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CMA
Preparatory Program

Part 1

**Financial Planning,
Performance and Control**

Manufacturing Input Variances Sample

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Editorial Notes

Throughout these materials, we have chosen particular language, spellings, structures and grammar in order to be consistent and comprehensible for all readers. HOCK study materials are used by candidates from countries throughout the world, and for many, English is a second language. We are aware that our choices may not always adhere to “formal” standards, but our efforts are focused on making the study process easy for all of our candidates. Nonetheless, we continue to welcome your meaningful corrections and ideas for creating better materials.

This material is designed exclusively to assist people in their exam preparation. No information in the material should be construed as authoritative business, accounting or consulting advice. Appropriate professionals should be consulted for such advice and consulting.

Note: On the Exam, you may be asked a question about a variance of any component of a budget. For example, you may be asked to calculate the variable costs flexible budget variance. You simply calculate the difference between the actual and the flexible budget amounts of variable costs and determine whether the variance is favorable or unfavorable.

If a question does not say what line to use, use either the contribution margin line or the operating income line. If the question is asking for the volume variance, the variances on the contribution margin line and the operating income lines will be exactly the same, so it does not matter which line you use. The reason the variances on these two lines are the same is that the volume variance is the difference between the static budget amount and the flexible budget amount. The only difference between the contribution margin line and the operating income line is fixed costs; and fixed costs are exactly the same in the flexible budget as they are in the static budget. Therefore, the volume variance for the contribution margin line will be exactly the same as the volume variance for the operating income line.

As shown on the following pages, we are really most interested in the flexible budget and the flexible budget variances. This is because the sales volume variances are explained simply, by the fact that the actual level of sales was different from the budgeted level of sales. The flexible budget variances, on the other hand, identify variances that are not the result of different-than-expected sales.

In fact, a flexible budget variance for a revenue item is called a **selling price variance**, because it is caused exclusively by differences between the actual selling price and the budgeted selling price.

Types of Variances

Before looking at the different individual variances in greater detail, we will simply list the different variances that we will study. You need to know how to calculate each of these and understand what they tell us when calculated. Additionally, you also must be able to identify what may cause the different variances. The variances that we will look at are:

Manufacturing Input Variances:

Direct Materials Variances

- 1) **Price variance**
- 2) **Quantity or efficiency variance**
 - 2a) **Mix variance***
 - 2b) **Yield variance***

Direct Labor Variance

- 3) **Rate (price) variance**
- 4) **Efficiency (quantity) variance**
 - 4a) **Mix variance***
 - 4b) **Yield variance***

Factory Overhead Variances

- 5) **Total Variable overhead variance**
 - 5a) **Variable overhead spending variance**
 - 5b) **Variable overhead efficiency variance**
- 6) **Total Fixed overhead variance**
 - 6a) **Fixed overhead spending or budget variance**
 - 6b) **Fixed overhead production-volume variance**

Sales Variances:

- 7) **Sales price variance**
- 8) **Sales volume variance**
 - 8a) **Quantity variance****
 - 8b) **Mix variance****

* These specific manufacturing variances are calculated only when there is more than one input (either classes of labor or types of material) into the final product.

** These specific sales variances are calculated when the company sells more than one product.

Manufacturing Input Variances

Manufacturing input variances are a special class of variances, including direct materials, direct labor, and manufacturing overhead used in production. These variances are concerned with **inputs** to the manufacturing process and whether the amount of inputs used per unit manufactured was over or under the standard or whether they cost more or less per unit than the standard, and what the cost impact was of each type of variance. Manufacturing input variances are used in controlling production.

In the accounting system, manufacturing input variances are closed out at the end of each period to cost of sales or, if material, they are prorated among cost of sales, finished goods inventory and work in process inventory. A variance report like the one a few pages back will not reflect the exact manufacturing input variances, because that variance report reflects **sold** units, not manufactured units. The input cost variances for the **sold** units **are** included in the flexible budget variance amount on the above report, because they are included in the Actual Results column that is compared with the Flexible Budget column to calculate a Flexible Budget variance. However, the detail is not there, and they should not be expected to reconcile with a production variance report. A production variance report includes all units produced, whether they were sold or whether they remained in inventory as unsold units at the end of the period. But a variance report like the one we saw first is a Sales Variance Report, and it presents results of sales.

Before getting into the specific manufacturing input variances, let us think for a moment about the possible reasons for an actual input cost to be different from the standard (i.e., expected or budgeted) cost. The standard cost is determined using an **estimated cost and an estimated level of usage**. It is obvious that if the company either pays a different price than had been budgeted, or uses a different amount than was budgeted for the actual output, the actual cost for the actual output will be different from the budgeted cost for the actual output.

The simple fact that the actual cost is different from the budgeted amount is not, by itself, useful enough for management. Management needs to know **why** the actual cost is different from the budgeted amount.

- Is it because a different amount of raw materials or labor was used than should have been used for the actual output?
- Or was it because a different price was paid for the raw materials or labor?
- Or (more likely) was it because of differences in both?

The process of variance analysis will enable management to separate out the specific reason(s) for the variance and then focus its efforts on the areas that have a negative impact on the business – identified by unfavorable variances.

In variance analysis, we subdivide input cost variances into

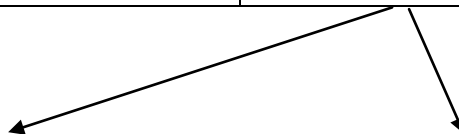
- 1) a **price variance** that reflects the difference between actual and budgeted input **prices** and
- 2) a **quantity variance**, also called an **efficiency variance**, that reflects the difference between actual and budgeted input **quantities** used.

If you are able to keep this simple, conceptual understanding of how variances occur, you should find variance analysis questions a little easier.

Summary of Manufacturing Input Variances

The following table summarizes the calculations that we make and the different terms that we use in variance analysis. We will look at all of these in more detail later, and this table is again presented at the end of the section on variances. We have simply included this table at the beginning to help you see what will be covered.

Prime Costs	Price Variance $(AP - SP) \times AQ$	Quantity Variance $(AQ - SQ) \times SP$
Materials	Price Variance	Quantity Variance
Labor	Rate Variance	Efficiency Variance



Multiple Inputs (both Material and Labor)	Mix Variance $(WASPAM - WASPSM) \times AQ$	Yield Variance $(AQ - SQ) \times WASPSM$
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Variable Overhead	Spending Variance $(AP - SP) \times AQ$	Efficiency Variance $(AQ - SQ) \times SP$
Fixed Overhead	Spending (Flexible Budget) Variance Actual OH – Budgeted OH	Production Volume Variance Budgeted OH – Applied OH

Direct Materials Variances

We will start by looking at the variances related to direct materials and their usage.

The **total material variance (also called the flexible budget variance)** is an easy one to calculate. It is the difference between the actual direct materials costs for the period and the standard costs for the standard amount of materials at the standard price per unit **for the level of output actually produced** (the flexible budget).

Example: Paterno Co. produces footballs. Each football requires a standard of 1 square meter of leather that has a standard cost of \$5. During the period, Paterno produced 250 footballs and used 290 meters of leather. The cost of the leather was \$4.50 per meter.

Therefore, the actual total cost of the leather was \$1,305. However, given the actual output of 250 footballs, Paterno should have used only 250 meters. And since each meter should have cost \$5, Paterno should have spent \$1,250 on leather in order to produce 250 footballs.

The total materials variance is:

Actual cost – 290 meters × \$4.50	\$ 1,305
Standard cost – 250 meters × \$5.00	\$ <u>1,250</u>
Total variance	\$ <u>55</u> U

In total, we can see that Paterno spent more money than it should have for the leather to make the footballs. If a manager simply looks at this total variance, the conclusion may be that things are acceptable (it is an unfavorable variance, but it is not that large) and don't require any significant attention. But, when we look in more depth at this example, it is obvious to us that the company used more materials than it should have, but paid less for each square meter of leather than expected. Management will most certainly look at the production process to find out why so much leather was required to make the 250 footballs.

Even though Paterno's total actual cost came close to the total standard cost, there is a significant problem with production. The company may have a very inefficient process that wastes too much leather; or perhaps it has new workers that are not as experienced as they will be in the future; or perhaps the less expensive leather that was purchased was more difficult to work with and an excessive amount was spoiled in the production process. In any case, despite the fact that the total cost variance was small, Paterno needs to investigate further the cause of the variance in its usage of leather.

Because of the need to have this more useful analysis, the total materials variance is divided into two components – price and quantity. The **price variance** measures how much of the total variance was caused by paying a different amount for the material than had been budgeted, and the **quantity variance (also called the efficiency or usage variance)** measures how much of the variance is due to using more or less of the material than budgeted.

The Quantity Variance

The quantity variance (**also called the efficiency or usage variance**) is calculated as:

$$\begin{aligned} & (\text{Actual Quantity} - \text{Standard Quantity for Actual Output}) \times \text{Standard Price} \\ & \text{or} \\ & (\text{AQ} - \text{SQ}) \times \text{SP} \end{aligned}$$

This is simply the difference between the actual material usage and the standard usage for this level of output, multiplied by the standard price. We use the standard price because we are trying to determine what the variance actually is, because we used either too much or too little material, not how much we paid for it. A positive variance is an unfavorable variance, while a negative variance is a favorable variance.

In the example above, the **quantity variance** is calculated as:

$$(290 - 250) \times \$5 = \$200$$

This is an **unfavorable variance** because if the actual price had been the same as the standard price, Paterno would have had to pay \$200 more for the materials it used than it should have, given the number of footballs produced, because it used too much material. The fact that it is unfavorable is indicated by the fact that the number we have calculated is positive. A positive variance for a cost indicates an unfavorable variance, while a negative variance for a cost indicates a favorable variance.

The Price Variance

The price variance is calculated as:

$$(\text{Actual Price} - \text{Standard Price}) \times \text{Actual Quantity}$$

or

$$(\mathbf{AP} - \mathbf{SP}) \times \mathbf{AQ}$$

This measures how much of the variance was due to a difference in the price between what we expected it to be per unit and what it the price paid actually was.

In the example above, the price variance is calculated as:

$$(\$4.50 - \$5) \times 290 = \$(145)$$

This means that we saved \$145 because the price of the leather was lower than expected. This is a **favorable variance**. Remember that a negative variance for a cost is a favorable variance because it means that actual cost was lower than budgeted cost. So even though Paterno used more leather than it should have for each football it manufactured, it saved \$.50 per meter because the price was lower than expected.

If we take these two variances and add them together, we will have the total materials variance that we first calculated.

Quantity variance	\$ 200	U
Price variance	<u>(145)</u>	F
Total Variance	<u>\$ 55</u>	U

In total, Paterno had a positive variance of \$55, which is unfavorable, because the cost for the extra leather that was used was more than the savings on each meter of leather.

Purchase Price Variance

If an Exam question asks for the **purchase** price variance, you calculate the purchase price variance using **all of the units purchased**, not just the units that were put into production. You need to be certain to notice this word if it is used, since it changes your calculation.

One way of looking at these two price variances is as follows: the price variance is calculated at the time of usage, while the **purchase** price variance is calculated at the time of purchase.

Likewise, if a question says that the company recognizes variances **as early as possible**, you would use the **quantity purchased** instead of the quantity used. Most questions ask for the price variance as calculated above, using the units placed into production. But be aware of these possible variations.

Note: On the Exam, you will need to identify possible reasons why a particular variance is favorable or unfavorable. You should usually be able to do this by common sense. For example, an unfavorable quantity variance may be caused by the purchasing department because it bought an inferior product that was damaged or broken, or because of new employees or poor techniques.

In the example above, the variances could be due to the purchasing department getting a good price on inferior leather that was damaged in the production process, or was not always of an acceptable quality.

Accounting for Direct Materials Variances in a Standard Cost System

Standard costing systems use actual variance accounts to record the variances from the standard costs as they occur. At the end of the period, the variances are closed out to cost of goods sold or, if material, prorated among cost of goods sold, finished goods inventory and work in process inventory.

Purchases of direct materials are recorded as debits to the Materials Inventory account at their **standard cost**. If the company recognizes price variances at the time of purchase, any difference in price from the standard is recorded in a Direct Materials Purchase Price Variance account (a debit if the price is higher than the standard price and a credit if the price is lower than the standard price). The company will probably have a separate variance account for each material used. The credit is to Accounts Payable for the total amount due.

When direct materials are requisitioned from materials inventory for use in the production process, the debit to Work-In-Process Inventory is for the **standard quantity** of materials that should have been used for manufacturing the units manufactured, at their **standard cost**. The credit to the Materials Inventory account is for the **total amount of materials actually used**, at their **standard cost**. The difference is the direct materials quantity variance, and it is recorded in the Direct Materials Quantity (or Usage) Variance account (a debit for an unfavorable variance and a credit for a favorable variance).

This isolates the variances so they can be analyzed. It also maintains standard costs in the Work-In-Process Inventory accounts during the production process.

At the end of the period, the variances are closed out, either to Cost of Goods Sold or, if they are material, they are usually prorated among Work-In-Process Inventory, Finished Goods Inventory, and Cost of Goods Sold.

Question 45: Under a standard cost system, the materials efficiency variances are the responsibility of:

- a) Production and industrial engineering.
- b) Purchasing and industrial engineering.
- c) Purchasing and sales.
- d) Sales and industrial engineering.

(CMA Adapted)

Question 46: A favorable materials price variance coupled with an unfavorable materials usage variance would most likely result from:

- a) Machine efficiency problems.
- b) Product mix production changes.
- c) The purchase and use of higher than standard quality materials.
- d) The purchase of lower than standard quality materials.

(CMA Adapted)

Question 47: Garland Company uses a standard cost system. The standard for each finished unit of product allows for 3 pounds of plastic at \$0.72 per pound. During December, Garland bought 4,500 pounds of plastic at \$0.75 per pound, and used 4,100 pounds in the production of 1,300 finished units of product. What is the materials price variance for the month of December?

- a) \$117 unfavorable.
- b) \$123 unfavorable.
- c) \$135 unfavorable.
- d) \$150 unfavorable.

(CMA Adapted)

The following information is for the next three Questions: ChemKing uses a standard costing system in the manufacture of its single product. The 35,000 units of raw material in inventory were purchased for \$105,000, and 2 units of raw materials are required to produce 1 unit of final product. In November, the company produced 12,000 units of product, which was as budgeted. The standard allowed for material was \$60,000, and there was an unfavorable quantity variance of \$2,500.

Question 48: ChemKing's standard price for one unit of material is:

- a) \$2.00
- b) \$2.50
- c) \$3.00
- d) \$5.00

Question 49: The units of material used to produce November output totaled:

- a) 12,000 units.
- b) 12,500 units.
- c) 23,000 units.
- d) 25,000 units.

Question 50: The materials price variance for the units used in November was:

- a) \$2,500 unfavorable.
- b) \$11,000 unfavorable.
- c) \$12,500 unfavorable.
- d) \$3,500 unfavorable.

(CMA Adapted)

Direct Labor Variances

As with the materials variance, the **total labor variance (also called the flexible budget variance)** is the difference between the standard labor costs for the actual level of output (the flexible budget) and the actual costs incurred by the company. Also similar to the materials variance, this total variance is attributable to variances in both labor rates and labor usage. This means that the company either paid a different wage rate than standard or used a different number of labor hours than standard for this level of output, or both.

Because this is so similar to variance analysis for materials, we will not cover it in detail again, but the total labor variance can be broken down into the labor rate variance (a price variance) and the labor efficiency variance (a quantity variance). These are calculated in the exact same manner as the direct material cost and usage variances, but simply have different names.

The Labor Rate Variance

The labor rate variance is calculated as the direct materials price variance was calculated:

$$(\text{Actual Rate} - \text{Standard Rate}) \times \text{Actual Hours}$$

or

$$(\text{AP} - \text{SP}) \times \text{AQ}$$

The Labor Efficiency Variance

The labor efficiency variance is calculated the same way as the direct materials quantity variance was calculated:

$$(\text{Actual Hours} - \text{Standard Hours for Actual Output}) \times \text{Standard Rate}$$

or

$$(\text{AQ} - \text{SQ}) \times \text{SP}$$

Note: On the Exam, you need to be able to use these formulas not only to solve for the variance itself, but also to solve for any of the individual variables in these equations. In this second case, you will be given the variance and asked to solve for one of the quantity or price numbers, either actual or standard. This is simply using the same formulas, but solving for a different variable.

Accounting for Direct Labor Variances in a Standard Cost System

The production payroll is recorded by debiting Work-In-Process Inventory for the total number of **standard hours for the units manufactured** at the **standard hourly rate**. The credit is to accrued payroll at the **total number of hours actually spent** and at the **actual hourly rate**. The difference is recorded in the Direct Labor Rate Variance (the price variance) and the Direct Labor Efficiency Variance (the quantity variance) accounts. Unfavorable variances are debits, and favorable variances are credits.

As with direct materials variances, the variances are closed out at the end of the period, either to Cost of Goods Sold or, if they are material, prorated among Work-In-Process Inventory, Finished Goods Inventory, and Cost of Goods Sold.

Note: The company must also choose how the costs of employee related costs such as employee benefits and payroll taxes will be treated. They may be included in the cost of direct labor or treated as an overhead and allocated to the units produced. In some cases, these costs may be treated as a period cost. The method in which these costs are treated may have a small effect on cost of goods sold, income or inventory. Only in cases where direct labor is a large portion of the total expenses will this difference be significant.

Question 51: An unfavorable direct labor efficiency variance could be caused by a(n):

- a) Unfavorable variable overhead spending variance.
- b) Unfavorable materials usage variance.
- c) Unfavorable fixed overhead volume variance.
- d) Favorable variable overhead spending variance.

(CMA Adapted)

Question 52: Under a standard cost system, labor price variances are usually not attributable to:

- a) Labor rate predictions.
- b) The use of a single average standard rate.
- c) Union contracts approved before the budgeting cycle.
- d) The assignment of different skill levels of workers than planned.

(CMA Adapted)

Question 53: Price variances and efficiency variances can be key to the performance measurement within a company. In evaluating performance, all of the following can cause a materials efficiency variance except the:

- a) Performance of the workers using the material.
- b) Actions of the purchasing department.
- c) Design of the product.
- d) Sales volume of the product.

(CMA Adapted)

Question 54: A company set the total budgeted direct labor cost at \$75,000 for the month for producing 5,000 units. The following standard cost, stated in terms of direct labor hours (DLH), was used to develop the budget for direct labor cost:

$$1.25 \text{ DLH} \times \$12.00/\text{DLH} = \$15.00/\text{unit produced}$$

The actual operating results for the month were as follows:

Actual units produced	5,200
Actual direct labor hours worked	6,600
Actual direct labor cost	\$77,220

The direct labor efficiency variance for the month would be:

- a) \$4,200 unfavorable.
- b) \$3,000 unfavorable.
- c) \$2,220 unfavorable.
- d) \$1,200 unfavorable.

(CIA Adapted)

The following information is for the next three Questions: Jackson Industries employs a standard cost system that carries direct materials inventory at standard cost. Jackson has established the following standards for the prime costs of one unit of product:

	<u>Standard Quantity</u>	<u>Standard Price</u>	<u>Standard Cost</u>
Direct Materials	5 pounds	\$3.60 per pound	\$18.00
Direct Labor	1.25 hours	\$12.00 per hour	\$15.00
			\$33.00

During May, Jackson purchased 125,000 pounds of direct material at a total cost of \$475,000. The total factory wages for May were \$364,000, 90% of which were direct labor. Jackson manufactured 22,000 units of product during May, using 108,000 pounds of direct materials and 28,000 direct labor hours.

Question 55: The direct materials usage (quantity) variance for May is:

- a) \$7,200 unfavorable.
- b) \$7,600 favorable.
- c) \$5,850 unfavorable.
- d) \$7,200 favorable.

Question 56: The direct labor price (rate) variance for May is:

- a) \$8,400 favorable.
- b) \$7,200 unfavorable.
- c) \$8,400 unfavorable.
- d) \$6,000 unfavorable.

Question 57: The direct labor usage (efficiency) variance for May is:

- a) \$5,850 favorable.
- b) \$6,000 unfavorable.
- c) \$5,850 unfavorable.
- d) \$6,000 favorable.

(CMA Adapted)

More than One Material Input or One Labor Class

What has been outlined above is the variance analysis process when we have only one material input into the product or only one class of labor (a class of labor is nothing more than a different wage rate).

In situations where there is a **mix of materials (or labor)** that goes into the product (such as for dog food or cereal), there will be a total variance, a price variance, and a quantity variance. In addition, the quantity variance is subdivided into a **mix variance** and a **yield variance**. The **mix variance** tells us how much of the quantity variance was caused by the fact that the actual **mix** that was used was different from the standard mix (i.e., more of one ingredient was used and less of another ingredient was used). The **yield variance** tell us how much of the quantity variance was caused by the fact that the **total** actual amount of all ingredients used was different from the **total** standard amount.

The price variance of a weighted mix is not broken down the way the quantity variance is.

The mix of ingredients is called a **weighted mix**.

Total Variance of a Weighted Mix

The **total variance** of a weighted mix is the **Total Actual Cost** minus the **Total Standard Cost**.

This and the following variance calculations will be illustrated in an example that follows this discussion.

Materials Price Variance or Labor Rate Variance of a Weighted Mix

The price variance of a weighted mix is the sum of the price variances for each component of the mix, each one calculated individually, using the formula $(AP - SP) \times AQ$.

So if the product manufactured has more than one material input or more than one labor rate, a price variance is calculated for each separate input, and the individual price variances are added together to calculate the total price variance.

Total Material Quantity or Labor Efficiency Variance of a Weighted Mix

The **total** material quantity or labor efficiency variance of a weighted mix is the sum of the quantity variances for each component of the mix, each one calculated individually.

The formula $(AQ - SQ) \times SP$ is used to calculate the quantity variance for each component of the mix separately, and then the individual quantity variances are added together to calculate the total quantity variance.

We then break down this total material quantity or labor efficiency variance into two subvariances – the **mix** and the **yield variances**.

The Mix Variance (Materials or Labor)

The mix variance is the part of the quantity variance that results because the mix of materials actually used or the mix of the labor used was different from the mix that should have been used (i.e., the standard). An example would be including more corn and less wheat in the cereal than the standard calls for.

This can occur if there is not enough of a specific input and substitutes were required, or if the wrong proportions were accidentally used in the product.

The formula used to calculate the mix variance is a variation of the **price variance** formula: $(AP - SP) \times AQ$. But instead of using the actual and standard prices for the input, we use **weighted average standard prices**. We use:

- 1) The **weighted average standard price of the actual mix**. We calculate this as the **actual quantity used for each input** multiplied by the **standard cost** for each input, and then adding the results; and

- 2) The **weighted average standard price of the standard mix**. This is calculated as the **standard quantity of each input for the actual output** multiplied by the **standard cost** for each input, and then adding the results.

This is demonstrated with numbers in the example following the explanations of these subvariances. (It is not as bad as it sounds.)

The mix variance is calculated as follows:

$$\left(\begin{array}{l} \text{Weighted Average Standard Price of the} \\ \text{Actual Mix} - \text{Weighted Average Standard} \\ \text{Price of the Standard Mix (both calculated} \\ \text{using the Standard Costs)} \end{array} \right) \times \text{Actual Quantity of all} \\ \text{material or labor inputs}$$

or

$$(\text{WASPAM} - \text{WASPSM}) \times \text{AQ}$$

Note: When looking at any mix variances, it is essential that responsibility be given to an individual only if the person actually has control over the mix, or the substitutions, used.

The Yield Variance (Material or Labor)

The yield variance results from the difference between the **total actual quantity** of the inputs that were actually used to produce the actual output and the **total standard quantity** that should have been used to produce the actual output.

The formula to calculate the yield variance is a variation of the **quantity variance** of the mix, or $(\text{AQ} - \text{SQ}) \times \text{SP}$. Instead of using the standard price of a single input, we use the **weighted average standard price of the standard mix**.

The yield variance is calculated as follows:

$$\left(\begin{array}{l} \text{Actual Total Quantity of All Inputs} - \\ \text{Standard Total Quantity of All Inputs} \end{array} \right) \times \text{Weighted Average Standard Price} \\ \text{of Standard Mix of All Inputs}$$

or

$$(\text{AQ} - \text{SQ}) \times \text{WASPSM}^b$$

Note: In the formula above, the actual quantity of input to the product (AQ) is equal to the **total** number of all of the pounds or hours (or whatever else) that **actually was used** to produce the actual level of output.

The standard quantity of input to the product (SQ) is equal to the **total** number of all of the pounds or hours (or whatever else) that **should have been used** to produce the actual level of output.

Note: Remember, if there is only one input to the product, there is no need to calculate these two additional variances.

On the following two pages is a full example of the calculation of the total variance, the price variance, the quantity variance, and the materials mix and yield variances of a weighted mix.

^b This is the same WASPSM as was used in the calculation of the mix variance.

Example: Using the following information, calculate the material price and quantity variances, and also the material mix and yield subvariances.

A company produces cereal made up of different grains. The material prices in effect for the fiscal year ending June 30 and the standard kg allowed for the output of April are:

	<u>Standard Price/Kg</u>	<u>Standard Kg for Output</u>	<u>Standard Cost</u>
Corn	\$10.00	250	\$2,500.00
Wheat	\$ 8.00	250	2,000.00
Rice	\$ 3.00	<u>250</u>	<u>750.00</u>
		<u>750</u>	<u>\$5,250.00</u>

Due to various natural disasters around the world, the price for each input increased on January 1. The standard prices were not revised, and the actual output in April was the same as planned.

The actual material prices and the actual usage for April were as follows:

	<u>Actual Price</u>	<u>Actual Usage</u>	<u>Actual Cost</u>
Corn	\$12.00	375	\$4,500.00
Wheat	\$ 8.50	200	1,700.00
Rice	\$ 5.50	<u>325</u>	<u>1,787.50</u>
		<u>900</u>	<u>\$7,987.50</u>

Total Variance

The total variance is the difference between the **standard cost for the actual level of output** and the **actual cost**. The standard cost for April was \$5,250. The actual cost for April was \$7,987.50. This gives a **total unfavorable variance of \$2,737.50**, which is broken down into the price and the quantity variances as below.

Materials Price Variance

This is calculated by determining the price variance for each of the three products individually and adding them together. The formula $(AP - SP) \times AQ$ and the 3 calculations are:

Corn	$(\$12 - \$10) \times 375$	=	\$ 750.00
Wheat	$(\$8.50 - \$8) \times 200$	=	100.00
Rice	$(\$5.50 - \$3) \times 325$	=	<u>812.50</u>

Total Materials Price Variance **\$1,662.50**

Total Materials Quantity Variance

The total materials quantity variance is calculated by using the usage formula $(AQ - SQ) \times SP$ for each of the classes individually and then adding them all together:

Corn	$(375 - 250) \times \$10$	=	\$ 1,250.00
Wheat	$(200 - 250) \times \$8$	=	(400.00)
Rice	$(325 - 250) \times \$3$	=	<u>225.00</u>

Total Materials Quantity Variance **\$1,075.00**

At this point, we can do a simple test of the two main variances. The price variance added together with the quantity variance should equal the total variance. In this case, that is true: $(\$1,662.50 + \$1,075.00 = \$2,737.50)$.

From this point, we need to calculate the mix variance and the yield variance, and when those two items are added together, they must equal \$1,075, the total material quantity variance.

Mix Variance

We will start with the **Mix Variance**. What we are calculating here is how much of the material quantity variance was a result of the actual mix that was used being different from the standard mix. We do this by comparing the weighted average standard prices of the actual and standard quantities of each material input, using the standard price for each input. We then multiply this difference by the actual total quantity of all inputs used. The formula for this is:

$$(WASPAM - WASPSM) \times AQ$$

The **Weighted Average Standard Price of the Standard Mix (WASPSM)** is calculated as follows:

$$\text{Total Standard Cost} \div \text{Total Standard Kgs}$$

The total standard kilograms is 750 and the total standard cost is calculated as follows:

Corn	250 × \$10	=	\$2,500
Wheat	250 × \$ 8	=	2,000
Rice	250 × \$ 3	=	<u>750</u>

Total Standard Cost 750 kg \$5,250

This will make the **Weighted Average Standard Price of the Standard Mix (WASPSM) \$7.00 per kg** (\$5,250 ÷ 750).

The **Weighted Average Standard Price of the Actual Mix (WASPAM)** is calculated as follows:

$$\text{Total Cost using Actual Kg and Standard Price} \div \text{Total Actual Kg.}$$

The total actual kg was 900 and the total standard cost of the actual mix is calculated as follows:

Corn	375 × \$10	=	\$3,750
Wheat	200 × \$ 8	=	1,600
Rice	325 × \$ 3	=	<u>975</u>

Total Cost at Standard Rate 900 kg \$6,325

This will make the **Weighted Average Standard Price of the Actual Mix (WASPAM) \$7.0277 per kg** (\$6,325 ÷ 900).

This tells us that because the mix was wrong, the standard price of each kilogram of actual input used was \$.0277 more than it should have been.

Putting all of these numbers into the formula (WASPAM – WASPSM) × AQ we get the following:

$$(\$7.0277 - \$7.00) \times 900 = \mathbf{\$25 \text{ Unfavorable Materials Mix Variance}}$$

\$25 of the unfavorable quantity variance arose because the mix that was used was not the correct mix.

Yield Variance

We now need to calculate the **Materials Yield Variance**, which calculates how much of the quantity variance occurred as a result of using more or less total input than the standard total input. In this calculation, we are not worried about the mix of the inputs, just the total quantity of inputs used. The formula for this is:

$$(\text{AQ} - \text{SQ}) \times \text{WASPSM}$$

We already know the WASPSM was \$7 per kg from the previous calculations, the Actual Quantity was 900 kg, and the Standard Quantity was 750 kg.

Putting all of this into the formula we get the following:

$$(900 - 750) \times \$7 = \mathbf{\$1,050 \text{ Unfavorable Materials Yield Variance}}$$

This means that \$1,050 of the unfavorable quantity variance was caused by the fact that we used more material input than we should have for the amount of output. From these calculations, we see that it was not so much the change in the mix that caused the variance, but rather a general inefficiency in the use of the material inputs.

To prove all of the calculations, we can do a simple check comparing the two subvariances to the total quantity variance:

	Materials Mix Variance	\$	25 U
+	<u>Materials Yield Variance</u>		<u>1,050 U</u>
=	Total Materials Quantity Variance		<u>\$1,075 U</u>

The following information is for the next two Questions: Azat Corporation produces ketchup. Azat mixes two varieties of tomatoes: a locally grown variety to provide excellent taste and an imported variety to provide a richer color. The standard costs and inputs for a 200-kg batch of ketchup are as follows:

<u>Tomato Type</u>	<u>Standard Quantity in Kg.</u>	<u>Standard Cost per Kg</u>	<u>Total Cost</u>
Local	200	.75	\$150
Imported	<u>100</u>	.90	<u>90</u>
Total	<u>300</u>		<u>\$240</u>

A total of 110 batches were produced during the current period. The quantities actually purchased and used during the current period as well as the prices paid are shown below:

<u>Tomato Type</u>	<u>Quantity in Kg.</u>	<u>Actual Cost per Kg</u>	<u>Total Cost</u>
Local	21,000	.65	\$13,650
Imported	<u>14,000</u>	.95	<u>13,300</u>
Total	<u>35,000</u>		<u>\$26,950</u>

Question 58: What is the materials mix variance for the current period?

- a) \$1,050 favorable
- b) \$350 favorable.
- c) \$1,050 unfavorable.
- d) \$350 unfavorable.

Question 59: What is the materials yield variance for the current period?

- a) \$1,600 favorable.
- b) \$1,600 unfavorable.
- c) \$1,620 unfavorable.
- d) \$1,620 favorable.

(HOCK)

Factory Overhead Variances

In this section we are looking at the calculation of the variances related to factory overhead. Unfortunately, these are a little more difficult for most people to logically “see” what is happening. If this is the case for you, simply memorize the formulas for these calculations. They are very similar to the formulas used for labor and material variances.

There are both variable and fixed overhead variances. We will look first at the total overhead variance, then at the variable overhead variances and the fixed overhead variances. Both of these two general variances can be broken down into two variances, as we did for the material and labor variances. As such, there are actually four individual variances that are calculated for overhead.

The four individual variances are:

- 1) Variable overhead spending variance,
- 2) Variable overhead efficiency variance,
- 3) Fixed overhead spending variance, and
- 4) Fixed overhead production-volume variance.

The four overhead variances can be combined in various ways, according to what management wants to see. These different ways are known as four-way, three-way and two-way analysis. The different methods are simply different combinations of the same four variances. We will first look at the four variances individually, and then look at the different combinations.

Overview of Manufacturing Overhead Variances

The **total overhead variance** includes both the variable and the fixed overhead variance. It is

$$\begin{aligned} & \text{Actual total variable and fixed overhead incurred (money actually spent on these items)} \\ & - \text{Total variable and fixed overhead applied to production using predetermined rates} \\ & = \text{Total Overhead Variance} \end{aligned}$$

The total overhead variance is the same as the amount of over- or underapplied factory overhead.

The total overhead variance is divided into the total variable overhead variance and the total fixed overhead variance. Each of those variances is subdivided into two other subvariances.

- The **variable overhead spending variance** plus the **variable overhead efficiency variance** equals the total variable overhead variance.
- The **fixed overhead spending variance** plus the **fixed overhead production-volume variance** equals the total fixed overhead variance.
- And the **total variable overhead variance** plus the **total fixed overhead variance** equals the total overhead variance.

Note that the total overhead variance is **not** the difference between actual overhead incurred and budgeted overhead. It is the difference between the actual overhead incurred and the **overhead applied to production**. We will talk about this more later.

Variable Overhead Variances

Total Variable Overhead Variance (or Variable Overhead Flexible Budget Variance)

Variable overheads are overhead costs that change as the level of production changes. Examples are plant electricity, equipment maintenance, other utilities, etc. They cannot be traced to specific units manufactured, and for that reason they are called overhead costs. However, since they do increase when production increases and decrease when production decreases, they are variable costs.

The total variable overhead variance is equal to the difference between the actual variable overhead incurred and the standard variable overhead applied. The standard variable overhead applied is based on the standard usage (given the actual output) of the overhead allocation base (machine hours, direct labor hours, etc).

$$\begin{aligned} & \text{Actual total variable overhead incurred (money spent on these items)} \\ & - \text{Variable overhead applied to production using predetermined rate}^c \\ & = \text{Total variable overhead variance}^d \end{aligned}$$

This total variance may be broken down into the spending and efficiency variances.

Variable Overhead Spending Variance

This variance is the difference between the **actual amount of variable overhead incurred** and the **standard amount of variable overhead allowed for the actual quantity of the VOH allocation base used for the actual output produced**.

This is essentially a price variance and this variance is caused by a difference between the actual variable overhead cost per unit of the allocation base (this is calculated as the actual overhead costs ÷ the actual usage of the allocation base) and the standard application rate per unit of the application base.

$$\begin{aligned} & \text{Actual total variable overhead incurred (money actually spent)} \\ & - \text{Budgeted variable overhead based on inputs actually used (labor or machine hours)} \\ & = \text{Variable overhead spending variance} \end{aligned}$$

The budgeted variable overhead based on inputs actually used is the standard (budgeted) variable overhead rate per hour (machine hour or direct labor hour, as appropriate) multiplied by the number of hours **actually used** to produce the actual output.

The variable overhead spending variance can also be calculated as follows:

$$\begin{aligned} & (\text{Actual VOH Cost Per Unit of} \\ & \text{Allocation Base Actually Used} - \\ & \text{Standard VOH Cost Per Unit of} \\ & \text{Allocation Base [i.e., Standard} \\ & \text{Application Rate]}) \times \text{Actual Quantity of VOH Allocation Base} \\ & \text{Used for Actual Output} \\ & \text{or} \\ & (\text{AP} - \text{SP}^e) \times \text{AQ} \end{aligned}$$

Variable Overhead Efficiency Variance

This is essentially a quantity variance, and it determines the amount of the total variance caused by a different usage of the allocation base than was expected (i.e., the standard hours for the actual output).

$$\begin{aligned} & \text{Budgeted variable overhead based on inputs actually used (actual labor or machine hours)} \\ & - \text{Standard variable overhead applied to production} \\ & = \text{Variable overhead efficiency variance} \end{aligned}$$

^c Overhead is applied to individual products produced, usually on the basis of either direct labor hours, machine hours, materials costs, units of production, weight of production, or some other similar measure. This will be covered in depth in Section C, Cost Management. The “variable overhead applied to production” is calculated as (Standard Rate × Standard Quantity for the Actual Production Level).

^d Note that this is the same as the amount of over- or underapplied variable overhead.

^e Note that this is really not a price, but rather a rate. We use the letter P in this formula to keep it the same as in the materials and labor variances since the formulas are essentially the same.

The variable overhead efficiency variance is also calculated as follows:

$$\frac{(\text{Actual Activity Level of VOH Allocation Base Used for Actual Output} - \text{Standard Activity Level of VOH Allocation Base Allowed for Actual Output})}{\text{Standard Application Rate}}$$

or, what is essentially

$$(\text{AQ} - \text{SQ}) \times \text{SP}$$

Note: This discussion is focused on standard costing. Under standard costing, overhead is applied to production on the basis of the amount of the allocation base *allowed* for the actual production. Under normal costing, a company will probably have both a Variable Overhead Spending Variance and a Variable Overhead Efficiency Variance. But if normal costing is being used instead of standard costing, overhead would be applied based on the amount of the allocation base *actually used* for the actual units of output rather than on the standard amount allowed. Thus, if normal costing is being used, we would use the AQ (Actual Quantity) for both the AQ and the SQ in the formula above. So the variance formula under normal costing would become $(\text{AQ} - \text{AQ}) \times \text{SP}$, which would be zero. Therefore, if overhead is applied based on the amount of the allocation base *actually used* for the actual units of output rather than on the standard amount allowed, there will be no Variable Overhead Efficiency Variance.

Question 60: The following information pertains to Roe Co.'s June operations:

Standard direct labor hours per unit	2
Actual direct labor hours	10,500
Number of units produced	5,000
Standard variable overhead per standard direct labor hour	\$3
Actual variable overhead	\$28,000

Roe's June unfavorable variable overhead efficiency variance was:

- a) \$0
- b) \$1,500
- c) \$2,000
- d) \$3,500

(CPA Adapted)

Fixed Overhead Variances

Total Fixed Overhead Variance

Fixed overhead costs are allocated to the units produced using the predetermined fixed overhead rate. Therefore, the total fixed overhead variance is the difference between the actual fixed overhead incurred and the amount that was applied using the standard rate and the standard usage for the actual level of output.

$$\begin{aligned} & \text{Actual fixed overhead incurred (money actually spent)} \\ & - \text{Standard fixed overhead APPLIED (standard rate} \times \text{standard for actual output)}^f \\ & = \text{Total fixed overhead variance}^g \end{aligned}$$

^f The "standard for actual output" in the formula is the **standard amount of the application base allowed for the actual output**.

The total fixed overhead variance is the same as the amount of over- or under-applied fixed factory overhead.

- If actual fixed overhead incurred is greater than the amount of fixed overhead applied, fixed overhead is **underapplied**.
- If the amount of fixed overhead applied is greater than the actual fixed overhead incurred, fixed overhead is **overapplied**.

Over- and under-applied fixed factory overhead will be covered in detail in Section C of this textbook, "Cost Management."

As with the total variable overhead variance, the total fixed overhead variance can be broken down into two other variances – the spending (or budget) variance and production-volume variance.

When the fixed overhead spending variance and the fixed overhead production-volume variance are combined, they will equal the total fixed overhead variance and the amount of over- or under-applied fixed overhead.

Fixed Overhead Spending (Flexible Budget) Variance

The fixed overhead spending variance, also called the flexible budget or just the budget variance, is the difference between the actual fixed overhead costs incurred and the budgeted fixed overhead (flexible budget **and** static budget) amount.

$$\begin{aligned}
 & \text{Actual Fixed Overhead Incurred} \\
 & - \text{Budgeted Fixed Overheads (the flexible budget and static budget amount)} \\
 & = \text{Fixed Overhead Flexible Budget Variance}
 \end{aligned}$$

Note that the flexible budget and the static budget amounts are the same. That is because fixed overhead is fixed and thus does not change with changes in production, as long as production remains within the relevant range.

Fixed Overhead Production-Volume Variance

The fixed overhead volume variance is the difference between the budgeted amount of fixed overhead and the amount of fixed overhead applied (standard rate × **standard input for the actual level of output**). The Fixed Overhead Production-Volume Variance is caused by the actual production level being different from the production level used to calculate the budgeted fixed overhead rate.

The fixed overhead production-volume variance has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs the way other variances are. Instead, it is a measure of capacity utilization.

The fixed overhead production-volume variance is calculated as follows:

$$\begin{aligned}
 & \text{Budgeted Fixed Overheads (the flexible budget and static budget amount)} \\
 & - \text{Standard fixed overhead APPLIED (standard rate × standard input for actual output)} \\
 & = \text{Fixed Overhead Production-Volume Variance}
 \end{aligned}$$

- A **negative amount** (applied fixed overhead is greater than budgeted fixed overhead) is **Favorable** because it indicates that actual production has **exceeded** the budgeted production level.
- A **positive amount** (budgeted fixed overhead is greater than applied fixed overhead) is **Unfavorable** because it indicates that actual production has been **lower** than the budgeted production level.

⁹ This amount is the same as the over- or under-applied fixed factory overhead.

Note: This is the only time for an expense variance calculation that a budgeted cost amount comes before an actual cost amount, and yet a negative amount is Favorable. This variance is different because it does not measure a difference between an actual incurred cost and a budgeted cost.

Total Overhead Variance Versus Total Overhead Flexible Budget Variance

Variances are used for different purposes. The Total Overhead Variance is the difference between total actual overhead incurred (fixed and variable) and the total amount of overhead applied (fixed and variable). The Total Overhead Variance is the sum of the overhead variances that arise in the accounting system when production is accounted for. These are the variances that are resolved at the end of the reporting period as part of the closing process. As we have seen, this total variance can be subdivided into four sub-variances.

However, the Total Overhead Variance does not tell us what the difference is between the actual overhead incurred and the flexible budget overhead. For that, we need the Total Overhead Flexible Budget Variance. The **Total Overhead Flexible Budget Variance** includes three of the four sub-variances above: Variable Overhead Spending Variance, Variable Overhead Efficiency Variance, and Fixed Overhead Spending Variance. It **does not** include the Fixed Overhead Production-Volume Variance, because that variance has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs as the other variances are.

The **total overhead flexible budget variance** is

$$\begin{aligned} & \text{Actual total variable and fixed overhead incurred (money spent on these items)} \\ & - \text{Total flexible budget variable and fixed overhead amounts for the actual output} \\ & = \text{Total Overhead Flexible Budget Variance} \end{aligned}$$

It is important to recognize that **the flexible budget amount for fixed overhead is exactly the same as the static budget amount for fixed overhead**, but the flexible budget amount for **variable** overhead will be an **adjusted amount** because it is the amount **allowed** for the actual output.

As we said above, the three individual variances that together make up the total overhead flexible budget variance are:

- Variable overhead spending variance,
- Variable overhead efficiency variance, and
- Fixed overhead spending variance.

The variable overhead spending (budget) variance plus the variable overhead efficiency variance equal the total variable overhead variance. However, only the fixed overhead spending (budget) variance is included in the total overhead flexible budget variance. As we said above, the fixed overhead production-volume variance is omitted from the calculation of the total overhead flexible budget variance because it has no connection to any actually incurred costs, so it is not a comparison between actual and budgeted costs as the other sub-variances are.

There is no fixed overhead efficiency variance because fixed costs do not relate to levels of output and therefore cannot be used either efficiently or inefficiently.

Comprehensive Example

Following is a comprehensive example of variable, fixed, and total overhead variance calculations. In addition to this example, you will find a comprehensive example of accounting for fixed overhead and fixed overhead variances in Section C of this textbook under the topic of "The Process of Accounting for Factory Overhead." The example in Section C will highlight fixed overhead and show how the fixed overhead variances arise in the accounting system and how they are cleared out. The fixed overhead example in Section C will use the same amounts as this example does for fixed overhead, so it will maintain continuity.

Example: Overhead is applied to production based on machine hours. Before 2010 begins, the company budgets the following for the year 2010:

Standard for number of machine hours used/unit produced	5 MH/unit
Budgeted activity level	1,000,000 units
Budgeted fixed overhead	\$10,000,000
Budgeted fixed overhead application rate:	
\$10,000,000 ÷ (5 MH/unit × 1,000,000 units)	\$2/MH (also \$10/unit)
Budgeted variable overhead for budgeted activity level	\$5,000,000
Budgeted variable overhead application rate:	
\$5,000,000 ÷ (5 MH/unit × 1,000,000 units)	\$1/MH (also \$5/unit)

Actual production during 2010 is 1,200,000 units. The **standard** number of machine hours (the machine hours **allowed** for the actual production) is 1,200,000 units × 5 MH per unit, or 6,000,000 machine hours. The **actual** number of machine hours used during 2010 for the actual production is 6,300,000 hours.

During 2010, fixed and variable overhead is applied to production at the predetermined rates of \$2 per machine hour **allowed** for fixed overhead and \$1 per machine hour **allowed** for variable overhead, for a total of \$3 per machine hour allowed. Since 6,000,000 machine hours were allowed for the actual production of 1,200,000 units, the total amount of fixed overhead applied is \$2 × 6,000,000, or \$12,000,000; and the total amount of variable overhead applied is \$1 × 6,000,000, or \$6,000,000. Total fixed and variable overhead applied is \$12,000,000 + \$6,000,000, or \$18,000,000.

Actual overhead incurred during 2010:

Fixed overhead	\$11,000,000
Variable overhead	<u>5,670,000</u>
Total actual overhead incurred	\$16,670,000

Applied overhead for 2010:

Fixed overhead (\$2/MH × 5MH/unit × 1,200,000 units produced)	\$12,000,000
Variable overhead (\$1/MH × 5MH/unit × 1,200,000 units produced)	<u>6,000,000</u>
Total flexible budget overhead, fixed and variable	\$18,000,000

Total overhead variance (total actual OH – total applied OH) **\$(1,330,000) Favorable**

Variable Overhead Variances

Total Variable OH Variance:

Actual Total Variable OH incurred	\$5,670,000
Minus: VOH Applied: standard rate × standard qty. of application base	
(machine hours) allowed for actual output (\$1 × 5 × 1,200,000)	<u>6,000,000</u>
Total Variable Overhead Variance	<u>\$(330,000)</u> Favorable

The total variable overhead variance is broken down into the **variable overhead spending variance** and the **variable overhead efficiency variance**.

(continued)

Variable Overhead Spending Variance:

Actual VOH incurred – Budgeted VOH based on actual usage =

$$\$5,670,000 - (6,300,000 \times \$1) = \mathbf{\$(630,000) \text{ Favorable}}$$

OR

$$\left[\begin{array}{l} \text{Actual VOH cost/unit of allocation base actually used} \\ \text{Minus standard VOH application rate/unit of allocation base} \end{array} \right] \times \begin{array}{l} \text{Actual Qty. of VOH} \\ \text{application base used for} \\ \text{actual output} \end{array}$$

$$\text{OR } (AP - SP) \times AQ$$

$$[(\$5,670,000 \div 6,300,000) - \$1] \times 6,300,000 = (.90 - 1.00) \times 6,300,000 = \mathbf{\$(630,000) \text{ Favorable}}$$

Variable Overhead Efficiency Variance:

Budgeted VOH based on actual usage – Variable OH applied to production =

$$(6,300,000 \times \$1) - (\$1 \times 5 \times 1,200,000) = \mathbf{\$300,000 \text{ Unfavorable}}$$

OR

$$\left[\begin{array}{l} \text{Actual activity level of VOH application base **actually used**} \\ \text{Minus standard activity level of application base **allowed**} \end{array} \right] \times \text{Standard Application Rate}$$

$$\text{OR } (AQ - SQ) \times SP$$

$$[6,300,000 - (1,200,000 \times 5)] \times \$1 = (6,300,000 - 6,000,000) \times \$1 = \mathbf{\$300,000 \text{ Unfavorable}}$$

The Variable Overhead Spending Variance of \$(630,000) Favorable plus the Variable Overhead Efficiency Variance of \$300,000 Unfavorable equals the Total Variable Overhead Variance of \$(330,000) Favorable.

The variance analysis tells us that the actual variable overhead cost per unit of the allocation base (machine hours) incurred was lower than budgeted for the amount actually produced (\$630,000 Favorable); but the number of units of the allocation base (machine hours) actually used was higher than budgeted (\$300,000 Unfavorable). The net, or total, variable overhead variance is (630,000) + 300,000 = (330,000) Unfavorable.

Fixed Overhead Variances**Total Fixed Overhead Variance:**

Actual fixed overhead incurred	\$11,000,000
Minus: Applied fixed overhead (standard rate × standard quantity of application base for actual output, or \$2 × 6,000,000 MH)	<u>12,000,000</u>
Equals: Total fixed overhead variance	<u>\$(1,000,000) Favorable</u>

The total fixed overhead variance is broken down into the **fixed overhead spending variance** and the **fixed overhead production-volume variance**.

Fixed Overhead Spending (Flexible Budget) Variance:

Actual fixed overhead incurred	\$11,000,000
Minus: Flexible & static budget fixed overhead	<u>10,000,000</u>
Equals: Fixed overhead spending variance	<u>\$1,000,000 Unfavorable</u>

(continued)

Fixed Overhead Production-Volume Variance:

Budgeted Fixed Overhead	\$10,000,000
Minus: Applied fixed overhead (standard rate × standard quantity of application base for actual output, or \$2 × 6,000,000 MH)	<u>12,000,000</u>
Equals: Fixed overhead production-volume variance	<u>\$(2,000,000)</u> Favorable

The Total Fixed Overhead Variance is the total of the \$1,000,000 Unfavorable spending variance plus the \$2,000,000 Favorable production-volume variance, or \$1,000,000 Favorable.

- The unfavorable spending variance means more fixed overhead was actually incurred than was budgeted.
- The favorable production-volume variance means that actual production exceeded the budgeted production level.

The total variable overhead variance of \$(330,000) Favorable plus the total fixed overhead variance of \$(1,000,000) Favorable is equal to the total overhead variance we calculated at the beginning of this example of \$(1,330,000) Favorable.

Total Overhead Flexible Budget Variance

The Total Overhead Flexible Budget Variance is the difference between actual total overhead incurred and the flexible budget total overhead. When we look at this total variance, we see a different picture. This total overhead variance is Unfavorable, not Favorable.

Actual overhead incurred during 2010:

Fixed overhead	\$11,000,000
Variable overhead	<u>5,670,000</u>
Total actual overhead incurred	\$16,670,000

Budgeted overhead for 2010 (**flexible** budget):

Budgeted fixed overhead (flexible and static budget amount)	\$10,000,000
Flexible budget variable overhead ($\$1/\text{MH} \times 5\text{MH}/\text{unit} \times 1,200,000$ units produced)	<u>6,000,000</u>
Total flexible budget overhead, fixed and variable	\$16,000,000

Total overhead flexible budget variance (total actual overhead incurred minus total flexible budget overhead)	<u>\$ 670,000</u> Unfavorable
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The total overhead flexible budget variance is broken down into the variable overhead spending variance, the variable overhead efficiency variance (calculated above), and the fixed overhead spending variance, as follows:

Variable overhead spending variance	\$(630,000) Favorable
Variable overhead efficiency variance	300,000 Unfavorable
Fixed overhead spending variance	<u>1,000,000</u> Unfavorable
Total overhead flexible budget variance	<u>\$ 670,000</u> Unfavorable

(continued)

Why are these two total overhead variances so different? The difference is in the fixed overhead production-volume variance, which is included in the Total Overhead Variance and not included in the Total Overhead Flexible Budget Variance. The fixed overhead production-volume variance was \$(2,000,000) Favorable. When we omit that variance, the Total Overhead Variance changes from \$(1,330,000) Favorable to the Total Overhead Flexible Budget variance of \$670,000 Unfavorable. The Fixed Overhead Production-Volume variance was favorable because production exceeded expectations (1,200,000 units produced versus 1,000,000 units budgeted), which is a good thing. However, total actual fixed costs exceeded the amount budgeted for them by \$1,000,000. Did actual fixed costs increase because production was so great that it moved out of the relevant range? That is something that needs to be investigated, and it may be that the predetermined or standard application rate for fixed costs needs to be adjusted.

Question 61: The total fixed overhead variance is the:

- a) Measure of the lost profits from the lack of sales volume.
- b) Amount of the underapplied or overapplied fixed overhead costs.
- c) Potential cost reduction that can be achieved from better cost control.
- d) Measure of production inefficiency.

(CMA Adapted)

Question 62: Variable overhead is applied on the basis of standard direct labor hours. If the direct labor efficiency variance is unfavorable, the variable overhead efficiency variance will be:

- a) Favorable.
- b) Unfavorable.
- c) The same amount as the labor efficiency variance.
- d) Indeterminable because it is not related to the labor efficiency variance.

(CMA Adapted)

Two-Way, Three-Way and Four-Way Analysis

What we have covered above is the analysis of overheads (fixed and variable) in the four-way method. There are four variances and each is calculated separately. There are also three-way and two-way methods of analyzing overheads, which we do by simply combining some of the four-way analysis variances that we calculated.

In **Three-way Analysis**, the three variances are the volume, efficiency and spending variances.

- 1) The **volume variance** is equal to the production-volume variance as calculated for fixed overhead.
- 2) The **efficiency variance** is equal to the variable overhead efficiency variance.
- 3) The **spending variance** is equal to the variable overhead spending variance **plus** the fixed overhead spending variance.

Two-way Analysis uses the same information as calculated for four-way analysis, but we are going to combine it in a slightly different manner. The two variances are called the volume variance and the controllable (or budget) variance.

- 1) The **volume variance** is equal to the production-volume variance for fixed overhead.
- 2) The **controllable variance** is equal to the sum of the remaining three variances, which are the variable spending variance, variable efficiency variance and fixed spending variance.

The following table illustrates the way the four variances are combined for three-way and two-way analysis.

	Variable Overhead Variance Analysis		Fixed Overhead Variance Analysis	
4-way	Efficiency Variance $(AQ - SQ) \times SP$	Spending Variance $(AP - SP) \times AQ$	Spending Variance Actual - Budgeted	Production-Volume Variance Budgeted - Applied
3-way	Efficiency Variance	Spending Variance		Volume Variance
2-way	Controllable Variance			Volume Variance

In the example above, we did the 4-way analysis first. We actually did the Controllable Variance part of the 2-way analysis second, when we calculated the Total Overhead Flexible Budget Variance.

2-Way Overhead Variance Analysis

The second way we looked at the overhead in the preceding example, which we called the Total Overhead Flexible Budget Variance, was the same thing as the Controllable Variance in 2-way analysis. It included the Variable Overhead Spending Variance, the Variable Overhead Efficiency Variance, and the Fixed Overhead Spending Variance. Just the same way as we calculated the Total Overhead Flexible Budget Variance, the Controllable Variance is

$$\begin{aligned}
 & \textbf{Total Actual Overhead Incurred} \\
 & - \textbf{Budgeted Fixed Overhead (static and flexible)} \\
 & - \textbf{Flexible Budget Variable Overhead (or variable overhead applied to production)} \\
 & = \textbf{Controllable Variance}
 \end{aligned}$$

From the facts in the preceding example:

$$\begin{aligned}
 & \$16,670,000 \quad \text{Total Actual Overhead Incurred} \\
 & - \quad 10,000,000 \quad \text{Budgeted Fixed Overhead (static and flexible)} \\
 & - \quad \underline{6,000,000} \quad \text{Variable OH Applied: } \$1/\text{MH} \times 5\text{MH/unit} \times 1,200,000 \text{ units produced} \\
 & = \quad \underline{\$ \quad 670,000} \quad \text{Unfavorable Controllable Variance}
 \end{aligned}$$

The Fixed Overhead Volume Variance in 2-way analysis is the same as the Fixed Overhead Production-Volume Variance in 4-way analysis: \$(2,000,000) Favorable.

Reconciling to the Total Overhead Variance: The Total Overhead Variance is the sum of the \$670,000 Unfavorable Controllable Variance plus the \$(2,000,000) Favorable Fixed Overhead Volume Variance, or \$(1,330,000) Favorable.

That just leaves 3-way analysis. So using that same example, let's do the 3-way analysis:

3-Way Overhead Variance Analysis:

In 3-way overhead variance analysis, the Variable Overhead Spending Variance and the Fixed Overhead Spending Variance are combined into one Spending Variance. The Variable Overhead Efficiency Variance and the Fixed Overhead Production-Volume Variance are separate and are the same as in 4-way analysis.

The total Spending Variance (fixed and variable) is calculated as:

$$\begin{aligned}
 & \textbf{Actual Total Overhead Incurred} \\
 & - \textbf{Budgeted Fixed Overhead (static and flexible budget)} \\
 & - \textbf{Budgeted Variable Overhead based on actual usage of the allocation base} \\
 & = \textbf{Total Spending Variance}
 \end{aligned}$$

Using our example:

$$\begin{aligned}
 & \$16,670,000 \quad (\text{Actual Total Overhead Incurred}) \\
 & - \quad 10,000,000 \quad (\text{Budgeted fixed overhead}) \\
 & - \quad \underline{6,300,000} \quad (6,300,000 \text{ actual machine hours used} \times \$1/\text{MH}) \\
 & = \underline{\underline{\$ \quad 370,000}} \quad \text{Unfavorable}
 \end{aligned}$$

The same variance calculated by combining the Variable Overhead Spending Variance and the Fixed Overhead Spending Variance is:

Variable Overhead Spending Variance	\$(630,000)	Favorable
Fixed Overhead Spending Variance	<u>1,000,000</u>	Unfavorable
Spending Variance	<u>\$ 370,000</u>	Unfavorable

Reconciling the Spending Variance to the Total Overhead Variance:

Plus: Variable Overhead Efficiency Variance	\$ 300,000	Unfavorable
Minus: Fixed Overhead Volume Variance	<u>(2,000,000)</u>	Unfavorable
Equals: Total Overhead Variance	<u>\$ (1,330,000)</u>	Favorable

Question 63: Which of these variances is least significant for cost control?

- a) Labor price variance.
- b) Materials quantity variance.
- c) Fixed O/H volume variance.
- d) Variable O/H spending variance.

(CMA Adapted)

The following information is for the next six Questions: Franklin Glass Works' production budget for the year ended November 30 was based on 200,000 units. Each unit required two standard hours of labor for completion. Total overhead was budgeted at \$900,000 for the year, and the fixed overhead rate was estimated at \$3.00 per unit. Both fixed and variable overhead are assigned to the product on the basis of direct labor hours. The actual data for the year ended November 30 is presented as follows.

Actual production in units	198,000
Actual direct labor hours	440,000
Actual variable overhead	\$352,000
Actual fixed overhead	\$575,000

Question 64: The standard hours allowed for actual production for the year ended November 30 total:

- a) 247,500
- b) 396,000
- c) 400,000
- d) 495,000

Question 65: Franklin's variable overhead efficiency variance for the year is:

- a) \$33,000 unfavorable.
- b) \$35,520 favorable.
- c) \$66,000 unfavorable.
- d) \$33,000 favorable.

Question 66: Franklin's variable overhead spending variance for the year is:

- a) \$20,000 unfavorable.
- b) \$19,800 favorable.
- c) \$22,000 unfavorable.
- d) \$20,000 favorable.

Question 67: Franklin's fixed overhead spending variance for the year is:

- a) \$19,000 favorable.
- b) \$25,000 favorable.
- c) \$5,750 favorable.
- d) \$25,000 unfavorable.

Question 68: The fixed overhead applied to Franklin's production for the year is:

- a) \$484,200.
- b) \$575,000.
- c) \$594,000.
- d) \$600,000.

Question 69: Franklin's fixed overhead volume variance for the year is:

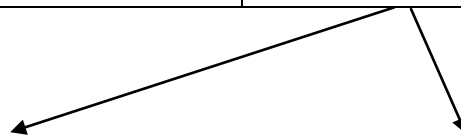
- a) \$6,000 unfavorable.
- b) \$19,000 favorable.
- c) \$25,000 favorable.
- d) \$55,000 unfavorable.

(CMA Adapted)

Summary Table of Manufacturing Variance Calculations

The following table summarizes the calculations that are made and the different terms used in variance analysis.

Prime Costs	Price Variance $(AP - SP) \times AQ$	Quantity Variance $(AQ - SQ) \times SP$
Materials	Price Variance	Quantity Variance
Labor	Rate Variance	Efficiency Variance



Multiple Inputs^h (both Material and Labor)	Mix Variance $(WASPAM - WASPSM) \times AQ$	Yield Variance $(AQ - SQ) \times WASPSM$
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Variable Overheadⁱ	Spending Variance $(AP - SP) \times AQ$	Efficiency Variance $(AQ - SQ) \times SP$
Fixed Overhead	Spending (Flexible Budget) Variance Actual OH – Budgeted OH	Production Volume Variance Budgeted OH – Applied OH

^h The sum of the mix and yield variance is equal to the total of the quantity or efficiency variance for each of the inputs calculated separately, and then added together.

ⁱ For overhead variances, we use the standard and actual application rate rather than price. The standard rate is the rate that is calculated at the beginning of the year and used to allocate overhead, and the actual rate is calculated as Actual Costs / Actual Level of Usage.

45 a – The efficiency variance measures the actual usage of the materials against the standard that should have been used. This usage is mostly under the control of the production department and industrial engineering.

46 d – If the company buys lower quality materials, there will be a favorable price variance. However, because the input materials are of a lower quality, it is very possible that a higher than normal quantity will need to be used because the lower quality materials may break or be damaged or unusable in some cases because of the lower quality.

47 b – The price variance formula is $(AP - SP) \times AQ$. Putting the numbers from the question into the formula, we get $(.75 - .72) \times 4,100$. (Remember that in the price variance we use the number of units **used** in production, unless the problem asks for the **purchase** price variance.) This gives us an unfavorable variance of \$123.

48 b – The standard price is calculated using budgeted amounts. ChemKing expected to make 12,000 units, which would require 24,000 units of raw material. Since the budgeted cost of these raw material units was \$60,000, the standard cost per unit is \$2.50 ($\$60,000 \div 24,000$).

49 d – In this question, we need to solve for AQ and since we are given the quantity variance in the question, we can use this formula: $(AQ - SQ) \times SP = \text{Quantity Variance}$. Or, $(AQ - 24,000) \times \$2.50 = \$2,500$. Solving for AQ we get 25,000. We also could have solved this in the following manner: because the standard price for each unit of material was \$2.50 and ChemKing's quantity variance was \$2,500 unfavorable, it must have used 1,000 units of raw materials too many. The standard is 2 units of material for each unit of output, so for 12,000 units of output, the standard would be 24,000 units of material. Thus, the actual units of raw material used were $24,000 + 1,000$, or 25,000.

50 c – The formula for the price variance is $(AP - SP) \times AQ$. Using the amounts in the questions, we get $(\$3.00 - \$2.50) \times 25,000 = \$12,500$ Unfavorable. We know that the actual price was \$3.00 per unit because the company bought 35,000 units for \$105,000.

51 b – If the company has an unfavorable materials usage variance, this will mean that more materials were used than necessary. This in turn may cause more labor hours in order to handle and process the additional materials. Therefore, the unfavorable materials usage variance may also cause an unfavorable labor variance as well.

52 c – If a new labor contract has been signed prior to the budgeting cycle, the new labor rates should have been incorporated into the budget. Therefore, this is not an explanation of a labor price variance.

53 d – The actual sales volume of the product will not impact the materials efficiency variance. The difference between sales and production does not affect the comparison of how much material should have been used in the production and how much actually was used.

54 d – In order to calculate the labor efficiency variance, we need to use the following formula: $(AQ - SQ) \times SP$. The standard price is \$12 per direct labor hour. The standard number of hours for the level of production is 6,500 ($5,200 \text{ units} \times 1.25 \text{ hours per unit}$). The actual number of hours was 6,600. Putting this into the formula, we get $(6,600 - 6,500) \times \$12 = \$1,200$. This is a \$1,200 unfavorable variance.

55 d – To solve for the direct materials usage variance, we need to solve the following equation: $(AQ - SQ) \times SP$. The standard price is \$3.60 per pound and the standard quantity required to produce the actual quantity of output is 110,000 ($22,000 \text{ units} \times 5 \text{ pounds per unit}$). We are told that the actual quantity used was 108,000. Therefore, the formula is $(108,000 - 110,000) \times \3.60 and this gives us a favorable variance of $\$(7,200)$.

56 a – To solve for the direct labor rate variance, we need to solve the following equation: $(AP - SP) \times AQ$. The actual quantity of labor hours was 28,000 and the standard rate is \$12.00 per hour. The actual rate may be calculated by dividing the actual cost of \$327,600 (this is calculated as 90% of the total labor cost) by the actual hours worked of 28,000. This gives an actual labor rate of \$11.70. Putting these numbers into the formula, we get $(\$11.70 - \$12.00) \times 28,000$. This gives us a favorable variance of \$(8,400).

57 b – To solve for the labor usage variance, we need to solve the following equation: $(AQ - SQ) \times SP$. The standard price was \$12.00 and the actual quantity was 28,000. The standard quantity for the actual level of output is 27,500 (22,000 units \times 1.25 hours per unit). Putting these numbers into the formula, we get $(28,000 - 27,500) \times \12 , and this gives us an unfavorable labor usage variance of \$6,000.

58 d – The materials mix variance equals the actual total quantity used times the difference between the weighted average standard price for the actual mix per unit and the weighted average standard price for the standard mix per unit. The weighted average standard price for the actual mix was $(21,000 \times \$0.75) + (14,000 \times \$0.90) = \$28,350$. So, the weighted average standard price for the actual mix per unit was \$.81 ($\$28,350 \div 35,000$ kg). The weighted average standard price for the standard mix is \$.80 per unit. ($\240 standard total cost per batch \div 300 standard total kg per batch), and the mix variance was \$350 unfavorable: $(\$0.81 - \$0.80) \times 35,000 = \$350$.

59 b – The materials yield variance equals the weighted average standard price for the standard mix per unit multiplied by the difference between the actual total quantity used and the standard total quantity for the actual output achieved. The weighted average standard price for the standard mix is \$.80 per kg. ($\240 standard total cost per batch \div 300 standard total kg per batch). The actual total quantity used is 35,000. The standard total quantity for the actual output achieved is 300 kg per batch \times 110 batches = 33,000 kg. So, the yield variance was \$1,600 unfavorable: $(35,000 - 33,000) \times 0.80 = \$1,600$.

60 b – The variable overhead efficiency variance is calculated as $(AQ - SQ) \times SP$, where SP is the budgeted application rate. Given that 5,000 units were produced, the standard quantity of DLH would be 10,000. Given that the actual hours was 10,500 and that the standard rate was \$3, we get $(10,500 - 10,000) \times 3 = \$1,500$, and an unfavorable variance of \$1,500.

61 b – The total fixed overhead variance is the difference between the actual total fixed overhead cost incurred and the applied fixed overhead. It is the amount of the underapplied or overapplied fixed overhead costs.

62 b – If variable overhead is applied based on standard direct labor hours and the direct labor efficiency variance is unfavorable, the variable overhead efficiency variance will also be unfavorable. This is because the amount of variable overhead applied will be more than was budgeted for the actual output, because the actual direct labor hours used for the actual output were more than was budgeted for the actual output.

63 c – The fixed overhead volume variance results from a difference between actual and budgeted production. This does not relate to an expenditure problem in which either too much is paid or too much is used. Therefore, this is the least significant variance for cost control.

64 b – The standard hours for each unit is 2. Since Franklin Glass Works produced 198,000 units, the standard total hours should be 396,000 ($198,000 \times 2$).

65 a – To solve for the variable overhead efficiency variance, we need to solve for the following equation: $(AQ - SQ) \times SP$. In order to calculate the standard variable overhead allocation rate, we need to determine what the total variable overhead was budgeted to be. We are told that the total budgeted overhead is \$900,000 and that the fixed overhead is \$3 per unit. If there were 200,000 units budgeted, the total budgeted fixed overhead was \$600,000. This leaves variable overhead of \$300,000. Since 200,000 units were budgeted and there are 2 hours per unit, that gives a total of 400,000 budgeted hours. Calculating the allocation rate now, we get \$.75 of variable overhead per direct labor hour ($\$300,000 \div 400,000$ hours). The actual number of hours was 440,000 and the standard number of hours was 396,000. Therefore, the formula looks as follows: $(440,000 - 396,000) \times \0.75 and the variance is an unfavorable \$33,000.

66 c – To solve for the variable overhead spending variance, we need to solve for the following equation: $(AP - SP) \times AQ$. We know that the standard price was \$.75 and that the actual hours were 440,000. The actual price is calculated as the actual variable overhead \div actual direct labor hours, or $\$352,000 \div 440,000 = \0.80 per hour. We can now put these figures into the equation and get $(\$0.80 - \$0.75) \times 440,000$. The variance is an unfavorable \$22,000.

67 b – To solve for the fixed overhead spending variance, we must subtract budgeted fixed overheads from the actual fixed overheads. The actual fixed overheads were \$575,000 and the budgeted fixed overheads were \$600,000 (as calculated for the question above). Therefore, the fixed overhead spending variance is a favorable \$25,000.

68 c – The amount of fixed overhead applied is calculated as the application rate (\$3 per unit) multiplied by the number of units produced (198,000). This gives us fixed overhead applied of \$594,000.

69 a – The fixed overhead volume variance is calculated as the budgeted overhead minus the applied overhead, and a positive amount is unfavorable. The budgeted amount was \$600,000 and the applied amount was \$594,000, so the volume variance is an unfavorable \$6,000.