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Studies in Management and Accounting for the

# FOREST PRODUCTS INDUSTRIES

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"CONTROL AND MEASUREMENT OF CHIPS

by Kyle Gray, Pope & Talbot, Inc.  
Ron Ingram, Publishers Paper Co.



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## INTRODUCTION

The control and measurement of chips represent a significant challenge for virtually all solid wood products and pulp and paper producers. Control and measurement of sawdust, shavings and hog fuel are equally challenging; however, for simplicity this monograph directly addresses only chips. Hopefully, by providing a sound understanding of the basic difficulties associated with the control and measurement, a foundation will be laid from which improved approaches and/or techniques will be developed.

## OVERVIEW

Chip measurements are required by both producers and consumers. Chips may be produced from whole logs or as a by-product (residual) of solid wood products' manufacturing. Chips are used in the production of pulp, hardboard, oriented strand board, particle board etc. Some manufacturing processes require specific wood species due to differing physical properties.

A typical pulp mill or other chip consumer receiving installation consists of platform scales to weigh incoming trucks or rail cars, a receiving/unloading station, a sample testing lab, pneumatic or belt conveyors to and from the storage and process facilities, silos or bins for smaller volume storage, a large relatively level area for high volume storage, and processing facilities.

Since the moisture content of chips is variable and the user is concerned only with actual fiber content, the units of measure most frequently used are the bone-dry ton or oven-dry ton (BDT or ODT) which are 2,000 pounds and the bone dry unit (BDU) which is 2,400 pounds. The BDT and BDU reflect the actual weight of fiber at zero moisture content.

A load of chips when received is weighed and a sample obtained for moisture and quality testing.

The sample is weighed before the moisture is removed. It is then placed in a testing oven at a specified temperature for a specified period of time. There is some inconsistency in the industry regarding the exact temperature and time to be dried. After the dry sample is removed the ratio of the sample's net dry weight to the sample's wet weight is then applied to the total weight of the load to determine "bone-dry" weight. This is then divided by 2,000 or 2,400 to determine BDT's or BDU's.

Quality testing usually involves processing the chips through a "chip classifier" and also hand sorting. The purpose is to determine chip size (length and thickness), the amount of oversized material ("overs"), the amount of undersized material ("fines"), the proper species and the amount of bark and other contaminants. Contractual arrangements usually include varying specifications with regard to chip quality because different processes require different types of material. Various types of rot are also present in chips. Historically there has been a limited attempt to measure rot, however, its presence is continually becoming more important.

In addition to determining receipts, it is also necessary to calculate usage and inventory. Depending on the operation and equipment, measurement can be based on several methods, none of which produce totally reliable results.

Where belt conveyors are present, the process facility usage is often calculated based on measurements using a device called a weightometer. In batch processes, historical or sampled usage per batch may be applied to the number of batches produced. In continuous processes usage may be calculated from finished production using historical or standard process yields.

Inventories can be trigonometrically surveyed or topographically measured using aerial photography to calculate volume. Both methods produce a volume result which must be converted to BDT's or BDU's. The conversion factor (dry pounds of wood fiber per cubic foot) is subject to error due to the compaction and moisture content of the inventory. The potential for error in measuring chip inventories increases with pile size, inventory age and pile shape irregularity. Some companies break their chip inventories into two or more piles to reduce the pile sizes and chances for error in calculating inventories and usage. Where inventory volumes are very large, the inventories are often calculated from usage and the results of physical inventories used only to confirm the reasonableness of the perpetual inventory.

Experience at any particular facility will indicate the most reliable method of determining chip usage and inventory.

## **SPECIFIC DIFFICULTIES OF CONTROL AND MEASUREMENT**

### **Receipts**

The gross weight of each load received is adjusted by sampled moisture to determine the weight of the actual fiber received. The following are problem areas involving receipts:

- (1) Sale error—A scale inspection and testing program should be adopted (even though most scales are inspected and certified by a governmental agency). While large errors are usually obvious, smaller errors can be difficult to detect and if unchecked can result in significant volume errors.
- (2) Sample taking—The sample should be representative of the entire load; i.e., some from the top, center, bottom, front and rear. It is difficult to manually obtain such a sample, but some automatic samplers have been developed.
- (3) Sample handling—The sample must be properly sealed and tested as quickly as possible to avoid contamination and change of moisture content.
- (4) Sample testing—Testing procedures must be monitored to insure they are consistently followed. Sample volume, scale procedures, temperature, and time in oven are all critical in obtaining accurate results.
- (5) Quality Control—Tests for chip size, “over,” “fines,” species and bark should all be consistently performed, and procedures developed for rejection or down-grading to insure that the material received is within the established standards.
- (6) On-site production—Chip production at the same facility can be 1) measured by a weightometer, 2) estimated by applying a recovery factor to the volume of logs processed, or 3) isolated and inventoried separately.
- (7) Fraudulent activities—Collusion or gross lack of attention is usually necessary for fraud to occur. The fraudulent objective normally would be to falsify (reduce) the moisture content or in other ways overstate weight received. While probably not common, the possibility of fraud should not be ignored.

### **Storage**

In storage the actual chip volume and quality can be affected by:

- (1) Fiber breakdown caused by heavy machinery (such as a front-end loader or bulldozer) working on the pile.
- (2) Fiber breakdown caused by pneumatic or other conveyance systems. This is particularly a problem with sharp bends or poorly maintained pneumatic piping.
- (3) Fiber deterioration caused by long-term storage.
- (4) A fire in the pile storage caused by spontaneous combustion.
- (5) Contamination from the surroundings; i.e., other species, dirt, fly ash, etc.

### **Usage**

Problems in determining usage include:

- (1) Weightometer measured usage is subject to the limited accuracy of the device and variable moisture. A regular program of maintenance and calibration is necessary to obtain acceptable results. Chips in outside storage are subject to changes in moisture after receipt; thus, moisture should be routinely tested at the time of usage.
- (2) If usage is based on a standard quantity per batch, it is important that the quality be regularly tested and any change in operation be reported. Obviously, the batch count must be reliable.
- (3) Where usage is calculated from finished production and a process yield, all phases of the process must be considered, and the standard or expected yield must be representative of current operating conditions. All downfall or waste must be considered in the calculation.

### **Inventory Measurement**

Physical measurement of chip inventories can be accomplished by the trigonometric method or topographical photography. The latter is generally considered to be more accurate. With both methods, the pile is sectioned into measurable shapes and the volume calculated for each. The volume is then extended, using a density factor, to obtain weight. Following are some of the difficulties encountered:

- (1) Pile shape/size—Accuracy decreases as pile size and shape irregularity increase. For example, a simple cone is more accurately measured than a sectioned trapezoidal shape.
- (2) Ground settling—Assuming that the pile base is level may be incorrect. It is common for the base to be concave, thus producing an understatement of volume.

- (3) Photograph measurement—The same photograph may be measured differently by different technicians, even if the sectioning technique is the same.
- (4) Weather—The aerial photograph may be impossible to obtain due to low clouds or other hazardous flying conditions at the time which coincides with an operational or accounting cut-off.
- (5) Compaction—The density of the pile is a function of material size, pile shape, pile size, and other factors such as equipment weight and operating time on the pile.
- (6) Moisture—Weather conditions and pile shape influence the moisture content of stored chips. For example, it has been determined that conical piles tend to shed rain, while large, flat-topped piles absorb rain. To what extent the material itself is affected depends on species, time of exposure, and initial moisture content.

### EXAMPLE 1—A TYPICAL CHIP CONSUMER

The overview discussed various aspects concerning the control and measurement of chips. Following is a narrative describing an actual chip consumer.

The products sold from this location are light-weight paper and market pulp. Chips are used in two processes—one to produce chemically processed pulp and another to produce refiner pulp. The mill also uses hog fuel (for production of steam) which is handled in the same manner as chips.

Chips are received by rail and truck, hog fuel by truck, and both can also be produced in a whole log chipping facility. Unloaded and produced chips are pneumatically conveyed to either the process facilities or pile storage. Hog fuel is conveyed to separate pile storage. Material in pile storage is reclaimed by a front end loader when needed. Chips are segregated by species, because the chemical process cannot use all wood types.

Separate inventories are maintained for each species. A perpetual inventory of chips is prepared weekly for operations and purchasing. The inventory volume is small enough (less than 15,000 BDT) to justify booking the physical inventory at each period-end unless correlative statistics indicate an error may be present. If an error is indicated adjustments may be made.

Note: Many mills, particularly those with larger inventories, take their physical inventories less often than at each period-end and may,

depending on several factors, book all, none, or only a portion of the difference between the physical and perpetual inventories.

The physical is aerially measured and converted to weight using a constant factor. This method usually produces good results, except when the piles are large and/or irregularly shaped. Under these conditions both the method and conversion factor are subject to greater error.

Chips and hog fuel produced on site are calculated based on logs processed and a historical recovery factor for each. While a weightometer measures chip production, its results often correlate poorly to other statistics.

Chip usage is calculated from receipts and aerial inventories. The yield for each pulp mill is calculated and reviewed for reasonableness, considering actual operating conditions during the period. If the yield falls within an acceptable range, the results may be recorded; if not, the results are verified and other correlative data reviewed. If the yield cannot be justified, the chip usage and inventory are adjusted. Should the problem continue in subsequent periods, a complete audit of the statistics is performed, and unless the inventories appear suspect, the physicals are recorded.

Following are the simplified statistics for the above example mill during a recent month when the normal aerial inventory was not supported by the resulting correlative statistics. The first column titled "Aerial" includes inventories and other related statistics based on the normal aerial survey. The second column titled "Adjusted" includes inventories after an adjustment was made to bring the pulp yields and other correlative statistics within an acceptable range.

	Aerial	Adjusted
Chips—Beginning Inventory	6,441 B.D.T.	6,441 B.D.T.
Receipts	25,827	25,827
Ending Inventory	2,408	3,408
Usage—Refiners	16,679	16,335
Chemical	12,560	11,904
Rejected	621	621
Pulp Production—Refiners	14,704	14,704
Chemical	4,928	4,928
Pulp Yields—Refiners	88.2%	90.0%
Chemical	39.2%	41.4%

While the relatively small inventory volume should not have been in error by a volume sufficient to substantially affect the yields, there was no other evidence to support the drastically lower yields. Thus an adjustment of 1,000 BDT was made

Before the inventory adjustment was recorded, the following correlative statistics were considered:

- (1) Yields under similar conditions average 90.9% for refiners and 42.3% for the chemical process.

- (2) The perpetual inventory, using estimated receipts and usage was 3,100 BDT and the trigonometric physical was 2,700 BDT.
- (3) Both refiner and chemical pulp production compared favorably to electricity, steam, and chemical usages.
- (4) Monitored flows of waste water from each process did not substantiate the lower yields; i.e., increased losses indicated by the aerial.

In the following month, the results supported the above adjustment. With no adjustment, the yields and other statistics were within expected ranges. Speculating on the source of the error—because of the small volume in inventory it would appear that the majority of the problem was an error in receipt cut-off (overstated example month, understated following month).

### EXAMPLE 2—AERIAL SURVEY COMPARISON

As noted above—the topographical photography (aerial survey) method is considered to be the most accurate method of measuring the volume of wood chips in an inventory.

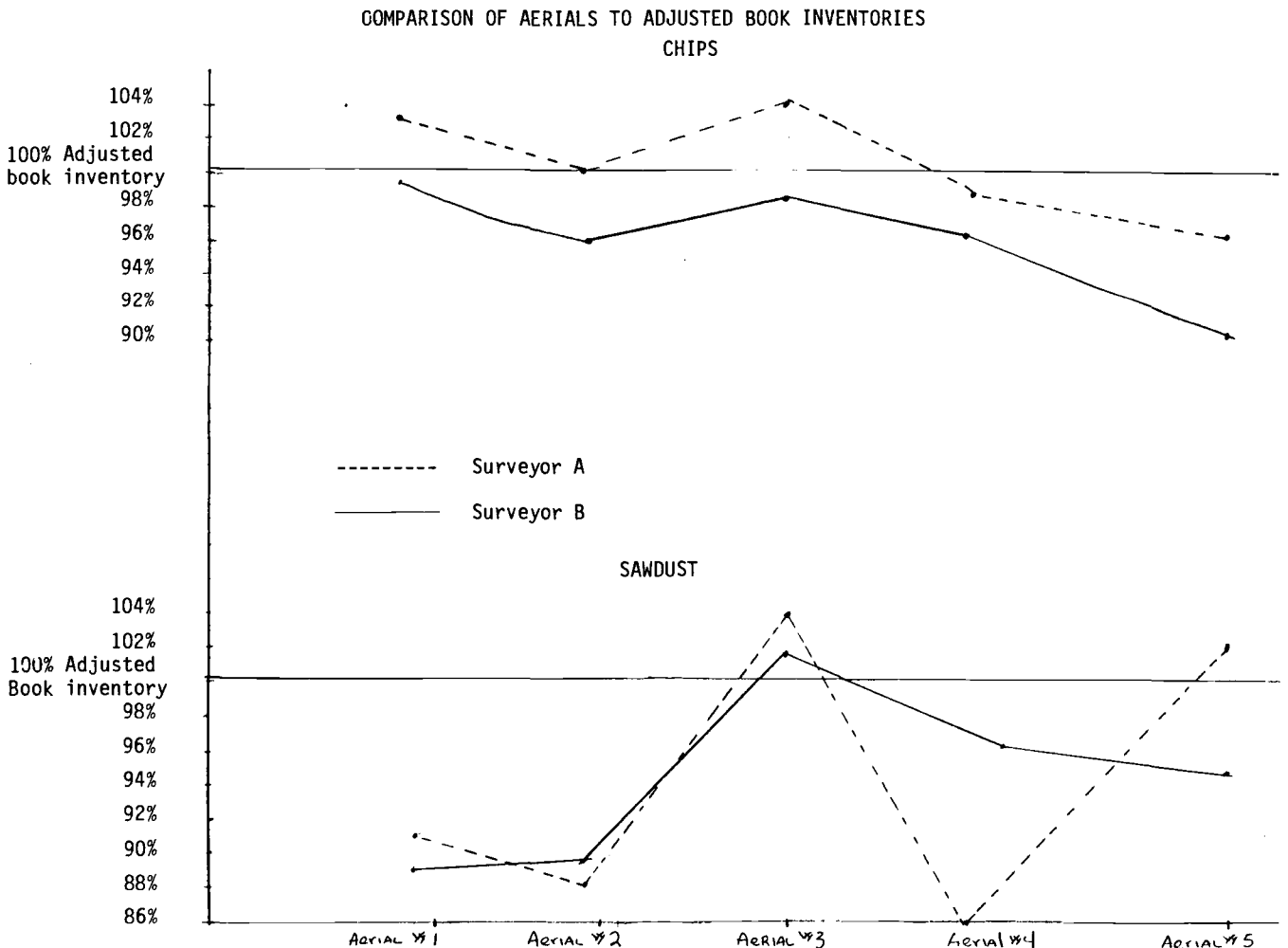
Over a period of approximately four months five aerial surveys of both a chip and sawdust pile were taken by two separate aerial surveyors. Using consistent compaction factors, the results of those aerial surveys are displayed below. The results of these comparisons is a significant amount of consistency between the two surveyors excepting the saw dust aerials #4 and #5.

### CONCLUSION

Statistics alone and physicals alone are seldom conclusive. Proper control and measurement of chips require (1) procedures and systems which are continually monitored, reviewed and updated, (2) physical measurements of inventories (at least periodically), (3) sophisticated correlative statistics, and (4) most importantly, an analytical mind which can assimilate the results of the above to reach acceptable conclusions.

Company policies should specify (1) the amount of procedural and systems monitoring and reviewing, (2) the frequency of taking physical inventories and (3) statistics which are to be utilized.

Keep in mind that every installation is different and every installation will have preferable practices to obtain the best results.



## **MONOGRAPHS PUBLISHED TO DATE**

“The Rush to LIFO: Is It Always Good for Wood Products Firms?” issued in December 1974 and published in condensed form in the April 1975 issue of Forest Industries. This monograph was revised and reissued in January 1976.

“Accounting and Financial Management in the Forest Products Industries: A Guide to the Published Literature,” issued in June 1975. (A supplement to this monograph was issued in March 1977 and January 1981.)

“A Decision Framework for Trading Lumber Futures, issued in October 1975.

“Capital Gains Tax Treatment in the Forest Products Industries,” issued June 1976.

“Measurement Difficulties in the Log Conversion Process,” issued June 1976.

“Capital Budgeting Practices in the Forest Products Industry,” issued March 1978.

“A Reporting and Control System for Wood Products Futures Trading Activities,” issued July 1978.

“Selected Issues of Financial Accounting and Reporting for Timber,” issued November 1978.

“Pool Log Transfer System,” issued August 1979.

“Fundamentals of Financing Major Timber Acquisitions,” issued February 14, 1980.

“LIFO Inventories in the Forest Products Industry,” issued July 1980.

“Accounting Controls for a Forest Products Firms,” issued January 1981.

“Log Inventory Controls,” issued April 1981.

“Accounting Treatment for Wood Products Futures Trading Activities,” issued October 1981.

“A Reporting and Planning System for a Wood Products Operations,” issued November 1981.

“Boise Cascade’s Productivity Improvement Program,” issued January 1982.

“Information Systems Planning in Weyerhaeuser Company,” issued August 1982.

“Developing a Strategic Plan for a Forest Products Company: A Case Study,” issued March 1983.

“Company/Employee Gainsharing Programs,” issued July 1983.

“Productivity Improvement Programs of Knowledge Workers in the Forest Products Industry,” issued November 1983.

“Microcomputer Modeling in the Forest Products Industry,” issued May 1984.

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This series of monographs is published by the School of Business, Oregon State University, to disseminate information, research findings, and informed opinion about current problems and opportunities in the management of, and accounting for, enterprises in the forest and wood products industries.

Additional information about these Studies may be obtained from the program director, Dr. Robert E. Shirley, at the School of Business, Oregon State University, Corvallis, Oregon 97331.

