Summary

In present day terminals enormous quantities of bulk materials are handled. These large quantities represent huge amounts of money. Determining the weight and quality of these materials is of great interest to the parties involved since it directly translates into financial terms. One could for example consider generating a lowered income because of less efficient production of a production facility due to inferior quality of the material processed, not to mention paying for an amount of material that appears to be smaller then paid for after careful mass measurements.
However, determining the weight and quality of all materials in stockpiles or shipments of hundreds of tons is practically impossible. Both the capacity of the needed equipment and the amount of time required for analysis would render this an economically and practically non viable option. Therefore small amounts, samples, of these materials should be taken that represent the entire stockpile or shipment. These samples can be used to determine the weight and quality of the entire amount of material. Obviously it is of utmost importance that a representative sample is taken. The objective of this research is to investigate which method(s) should be used in sampling and weighing of bulk materials to obtain representative samples.

In chapter 2 the Theory of Sampling (TOS) of Pierre Gy [1-6] is presented which provides a complete scientific theory that allows us to estimate the sampling errors. Chapter 2 will focus on the introduction of the TOS and the generation of different sampling errors. In chapter 3, focus will lay on quantifying these errors. Together these chapters aim to answer the question on how a sample should be selected. Furthermore in chapter 4 different phases in the sampling process will be identified and tools will be provided to calculate how much material should be selected. For the different phases it becomes clear where samples can be extracted.
Chapter 5 will illustrate previous chapters using two cases to allow the theory to become practical and applicable.
In chapter 6 different types of sampling and weighing equipment will be assessed on their ability to generate a representative sample. Chapter 6 makes clear what equipment should be used.
Finally chapter 7 summarizes the findings of the previous chapters and aims to answer the question, which method(s) should be used in sampling and weighing of bulk materials to obtain representative samples.

From these chapters it can be concluded that the principles of the Theory of Sampling (TOS) should at all times be respected to obtain representative samples. These principles require the sample to be probabilistic correct, therefore all material in the lot should have equal probability of ending up in the final sample.

As ISO 11648 recognizes the Theory of Sampling it is advised to use this standard instead of the ASTM and JIS standards that do not recognize this theory.
The number and mass of increments to be taken can be determined depending on the maximum allowable sampling error using formulae proposed throughout this report.

Representative samples can only be obtained for zero- or one-dimensional objects. In practice this means samples can only be taken from a falling stream of material or from a cross stream of the material. Furthermore there are three sampling schemes that can be used to select a sample, namely random, stratified random and systematic selection. These three sampling schemes can be exercised on a mass- or time-basis.

The sampling process can be subdivided in three different phases, the sample extraction, sample preparation and sample analysis phase. Each of these phases uses different equipment. However, not all available equipment is able to generate representative samples since not all equipment recognizes the principles of the Theory of Sampling. It should be noted that equipment that can theoretically generate representative samples will only prove successful if they are used correctly.

Finally it can be concluded that respecting the principles of the Theory of Sampling (TOS) in all its facets allows for representative samples to be obtained from very large amounts of materials in a way that is viable in practice.