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TRADE BY DRAFT SURVEY OR BY BELT WEIGHING?

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SUMMARY – The author discusses the accuracy of cargo draft surveys which continue to be used in some cases for international shipments of bulk materials and compares it with the accuracy obtainable with verified beltweighers.

The article is reproduced from the review Bulk Solids, Volume 11, Number 1, March 1991.

Introduction

In the area of the international trade in bulk commodities, there is an intriguing, and to some extent puzzling, anachronism as regards the methods used to determine the quantities of materials traded, which if allowed at retail level would be ridiculed and scorned, let alone be illegal!

Overview

Trade involves the buying and selling of a commodity on the basis of its qualitative and quantitative properties which are to be determined in a way which is mutually acceptable to both parties to the contract. The qualitative properties are usually determined by some form of assay, be it human or instrumental, whilst the quantitative properties are more easily controlled by absolute measurement of weight, volume or length.

Whilst both the means and the laws exist to satisfactorily control the measurement or weight under controlled conditions, the means of determining quality are more obscure, particularly in the early days of trade in bulk solids, i.e. metalliferous ores. This perhaps explains the role of the early assayer at mines and plants, and the necessity for him to be seen to be independent and working to "classical" criteria having some basis in science. Even today, the question of the qualitative definition of a traded material is a matter entirely private to the parties concerned, and they are free to choose or abide by whatever method is acceptable to both.

However, when it comes to the quantitative determination of the bulk material, there is a confusing and curious situation which exists, having its basis perhaps in history. With the possible exception of grains and their derivatives, the majority of trade in bulk solids across the world is quantified by reference not to its weight, but to the amount of water it displaces when contained in a vessel.

This use of Draft Survey for such trading is a relic of the days when accurate and reliable means for weighing large quantities of bulk solids did not exist, but whilst that situation has been corrected in the last 10-15 years, the use of surveys still commands a large following in the bulk trade. Why should this be so, and what are the attractions of using such techniques, which are inherently less accurate than weighing and which have no basis in legal metrology?

Clearly, a whole industry has developed to supply a service to traders over a long period of time, and the independent surveyor is a respected member of the community of traders. However, his craft has been overtaken by technology in the weighing field such that it is now indisputably possible to carry out the weight determination to a far higher accuracy than by survey, and most importantly, to a set of laws which have wide commonality across the world – indisputable because Certified weighing installations have proven traceability which is controlled by the legal Metrology Authority concerned.

Legal Metrology

Legal Metrology is the practice of controlled measurement of an item, be it by weight, volume or length, with reference to known standards and subject to periodic inspection by the Authority concerned. This is usually the National Weights & Measures Authority of the country concerned, but since long there have been continual efforts to internationalise the laws on all weighing equipment, which will culminate in the new EEC Directives which take force in the coming years. In the case of belt weighing, this will mean that each member of the EEC will submit to the new standards which will apply across the Community, but which have also been agreed by the whole community of legal metrology bodies across the world. The International Organisation of Legal Metrology (OIML) co-ordinates the law-making process of all National Authorities, and soon there will be a common set of standards for belt weighing, and other types of instrument, which can be used by bulk traders for the purpose of achieving legally-controlled weighing of their materials.

However, if their actions thus far are at all indicative, then the traders will continue to ignore this development. In contrast, any trader who trades on a domestic basis, *must* submit to the laws applying to legal metrology, and the so-called "private treaty", whereby the parties to the trade agree their own method of weight determination, is strictly illegal.

How curious that what is illegal domestically, is tolerated internationally for far greater quantities of materials having correspondingly astronomic values. Whilst it is appreciated that International Law is of little consequence in this specialist area, one would expect that at least the buyer of raw materials would want the very best method of weighing used if it possibly affected the amount of money he would be paying.

Imagine your street trader trying to convince the keen-eyed housewife shopping for the week's supplies, that instead of weighing the potatoes, he should put them in a bucket which be would then place in a bath full of water, and then measure the volume of water displaced, and knowing the specific gravity of same, he would then calculate the weight!

Yet this is what is done for the majority of trade in bulk cargoes such as coal, iron ore, phosphates etc. Legally approved belt weighing installations are known to be accurate to at least ± 0.5 % and in recent years, more than hundred such installations have been completed by INFLO in the greater European area, at ratings up to 8 000 t/h. Nevertheless, many traders and their customers refuse to even consider the alternative to draft survey, although quantitative proof exists of the superiority of the belt weighing technique. By using belt weighing at either, or

both, the ports of loading and discharge, it is possible to measure more accurately, in a shorter time, to legally-approved methods subject to third party inspection, and at a lower cost than by using surveying techniques.

Why then, do so many traders and their customers, cling to the surveying route? What is so different in their trade to those trades or customers who have suffered from the relative inaccuracies and higher costs associated with surveying, and converted successfully to trading solely by belt weighing? What possible disadvantage can there be in measuring to smaller tolerances, at lower cost and shorter time, and to legally controlled procedures?

Some years ago, attempts were made within the bulk trades, to adopt belt weighing as a means of trading, but unfortunately both the techniques then used and the regulatory situation applicable, resulted in some unsatisfactory experiences for those involved. This was seized upon by those with a contrary interest, for the purpose of damning forevermore the principle of legal belt weighing.

The situation has now improved to the extent that users can be confident, based on the proven experience elsewhere, of obtaining a well-engineered and legally-controlled installation which will bear scrutiny to the highest standards by any authority. The cost of an appropriate belt weighing installation at a bulk terminal, will be recovered by the savings in dispensing with surveys within a very short time, depending on the size of vessel handled, and whether full or partial surveys are involved.

It is interesting to note that *Jan Merks,* author of the widely respected book "Sampling and Weighing of Bulk Solids" [1] advocates the use of belt weighing for the highest accuracies, and positively discourages the use of surveys for high value shipments, especially on partial shipments – and that from a former surveyor! This is a clear indication that the claimed accuracy of surveying of ± 0.5 % is at best fanciful, and at worst misleading.

Surveying Techniques

Consider the techniques used in draft surveying for a moment.

- Draft readings – are taken of the vessel at forward, middle and after positions on both port and starboard, preferably by boat rather than from a swinging rope ladder. Forward and after drafts are to be corrected, when necessary, for stem and stern corrections.

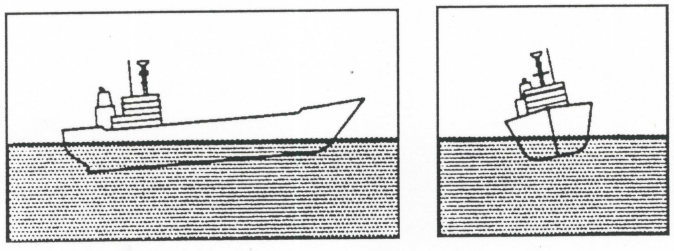

Fig. 1 – Squat Effects – trim, heel and listing.

- Density of the dockwater – representative samples of the dockwater must be taken by a special sampling device on the stern and midships at various depths. The "true" density is then determined by a draft survey hydrometer.

- Deductible liquids on board – these have to be measured by sounding, at both initial and final survey, and corrected for trim and heel. Ballast tanks should preferably be completely full or empty at these times, but this is rarely possible.
  The density of these liquids must also be determined.
- Stores – these have to be determined on every trip by conducting a light draft survey, and any variations which may be known used to correct the final survey.
- Displacement – this is determined by reference to the vessel's deadweight scale, which is based on a calculation made by the shipyard at the time of the vessels construction.

None of the above procedures is absolutely accurate, and we therefore have to assign a tolerance to each in order to be able to assess the probable overall accuracy of the survey technique.

The sources of error in each case are:

- Draft readings
  - accuracy of visual sighting
  - degree of disturbance of the water
  - current/bow wave effects
  - squat effects (Fig.1)
- Density of dockwater
  - sampling of water
  - measurement of density
- Ballast determination
  - fuel, freshwater, saltwater, oils
- Stores
  - quantities can change significantly over a voyage
- Displacement
  - the builder's calculation, based on weight of steelwork used in constructing the vessel plus boiler water if a steamer, crew, baggage etc.

The deadweight figure varies continually by unknown amounts for which estimates have to be made, and includes the weight of mud in double bottom ballast tanks, marine growth on the hull etc.

Assessing Errors

Thus is it seen that there are at least 9 separate sources of possible error in the surveying technique, which are recognised and for which allowances have to be made by the surveyor if he is to declare the weight of the cargo to within an overall precision, as is his practice.

Using conventional statistical techniques to assign these individual tolerances, we shall consider two levels of overall precision: ± 1.0 % and ± 0.5 %. If the stated levels of precision are to be actually achieved to a confidence level of 95 %, (i.e. of all the surveys done, 95 % will lie within the stated tolerance) then the standard deviation (σ) of a series of surveys has to be contained within the limits:

Overall precision	*Standard deviation*
± 1.0 %	$\sigma \leq 0.5$ %
± 0.5 %	$\sigma \leq 0.25$ %

In a survey conducted in the presence of at least 9 random variables, then the tolerance on each individual variable must be contained within the limits:

Overall precision	*Tolerance on each variable*
± 1.0 %	0.166 %
± 0.5 %	0.083 %

Space limitations do not allow a detailed examination of the impact of this level of tolerance for each of the variables, but the reader should consider carefully that a tolerance of ± 0.1 % equates to 1 part in 1,000, i.e. with a ship's draught of say 15 m, this requires the draught to be observed to within ± 15 mm or approximately the thickness of the top joint of the little finger! Try doing that on a cold day in the North Sea!

Suffice it to say that the sheer complexity and the laborious nature of the complete exercice *must* introduce significant errors into each of the measurements taken, before any consideration is even given to the "corrections" which necessarily have to be applied to take account of the vessels hog/sag and trim/heel characteristics under different loading conditions, and so on.

Conclusion

In the final analysis, draft survey can only, at best, involve the surveyor using his best endeavours, without any traceability or audit trail, such as is common practice in industry at large. In those locations when it has been possible to compare the results of "blind" draft survey with certified belt weighing equipment, there has been a clear indication of significant and consistent differences, which usually act against the receiver of the cargo.

Because of the unchallengeable traceability of certified belt weighing equipment, it must be accepted that the survey technique is inferior because it is merely an inferential, yet highly complex method with inherent uncertainties, conducted in a hostile environment.

It is high time that the purchaser of bulk cargoes received the same protection afforded by the Law as the common shopper in the supermarket!

Literature

[1] *Merks, Jan W.:* "Sampling and Weighing of Bulk Solids", Trans Tech Publications, Clausthal-Zellerfeld, Germany 1985.

[2] *Bibby Line:* "Draught Surveys".

[3] *SGS Van Bree:* "Draught Survey Methodology".