusieurs camions, afin d'accroître la capacité de vérification, peut dans ce cas éviter l'acquisition d'une remorque spéciale.

L'élévateur hydraulique à fourche peut être d'un modèle couramment utilisé dans les ports et magasins, ayant une capacité de charge de 1 000 à 2 000 kg et une hauteur de levage convenant aux camions normalement employés. Certains types d'élévateurs peuvent, lorsqu'ils sont fortement chargés, ne pas convenir lorsque le terrain n'est pas plan. Le type choisi doit par conséquent être spécialement conçu pour usage en plein air (grandes roues pneumatiques).

Il convient de signaler une difficulté avec l'élévateur à fourche: il faut prévoir un moyen de transport lorsque les lieux de vérification sont éloignés. S'il est transporté sur un camion, il est possible de l'embarquer à l'aide de deux rails et d'un treuil [1] ou à l'aide d'un plateau hydraulique monté à l'arrière d'un camion [2].

Certains services de vérification utilisent pour plus de flexibilité simultanément les deux systèmes: élévateur à fourche et grue [20,21].

Dans certains pays (les Etats-Unis d'Amérique et le Canada) on utilise des chariots spéciaux à moteur électrique alimentés par une batterie. Un palan est alors utilisé pour le déchargement du camion.

1. The number of weighbridges which have to be calibrated yearly, their capacity and geographical distribution, size of platform, accessibility to the site and when there to the plate itself, etc. (this information should be catalogued).

2. The maximum allowable axle load of vehicles on access roads.

3. The maximum regulatory admissible mass of the vehicle combination (lorry and trailer).

4. The available maintenance facilities for the equipment to be procured.

5. Safety of personnel handling the weights (some types of unloading devices may be unsuitable).

The latter two points are particularly important for the choice of the proper equipment. It is strongly advised that the lorries, cranes or fork-lifts to be procured are of a type which is currently used in the country and therefore can be easily repaired or replaced.

Since the publication of the OIML Recommendation R 47 it has become more customary to use hydraulic fork lifts for handling test weights. The latter must then be of such a shape as to enable safe lifting and unloading using the fork blades. In other words the choice of the fork lift and the shape of the weights have to be coordinated.

The great advantage is in particular that the transport lorry does not need to be specially constructed but can be of a current type which may also be used for other purposes or may simply be hired. The use of several lorries to increase the calibration capacity can in this case avoid the procurement of a special trailer.

The hydraulic fork lift can be of the current pattern used in warehouses, having a load carrying capacity of 1 000 to 2 000 kg and a lift height suitable for the lorries normally used. Some types of fork lifts may when heavily loaded prove inconvenient to use if the ground is not flat. The fork lift chosen must thus be specially designed for outdoor use (big wheels with pneumatic tyres).

One difficulty with fork lifts is that special provisions have to be made for their transport over long distances. If they are transported on a lorry, loading and unloading can be made using two rails and a winch [1] or by use of an hydraulically operated unloading plate located at the rear of the lorry [2].

Some verification services use for better flexibility simultaneously the two systems: fork lift and crane [20,21].

In some countries (USA and Canada) special battery operated carts (dollies) are used. A special hoist is then used for their loading and unloading on the lorry.

Si l'on tient compte de la non-planéité du sol, on peut préférer limiter les masses à 500 kg et les rendre superposables [6], ce qui également facilite leur stockage. Dans certains pays on a cependant augmenté la valeur des masses à 1 000 kg de façon à accroître la rapidité de la vérification. Ceci est notamment le cas aux Pays-Bas où la manipulation des masses par élévateur à fourche a été introduite très tôt.

Dans le cas où l'on choisit la combinaison camion-grue, il est en général préférable que les masses soient de forme cylindrique de façon à permettre leur roulage à l'endroit exact désiré et ceci en particulier lorsque le camion lui-même doit être utilisé comme charge additionnelle. La grue doit être placée à 1'arrière du camion de façon à augmenter son rayon d'action et permettre d'atteindre les masses de la remorque. De plus il est préférable, pour la flexibilité de l'ensemble, que le camion ait un court écartement d'essieux. Afin de permettre une manipulation plus aisée mais aussi pour la sécurité du personnel, on limite en général la valeur des masses roulables à 500 kg maximum; quelques services utilisent cependant des valeurs plus élevées. En ce qui concerne le rayon d'action de la grue, il faut également tenir compte de la charge et le camion doit souvent être équipé de crics d'immobilisation fixés à l'extérieur des roues arrière de façon à éviter le basculement.

Lorsque la remorque, le camion, ou les deux, sont utilisés comme charges additionnelles, il est nécessaire que les essieux extrêmes soient suffisamment rapprochés afin de permettre la vérification de tous les ponts-bascules. Certains peuvent en effet avoir des tabliers relativement courts même lorsqu'ils sont construits pour recevoir des charges élevées.

Dans certains cas, lorsque les lieux de vérification ne sont pas éloignés du bureau local de métrologie, il peut être possible d'utiliser la remorque comme une masse étalonnée [2,14]. Des précautions doivent alors être prises afin d'éviter l'accumulation d'eau de pluie ou des matières étrangères sur la remorque et le bureau local doit être équipé d'un pont-bascule sensible permettant l'étalonnage ou l'ajustement de la masse de la remorque immédiatement avant chaque vérification.

Encore une fois, l'inventaire des portées et dimensions des ponts-bascules, conditions des routes, réglementations routières et possibilités de maintenance doit permettre de trouver la meilleure solution ou le meilleur compromis en ce qui concerne le choix des moyens de transport et de manipulation des masses de vérification.

On ne doit pas oublier non plus de tenir compte du temps nécessaire pour la vérification en utilisant le type d'équipement choisi.

Construction des masses de vérification

Les masses sont en général fabriquées en fonte. La fonte ductile (alliage contenant un faible pourcentage de magnésium) telle que couramment utilisée pour les tuyaux d'eau de grand diamètre, est également utilisable. Il est en tout cas nécessaire d'éviter des formes présentant des protubérances aiguës qui peuvent facilement se casser. Toute cavité doit être soit largement ouverte de façon à éviter l'accumulation d'eau ou des matières étrangères, soit hermétiquement fermée (avec un scellement de plomb).

Taking unevenness of the ground into account one may prefer to limit the size of weights to 500 kg and to make them suitable for stacking [6] which also facilitates storage.

To speed up the verification operation a number of countries have increased the mass of the standard weights to I 000 kg. This is case in the Netherlands where fork lift handling was introduced quite early.

If a lorry and crane system is chosen, weights should preferably be of cylindrical type so that they can be rolled to the exact location in particular when the lorry itself is used as dead load. The crane should be located at the rear of the lorry in order to provide a long range including the trailer. Furthermore the lorry should in this case have a rather short distance between axles to be more flexible. For reasons of easy handling and safety cylindrical weights are generally limited to a mass of maximum 500 kg although a few services use higher values. Particular attention has to be paid to the operating radius of the crane in relation to the load; the lorry may often have to be equipped with stabilizing jacks fitted outside of the rear wheels so as to avoid tipping over.

When the trailer, the lorry, or both, are to be used as additional loads it is important for the distance between the extreme axles to be short enough to enable all the weighbridges to be verified. Some of these, although designed for heavy loads, may in fact have relatively short platforms.

When the testing sites are located close to the local metrology office it may be possible to use the unloaded trailer as a standard weight [2,14]. Precautions must then however be taken against accumulation of rain of foreign materials on the trailer and the local metrology office must be equipped with a sensitive weighbridge so that all verifications can be immediately proceeded by a calibration or adjustment of the mass of the trailer.

To repeat, an inventory of the weighbridge sizes, road conditions, traffic regulations and maintenance possibilities should indicate the most practical solution as far as the choice of transport and weight handling equipment.

In addition it should also not be forgotten to take into account the time required for the testing of weighbridges using the type of equipment chosen.

Construction of heavy test weights

Heavy test weights are usually made from alloyed cast iron. Ductile cast iron (slightly magnesium alloyed) such as currently used for water and waste water city pipes would also be suitable. Particular attention has to be paid so as to avoid any sharp corners which are likely to break off. Any cavity must either be fully open and designed to avoid accumulation of water or dirt or must be hermetically closed (with lead seal).

Quelques modèles de masses figurent en tant qu'exemples dans la Recommandation OIML R 47. D'autres modèles ont été reproduits dans les annexes à cette brochure, y compris des modèles se prêtant à la manipulation par des élévateurs à fourche. Les dimensions exactes dépendent dans tous les cas de la masse volumique du matériau utilisé et du volume de la cavité d'ajustage, et doivent être trouvées par des expériences pratiques. Les masses superposables doivent avoir des bordures ou broches d'arrêt qui évitent le glissement lorsqu'elles sont inclinées. Certains pays utilisent des masses fabriquées en tôles d'acier. Ces masses sont remplies de ballast et doivent être complètement étanches à l'eau, ce qui exige des essais spéciaux. La protection contre la corrosion peut être réalisée en utilisant une peinture du type epoxy appliquée par projection.

Exactitude des masses de vérification

La règle généralement admise veut que des erreurs maximales tolérées de masses ou poids de vérification soient au moins trois fois inférieures à celles des instruments de pesage à vérifier. Si nous considérons que le service de métrologie doit être en mesure de vérifier des ponts-bascules ayant 5 000 échelons, nous trouvons d'après la Recommandation OIML R 47 que les masses de vérification doivent avoir des erreurs inférieures à 0,01 %, soit 50 g pour une masse de 500 kg.

L'instrument de pesage ou comparateur utilisé pour l'ajustage des masses doit par conséquent présenter un écart-type inférieur à 15 g.

L'étalonnage des masses de forte portée s'effectue en général par étapes successives utilisant Une masse sélectionnée en fonte ou en acier comme étalon de transfert ou simplement par comparaison directe à un jeu de poids de 20 kg (similaires à ceux de la Recommandation OIML R 2). Ceux-ci peuvent à leur tour être rapidement comparés à un étalon secondaire de 20 kg en utilisant une balance électronique à compensation électromagnétique et dont l'écart type peut être très faible, de l'ordre de 100 mg.

Comparateurs de masse

Les étalons de forte portée jusqu'à 1 000 kg sont généralement étalonnés au laboratoire central du pays au moyen de balances à fléau dont la précision peut être très élevée. Comme il ne reste que très peu de constructeurs de ces balances mécaniques, les services de métrologie doivent de plus en plus s'orienter vers des solutions de pesage électroniques.

Si le pays est grand, il s'avère souvent nécessaire de conserver des jeux de masses de vérification dans différentes localités du pays afin de réduire les transports. Leur vérification périodique doit cependant avoir lieu au moins une fois par an.

Afin d'éviter la nécessité de transporter toutes les masses de vérification au laboratoire central, plusieurs services de métrologie assurent le raccordement à l'aide d'un étalon de 500, 1 000 ou parfois seulement de 20 kg et utilisent des comparateurs de masse pour ajuster ou vérifier les autres masses sur leur lieu de stockage (ou bureau local).

A few typical designs of such weights are shown as examples in the OIML Recommendation R 47. Some other designs are included with this note including more recent ones suitable for use with fork lifts. The exact dimensions will, in all cases, depend on the density of the material available, the size of the adjustment cavity, etc. and may have to be found out by trial and error. Weights which can be stacked must have stops to prevent them from sliding when inclined. Some countries use weights made from thick welded steel plates. Such weights are filled with ballast and must be made completely watertight; this may require special testing.

Corrosion protection can be accomplished by using special epoxy paints which are applied by spraying.

Accuracy of the test weights

The generally accepted rule is that the maximum permissible errors of the weights used for verification must be at least three times smaller than those for the weighing machine to be verified. If we consider that the metrology service must be able to test weighbridges with up to 5 000 scale divisions We find from OIML Recommendation R 47 that the weights used shall have errors less than 0.01 %, or 50 g for a 500 kg weight.

The platform machine or other mass comparator used for the adjustment of the heavy weights shall thus have a standard deviation less than 15 g.

The calibration of heavy Weights is usually done in successive steps using a selected weight of cast iron or a standard weight of steel as transfer device or simply by direct comparison to a stack of 20 kg weights (similar in design as those of OIML R 2). These may in turn be rapidly compared to a 20 kg secondary standard using an electronic top-pan balance with electromagnetic compensation which may have a standard deviation as low as 100 mg.

Mass comparators

Heavy secondary mass standards up to 1 000 kg are usually calibrated in the central laboratory of the country using beam balances allowing very high accuracy. As there are nowadays very few manufacturers of these mechanical balances metrology services must however more and more adopt solutions incorporating electronic weighing devices for such purposes.

If the country is large, it is necessary to store sets of test weights in various places in the country to reduce travel. Special consideration must then be given to the necessity for periodic (yearly) verification of these weights.

In order to avoid the necessity of bringing all the test weights to the main laboratory, several metrology services assure the traceability by the use of one standard of 500, 1 000 or sometimes only 20 kg and adjust or verify the test weights at their storage location (or local metrology laboratory) by means of mass comparators.

Ceci peut dans bien des cas s'effectuer par substitution successive en utilisant une cellule de charge installée dans une grue de levage et connectée à un indicateur de contrainte à affichage digital ayant une résolution suffisante (10^5 échelons ou plus). Afin de réduire la dérive de la cellule, il est nécessaire d'effectuer les lectures de l'affichage toujours au même moment après gué la masse ait été soulevée de son support (par exemple après 40 s). Les observations ne doivent commencer qu'après avoir fait subir a la cellule de charge au moins trois épreuves à pleine charge (par similitude à la méthode employée pour l'étalonnage de cellules de charge et de dynamomètres).

Un comparateur de masse de 500 kg utilisant ce principe et comprenant une cellule de charge de construction spéciale, une grue de levage et un dispositif automatique d'affichage de contrainte à mémoire a été construit pour le service national suédois de métrologie. La grue et une masse étalon de 500 kg sont montées sur une petite remorque. Par ce moyen, l'étalonnage des masses peut s'effectuer avec une sensibilité de quelques grammes en utilisant des comparaisons successives. La grue comportant la cellule de charge doit cependant être placée de façon à éviter le vent, l'ensoleillement direct ou des gradients importants de température [30].

Un comparateur de masse d'un type particulier a été construit aux Etats-Unis d'Amérique, dans lequel l'influence de la dérive de la cellule de charge a été réduite en maintenant la charge entre les substitutions de masses, à l'aide d'un ressort. Selon Schoonover [29], des masses de 500 lb (225 kg) ont ainsi pu être comparées avec une répétabilité de $\pm$ 2.10^{-6}.

Des comparateurs de masse ayant des capacités de 20 à 2 000 kg et comportant des cellules de charge sont également utilisés en URSS [32]. Le service de métrologie d'Autriche a également adopté cette méthode [31].

Pour répondre aux besoins des différents services de vérification, certains fabricants de balances électroniques ont mis au point des comparateurs de masse comportant un récepteur de charge à plateau et un système d'affichage à très haute résolution mais travaillant dans une étendue de mesure limitée [33]. Afin d'atteindre le maximum de précision, il est nécessaire d'installer ce type de comparateur de masse dans un environnement de température stable et sans courants d'air. Il faut également Veiller à chaque substitution au centrage du point de gravité des masses sur le plateau récepteur de charge.

Des instruments de pesage basés sur le principe gyroscopique sont également utilisés comme comparateurs de masse de 500 ou de 1 000 kg par plusieurs services régionaux de métrologie en Allemagne et au Royaume-Uni [34].

In many cases this can be done by successive substitution using a high quality crane load cell connected to a commercial digital strain indicator of sufficient resolution (10^5 divisions or more). To reduce the influence of creep in the load cell it is necessary to read the strain indicator always at the same moment after the load has been lifted off the floor (for instance after 40 seconds). The operation should start by full load of the cell at least three times before the start of the actual comparison (by similarity with the practice in calibrating load cells and proving rings).

A 500 kg mass comparator using this principle and comprising a special load cell, a small crane and an automatic strain-indicator with timer and memory has been constructed for the Swedish metrology service. The hydraulic crane and one standard weight of 500 kg are mounted on a small trailer. Calibration of test weights down to a few grammes or better seems to be possible with this method using successive comparisons. The crane-load cell device must however be placed so as to avoid wind, direct sunshine or significant temperature gradients [30].

A special load cell mass comparator has been developed in USA in which the influence of load cell creep is decreased by maintaining the load with the aid of a spring between the substitutions of the weights. It has been reported by Schoonover [29] that 500 pound weights (225 kg) could in this way be compared with a repeatability of $\pm\ 2.10\text{-}^{6}$.

Mass comparators in the range of 20 to 2 000 kg using crane load cells are also available in the USSR [32]. The Austrian metrology service has also adopted this method [31].

Responding to the needs of verification services, a few manufacturers have recently made adaptations of their current productions of electronic platform weighing machines by incorporating very high resolution displays for mass substitution measurements within a narrow range [33]. In order to obtain the highest accuracy this type of mass comparator must be installed in a stable temperature environment protected from air draught. Furthermore special attention must be paid to the centering of the effective loading point of the weights at each substitution.

Weighing machines based on the gyroscopic principle are also used as mass comparators for 500 and 1 000 kg weights by several local metrology services in Germany and the United Kingdom [34].

Mode opératoire de vérification des ponts-bascules routiers

Comme cela a déjà été dit, il n'est en général plus possible avec les constructions modernes de ponts-bascules d'utiliser des méthodes de vérification qui font intervenir des charges d'essais qui n'atteignent que 10 à 20 % de la portée des bascules à vérifier.

La portée des ponts-bascules peut cependant souvent être supérieure aux charges d'essai dont on dispose et il est maintenant fréquent d'installer des ponts-bascules d'une capacité de 50 ou 60 tonnes. En règle générale, on considère qu'il faut alors effectuer la vérification jusqu'à une charge légèrement supérieure à la charge statique pour laquelle le pont-bascule est habituellement utilisé en tenant compte par exemple de la réglementation routière (qui, selon le pays, souvent limite le poids total des véhicules à moins de 40 tonnes).

Comme exemple de description de la procédure de vérification d'un pont-bascule dans ces conditions/ nous indiquons ci-dessous, en abrégé, le mode opératoire décrit dans la réf. [1] pour une portée limitée à 40 tonnes d'un pont-bascule à tablier relativement long (16 m) permettant d'utiliser en même temps le camion et la remorque en tant que charges additionnelles:

1. Inspection visuelle du pont-bascule, contrôle du zéro, de la mobilité et de la fidélité à vide.
2. Essais avec 10 t sur les points d'appui du tablier.
3. Contrôle (répété) du zéro. Essais à charge croissante de 0 à 20 t.
4. Mêmes essais à charge décroissante.
5. Le camion et la remorque sont conduits sur le tablier et la masse totale est ajustée pour indiquer exactement 20 t.
6. Essais à charge croissante de 20 t à 40 t.
7. Mêmes essais à charge décroissante.
8. Déchargement du tablier.
9. Contrôle du zéro.
10. Embarquement de masses sur la remorque et sur le camion, prise de notes pour le rapport de vérification.

La durée totale pour la méthode ci-dessus a été indiquée comme étant de 3 heures en utilisant des masses de 1 tonne. Ceci nécessite bien entendu que le pont-bascule ait été entièrement nettoyé et mis au point avant la vérification de façon à éviter toute perte de temps inutile.

Développements possibles dans l'avenir

La tendance actuelle d'accroître la capacité des ponts-bascules augmente les difficultés des services de métrologie à fournir des moyens adéquats de vérification. A ceci s'ajoute l'introduction des ponts-bascules électroniques pour lesquels il n'est plus possible d'utiliser des méthodes simplifiées de vérification. Ces derniers peuvent, de plus, exiger des vérifications plus fréquentes. Il faut conseiller aux fabricants de tels ponts-bascules de les équiper de moyens de contrôle (automatiques ou manipulés par l'opérateur) qui peuvent être vérifiés par le service de métrologie.

On doit signaler également la possibilité de surveiller la maintenance des bascules électroniques par l'utilisation d'un semi-remorque qui est étalonné sur un pont-bascule précédemment vérifié [2,14].

Weighbridge testing procedures

As previously mentioned it is in general no longer feasable to use with modern weighing equipment test methods which only involve a maximum test load up to 10 or 20 % of the capacity of a weighbridge.

The weighbridge capacity may however in many cases be higher than the amount of available test load and reach frequently 50 or 60 tonnes for a road weighbridge. As a general rule the tests must then be made at least up to a load which is slightly higher than the maximum static load for which the weighbridge is normally being used taking into account for instance the traffic regulations (which depending on the country generally limit the maximum weight of transport vehicles to less than 40 tonnes).

As a typical description of an acceptable procedure for testing a weighbridge under these conditions we are reproducing a free translation of the test procedure described in ref.[l] for a maximum capacity of 40 tonnes and a weighbridge with a relatively long platform (16 m) allowing the use of both lorry and trailer as dead loads:

1. Visual inspection of the weighbridge and its operation including verification (or adjustment) of zero, its ability to react to small changes of load (discrimination) and the repeatability of indications at no load.
2. Tests with a load of 10 tonnes at each of the support points of the platform (corner tests).
3. Checking of zero. Tests with increasing load from 0 to 20 tonnes.
4. The same tests with decreasing load.
5. The available dead load (lorry and trailer) is brought on the platform and adjusted to exactly 20 tonnes.
6. Tests with increasing load from 20 to 40 tonnes.
7. The same tests with decreasing load.
8. Unloading of the platform.
9. Checking of zero.
10. Loading the weights into the lorry, drafting of the test report.

The total time for the above routine is stated to take 3 hours using 1 tonne weights. It is evident that this requires the weighbridge to be fully cleaned and serviced before the tests so as to avoid any unnecessary loss of time.

Possible future developments

The tendency to increase the capacity and size of weighbridges has made it more difficult for metrology services to provide for adequate verification facilities. The introduction of electronic weighbridges using load cells has added to this difficulty since certain simplified test methods can no longer be applied. Furthermore, electronic weighbridges may require more frequent calibrations. It is advisable that manufacturers of such weighbridges provide them with suitable calibration check facilities (either automatic or operated by the user) which, in turn, may be verified by the legal metrology service.

Supervision of the maintenance of electronic weighbridges may be accomplished by use of a heavy loaded trailer which is calibrated on a previously verified weighbridge [2,14].

Le coût des masses de vérification et de leur transport jusqu'aux lieux où sont installés les ponts-bascules est élevé et on a, dans le passé, proposé plusieurs moyens moins onéreux comme par exemple l'utilisation de leviers, pistons hydrauliques, etc. L'utilisation de vérins hydrauliques pour appliquer les forces et de cellules de charge transportables pour les mesurer a été essayée en Suède en s'inspirant des travaux effectués en Hongrie pour la vérification de dispositifs de mesure de la charge à l'essieu [36,37].

Des essais de ce même système de vérification ont également été effectués en Allemagne par le fabricant de ponts-bascules Schenck [38].

Dans ce cas, il sera cependant nécessaire que les ponts-bascules soient pourvus de trous convenant à la fixation des dispositifs d'étalonnage. De plus, les cellules de charge utilisées doivent être étalonnées fréquemment au laboratoire central, ce qui demande l'accès à un banc d'étalonnage à masses suspendues d'une capacité d'au moins 200 kN. (L'utilisation des cellules de charge comme simples comparateurs de masses lorsque celles-ci sont approximativement égales, ne nécessite bien entendu pas la présence de cet équipement coûteux).

Description des équipements utilisés

Nous avons, sur les pages suivantes de cette brochure, reproduit (en anglais) des informations actuellement disponibles au BIML concernant l'équipement existant dans quelques pays pour la vérification des ponts-bascules. Ces informations ne sont bien entendu pas complètes puisque seulement quelques services de métrologie y sont représentés. Les techniques sont cependant plus ou moins les mêmes et nous espérons que cette sélection permettra d'apporter quelque aide aux autres services de métrologie projetant de s'équiper.

Quelques fournisseurs d'équipement spécialisé ont également été indiqués. En ce qui concerne le matériel de transport tel que camions, remorques, élévateurs à fourche, grues, etc., les fournisseurs sont cependant trop nombreux et il convient plutôt de consulter les ressources locales.

The costs of heavy weights and their transportation to the testing site are high and several less expensive means have been proposed in the past such as the use of levers, hydraulic pistons etc. The use of force application through hydraulic jacks and measurement by transportable load cells will be experimented with in Sweden using as a point of departure the methods developed in Hungary for the verification of axle scales [36,37].

Tests of this method of verification have also been made in Germany by the weighbridge manufacturer Schenck [38].

In this case, however, weighbridge installations will have to be made so that the transportable calibration devices can be fitted into suitable fixing holes. Furthermore such load cells will have to be frequently calibrated at the central laboratory requiring the availability of a dead load machine with a capacity of at least 200 kN. (The use of load cells as simple mass comparators for approximately equal weights as mentioned in the previous chapter does of course not require any expensive calibration machines).

Description of equipment used

On the following pages we are reproducing in a condensed form the information presently available at BIML concerning existing equipment for the verification of road weighbridges in some countries. This information is by no means complete as only a few countries are represented. The technologies are however more or less the same and it is hoped that this selection may provide some help for those metrology services which are planning to equip themselves.

A few international suppliers of specialized equipment are listed. As regards adaptable lorries, trailers, forklifts, cranes etc. suppliers are, however, too numerous to be included and local sources of supply will have to be consulted.

DESCRIPTION OF EQUIPMENT

TYPICAL SPECIFICATIONS of MASS COMPARATORS for CALIBRATION of HEAVY WEIGHTS

Load capacity:	minimum 1100kg
Discrimination (or scale interval):	equal or less than 10 g
Standard deviation:	less than 15 g
Pan or platform size (fixed installations):	minimum 700 x 700 mm

For fixed installation in a laboratory

alternative A. Equal-armed balance designed for transposition of the load from one arm to the other through rotation of the beam or otherwise [26]

Transposition balances according to a design by Russell have been supplied by

Henri Tromner Inc.
6825 Greenway Avenue
Philadelphia Pa 19142
USA

Voland Corporation
5 Skyline Drive
P.O. box 1002
Hawthorne N.Y. 10532
USA

Other equal-armed balances of high capacity have been supplied by

Carl Schenk GmbH
Landwehstrasse 55
D- 6100 Darmstadt
Germany

International Steel
2880, Diab
Ville St-Laurent
Québec H4S 1M7

Chyo Balance Corporation
376-2 Tsukiyama- cho
Kuze, Minami-ku
Kyoto
Japan

alternative B. Platform weighing machine for comparison of equal weights by successive substitution, mechanical balancing by drop-weight or steelyard system [28], manufactured by

Avery Export Limited
Smethwick
Warley, West Midlands B66 2LP
United Kingdom

alternative C. Electronic platform weighing machine with partial electromagnetic compensation specially constructed as mass comparator [33], manufactured by Sauter, Germany (a Mettler subsidiary company) and supplied internationally by distributors of Mettler balances

alternative D. Weighing machine based on the gyroscopic principle specially constructed for comparison of heavy weights [34] , manufactured by
Wohwa GmbH
D-7114 Pfedelbach
Germany

alternative E. Specially constructed platform machine based on the principle of vibrating strings, manufactured by
Pesa Waagen AG
Industriestrasse 6
CH-8618 Oetwil am See
Switzerland

Transportable mass comparators

alternative F. Special load cell mounted in a hydraulically operated crane lifting device for comparison of heavy weights by successive substitutions [29,30,31,32]
For information about these transportable mass comparators write to
- SP, attention H. Källgren
P.O. Box 857, S-501 15 Boras
Sweden
-NIST, attention R.M. Schoonover
Office of Weights and Measures
Gaithersburg, Maryland 20899
USA
-SNIIM, Siberian State Scientific Research Institute
of Metrology
4 Dimitrov Prospekt, 630099
USSR
-Bundesamt fur Eich- und Vermessungswesen
Arltgasse 35, Postfach 20, A-1163 Wien
Austria

SPECIFICATIONS for LORRIES and TRAILERS

The specifications must take into account accessibility of the weighbridges, prevailing road conditions and traffic regulations with respect to heavy load carriage.

Fork lift operated weights can generally be transported by lorries and trailers of any conventional design which may simply be hired for this purpose if weighbridge verification is not a daily task.

Crane operated weights generally require a specially designed lorry, preferably with an independent power supply for the crane. The latter should be placed at the rear of the lorry for greater flexibility. The crane may require the use of stabilizing jacks on each side of the vehicle.

When vehicles are to be used as dead load it should be checked that the length between extreme axles does not exceed the length of the platforms of existing weighbridges. Some metrology services use hydraulic jacks placed behind the front wheels of the lorry to enable lifting of the wheels off the ground and thus, when needed, shorten the distance between the loading points. In this case it is necessary for the jacks to be provided with large studs in order to prevent damage to the weighbridge platform.

All means of transportation are subject to heavy wear and tear and should be of a design which can be easily maintained in the country of use.

The following tables summarize available information about test weight vehicles used in some countries. Details about trucks and cranes used may be found in the references.

EXAMPLES OF WEIGHBRIDGE TEST EQUIPMENT

Country and Year	Reference	Type of main weights	Lorry load tonnes tare	Lorry load tonnes weights	Trailer load tonnes tare	Trailer load tonnes weights	Total calibration capacity including tare, tonnes
Fork lift operated weights							
Netherlands (1974)	1	B - 1000 kg	12+2.2*	8	6.8	16	40
Belgium, > 20 t (1990)	2	B - 1000 kg	11+3*	11	5	14	44
Cuba (1985)	3	B - 1000 kg	separable tractor		14.8+3.8*	25	43.6
Germany, GDR (1977)	4	B - 1000 kg	conventional lorries				(any)
Quensland, Australia (1981)	5	B - 500 kg	"				"
Sweden (1990)	6	B - 500 kg	"				"
Crane operated weights							
South Australia (1981)	7	C - 500 kg B - 1000 kg	14.5	15.5	3.5	7	40.5
Austria (1990)	8	B - 500 kg	8.5	8.1	-	-	16
Belgium, < 20 t (1990)	9	C - 500 kg C - 200 kg	8	6	-	-	14
Denmark	10	B - 1000 kg	13.2	11	6	16	46.2
Germany							
Berlin (1962)	11	C - 500 kg B - 500 kg	short lorry with crane		4 8.5	8 21.5	12 30
Bremen (1981)	12	C - 500 kg	11	8	10	21	50 + 15 (water)
Schleswig-Holstein (1981)	13	C - 500 kg	12.5	9.5	4.5	11.5	38 (60 with additional weights)
Nordrhein-Westfalen (1980)	14	C - 500 kg	12	10	10	10	42
Rheinland-Pfalz (1989)	15	C - 500 kg	13	13	6.5	17.5	50
Spain (1990)	16	B - 500 kg	9	10.5	4	10	33.5
Switzerland (1990)	17	C - 500 kg	13.2	15.1	-	-	28.3

Cheshire	18	C - 500 kg B - 1000 kg		18	-	-	18 (weights only)
Norfolk	18	C - 500 kg			-	-	30
Strathclyde	18	C - 500 kg	14	16	-	-	30
Birmingham	18	**C - 500 kg B - 1000 kg	articulated vehicle with separable tractor unit		16.5	21	37.5
Kent	18	**C - 500 kg B - 1000 kg	"			19	38
Shropshire	18	C - 500 kg	"			19	38
Northumberland	18	**C - 500 kg B - 1000 kg	"				38
West Yorkshire	19	**C - 500 kg B - 1000 kg	"			20	38
<u>Fork lift and crane operated weights</u>							
Hampshire	20	B - 1000 kg	"			18	38
Somerset	21	B - 500 kg	13	14	-	-	14 (weights only)
<u>Supervision test trailer calibrated on laboratory weighbridge</u>							
Belgium (1991)	2	[C - 5000 kg]	articulated vehicle with separable tractor unit		7	30	37
<u>Special systems using carts or dollies</u>							
USA, General Body Co (1978)	22	B - 1000 lb		10000 lb	sealed 2000 lb electric cart		12 000 lb (weights and cart)
USA, Tromner Co, weights (1978)	23	B - 2500 lb		-	-		-
USA, Seraphin Co (1981)	24	B - 5000 lb		21500 lb	sealed 5000 lb battery operated cart		26 500 lb (weights and cart)

Note : B = block weights C = cylindrical rollable weights
* = weight of forklift
** = roller weights with self-balancing handle to maintain it vertical

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Fork lift operated weights and equipment

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7 - Information concerning South Australia given in enclosure to letter to BIML dated 15 April 1981 from the National Standards Commission, Australia

8* - Information received by BIML from Bundesamt fur Eich- und Vermessungswesen, Vienna in September 1990

9* - Belgium: Test unit for weighbridges below 20 t

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18* - Information supplied by the Local Authorities Coordinating Body on Trading Standards (LACOTS) in a letter to BIML of 20 October 1990. Extracts for Birmingham, Kent and Northumberland are reproduced in this booklet

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31* - Mass comparators used by the Bundesamt für Eich- und Vermessungswesen, Austria (1990)

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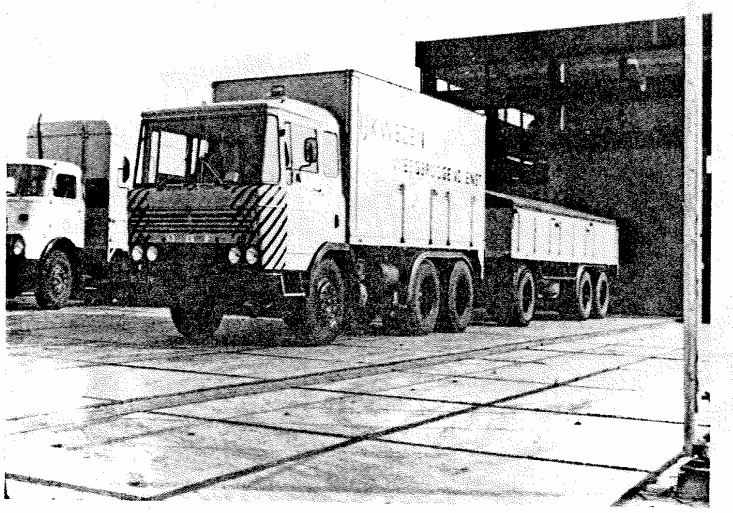
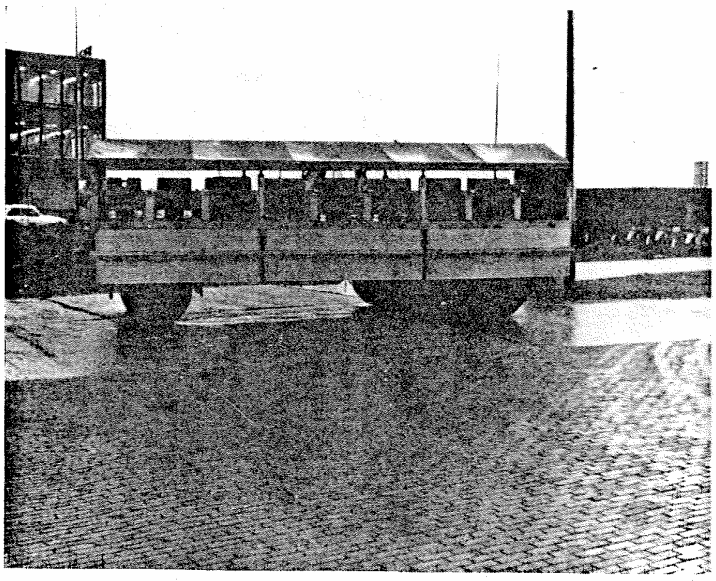


Tracting lorry

Make DAF, Eindhoven. Diesel engine 230 CV
Dead load empty 12 000 kg. Carrying 8 x 1 000 kg test weights and one fork lift (2 200 kg).
Three axles including two driven rear axles.
Maximum speed 80 km/h. Ten tyres 1100 x 20. Air brakes.
Length 6.95 m. Width 2.5 m. Height 3.26 m.



Trailer

Make DAF, Eindhoven. Dead load empty 6 800 kg. Carrying 16 x 1 000 kg weights and two boxes of other weights.
Chassis with three axles. Twelve tyres 1 000 x 20. Air brakes.
Length 8.85 m. Width 2.50 m. Height 2.32 m.

Ref 1

Netherlands

Hydraulic fork lift

Make Clark, gasoline engine. Total weight 2 200 kg. Four air tyres. Lifting capacity 1 000 kg. Lift height 2.25 m.

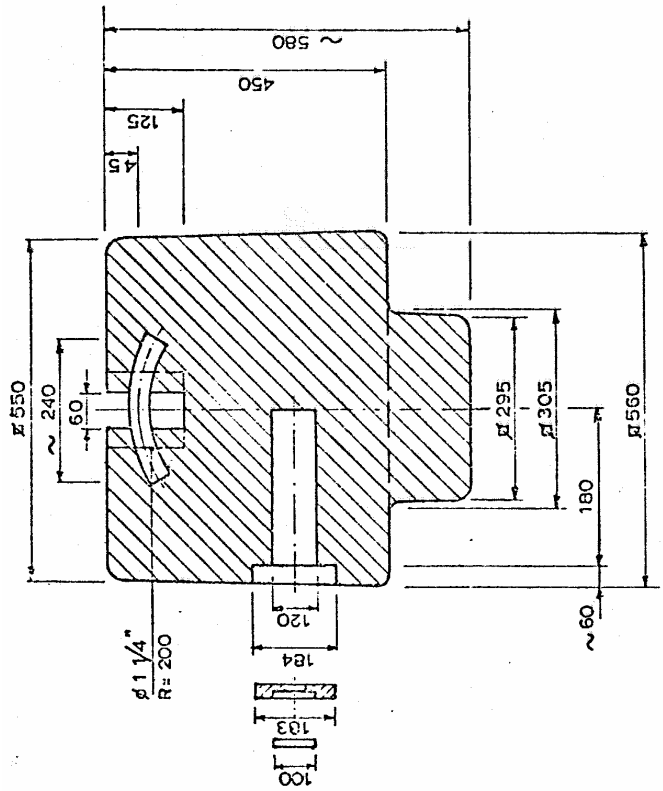
Preparation for corner test

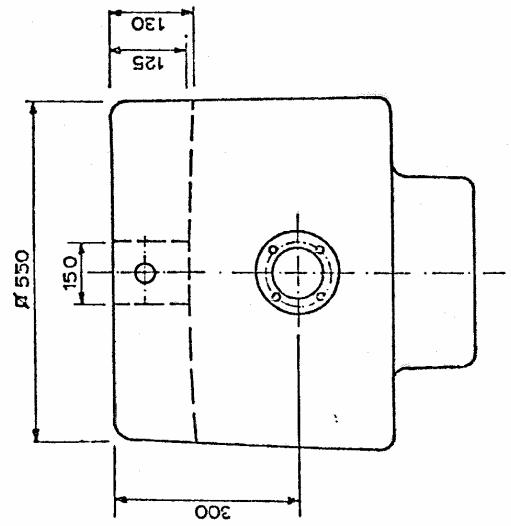
(for more details about the equipment, see Bulletin OIML No 54, 1974)

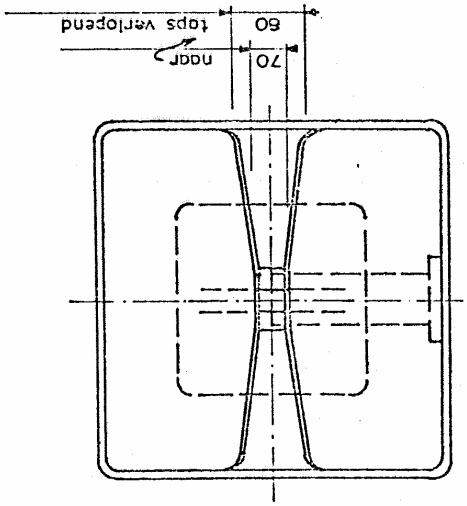
Ref 1
Netherlands
1 000 kg weights

IJKGEWICHT Gij

schaal 1:10

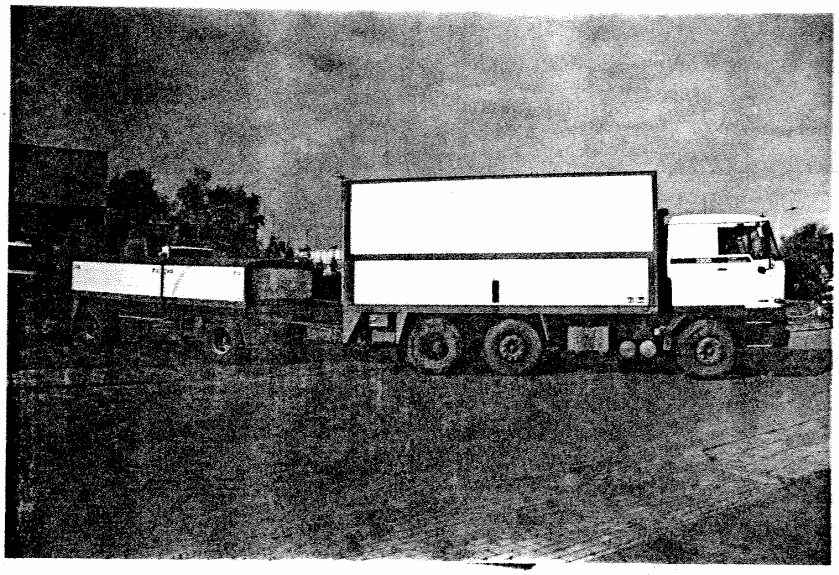


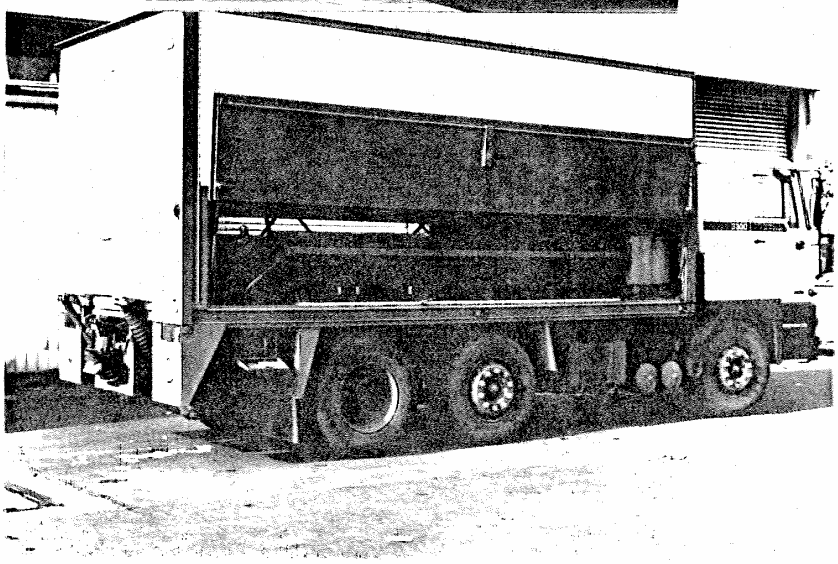




Ref 2
Belgium
(1990)

TEST UNIT FOR WEIGHBRIDGES UP TO 44 t





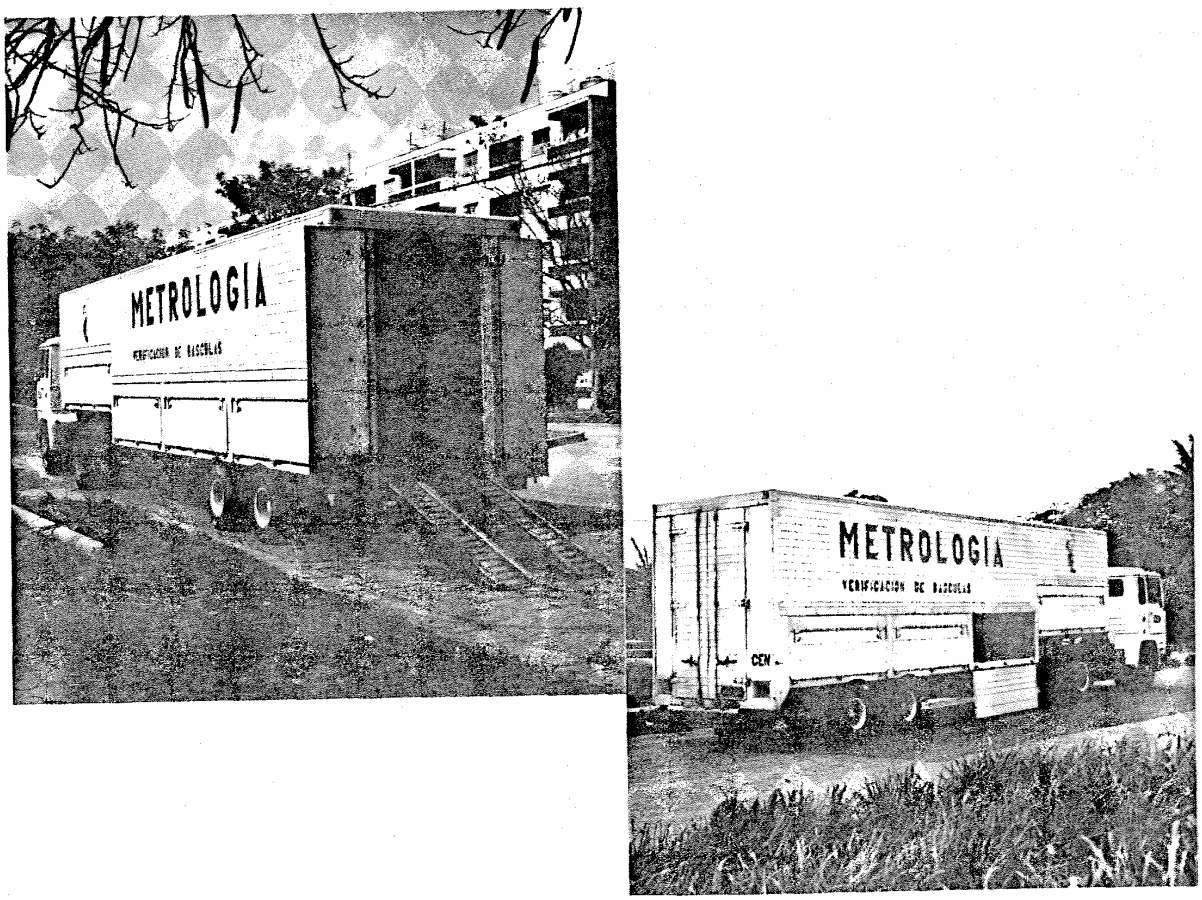


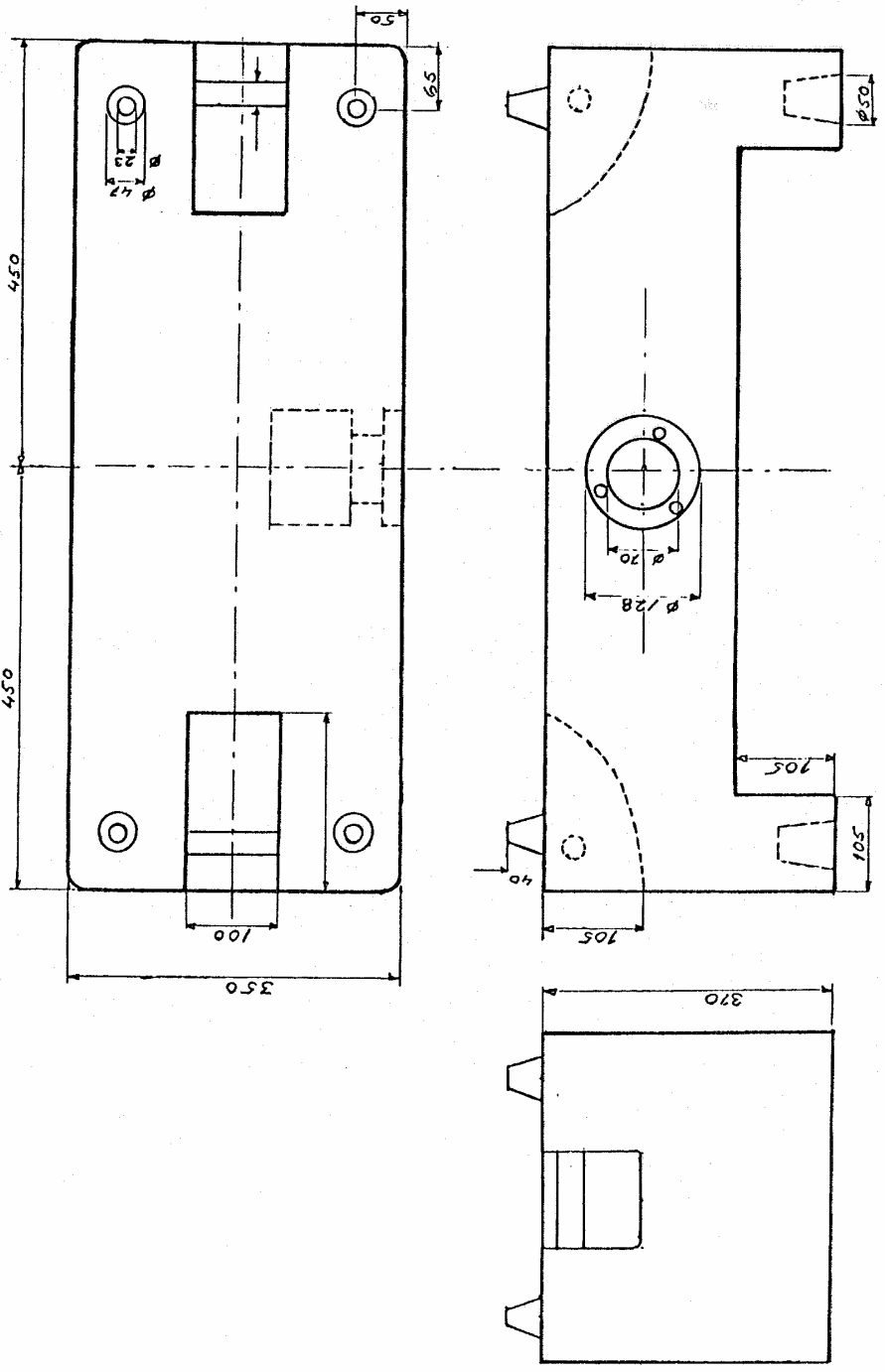
Fig. 1 — Mobile mass laboratory comprising a lorry carrying 1 000 kg test weights which can be unloaded from the side using a fork lift

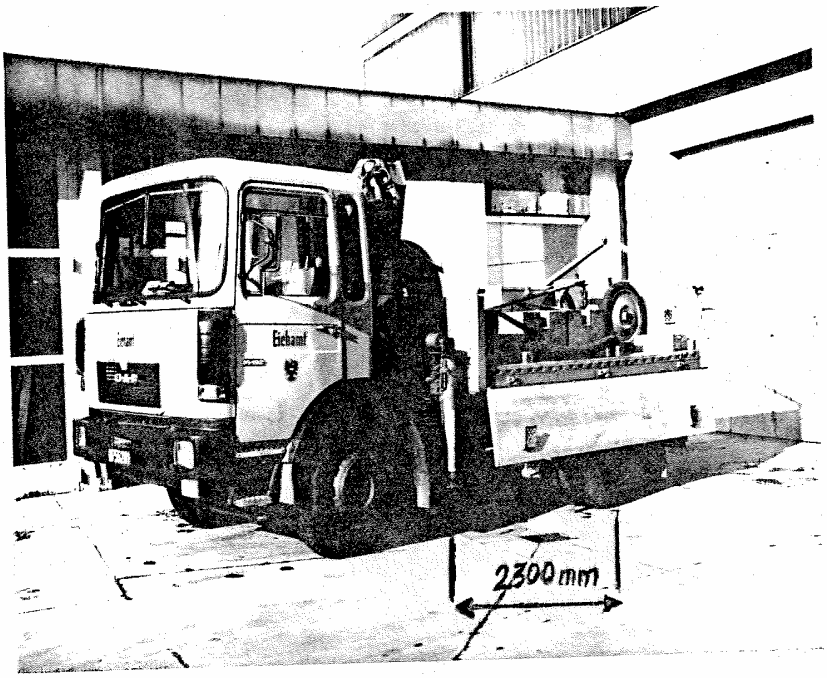
Table 1 — Weights carried by the mobile mass laboratories

Quantity of Standard test weights	Nominal Value	Maximum permissible error
24	1 t	± 100 g
50	20 kg	± 1 600 mg
2	10 kg	± 800 mg
2	5 kg	± 400 mg
2	2 kg	± 160 mg
2	1 kg	± 120 mg
2	box of 1 to 500 g	± (80 to 4 mg)

Ref 6
Sweden
(1990)

500 kg WEIGHTS FOR USE WITH FORK LIFTS



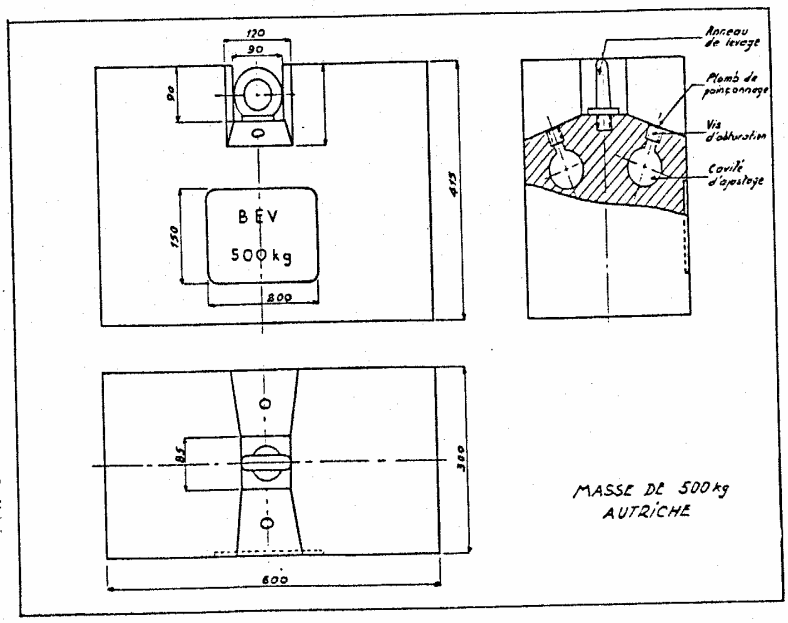


The Austrian verification service uses the following equipment for the verification of road weighbridges:

Lorries: Extra short lorries, length 6 m, width 2.5 m, height including crane less than 3.1 m, total load 16 t, pay-load 8.5 t (slightly more than half of the total load), equipped with a crane, capable of handling 500 kg-weights. Manufacturer: e.g. Gräf & Stift AG, Wien, or Steyr Daimler Puch, Wien

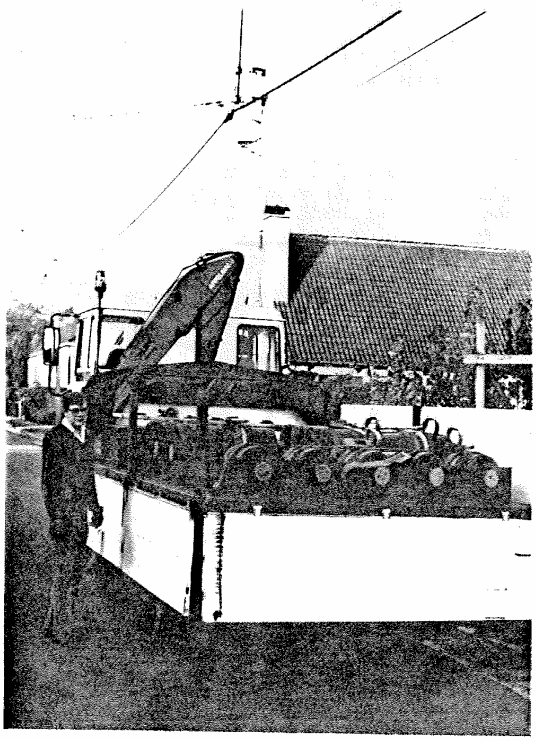
The lorry is equipped with supports (in connection with the crane) that enable to position it crosswise on a weighbridge with width more than 2 300 mm so that up to six lorries can be placed on one big weighbridge. Typically a lorry is loaded with sixteen 500 kg-weights and twenty-five 20 kg-weights.

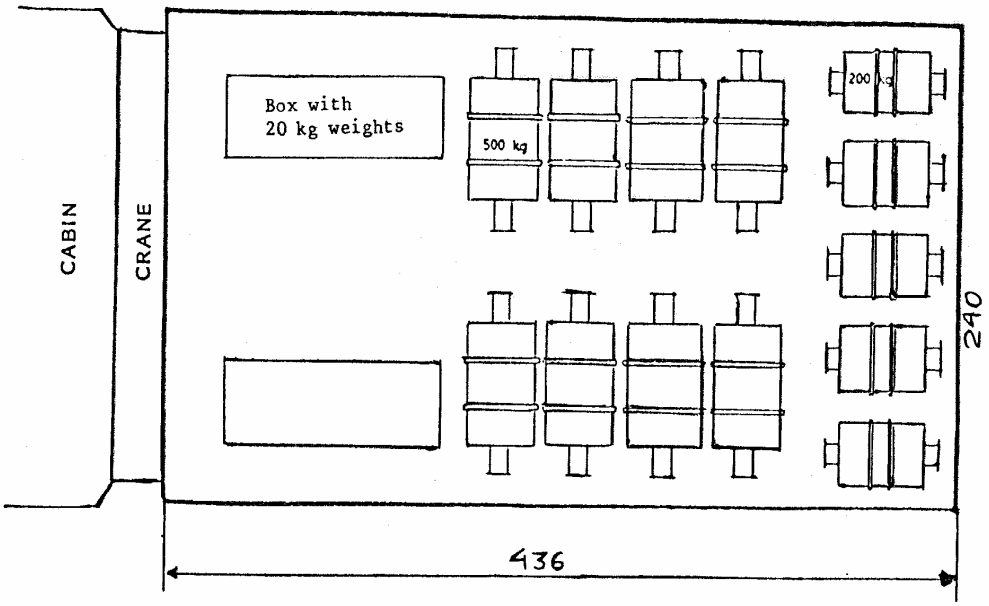
Weights: 500 kg weights, as below or similar



Ref 9
Belgium
(1990)

TEST UNIT FOR WEIGHBRIDGES BELOW 20 t





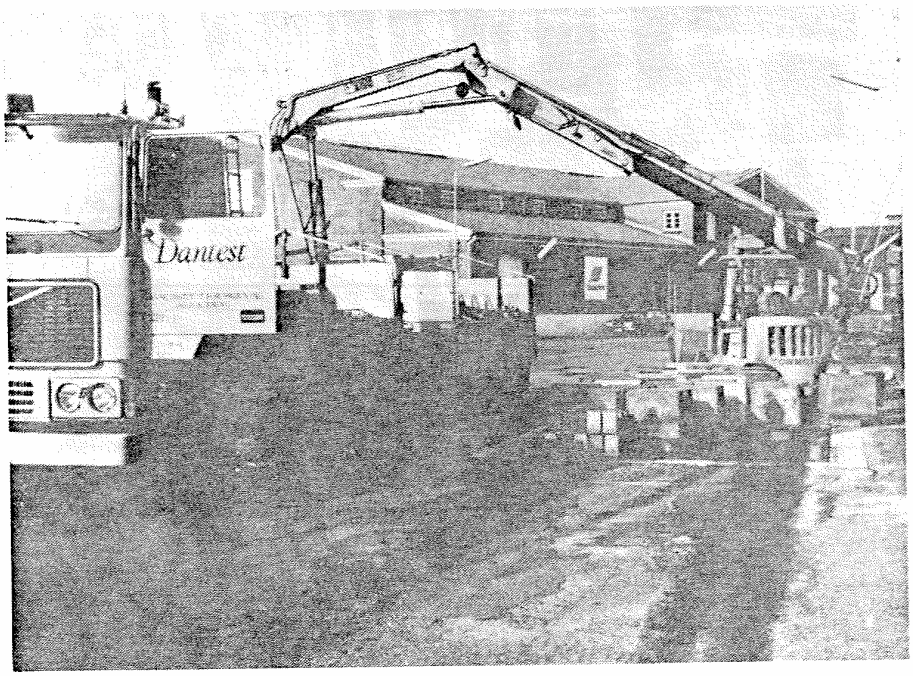
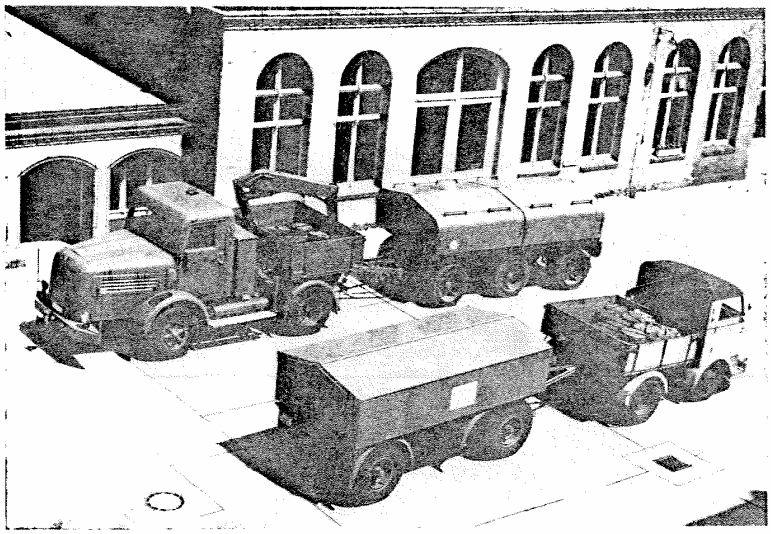


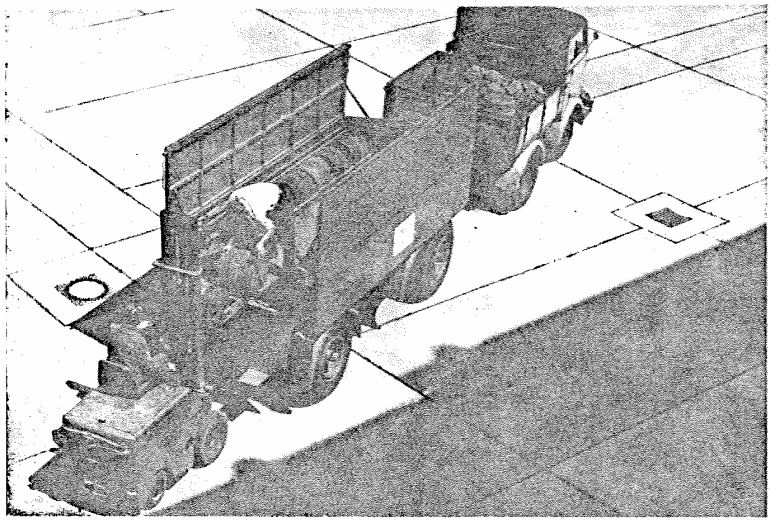
Fig. 1 — Calibration of a weighbridge by use of DANTEST's special type test vehicle.

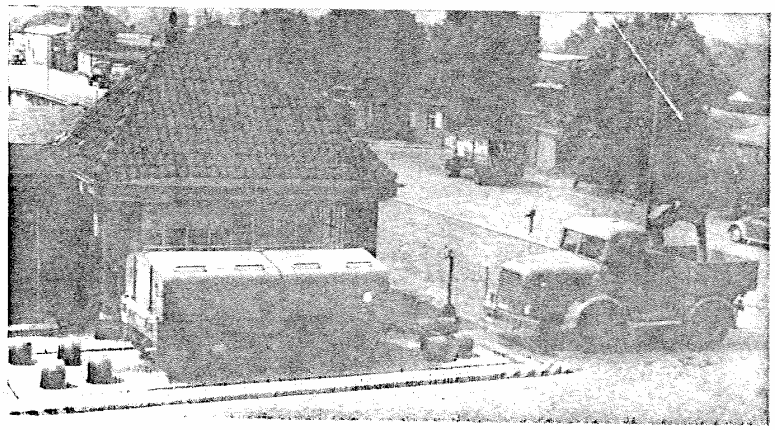
Fig. 2 — The special design of the weights is an important condition for quick operations with the hydraulic crane.

Ref 11
Berlin
(1962)



for details see Bulletin OIML No 9, September 1962

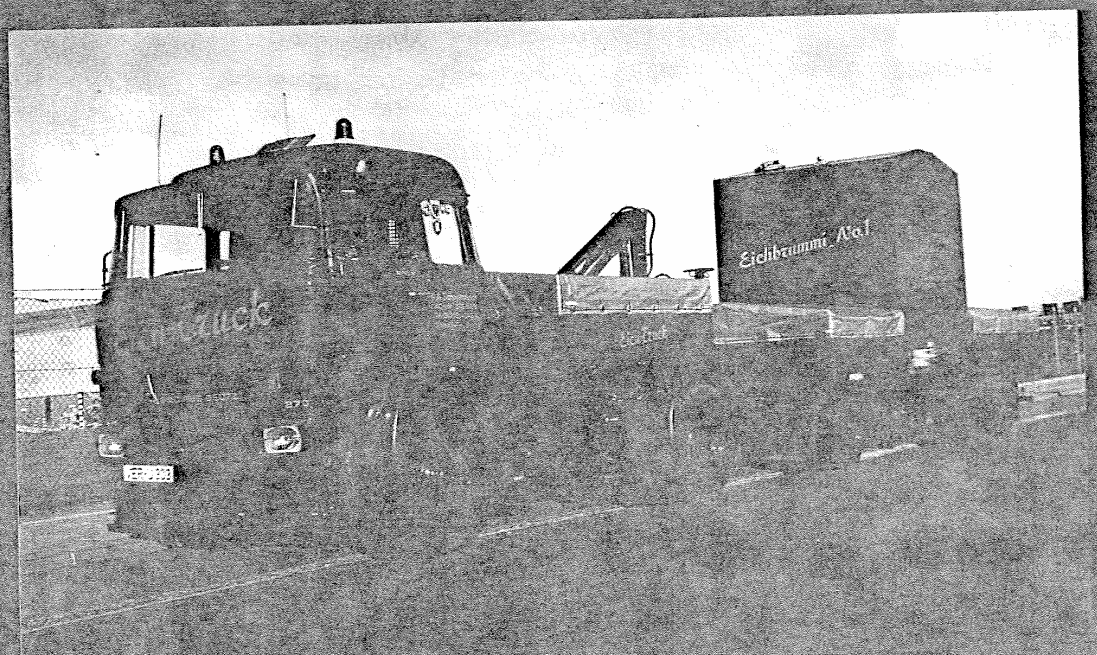


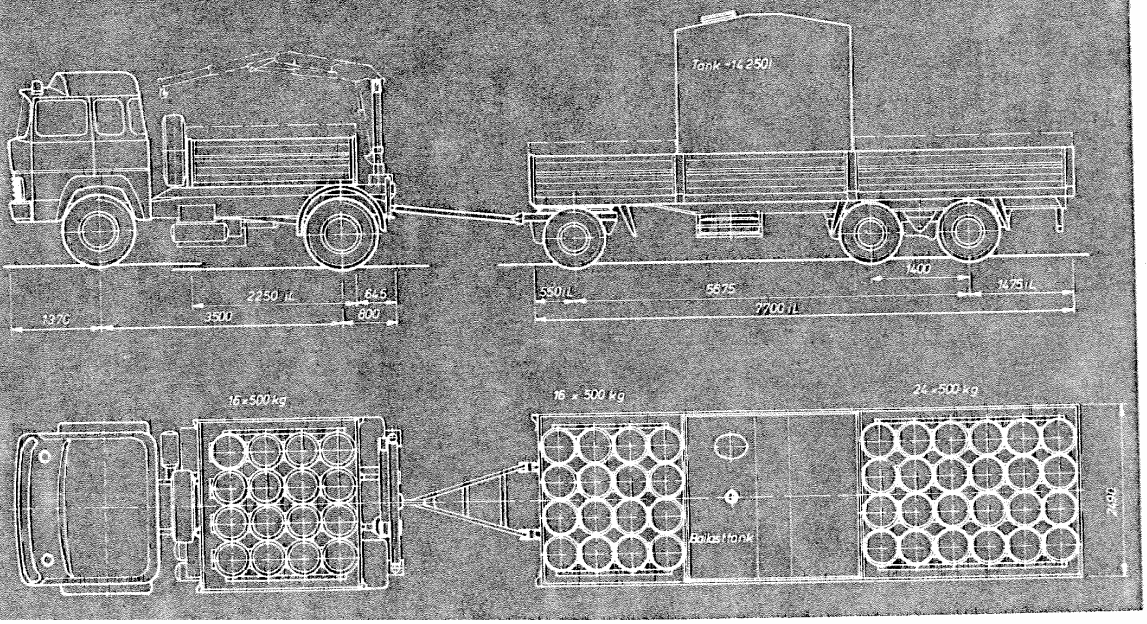


Ref 12
Bremen
(1981)

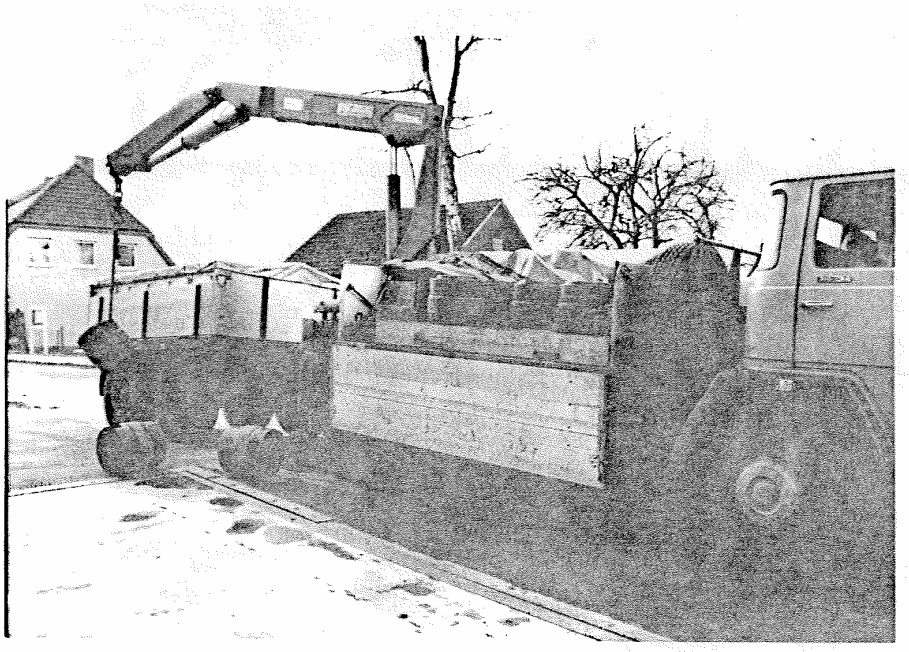
Eichfahrzeug

Unter Aufsicht der Landeseichdirektion Bremen
Zur Eichung und Überprüfung von Straßen-Fahrzeugwaagen
mit einer Höchstlast bis 60.000kg und mehr.

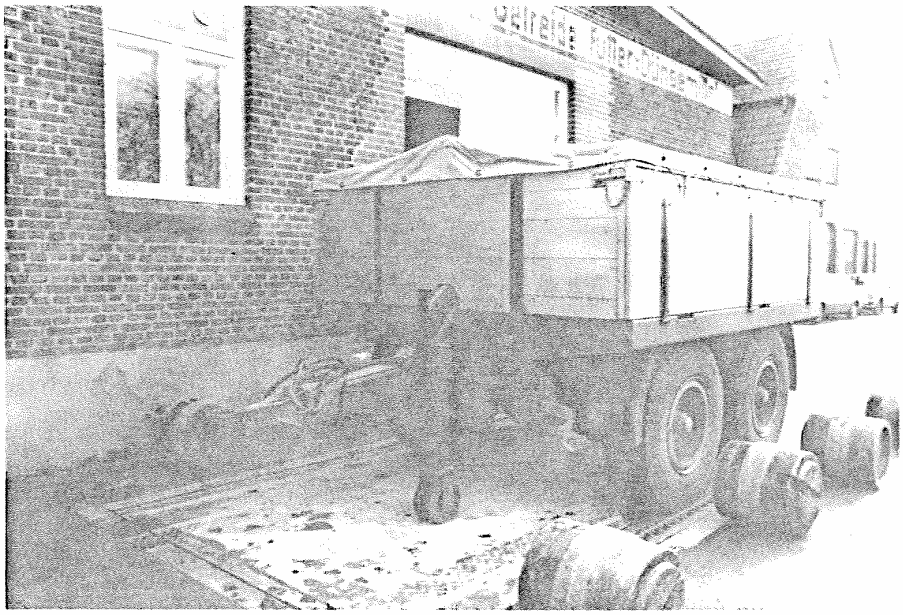




Ref 13
Schleswig-Holstein
(1981)

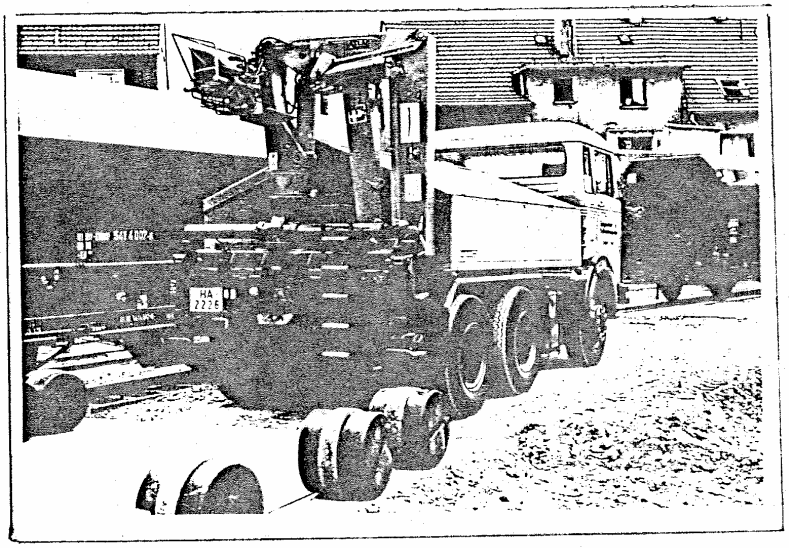


Tracting lorry with three axles, distance between extreme axles 3.8 m, total admissible weight loaded 22 t, unloaded 12.5 t. Crane at the rear, capacity 110 kN·m with external jack stabilizers.
Total distance between extreme axles with attached trailer 8.5 m.
Total weight with trailer 38 t, unloaded 17 t.
Amount of weights: 40 cylindrical 500 kg = 20 000 kg + 40 weights of 25 kg = 1 000 kg, making a total of 21 000 kg.

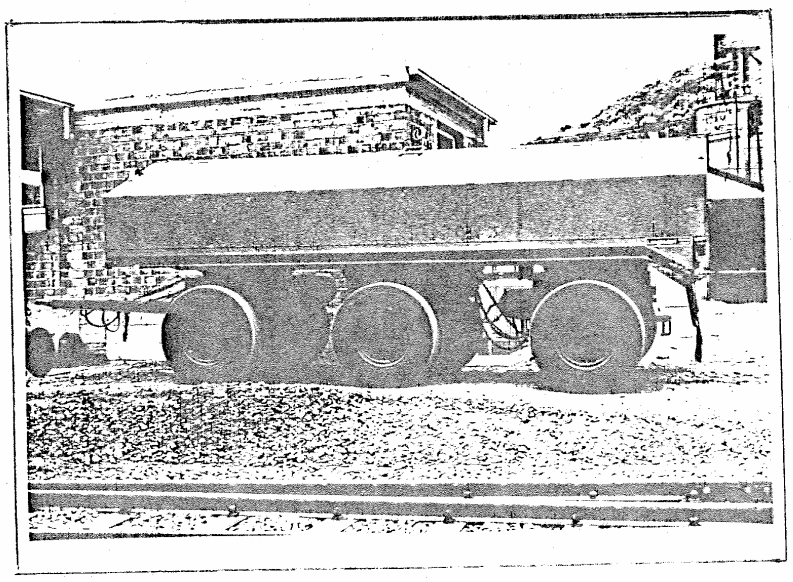


Two-axled trailer, distance between axles 1.2 m, total admissible weight loaded 16 t, unloaded 4.5 t

Ref 14
Nordrhein-Westfalen
(1980)

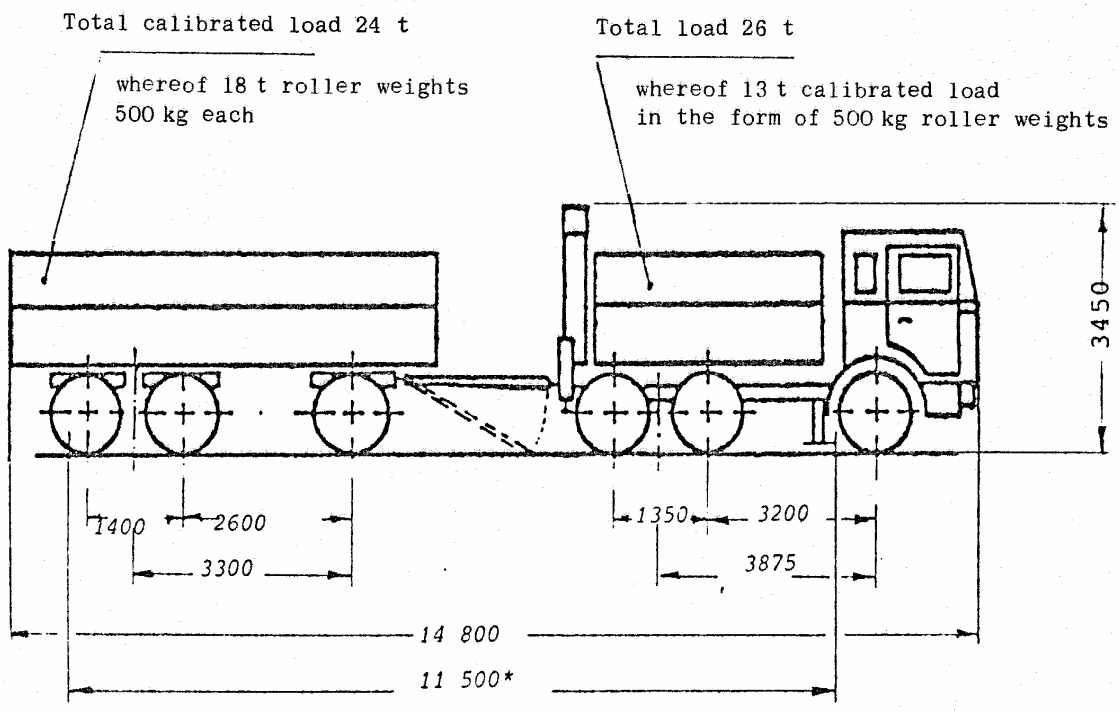


Tracting lorry with three axles, distances between axles 2.60 + 1.34 = 3.94 m.
Hydraulic crane at the rear for maximum range of 6.1 m at a load of 1 000 kg. Transporting 10 t of 500 kg roller weights.
Admissible loaded total weight : 22 t.

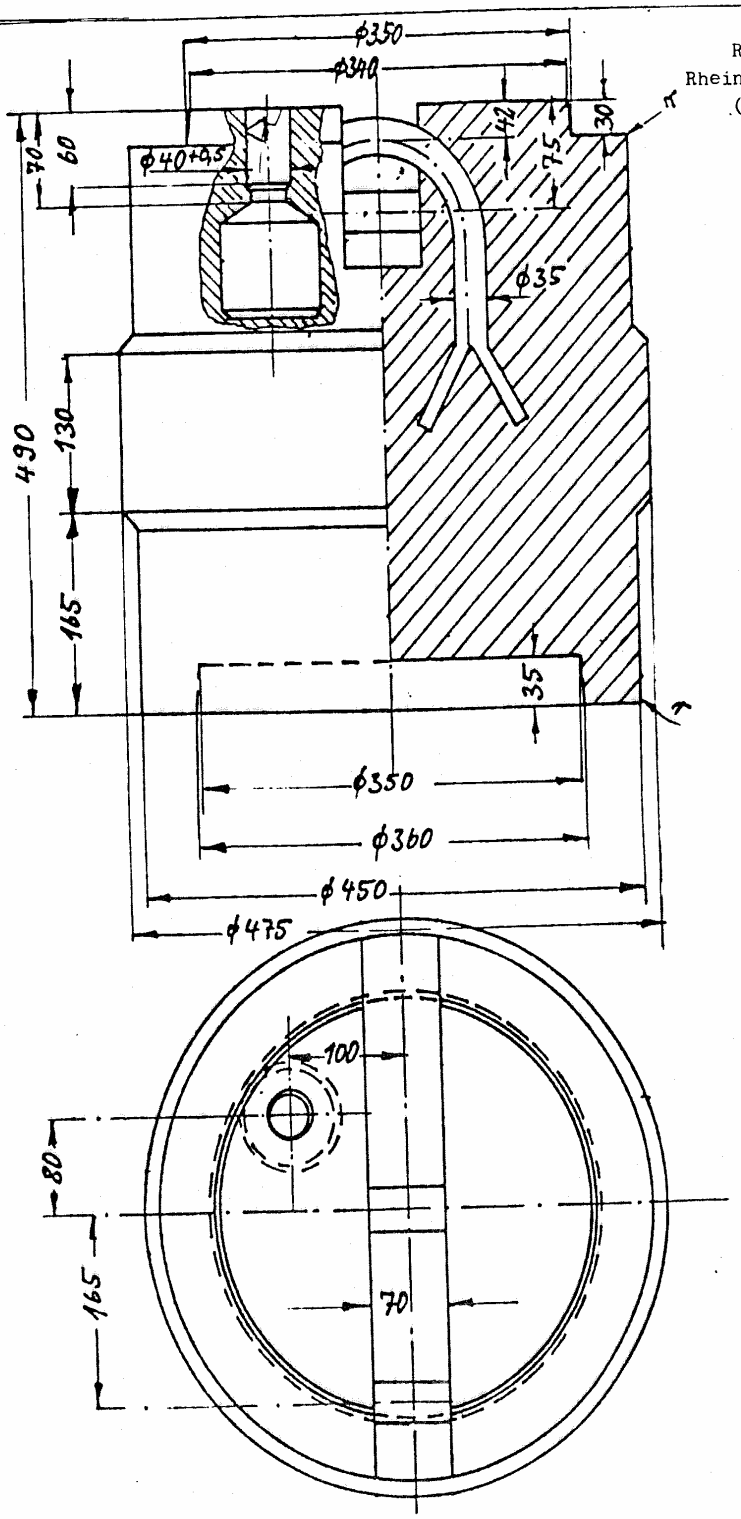


Trailer with three axles, distance between axles 1.90 + 1.90 = 3.8 m.
Admissible load on each axle 10 t. Length of loading space 6.1 m.
Dead load of trailer adjustable to 10 000 kg $\pm$ 1 kg.
Transporting as additional load 10 t of 500 kg roller weights.
The loaded trailer is used as a calibrated mass standard during weigh-bridge testing.

WEIGHBRIDGE CALIBRATION VEHICLE of EICHDIREKTION RHEINLAND-PFALZ



Ref 15
Rheinland-Pfalz
(1981)



~(▽)

Zylindrisches Blockgewicht
zu 500 kg
Rohgewicht: 496 ± 3 kg
Werkstoff: GG 20

M 1:5

Ref 16
Spain
(1990)

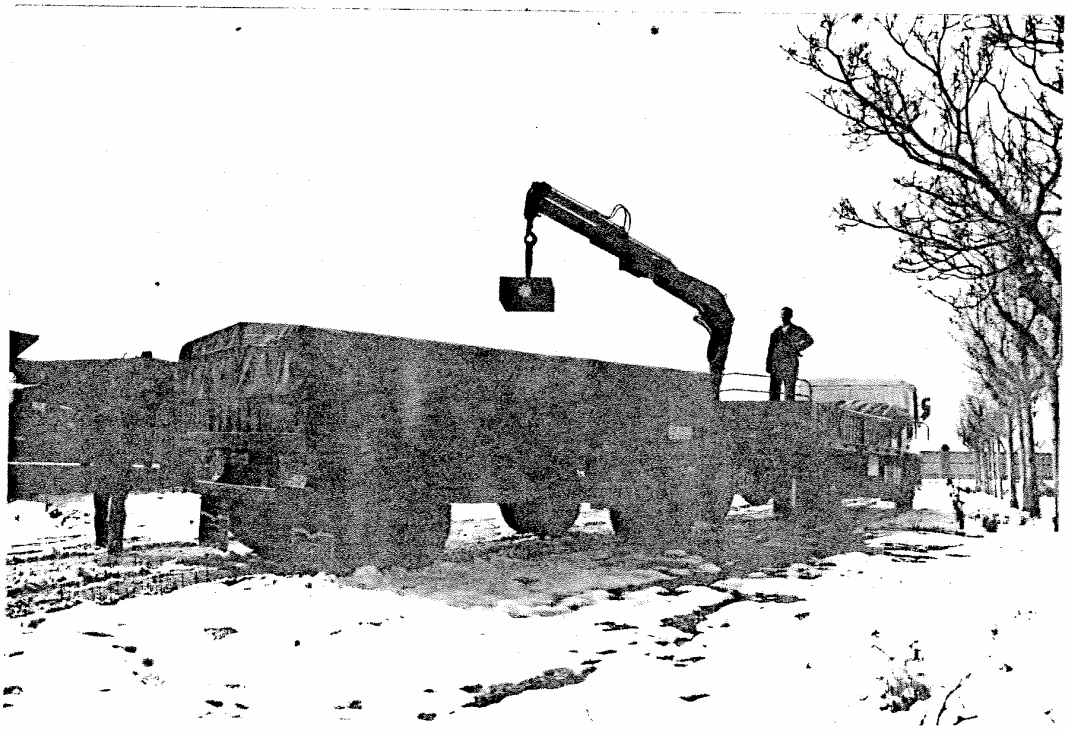
WEIGHBRIDGE VERIFICATION EQUIPMENT of the SPANISH CENTER of METROLOGY

1. Tracting lorry: make PEGASO, model 1181, tare load 9000 kg, full load 20 000 kg two axles.
   Length 8.90 m, width 2.50 m, height 3.30 m.
   It carries 20 block weights of 500 kg of cast iron according to R 47 and a set of weights from 1 mg to 50 kg.
   A crane is located in the rear part.

2. Trailer: make MONTENEGRO, tare load 4000 kg, full load 18 000 kg, two axles.
   Length 5.50 m, width 2.50 m, height 2.30 m.
   It carries 20 block weights of 500 kg of cast iron according to R 47.

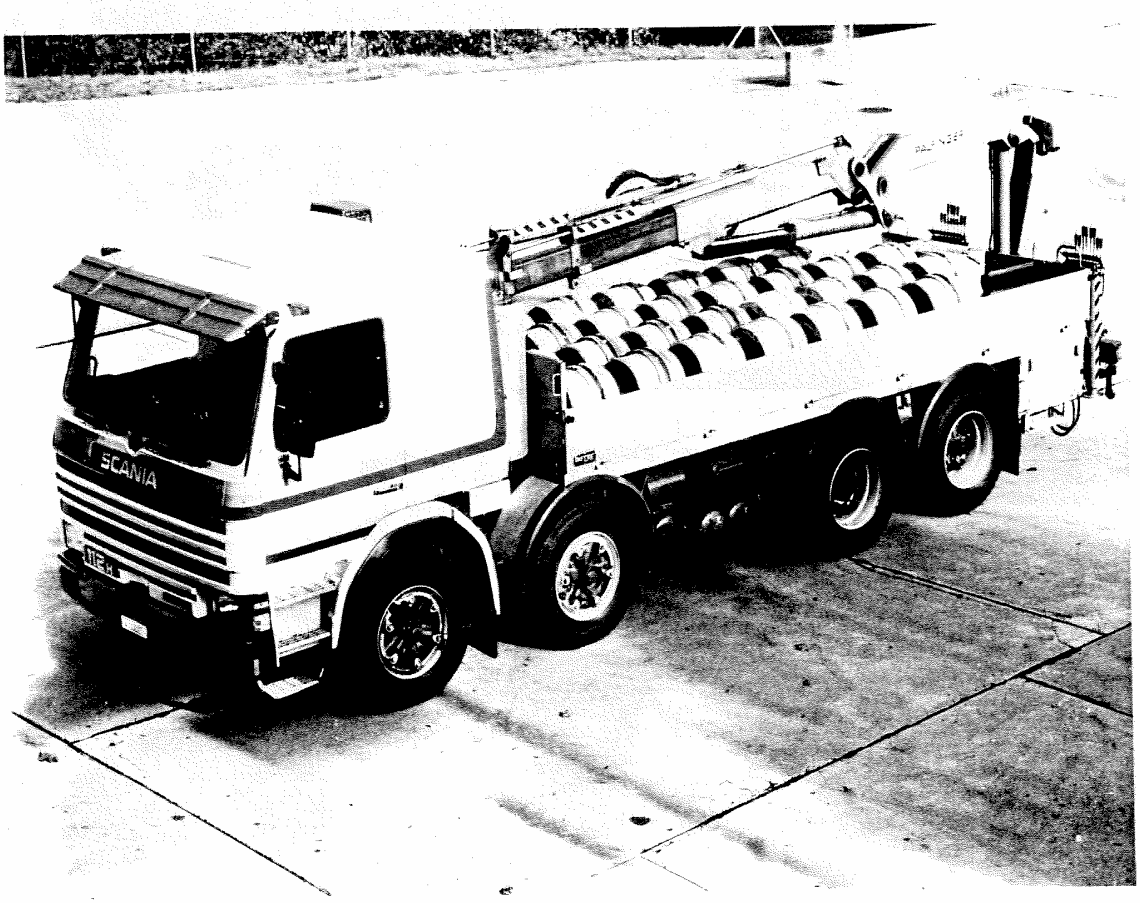
3. Hydraulic crane: make HIAB, model 650/1, maximum loading length 6.2 m (load 900 kg)

4. Test weights
   40 block-shaped weights of 500 kg of cast iron according to R 47.
   Weights of 20 and 50 kg of iron and brass obtaining as a whole 500 kg.
   A set of weights of maximum capacity 10 kg.



Swiss Federal Office of Metrology OFM (1990)

MOBILE EQUIPMENT FOR THE VERIFICATION OF ROAD WEIGHBRIDGES



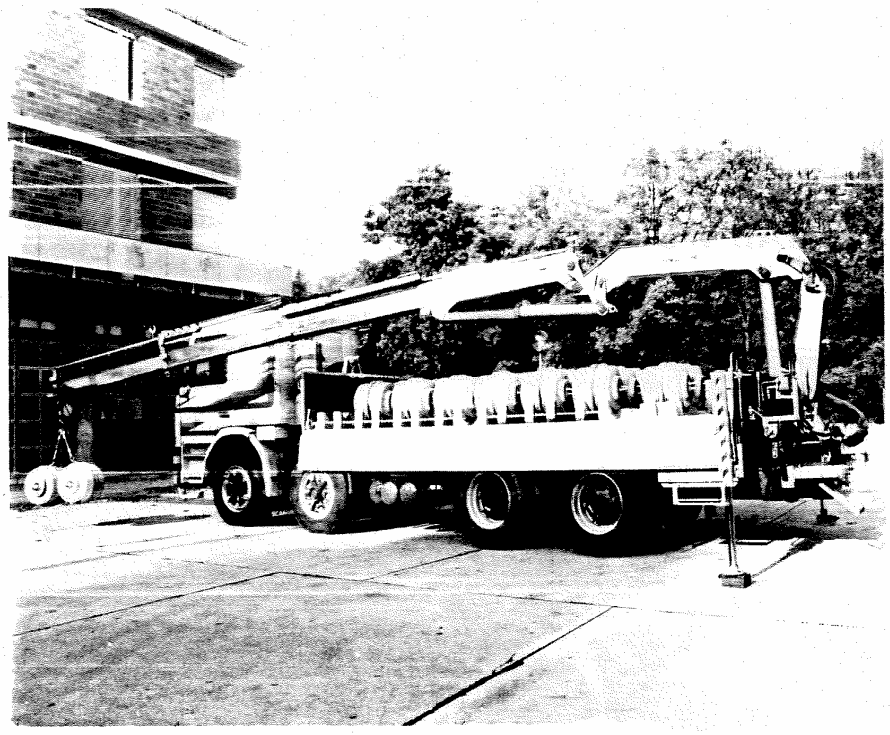
Vehicle

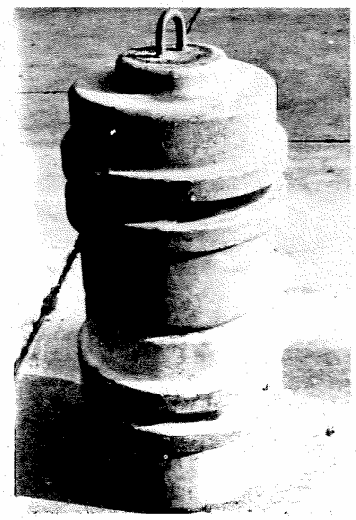
Lorry with 4 axles/sleeping cabine
length 9.2 m, width 3.30, height 3.21 m

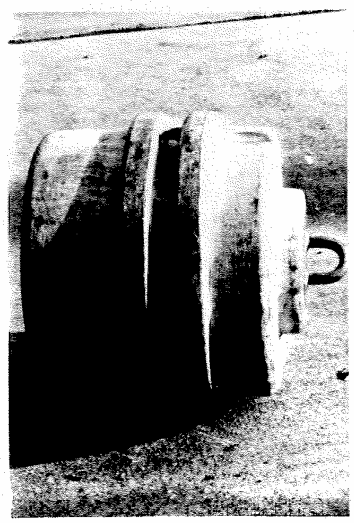
dead load empty	13 150 kg
total weight	28 560 kg
max. distance between axles	5.55 m
max. speed	96 km/h

Crane

at the rear, powered by the main engine
range of 9 m at a load of 1000 kg
slewing range 370°
two telescopic support jacks at the rear







Test weights: following OIML R 47

30 x 500 kg = 15 000 kg
cast iron, density 7000 kg/m³
facilities for standing, stacking, rolling, hanging
sealed adjustment cavity
+ a total of 100 kg of smaller weights

EXAMPLES of WEIGHBRIDGE TESTING EQUIPMENT USED

in the UNITED KINGDOM

Information supplied by LACOTS P.O.Box 6, Croydon, United Kingdom CR9 1LG

BIRMINGHAM

Tracting unit: Foden S 106

Trailers (3 axle) : 1 for roller weights, 1 for slab/roller weights

Weights: 6 tonne of 250 kg and 35 tonne of 500 kg roller weights

35 tonne of 1000 kg slab weights

Gross weight: 16 500 (trailer) + 21 000 kg weights = 37 500 kg Calibration of weights: 1300 kg gyroscopic weighing machine

General Remarks

There is a useful refinement to roller weights, which is a counterpoise weight attached to the pulling handle on either side of the weight, below the central axle. This ensures the handle is kept vertical above the weight and allows crane hooks to hook onto the handle without the need for a second person to lift the handle into an upright position.

With the ever increasing use of electronic weighbridges, which invariably have their smallest increment much finer than an equivalent capacity mechanical mach ine, the question of the accuracy of test weights, especially when used in large quantities on high capacity machines, has to be considered.

This calls for careful use of roller weights and perhaps more frequent calibration, this is evidenced by identifying each individual weight and recording a history of the weight change for each weight at every calibration.

This consideration is one important factor which has recently seen a move towards favouring the use of a fork-lift truck and 1 tonne slab weights.

These weights are not rolled on and off weighbridge plates, but gently lifted on and off which gives more confidence in their continuing accuracy between calibrations.

In addition, one person driving the fork-lift truck can do all the necessary work in a shorter time, than 2 or 3 persons normally used with roller weights.

One system in operation has two ramps and the fork-lift truck is driven off and on the low-level trailer.

KENT

This authority maintains a weighbridge test unit, which consists of a three axled tractor unit with a three axle trailer. The vehicle is designed to carry 44 tonnes, but due to current UK legislation it does not exceed 38 tonnes.

KENT (continued)

1. There are no heavy mass standards. The weights are all tested by means of previously tested 20 Kg and 10 Kg working standard weights, and hence have status as "test weights".

2. Kent has one 250 Kg roller weight, thirty-eight 500 Kg roller weights and twenty-one 1 tonne block weights. All are corrected to 50% of the prescribed tolerance (for the purpose of Regulation 30 of the Non-Automatic Weighing Machine Regulations 1988).

3. Kent owns a 1,300 Kg capacity giroscopic platform machine, which is used to test and correct all the above-mentioned weights.

4. The transport equipment consists of one tractor unit and one trailer. The trailer body is fitted out with rails which allow Kent to carry either nineteen of their 1 tonne blocks or thirty-eight half tonne rollers without the weights moving during transportation.

5. The handling equipment is a lifting crane, which is mid-mounted upon the trailer. They have a yoke with four handling hooks, which engage the self-balancing handles of the roller weights, so loading and unloading are both one man operations. The 1 tonne blocks are lifted by means of straps placed through holes in them designed for forklift operation, hence a two man operation. They did, in fact, experiment with a forklift, but in the light of experience, they decided against this system.

NORTHUMBERLAND

Our new vehicle is a 38 tonne articulated system (designed to carry an extra 2 tonnes when the maximum train weight becomes 40 tonnes).

The system:

1. Has a rear mounted hydraulic crane (HMF make of the "HIAB" type). Weights can be offloaded in various positions.

2. Will carry both roller weights and block weights (both conventional and fork-liftable).

3. Is capable of testing road and rail weighbridges (subject to road access).

4. Can be tested with the trailer connected to the tractor or disconnected.

5. Has power operated landing legs and stabilisers for quicker operation.

6. The overall wheelbase is 11 metres but the trailer has a lif table rear axle to reduce this to 9.7 metres if necessary. With the trailer disconnected and with the axle lifted, the trailer will fit on plate a length of 4.5 metres (although not to 38 tonnes capacity).

7. The crane is powered by a trailer mounted engine so can be operated independently of the tractor unit.

8. The crane can be operated by a remote control system so-that the operator has more visibility, control, etc.

ROYAUME-UNI

A NEW WEIGHBRIDGE TEST UNIT

for HAMPSHIRE COUNTY COUNCIL

by Rodney C. GOLDUP
Deputy County Trading Standards Officer,
Hampshire County Council, Winchester, England

In early 1990 the Trading Standards Department of Hampshire County Council, Winchester, England, took delivery of a new weighbridge test unit. This short article sets out the technical specification which may assist other departments likely to be faced with a similar purchase in the near future.

All of Hampshire County Council's vehicles are owned by the Transport Management Organisation, a section within the Commercial Services Department of that Council and vehicles are then leased to user departments. Early discussions with the T.M.O. agreed a maximum budget of £120000 for a new vehicle and in October 1989 a working party was set up to decide upon the vehicle's specification. 38 tonnes with forklift operation was quickly agreed as the basic specification, with the remaining parameters designed around that fundamental decision.

The various major components of the Unit will be replaced at differing intervals; the forklift will be replaced after 7 years, the tractor unit after 10 years and the trailer after 20 years. With legislative changes possible during these time scales, 44 tonnes design weight was specified and indeed, the finished vehicle has since been tested at the Chobham, Surrey test track at 44 tonnes with entirely satisfactory results. Whilst this specification has resulted in a very large vehicle, the tractor unit has twin drive axles and the trailer is fitted with a steering (and lifting) third axle, both of which help to make the vehicle very maneuverable. The twin drive axles are also fitted with locking differentials which will enable the vehicle to have traction in all situations including lime, sand and gravel quarries.

The primary method of operation is by forklift, which has an unladen weight of 5 tonnes and is capable of carrying 3 x 1 tonne weights. This allows much faster operation and no longer requires the use of other staff to manhandle weights. The block weights (Fig. 1) are particularly advantageous when testing axle weighers and

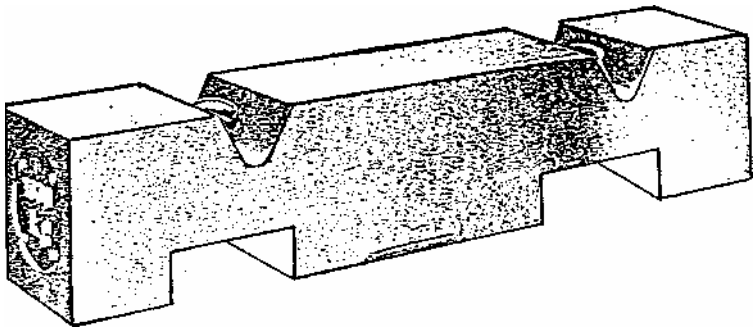


Fig. 1 — 1 000 kg block weight Length 1 670 mm, Width 285 mm, Height 360 mm No. of lifting bars 2, No. of slots 2 Slot width 300 mm, Slot height 120 mm

are of sufficient length to straddle railway lines on rail weighbridges. The weights are usually off-loaded from each side of the trailer by forklift, but where necessary the hoist may be used, which is capable of not only off-loading to each side but also to the rear of the trailer.

The trailer has the facility to carry 18 x 1 tonne weights, although fewer are currently loaded to enable the vehicle to stay within the maximum 38 tonnes United Kingdom limit. Also carried is a half tonne roller weight and another half tonne of 20kg blocks. The lifting third trailer axle reduces the wheel base to under 12 meters to allow this common size of plate to accommodate the complete vehicle.

The calibration of the 1 tonne block weights is by use of an Avery 32 N 52. The Avery is initially calibrated by use of a cradle and 20 kg weights which have in turn been calibrated using the F1 Hampshire Local Standard and a Sartorius 5788 MP8 balance. Once the initial calibration of the Avery is complete a 1 tonne block transfer standard is weighed. This transfer standard is then re-checked between every two test weights to ensure confidence in the repeatability of the Avery machine. Both machines have been fitted with a gantry System so that any weights suspended on the weighing mechanism invariably exert their force in an identical position.

Hampshire makes extensive use of its weighbridge test unit and hires it to some seven other authorities. The new unit (Fig. 2) came into operation during April, 1990 and has seen use in Hampshire and most of those other authorities, providing an effective and more efficient service.

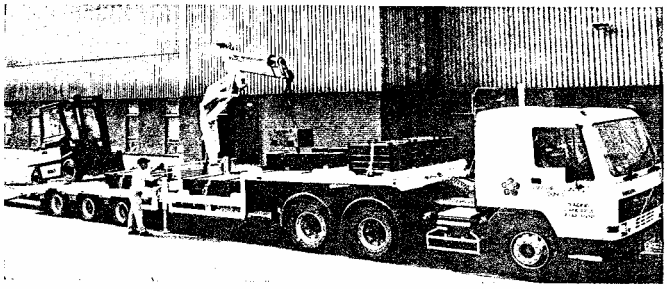


Fig. 2 — The complet test unit comprising tractor unit with holst, trailer and forklift

Ref Z I

Somerset U.K

(199C)

SOMERSET'S WE IGHBRIDGE TESTING UNIT

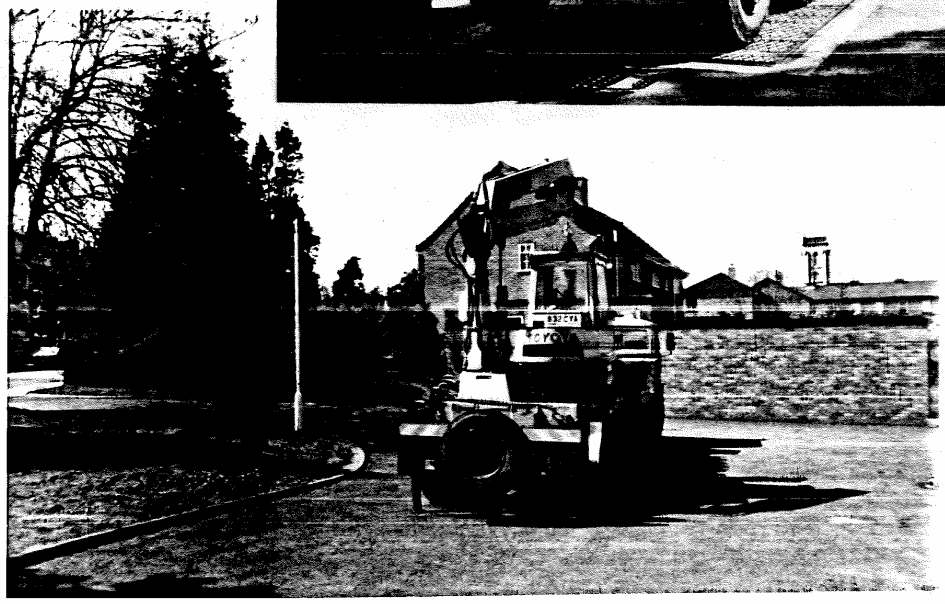
Lorry: Rigid Platform 8x4 Volvo F7-31 236 HP Truck with Flat Bed Diesel
Crane: TICO K1050T permanently fixed to rear end of lorry's chassis.
Lifting capacity - 5250 kgs. at 2 metres radius and 1400 kgs at 7 metres radius.

Forklift: Toyota Model 4FD 25 - lifting capacity - 2000 kgs

Block Weights

carried: 28 x 500 kg

Fully-laden gross Vehicle weight is approx. 30,400 kg.

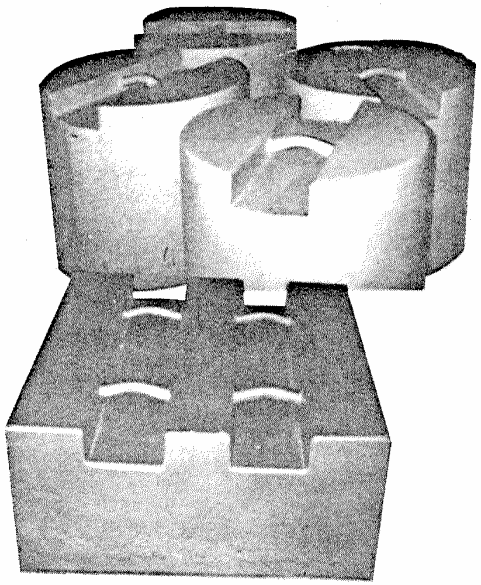


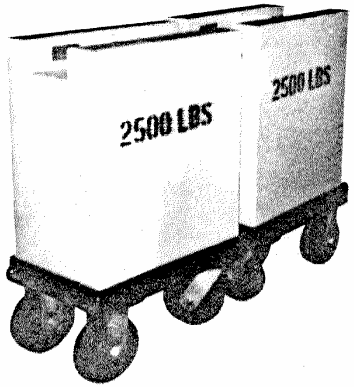
WEIGHTS ARE DESIGNED TO NATIONAL BUREAU OF STANDARDS HANDBOOK 105-1.

Specifications:
- Exterior: all steel construction ¼" thickness
- All edges and corners rounded
- Recessed lifting eye
- Side mount cavity: 2" I.D. dia.x7" deep. Holds approximately 10 lbs. of pure lead.
- Paint: one coat gray rustoleum type, with black numerals.

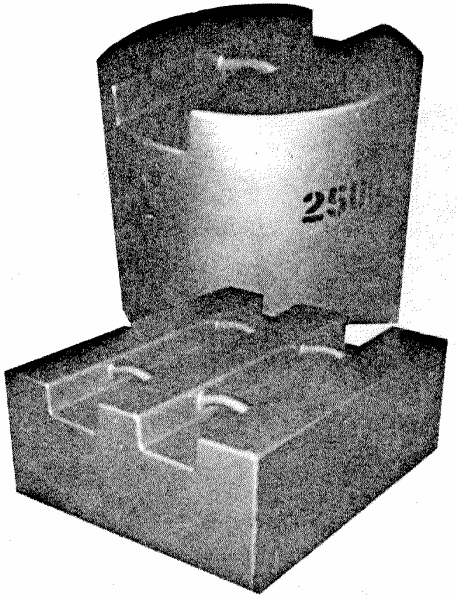
Interior: material has minimum density of 5 grams per cu. centimeter.

Calibration: Substitution method
- Approved sealing beam traceable to U. S. Bureau of Standards, Washington, D. C.
- Note: for official status, most weights have to be certified by a local state metrology lab.
- Serial number is stamped on the top of the weight for a permanent record.
- Recordaton of test results.
- Individual calibration reports available.
- Sealed to Class F tolerances 1 part in 10,000.





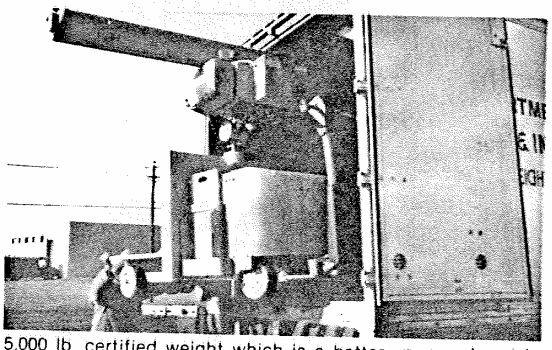
TRANSPORT CADDY



(from Tromner Inc. catalogue)

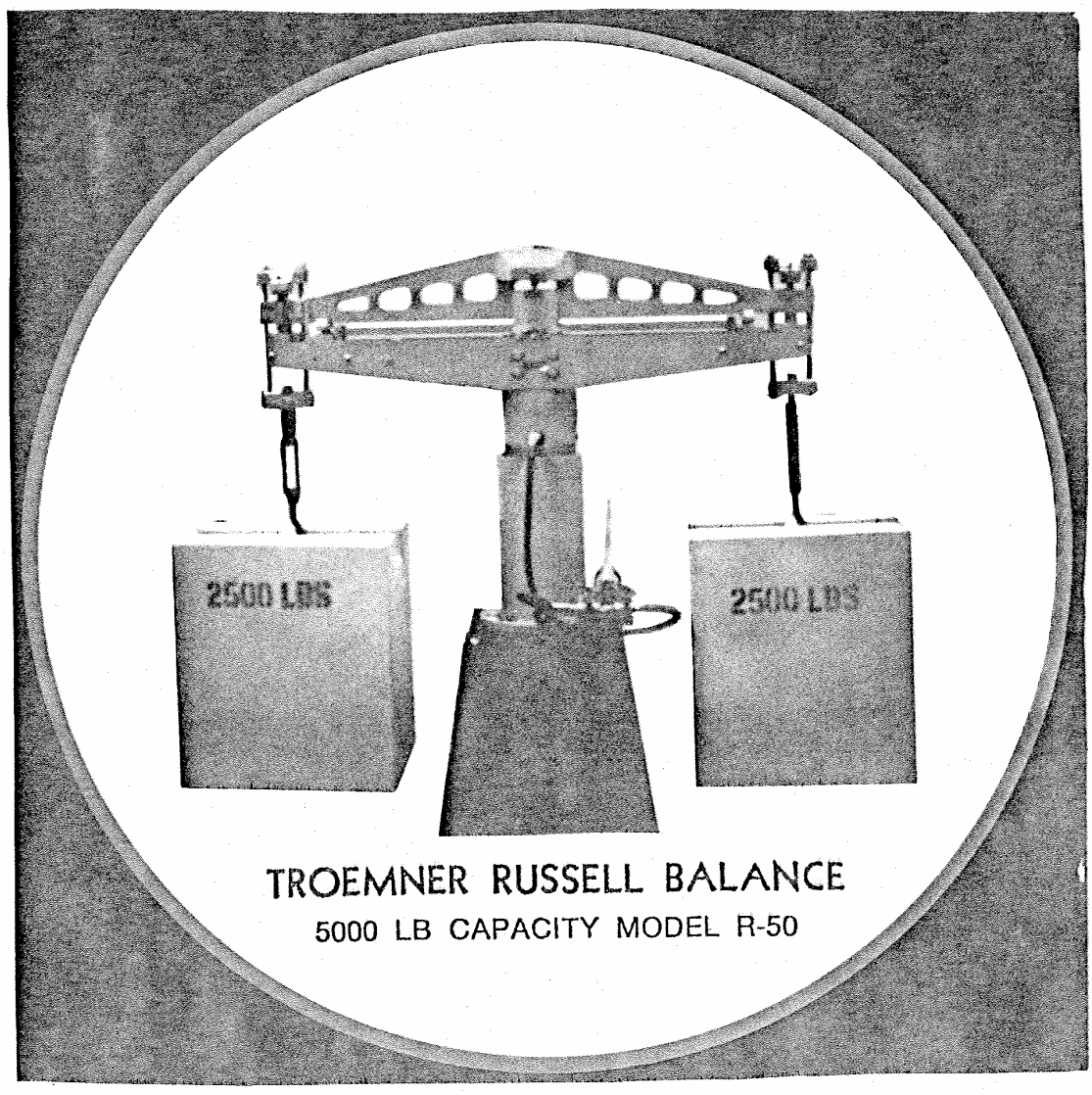
Ref 23
USA

Ref 24
USA
Seraphin Co



5,000 lb. certified weight which is a battery powered cart is shown being lowered from the rear door of the truck.

(Extracts of catalogue from
Seraphin Test Measure Company)



Specifications

Height – 74"
Width – 66"
Depth – 20"

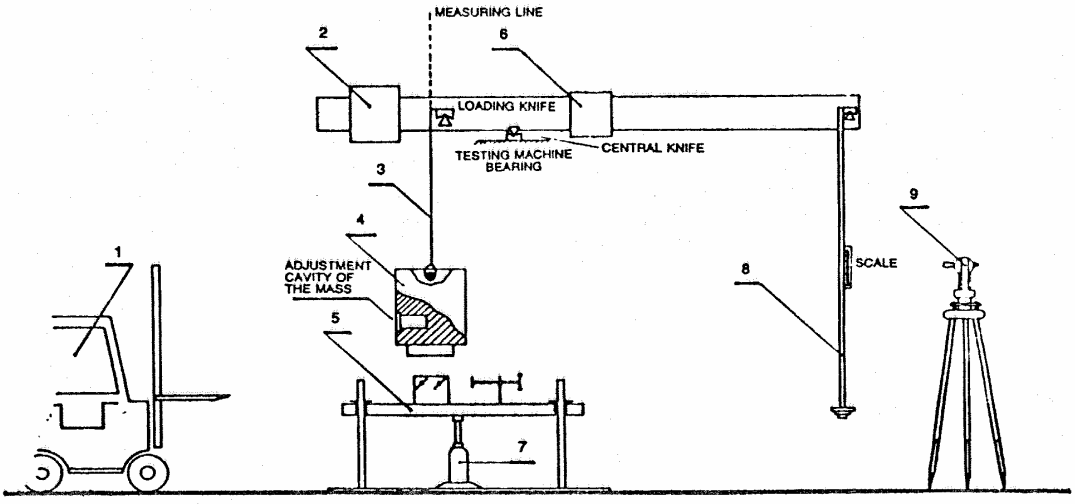
Beam – 66" long
Pan Size – 27" x 30" x 33" high
Capacity – 5000 lbs.
Sensitivity (Full load) – .03 lb
Standard Deviation – .01 lb
Readability – .001 lb

(Extracts from
Tromner catalogue)

Ref. 27
Cuba
(1986)

MASS COMPARATOR

constructed by the Metrology Research Institute of Cuba



1 — HOIST
2 — COUNTERWEIGHT
3 — TENSION MEMBER
4 — MASS TO BE CERTIFIED
5 — FREIGHT ELEVATOR DEVICE
6 — SLIDE PYLON
7 — HYDRAULIC JACK
8 — HANGING PYLON
9 — THEODOLITE

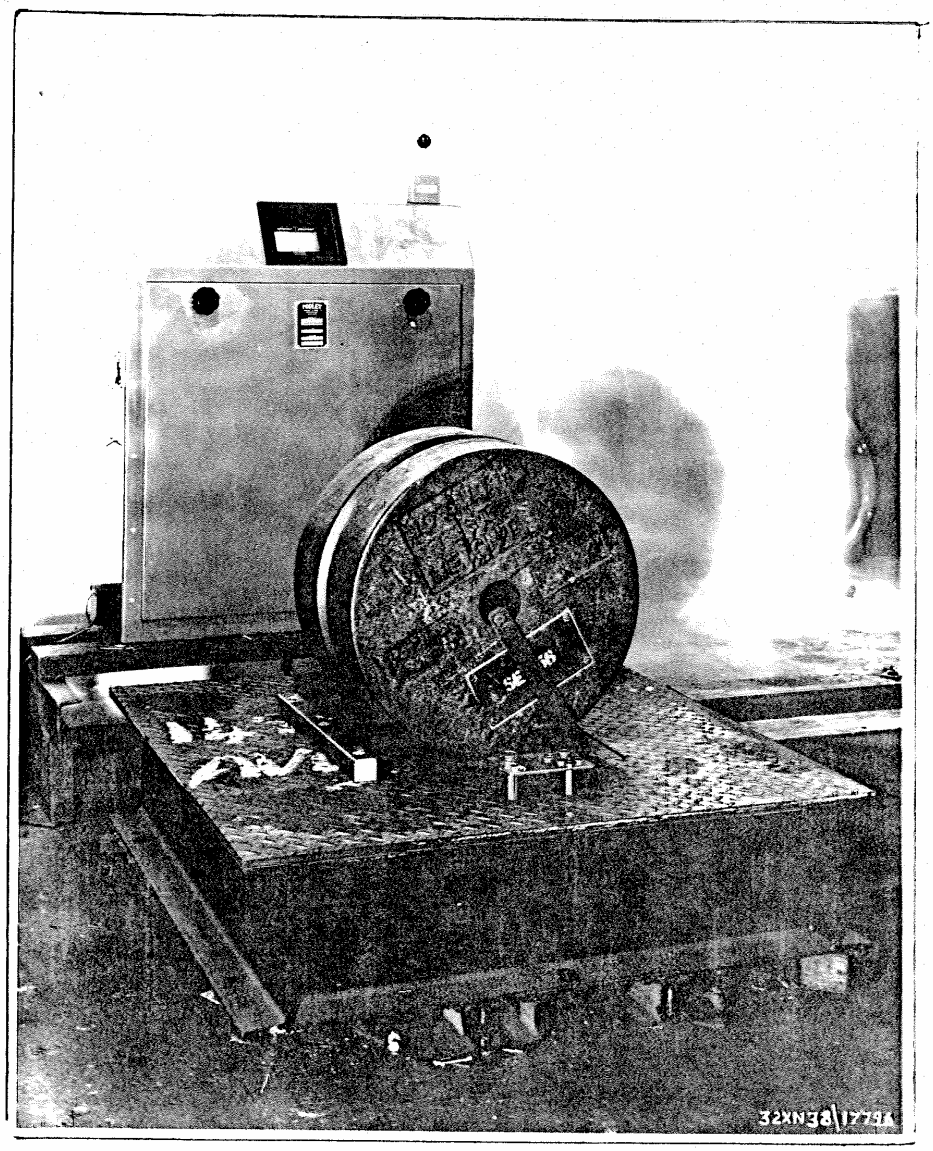
A mechanical mass comparator constructed at INIMET for the verification of 1 000 kg mass standards and described in INIMET Scientific-Technical Bulletin 1-1986

Illustration from the paper by L. Revuelta Formoso:

The National Service of Legal Metrology in the Republic of Cuba

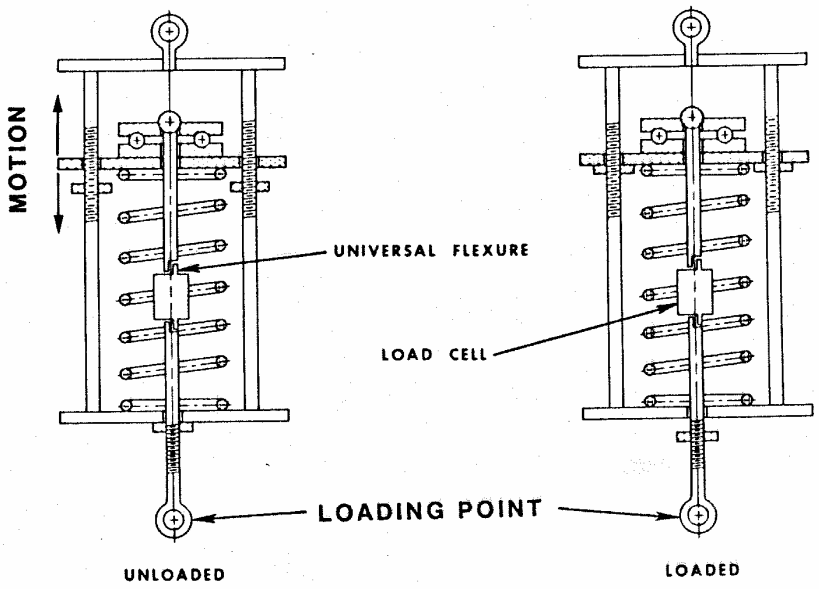
Bulletin de l'OIML N° 105, Décembre 1986

PLATFORM MACHINE FOR COMPARISONS OF HEAVY WEIGHTS

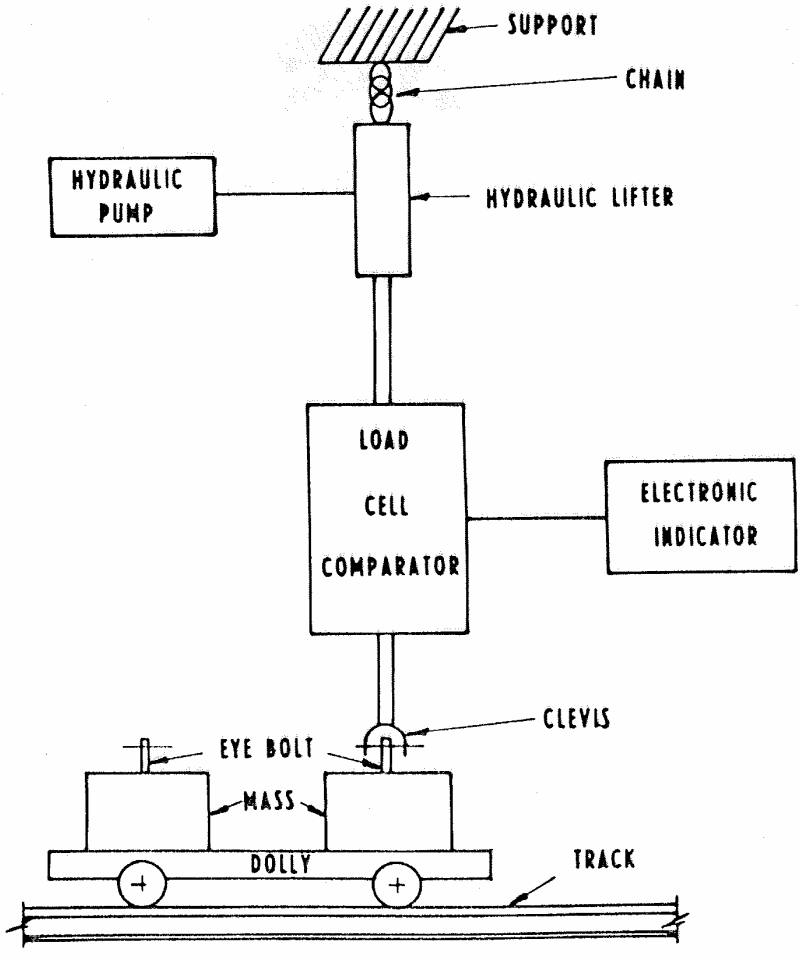


Avery Model 32 N 72

Capacity 1 016 kg



LOAD CELL MASS COMPARATOR



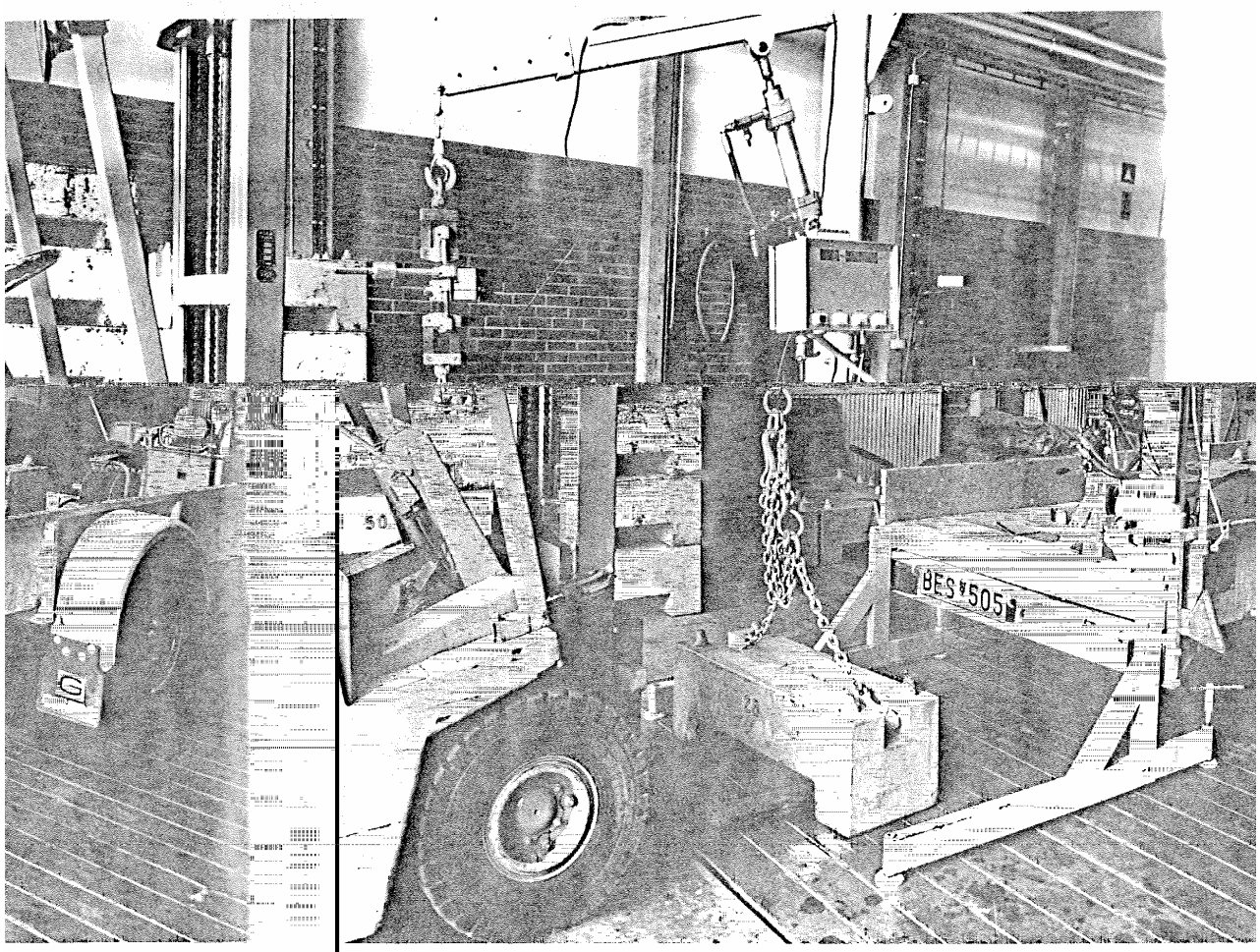
Sweden (1981) Ref 30

Mobile electronic weighing machine for calibration of 500 kg weights

A 500 kg standard weight which is transported on a trailer, is lifted by an hydraulically operated arm through a linkage system which contains the load cell. The weighing takes place 40 seconds after the weight has lifted from the floor and the display of the digital indicator is set to zero by pushing the "calibration" knob. The system is then unloaded and the unknown weight is suspended. After 40 seconds weighing of the unknown weight takes place and the difference in grams between the unknown weight and the standard weight is indicated with its sign on the digital display. The scale interval of the instrument is 1 g and the measuring range is ± 8 000 g.

Experience shows that when the equipment has reached stability (after approximately one hour) ten unknown weights can be weighed before the system has to be recalibrated. The drift is generally less than ten grams if the ten weights are calibrated within one hour.

If necessary, weighing can be carried out outdoors provided the weather conditions are stable and the load cell is not directly exposed to the sun. The inaccuracy of measurement which is obtained with this equipment is estimated to be lower than ± 20 g.



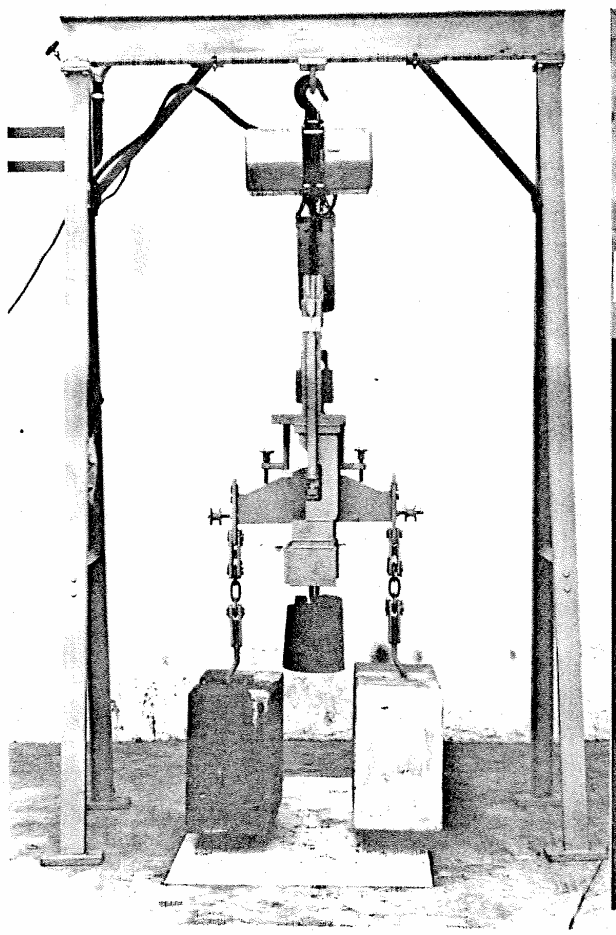
Ref 31
Austria
(1990)

BALANCES OR COMPARATORS FOR HEAVY TEST WEIGHTS

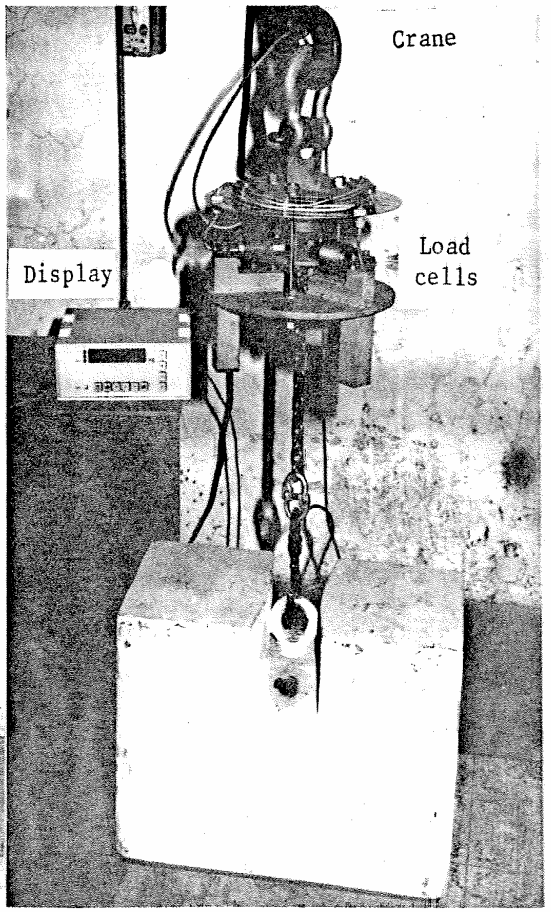
a) Equal arm balance 1000 kg
sensitivity: 2 g/mm, stationary
(Also used for other purposes than comparing 500 kg-weights).

b) Equal arm balance 500 kg
sensitivity: 5 g/mm, the balance being transportable and mounted on a crane (2 t).
(Care has to be taken on transport as regards the knives)
Manufacturer: Fa. Grimm, Wien

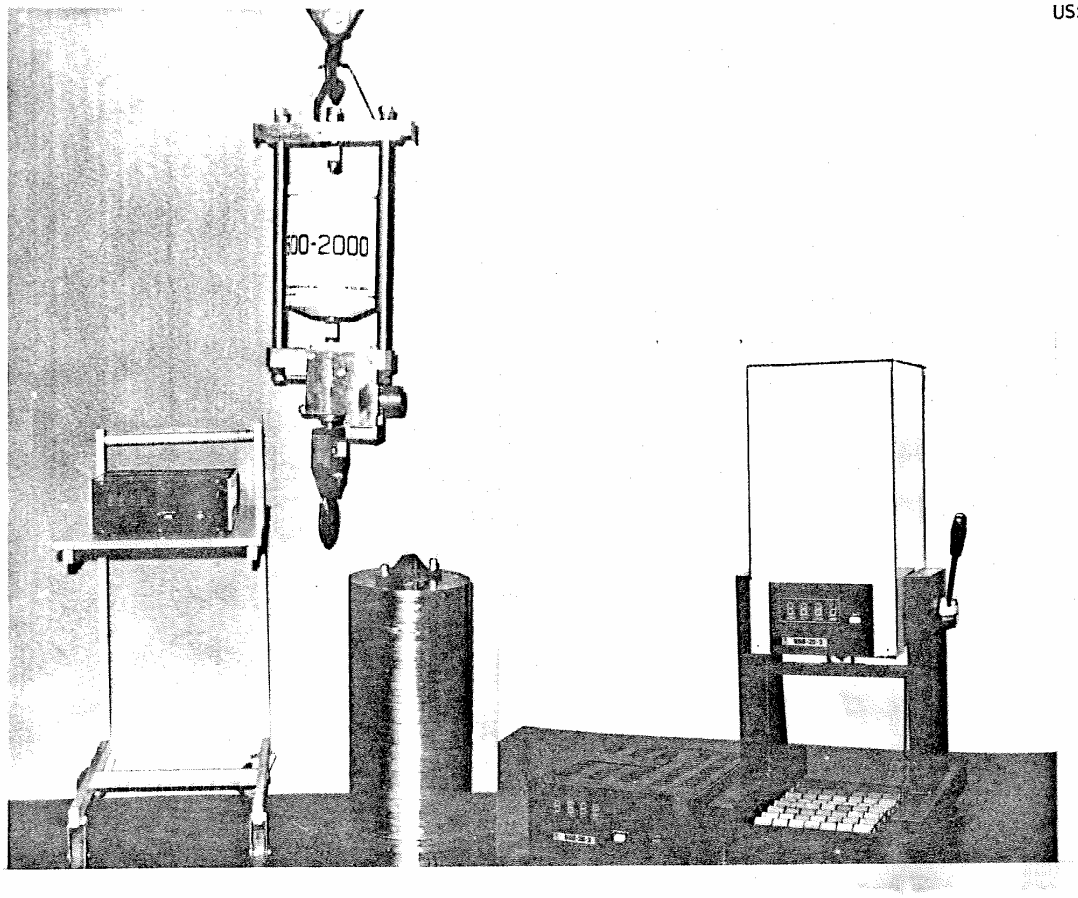
c) Electronic mass comparator 500 kg, d = 10 g, using three strain-gauge load cells, mounted on a crane (2 t), the equipment being transportable.
Manufacturer: Medwed, Villach.
This equipment is intended to replace b) in the future and will only be used for comparison.



(b)



(c)



M-500-2000 M-20

Denomination of characteristics	Models				
	M-20	M-50-100	M-500	M-1000-2000	M-500-2000
1. Nominal mass of test weights	20	50-100	500	1000-2000	500-2000
2. Limits of deviation from nominal value, g	± 50	± 50	± 500	± 500	± 500
3. Discreteness of reading, g	0.1	0.1	1	1	1
4. Limits of permissible error, g	± 0.5	± 1, ± 2	± 10	± 20, ± 40	± 10, ± 40
5. Mass of standard weight, kg	20	50	500	500	500
6. M.P.E. of standard weight, mg	± 100	± 250	± 7500	± 7500	± 7500
7. Number of standard weights	1	2	1	4	4
8. Dimensions:					
- of load cell	500x500x650	300x300x800	350x350x1000	410x400x1100	410x400x1100
- of measuring instrument	400x400x120	400x400x120	400x400x120	400x400x120	400x400x120
- of standard weight	ϕ300x80	ϕ400x200	ϕ400x700	ϕ400x700	ϕ400x700
9. Mass (w/o st.weight), kg	40	30	50	70	90

The comparator, model M-500-2000, is designed for the verification of weights with mass of 500, 1000 and 2000 kg.

For the verification of weights with mass of 1000 kg and 2000 kg the number of stacked standard weights increases correspondingly up to 2 or 4 units.

The standard weights are made of stainless steel and consist of parts (discs), with mass of each not exceeding 20 kg.

Comparator M-500-2000 operates as follows:

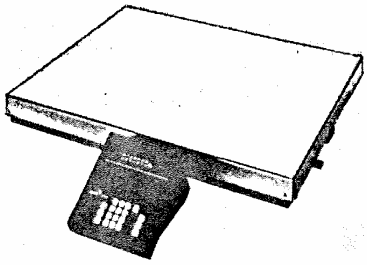
1. The arrested converter is hung on the hook of a crane (or hydraulic or electric lift).
2. The converter is set on a certain mass value by loading with standard weights.
3. By pressing the zeroing button, the measuring instrument is set to zero.
4. The converter is arrested and unloaded.
5. The converter is shifted to the test weight, loaded and re-arrested.
6. The deviation of mass of the test weight is indicated on the panel display.

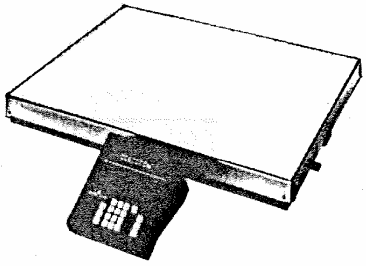
For more information:

SNIIM (Siberian State Scientific-Research Institute of Metrology),
4 Dimitrov prospekt, Novosibirsk 630099, USSR.

PLATFORM MASS COMPARATORS

FOR LABORATORY INSTALLATION





Model	ECC600/MC-E2	ECC600/MC-F1
Readability Capacity	0.1 g 600 kg	0.5 g 600 kg
Reproducibility (standard deviation) Linearity	≤± 0.5 g ± 20 g	≤± 1.5 g ± 20 g
Stabilization time (typical) Integration time	≈15 s 1 s	≈10 s 1 s
Electrical taring range (by subtraction) Zero setting range Initial zero setting range Sensitivity drift (15...25 °C)	600 kg ± 12 kg 108 kg ± 2 ppm/°C	600 kg ± 12 kg 108 kg ± 2 ppm/°C
Weighing platform of chrome-nickel steel Balance housing (width x depth x height) Net weight	1000 x 800 mm 1000 x 800 x 115 mm 139 kg	1000 x 800 mm 1000 x 800 x 115 mm 139 kg
Power supply - Voltage, adjustable - Admissible voltage fluctuations - Frequency - Power consumption approx.	 110, 130, 150, 220, 240, 260 V +10...-15% 50...60 Hz 30 VA	 110, 130, 150, 220, 240, 260 V +10...15% 50...60 Hz 30 VA
Operation temperature Relative humidity	15...25 °C ΔT = ± 0.5 °C 20...80% at 23 °C	15...25 °C ΔT = ± 1 °C 20...80% at 23 °C
Control instrument (width x depth x height) Net weight (cables included) Connection cable, 15-pole	 308 x 250 x 175 mm 5.7 kg 5 m	 308 x 250 x 175 mm 5.7 kg 5 m

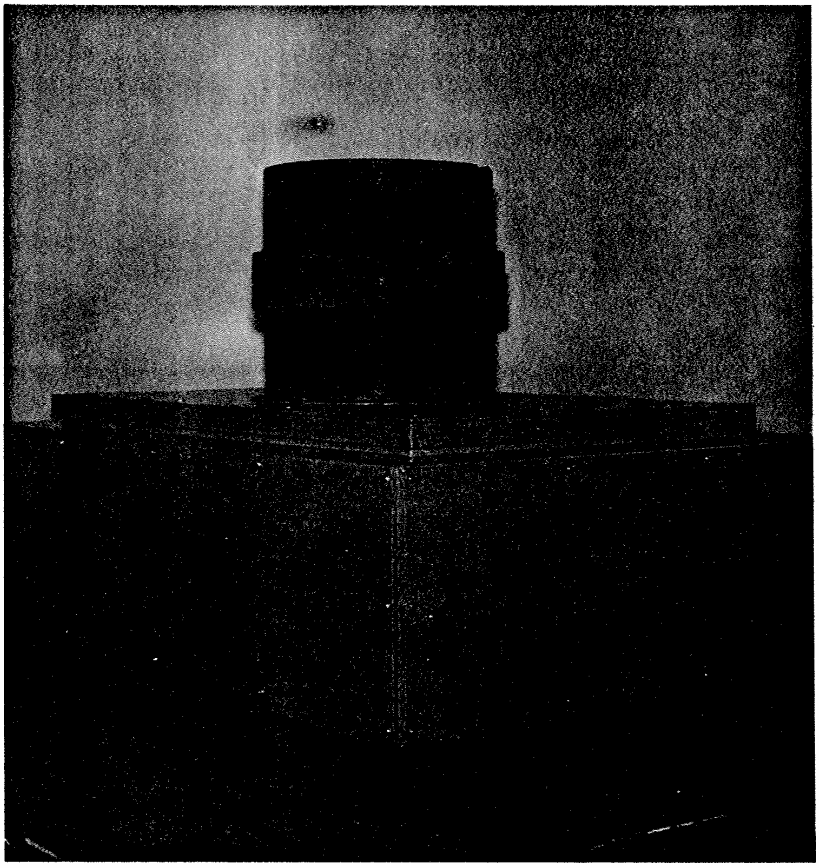
(Extract from Mettler leaflet 1990)

See also article by
A. KRETZER : "Prüfung von 500 kg Gewichtstücken mit der Genaugkeit von Analysengeweichten beim Berliner Landesamt für das Mess- und Eichwesen" in Wägen + Dosieren, No. 1, February 1990.

English translation : "Testing of 500 kg weights with the accuracy of analytical weights at the Berlin Landesamt für das Mess und Eichwesen" available on request from Mettler representatives.

Ref 34

Bascule de Grande Précision de WÖHWA



Construction en acier avec couverture en tôle polie.

Cellule de mesure (gyroscope) sous le pont.

Champs total de pesage:	600 kg
Graduation:	1 g
Précision:	600 000 échelons
Capacité du pont:	3 000 kg
Dimension du pont:	1 200 x 800 mm
Hauteur:	500 mm

Wöhwa
D-7114 Pfedelbach
☎ (07941) 3055
Telex 074471 woehwa

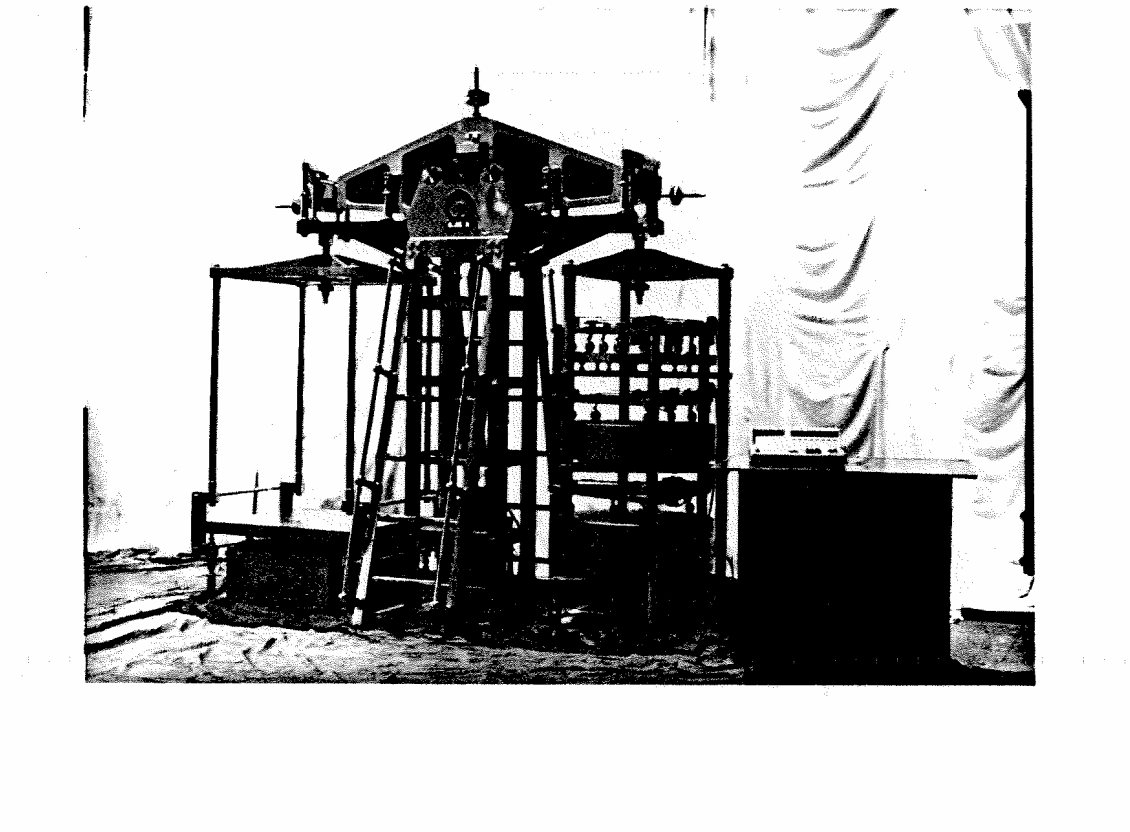
Bascule pour "Eichamt Ulm"
(Bureau de Vérification des Poids et Mesures à Ulm/Allemagne)

84/6304

08.05.85

500 KG/ 1000 KG DUAL-RANGE BALANCE

Equipment developed by Senior Engineer Guo Ruilin & Li Jianzeng
at the National Railway weighbridges Metrology center
China Academy of Railway Sciences, Beijing 100081, PR China
Information supplied by Engineer Wang Jinglin



MAIN TECHNICAL SPECIFICATIONS:

1. Measuring range: Range 1- 500 kg
   Range 2- 1 000 kg
2. Accuracy: Range 1 and Range 2 - better than 1 x 10^{-6}
3. Value of a scale division (d): Range 1 – d = 0.5 g
   Range 2 – d =1.0 g
4. Variability of the indication: ≤ 1 d
5. Errors caused by non-equal arm: ≤ 3 d
6. Structural form of the balance: equal arm balance
   a. The weighing pan of the left side is for measuring. It is a square of 750 x 750 mm.
   b. The weighing pan of the right side is a mechanical structure incorporating selectable balancing weights. These are all forged to cylinder or ring form and include the weight pieces of 10 kg, 20 kg, 20 kg, 50 kg, 100 kg, 200 kg, 200 kg, 500 kg.
7. The beam length of the balance: 1600 mm
8. Method of loading: the compared weight is transferred by a electric conveyor.
9. Dimensions (L × W× H): 2500 x 1600 x 2600 mm