bulk solids handling Volume 2, Number 3, September 1982

Sampling of Coal in the USA

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Summary

Over the years the use of mechanical sampling systems has grown rapidly in the USA. With about 1 billion (10^9) tons of coal being mined, the need for accurate sampling systems is proving itself throughout the industry.

The complexity of coal sampling, however, has not made it easy to design and maintain these mechanical coal sampling systems. Many installations, unfortunately, do not perform as anticipated. Redesign and retrofits are constantly being done on existing facilities. Gravity flow of sticky coals is generally the basic problem in a sampling system.

This paper discusses some of the common practices of coal sampling in the USA.

1. Introduction

Over the years, coal sampling has grown from the original, simple slurry samplers to multi-stage sampling systems that have become more and more comprehensive in order to accommodate rapidly changing sampling requirements and increased tonnage flow rates. As an example, it is not uncommon today to be confronted with coal feed rates as high as 10,000 t/h and with the maximum coal particle size sometimes exceeding 6 inches.

Coal is one of the most difficult materials to sample, due to its variability in composition between non-combustible particles to those which lend themselves to complete burning. The sampling responsibility is further complicated by the objectives to be realized in analytical examination, variable and sometimes very high moisture contents, the presence of clay, the size of the lot or consignment to be represented by the sample and finally the degree of sampling precision required.

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Paper presented at the First Australian Bulk Materials Storage, Blending and Sampling Conference, Sydney, March 15—17, 1982.

The proper collection of the sample involves an extensive understanding of the physical characteristics of the coal, the minimum number and weights of increments to be taken, the size consist of the coal and the overall sampling precision that is required.

This paper does not intend to present any new sampling techniques or theory, but will confine itself to some practical aspects of coal sampling in the USA.

The need for coal sampling occurs at various points from mine-face to the end-user. The design requirements, however, may vary greatly, as the objectives for the sampling will vary. The justifications for sampling of coal fall generally under one of the following categories:

1. To determine quality acceptances for purchase or sale.
2. To control a process or operation, such as blending or combustion.
3. To facilitate inventory control, for material balances, cost estimates and taxes.

Each of these categories will eventually influence the final design and operation of the sampling system. Lot size, flow rates, lump size and coal properties and variability are the basic parameters influencing the design of a sampling system.

Both mechanical sampling and manual sampling are practiced extensively in the USA with varying results. The complexity of coal sampling has not made it easy to design, install and maintain mechanical coal sampling systems.

2. Applicable Methods and Standards

The designs of the majority of the coal sampling systems are based upon standards generated by the American Society for Testing and Materials, the International Standards for Coal Sampling and the Japanese Industrial Standards. These groups delineate, in their standards, methods and procedures for the collection of coal samples. In the United States, the rules established by the American Society for Testing and Materials (as delineated in ASTM Specification D-2234 for Sampling Systems and D-2013 for Sample Preparation), establish the overall requirements for the collection and preparation of coal samples respecitively. A brief excerpt of these standards is included in the Appendix.

Normally, coal consists of particles of varied shapes and sizes which have different physical characteristics, chemical properties and ash content. To ensure that the final sample will truly represent the coal from which it is taken, it is collected by taking a definite number of portions known as "increments" periodically throughout the entire coal lot being sampled. The term "increment" refers to the quantity of coal obtained by a single operation of the sample machine cutter passing through a stream of coal — normally discharging off the head pulley of a belt conveying system.

The number and weight of increments required for a given degree of precision depends upon the variability in the coal itself. This variability increases with the increase in free impurities. As an example, an increase in ash content of a given coal usually indicates an increase in total variability. It is, therefore, imperative that not less than a minimum specified number of increments of not less than the minimum specified weight be collected for the total lot or consignment. This is particularly important today, when we are faced with some of the more difficult coals to sample. Much of the coal being produced today is from multiple seams — often high in ash content and in surface moisture content. Also, high clay contents in some coals (present in the form of bentonite) tend to make the coal extremely sticky, difficult to handle and to flow.

Although the ASTM standards intend to define the basic design criteria for a coal sampling system, it does not address itself to the influence of the flowability characteristics of coal. When problems occur in coal sampling systems — and we have many of them — it is usually a matter of "plugging" the system.

Unfortunately, most designers of coal sampling systems give lip service to the fact that a sampling system is basically a gravity-flow type of handling facility, running at very low flow rates. Equipment is generally sized on the basis of flow rates only, without concern for the cohesive and/or adhesive properties of the coal sample. As a result, many U.S. coal sampling systems are seriously deficient in their performance.

3. Mechanical Sampling Systems

Mechanical sampling of coal often is referred to as automatic sampling, a deceptive and misleading term. Though sampling operations can be automated, to many power engineers the word "automatic" implies essentially perfect sampling and unquestionable accuracy. Nothing could be further from the truth.

When you sample coal, nothing is automatically right. The physical and chemical characteristics of coal that cause so many problems in manual sampling, also plague mechanical systems, where errors usually have greater impact simply because of the large quantities of coal typically handled.

Many errors in mechanical sampling stem from material handling problems. It is difficult to imagine a substance more intractable to handle than coal. To illustrate:

- Dry coal creates dusting problems.
- Wet coal clings, plugs, hangs up and blinds.
- Very wet fine coal becomes a thick gooey slurry.
- Frozen coal causes blockage and selective rejection by sampling equipment designed for smaller pieces.
- All coal is abrasive and corrosive.

The variety of difficulties these diverse characteristics create is never-ending. Use of the term "automatic" results in casual disregard for them, as well as for more mundane mechanical failures. What is needed, instead, is a healthy respect for the real limitations on ideal performance that exist.

Mechanical sampling systems typically collect the gross sample, and perform at least part of the sample-preparation work by crushing and by reducing the size (weight) of the sample. The major advantage these systems have over manual methods is that they all sample coal from a moving stream. Hence, they usually can satisfy the first principle of ideal sampling — that is, every particle in the entire lot of coal to be represented by the sample, theoretically should have an equal chance of being included in the sample.

Two significant problems generally associated with conventional mechanical sampling systems are these:

1. the quantity of coal contained in each primary increment is inordinately large, typically orders of magnitude greater than the minimum weight required by ASTM D-2234, *"Standard Method for Collection of a Gross Sample of Coal"*, and
2. the quantity of coal collected with each pass of the sample cutter at the last stage of sample division tends to be too small.

The first inflates the overall size and cost of the system; the second inflates the variance of sample division and can adversely influence the sample's representativeness.

Most coal sampling systems are designed for a maximum particle size of 2—2½" or 50—65 mm. For conveying flow rates of up to 2,000 t/h, a two-stage system will generally suffice. For conveying rates of over 2,000 t/h, three-stage systems are usually applied. Figs. 1, 2 and 3 show some variations possible in a three-stage coal sampling system.

4. Primary Cutters

The large primary-increment problem comes from fundamental engineering limitations. Let us examine some of these for the most common type of primary cutter, one that collects increments from a falling stream of coal by traversing the width of stream. As shown in Fig. 4, the cutter moves across the flow of coal from one side of the stream to the other.

Cutter speed must not be too fast, otherwise it will disturb the flow of coal. This restricts the velocity of the cutter to a fraction of the velocity of the coal. Structural limitations may also influence cutter speed, especially in large systems where cutter acceleration and deceleration forces are significant. Current engineering practice in the US is to limit cutter speed to about 18 in/sec (0.457 m/sec) as specified in ASTM D-2234.

This relatively low speed, together with the ASTM D-2234 requirement that the effective width of the cutter be 2½ to 3 times the maximum particle size, makes for large primary samples. Typically, they range from a few hundred pounds to half a ton or more, depending on the rate of coal flow and coal top size.

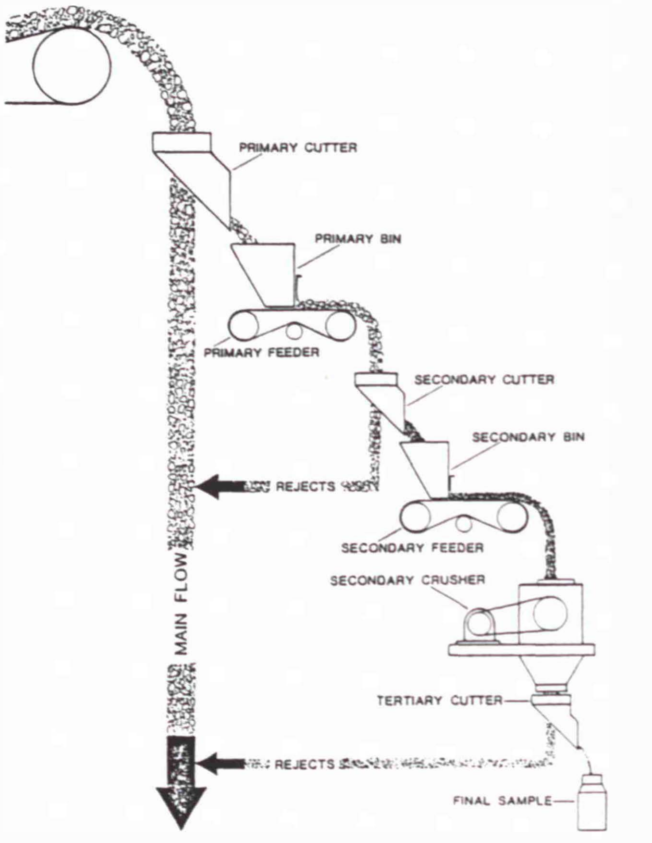

Fig. 1: Three stage sampling system utilizing resampling of the primary sample before crushing

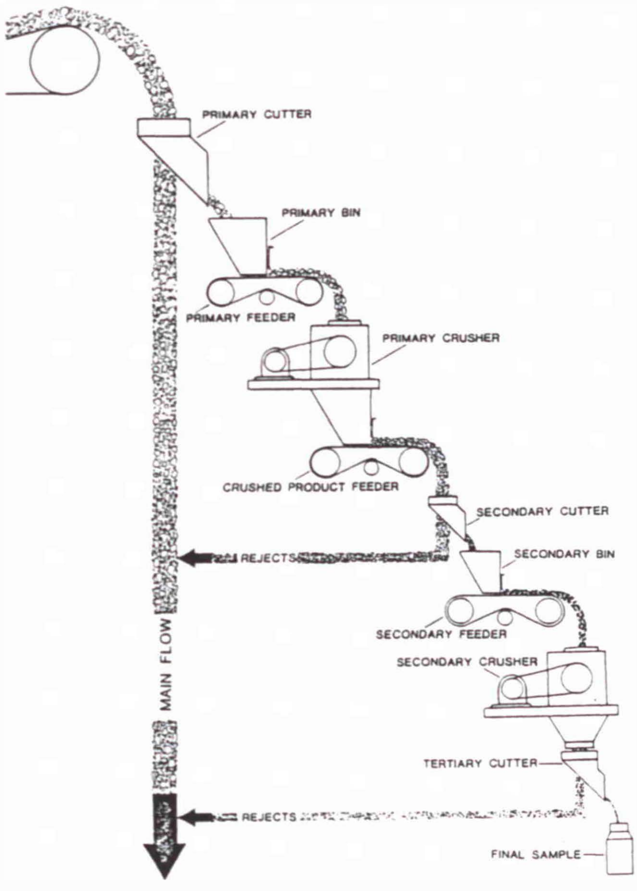

Fig. 3: Three stage sampling system utilizing two stages of crushing

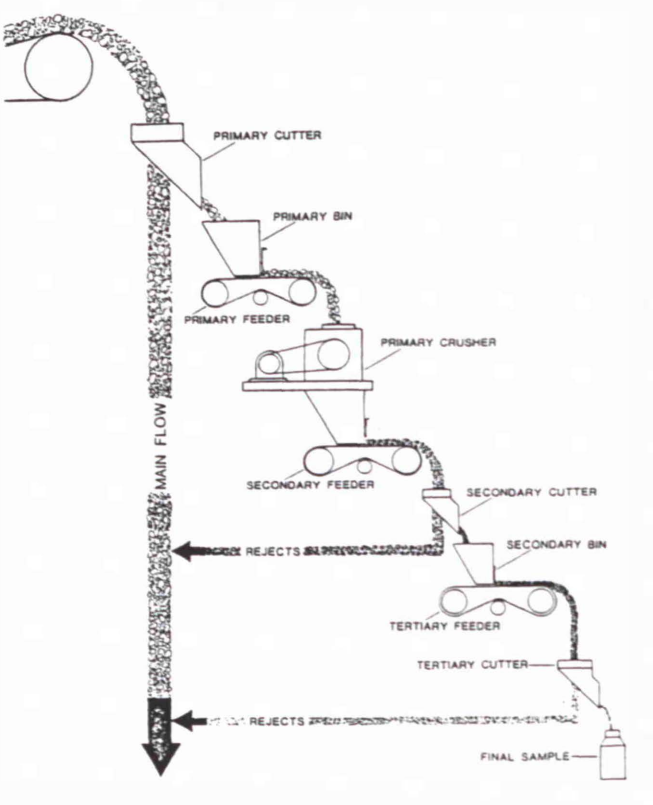

Fig. 2: Three stage sampling system utilizing crushing of the entire primary sample followed by secondary and tertiary sampling

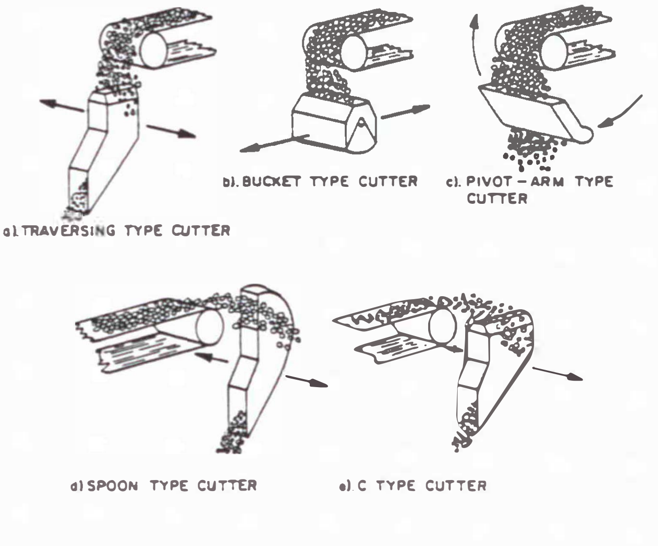

Fig. 4: Various types of sample cutters

In a system, where 3 in. (top size) coal flows at 2,500 t/h, the primary increment weight may be as large as 700 lbs. Increment size is given by the equation

$$Inc.\ Wt. = \frac{\text{t/h} \times CW}{1.8 \times CV}$$

where

CW = cutter width in inches
CV = cutter velocity, in/sec.

i.e., $Inc.\ Wt.$ for 2,500t/h of 3 in. coal:

$$\frac{2{,}500 \times 9}{1.8 \times 18} = 694 \text{ lbs.}$$

Considering that minimum increment size required by ASTM D-2234 is 6 lbs, this is clearly excessive, though unavoidable. It is also obvious that the physical size of towers, conveyors, drivers, crushers, bins and other system components must be correspondingly large and costly.

Conceptually, one of the simplest and most practical ways to collect increments from a falling stream is to traverse the depth of the stream — as opposed to its width — with a cutter moving in a plane perpendicular to the direction of the flow, as shown in Figs. 4b and c. The advantages of this approach are that it can reduce the primary increment size with cutter velocities greater than 18 in/sec, and it requires minimal headroom. This method is often considered for retrofit jobs.

When the direction of motion of the cutter in this plane is at an acute angle to the direction of flow, there is evidence that disturbance to the flow of coal may be reduced, permitting higher cutter velocities. A revision is currently contemplated in the ASTM D-2234 to allow higher cutter speeds than 18 in/sec, if no bias error occurs. Some authorities even consider the cross-sectional increment this system collects to be superior to the long, narrow, diagonal ribbon collected by a transverse cutter. The pivot-arm sample shown in Fig. 4c is capable of collecting increments that weigh only about 230 lbs from a 2,500 t/h stream at 54 in/sec (1.371 m/sec). This is about one-third the amount of coal collected by a conventional transverse cutter. However, care must be taken to design the cutter head in such a manner, that it does not reject any lumps during the cutting stroke. The cutter opening must be at least 3 times the largest particle size.

5. Secondary and Tertiary Cutters

The large primary increments gathered by the conventional sampling systems discussed above demand substantial subdivision to reduce sample quantity to practical amounts for laboratory use. This usually requires use of both secondary and tertiary cutters, and either one or two stages of crushing.

A wide variety of successful secondary cutters have been developed. Some simply are scaled-down models of the primary cutters, which traverse the width of the stream from side to side. The smaller secondary cutters of this type generally operate at only about half the velocity of the primary cutters. Top speed usually does not exceed 12 in/sec, although 18 in/sec is acceptable.

Secondary cutters often traverse the depth of the stream, rather than the width. A mechanically inverted variation of this design is the moving-hopper/fixed-position cutter (Fig. 5). Another variation is the slotted belt shown in Fig. 6. An advantage of the slotted belt is that it requires minimum headroom and that it moves the rejects laterally.

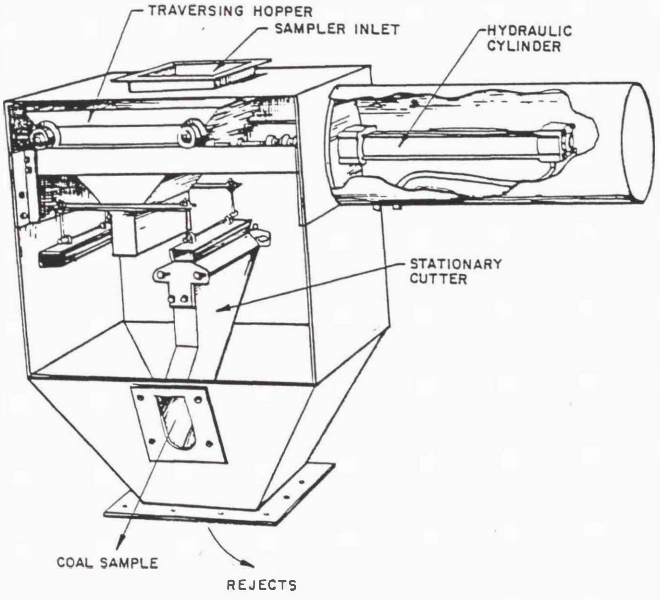

Fig. 5: Typical secondary or tertiary coal sampler

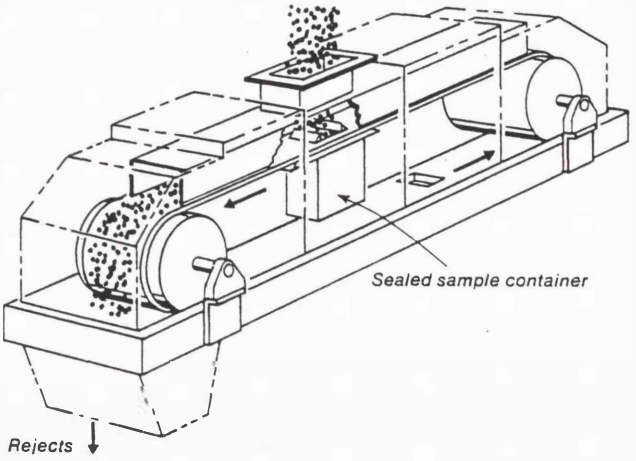

Fig. 6: Slotted belt sampler

Note that the parallel-slot riffle has not been used extensively for sample division in mechanical systems in the U.S. because of its susceptibility to plugging. The sloping faces of the slots usually are oriented at an angle of 60 deg. or more to horizontal, making demands on the amount of headroom needed — particularly in multistage arrangements.

There are practical lower limits to the number of coal particles per cut. Beyond these limits, it is difficult to avoid bias and the variance of division component tends to become too large a part of the total variance of sample preparation. As noted earlier, the representativeness of a particular sample is jeopardized by collection of a large number of too-small increments, even if the correct gross sample weight is achieved. This same phenomenon is operative in sample division.

Debate continues in the US over what the minimum weight of separate cuts from secondary and tertiary cutters should be. The problem is most acute at the tertiary-cutter stage, where bias in mechanical sampling systems is encountered most often. The bias undoubtedly relates to efforts to strive for increment sizes that are too small. For instance, some conventional systems produce tertiary cuts as small as a few grains of minus 8 mesh.

Some experts think that the lower limit at this stage should not be less than about 200 grams. A physical problem, associated with quantities less than this amount, is increased plugging tendency in downstream chutes and pipes, because there is insufficient mass to overcome the plugging forces.

Another serious problem with conventional state-of-the-art mechanical sampling systems is maintenance of uniform flow rates to the crushers and cutters. This affects moisture losses, uniformity of crusher-product size and composition, and uniformity of increment weight. The best system designs rely on a bin-and-feed step before and after crushers and before cutters.

But even with this sophistication, it is difficult to provide the flexibility needed for large variations in lot size or dumping rates. Without such refinements, cutters invariably cycle through their traverses, busily collecting "nonincrements" when coal is not flowing. Or they collect increments of widely varying weight, corresponding to variations in coal-flow rates, thereby giving disproportionate representation to some parts of the lot, relative to others.

6. Crushers

Crushing also demands close scrutiny. Most crushers selectively crush the more friable material first. This phenomenon is associated with segregation by composition. Result is that, as the feed rate tails off, the ash content of the crushed product tends to change. This can be a source of biased samples by causing cutters to collect disproportionate amounts of low-ash material relative to high-ash material.

In addition, crushers usually are responsible for more moisture loss in a system than any other component. The hammermill, the type of crusher most commonly used, is surprisingly effective as a fan and is capable of pumping substantial amounts of air. Thus, as coal flow decreases, the amount of air that sweeps across each unit weight of coal increases, and moisture losses increase correspondingly.

Bins before and after crushers act as seals and, therefore, are effective for controlling moisture losses of this kind. If bins are not used, air also may be pumped through upstream and downstream chutes and pipes, increasing moisture losses there. A further refinement used in some systems is a pressure-balancing pipe — connected across the mill between the entrance throat and the bin that receives crushed coal — to reduce the air-pressure differential and to recirculate the air. This allows the air in the system to seek an equilibrium saturation moisture level, inhibiting moisture losses.

Crushing produces a substantial amount of heat energy, causing evaporation of moisture contained in the coal. This is unavoidable, but evaporation losses could be limited by reducing mill speed (rpm). While changing speed probably does not influence the amount of work needed to crush a given batch of coal, some reduction in air throughput results. Generally, it is not practical to reduce mill speed below about 1,200 rpm. Also, because particle size is a function of top speed, reduction of mill speed produces a coarser product which requires closer bar spacing or smaller screen openings to achieve required product particle size. This reduces mill capacity, which must be compensated for by selection of mills rated at higher capacities.

Of course, if mill speed in an existing installation is reduced, more crushing capacity must be added.

7. Performance Testing

The desirability of performance testing of mechanical sampling systems is clearly indicated by the foregoing discussion. One test that ought to be run before accepting a new system — and one that should periodically be conducted while the system is in operation — is a bias test. Though this is a difficult, time-consuming exercise, and an expensive one, it is necessary.

It is essential to test overall system performance, but testing of each cutter independently may be desirable too. Proper performance is verified by manually collecting stop-belt reference samples approximately equal in weight to the primary-cutter increments, and then comparing their analysis with those of the system sample. This means that loaded belts need to be stopped and started during tests at much more frequent intervals than they are in normal service.

Also, provision should be made at the design stage to permit easy collection of stop-belt samples, as well as of individual primary increments ahead of the primary crushers. Since these are very large, transporting them from elevated locations to work areas often involves a substantial amount of back-breaking labor. Systems that do not provide for these needs, complicate the tests, increase their cost, and may jeopardize the validity of the results. Downstream secondary and tertiary cutters can be tested by collecting both the reject and save portions for comparison of analysis — but, again, provision must be made for doing so.

The particle-size reduction performance of crushers should be checked frequently too. This can be accomplished by diverting the full stream of crushed product at normal system flow rates into a suitable receiver, so screen tests can be conducted. Downstream cutter-save or cutter-rejects streams also can be used for screen tests, but they are less reliable.

8. Examples of Some Typical U.S. Coal Sampling Systems

The two examples discussed in this section have been designed by one of the most experienced mechanical sampling engineering firms in the U.S., James A. Redding Company in Pittsburgh, Pa.

Fig. 7 shows a typical two-stage "as fired" sampling system. This one is located at Public Service of Colorado, Pawnee Generating Station. 2 in. x 0 raw coal is sampled from the discharge of parallel 48 in. conveyor belts, each handling 750 t/h and either one or both belts can operate at the same time. A 4 hour consignment was requested. The primary samplers

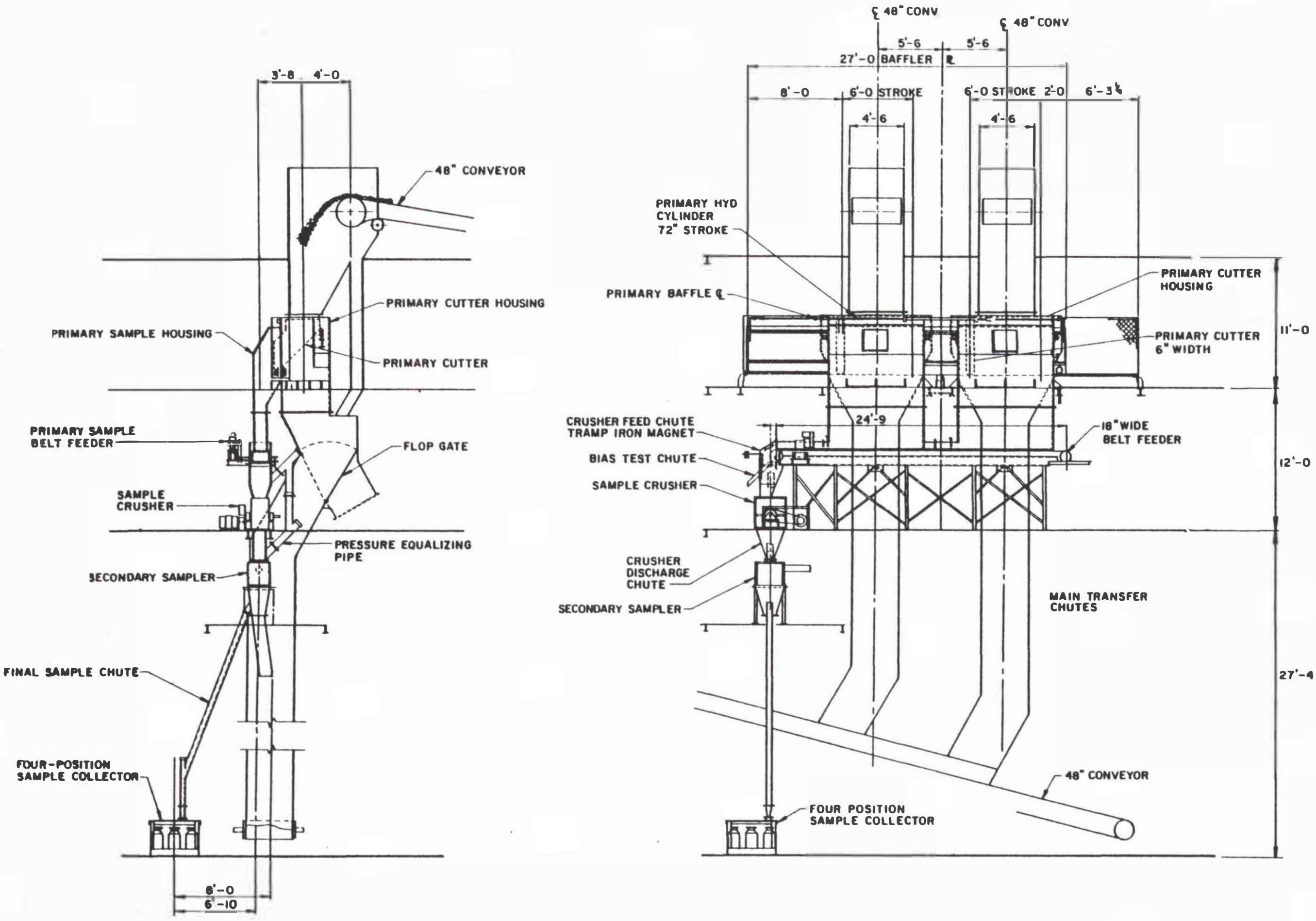

Fig. 7: Dual-coal sampling system (two stage)

each have a 6 in. cutter opening and operate from a common baffle plate. This ensures exactly the same speed, 18 in./sec, for both cutters, a "must" since a true representative sample in true proportional quantity must be obtained. The final sample is comprised from one or both conveyors that are feeding the boiler feed bunkers.

Each primary cut extracts 139 lbs/cut from each conveyor and operates at 24 cuts/hour. Therefore, 3,336 lbs/h is accumulated when one belt is operating, and 6,672 lbs/h when both belts are operating.

A vari-speed belt feeder, driven from a two-speed motor, feeds the primary sample to the sample crusher. The two-speed motor is essential in order to obtain a constant feed to the sample crusher and then to the secondary sampler. The lower motor speed (1/2 speed) is automatically selected when one belt is operating and the higher motor speed (full speed) is automatically selected when both belts are operating.

The extracted primary sample is crushed to 100 % —4 mesh, 95 % passing 8 mesh and goes directly to the secondary sampler.

The secondary sampler is a dust-tight, traveling hopper type with a fixed adjustable opening cutter set at 1 1/4 in. and is operating at a speed of 18 in/sec. The secondary sample extraction is 0.0635 lb/cut with one belt operating, and 0.127 lb/cut with both belts operating.

Operating at 90 cuts/h will produce 5.715 lbs/h with one belt operating and 11.43 lbs/h with both belts operating. The final sample, representing the 4 hour consignment, would then be a minimum of 22.86 lbs with one belt operating to a maximum of 45.72 lbs with two belts operating, or anything in between, depending on the operating frequency of one or both conveyors.

The rejects from the secondary sampler are deposited by gravity onto the lower bunker-feed conveyor.

This system is unique, for it produces a truly reliable, representative sample in accordance with ASTM from a dual belt system, automatically adjusting from one belt or the other or both.

Fig. 8 shows a sampling system that is sampling a 10,000 ton, 100 car unit-train loadout in Manchester, Ky. for the Interstate Coal Company. The bin feed is 3,500 t/h of 3 in. x 0 raw (uncleaned) coal, via a 60 in. belt conveyor, discharging into a loadout bin above the railroad track.

At 3,500 t/h, a train is loaded in a minimum of 2.86 hours. The primary sampler located at the discharge of the 60″ belt conveyor, is a traversing type cutter with a 9″ opening and operating at a speed of 18 in/sec. A baffle plate continuously seals the primary sample hopper from the main flow. The primary sampler operates at a frequency of 90 sec/cut, thus 40 cuts/h, 114 primary cuts for the 10,000 ton train, which ex-

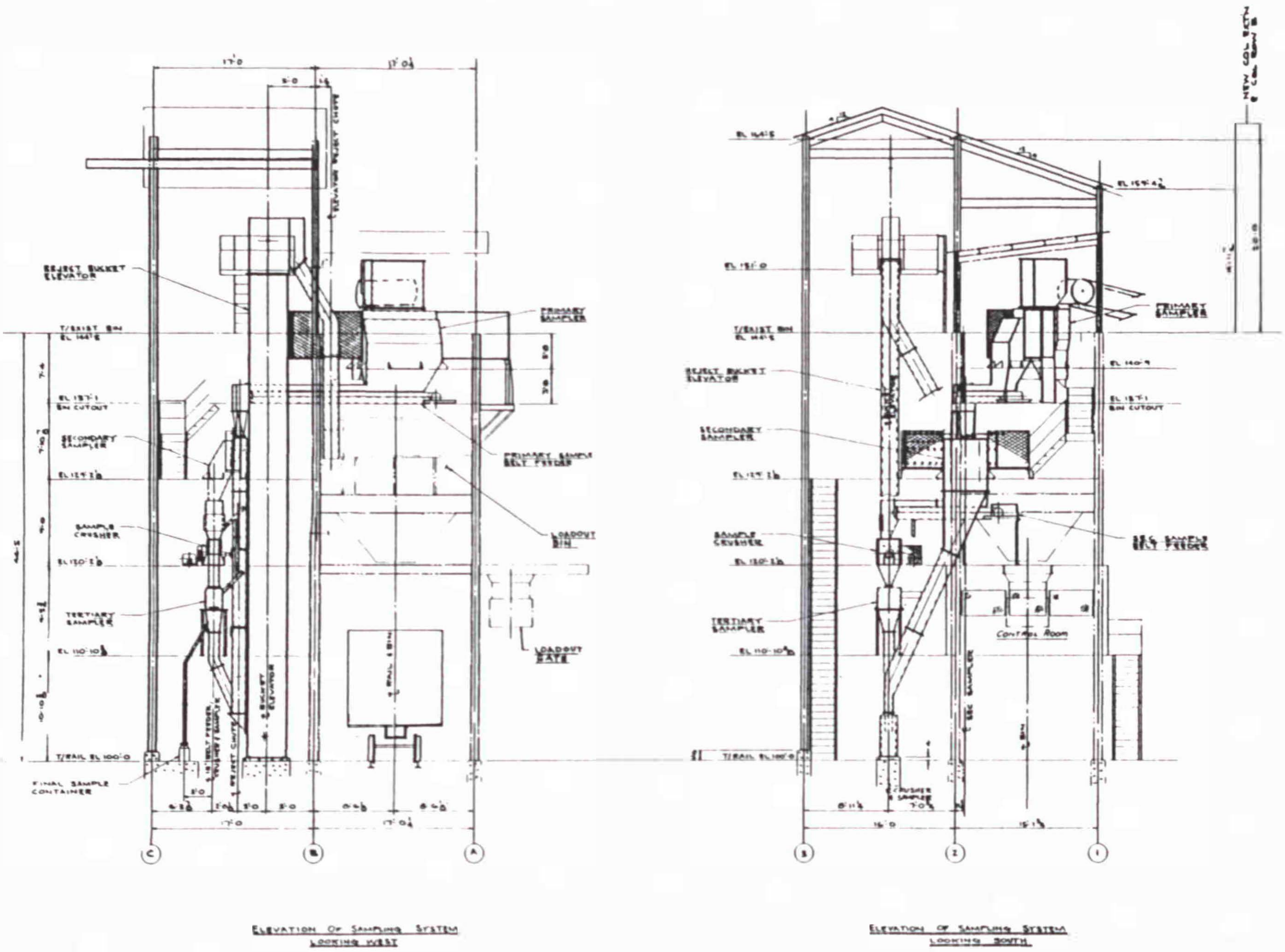

Fig. 8: Railroad loading three stage sampling system

ceeds the ASTM minimum of 111 cuts for the 10,000 ton train.

Each primary cut extracts 972 lbs, therefore, 38,880 lbs/h of primary sample is produced.

The 38,880 lbs/h of primary sample is fed via a vari-speed belt feeder to the secondary sampler. The secondary sampler is the same basic type as the primary, much smaller of course, and has also 9 in. opening and operates at a speed of 6 in/sec. The secondary sampler will extract 16.2 lbs/cut, and takes 270 cuts/h (13.3 sec/cut) for a secondary sample of 4,320 lbs/h. The 270 cuts/h exceeds the ASTM D-2234 requirement of 6 secondary cuts for each primary cut, and each cut exceeding 15 lbs of material.

The 4,320 lbs/h of secondary sample is fed via a vari-speed belt feeder to the sample crusher, where it is reduced to 100 % minus 4 mesh, 95 % passing 8 mesh and then directly to the tertiary sampler which is located directly beneath the crusher discharge. This is done to ensure a dust-tight condition and to minimize moisture loss.

The tertiary sampler is a dust-tight traveling hopper/fixed adjustable opening cutter type. The cutter opening is set at 1¼ in. and the sampler operates at a speed of 18 in/sec. This produces 0.082 lb/cut, and operating at 200 cuts/h (18 sec/cut) will produce 16.4 lbs/h of tertiary sample or 46.9 pounds of final for the 10,000 ton unit train.

The rejects from the secondary sampler and the tertiary are deposited into a bucket elevator and lifted back into the loadout bin.

Appendix

Excerpt of ASTM Standards

In order to facilitate the application of A.S.T.M. Designation D-2234-76 and D-2012-72, we have extracted the following principal provisions pertaining to coal sampling applications.

A.S.T.M. D-2234-76:

Data obtained from coal samples is used in establishing price; controlling mine and cleaning plant operations; allocating production costs, and determining plant or component efficiency. The procedures for dividing large gross samples before any crushing are given in this standard.

3.1 General-purpose sampling procedures are intended to provide a precision of ± 1/10 of the ash content of the coal sampled in 95 out of 100 cases.

4.1 **Accuracy:**
Generally a term used to indicate the reliability of a sample.

4.4 **Bias:**
(Systematic error) — an error that is consistently negative or consistently positive.

4.14 **Precision:**
A term used to indicate the capacity of a person, an instrument, or a method to obtain reproducible results.

4.15 **Representative Sample:**
A sample collected in such a manner that every particle in the lot to be sampled is equally represented.

6.2 Proper sampling involves an understanding and proper consideration of the minimum number and weight of increments, the size consist of the coal, the condition of preparation of coal, the variability of the constituent sought, and the degree of precision required.

6.2.1 The number and weight of increments required for a given degree of precision depends upon the variability of the coal. This variability increases with an increase in free impurity. For most practical purposes, an increase in the ash content of a given coal usually indicates an increase in variability.

6.2.2 In order to obtain complete representation of all sizes, it is most desirable that the sample increments be withdrawn from the full cross section of the stream. The best possible increment from a flowing stream of coal is one obtained by moving a cutter device entirely across the stream at a uniform speed, the same for each increment, into one side of the stream and out of the other, without allowing the receptacle to overflow.

6.3 **Distribution of Increments:**
It is essential that the increments be distributed throughout the lot to be sampled.

6.4 The opening of the sampling device shall be at least 2 1/2 to 3 times the top-size of the coal. However, for practical reasons, it is recommended that the opening of any sampling device be not less than 1 1/4 inch regardless of the top size of the coal.

6.5 In sampling from moving streams of coal, the sampling device shall be designed to minimize disturbance of the coal, thereby avoiding separation of various coal densities and sizes or both. To prevent segregation and rejection due to disturbance of the coal stream, practical evidence indicates that the velocity with which the sampling instrument travels through the stream shall not exceed 18 inches per second.

6.6 The increments obtained during the sampling period shall be protected from changes in composition due to exposure to rain, snow, wind, sun, contact with absorbent materials and extremes of temperature. The circulation of air through equipment must be reduced to a minimum to prevent both loss of fines and moisture.

6.7 The sampling arrangement shall be planned so that contamination of the increments with foreign material or unrelated coals is avoided.

7.1.1 The general-purpose sampling procedure is intended for a precision such that if gross samples are taken repeatedly from a lot or consignment and one ash determination is made on the analysis sample from each gross sample, 95 out of 100 of these determinations will fall within ± 1/10 of the average of all the determinations.

7.1.3 Variations in construction of the sampling device and flow, structure, or size consist of the coal may make it impracticable to collect increments as small as the minimum weight specified in table 2. In such cases, collect an increment of greater weight. However, do not reduce the minimum number of increments, regardless of large excesses of individual increment weights. Table 2 lists the absolute minimum of increments for general purpose sampling which may not be reduced except as specified in 7.1.5.2.

7.1.4 **Number of Gross Samples:**
Under the general purpose sampling procedure, for quantities up to approximately 1000 tons (908 metric tons) it is recommended that one gross sample represent the lot. Take this gross sample in accordance with the requirements prescribed in table 2.

7.1.5 For quantities over 1000 tons, use one gross sample to represent the total tonnage provided the number of increments, as stated in table 2, are increased as follows:

$$N_2 = N_1 \cdot \sqrt{\frac{\text{total lot size (short tons or metric tons)}}{\text{1000 short tons or 908 metric tons}}}$$

Where:

N_1 = number of increments specified in Table 2, and
N_2 = number of increments required.

9.1 In the case of very large and unwieldy gross samples, it is permissible to divide the gross sample to reduce its weight. If each very large increment is reduced in quantity by secondary sampling, take at least six secondary increments from each primary increment. The method of collection of secondary increments must be proved to be free from bias. In no case shall the weight of a secondary increment be less than shown in the schedule of table 2.

Table 2: Number and Weight of Increments for General Purpose Sampling Procedure

	Mechanically Cleaned Coal		
TOP SIZE	**5/8 In. (16 mm)**	**2 In. (50 mm)**	**6 In. (150 mm)**
Minimum number of increments	15	15	15
Minimum weight of increments, Pounds	2	6	15
Minimum weight of increments, Kg	1	3	7
	Raw (Uncleaned Coal)		
	5/8 In. (16 mm)	**2 In. (50 mm)**	**6 In. 150 mm)**
Minimum number of increments	35	35	35
Minimum weight of increments, Pounds	2	6	15
Minimum weight of increments, Kg	1	3	7

A.S.T.M. D-2013-72:

1.1 This method covers the reduction and division of gross samples, collected in accordance with methods D-2234, up to and including the individual portions for laboratory analysis.

6.0 **Precautions:**

6.1 **General:**

The preparation of the gross sample shall be done by trained and experienced personnel. If all precautions regarding sample preparation are not followed, the error in the preparation may exceed the recommended maximum allowed 4.5 percent of the average ash content of the sample.

6.4 In collecting, handling, reducing and dividing the gross sample, all operations shall be done rapidly and in as few operations as possible, since moisture loss depends on several factors other than total moisture content, such as time required for crushing, atmosphere temperature and humidity and type of equipment.

8.3.4.2 Mechanical division of the sample consists of automatically collecting a large number of increments of the properly reduced sample. Distribute this large number of increments equally throughout the entire discharge from the sample crusher because crushers can introduce appreciable segregation. At each state of division, take at least 60 increments.

8.4.2.2 Reduce the gross sample to Number 4 (4.74 mm) or Number 8 (2.36 mm) with suitable crushing equipment and divide to quantity limits in table 1 plus a minimum of 500 g. This is the laboratory sample.

Table 1: Preparation of Laboratory Sample

Crush to pass at least 95 percent through sieve	Divide to a minimum weight of g [a)]	
	Group A	Group B
Number 4 (4.75 mm)	2.000	4.000
Number 8 (2.36 mm)	500	1.000
Number 20 (850 μm)	250	500
Number 60 (250 μm) 100 % through	50	50

a) If moisture sample is required, increase the quantity of Number 4 (4.75 mm) or Number 8 (2.36 mm) sieve subsample by 500 g.