18 Spoilage, Rework, and Scrap

Learning Objectives

1. Understand the definitions of spoilage, rework, and scrap
2. Identify the differences between normal and abnormal spoilage
3. Account for spoilage in process costing using the weighted-average method and the first-in, first-out (FIFO) method
4. Account for spoilage at various stages of completion in process costing
5. Account for spoilage in job costing
6. Account for rework in job costing
7. Account for scrap

When a product doesn't meet specification but is subsequently repaired and sold, it is called rework.

Firms try to minimize rework, as well as spoilage and scrap, during production. Why? Because higher-than-normal levels of spoilage and scrap can have a significant negative effect on a company's profits. Rework can also cause substantial production delays, as the following article about Boeing shows.

Rework and Delays on the Boeing Dreamliner[1]

In 2007, Boeing was scheduled to introduce its newest airplane, the Dreamliner 787. Engineered to be the most fuel-efficient commercial plane, the Dreamliner received more than 900 customer orders, making it the fastest-selling commercial airplane in history.

The first Dreamliner did not take flight, however, until late 2011. The design and assembly process was riddled with production snafus, parts shortages, and supply-chain bottlenecks. The Dreamliner was Boeing's first major attempt at giving suppliers and partners far-ranging responsibility for designing and building the wings, fuselage, and other critical components to be shipped to Boeing for final assembly. The problems continued after planes began rolling off the production line. In 2013, regulators grounded all 50 operational Dreamliners after batteries overheated on two separate aircraft—a Japan Airlines plane parked at the Boston airport and an All Nippon Airways jet forced to make an emergency landing in Japan.

The Boeing Dreamliner aircraft has required significant rework over the years. The company's engineers have redesigned structural flaws in the airplane's wings, repaired cracks in the composite materials used to construct the airplane, fixed faulty software, and reworked the plane's lithium-ion battery system. This rework has led to costly delays for Boeing. Many customers asked the company to compensate them for keeping less fuel-efficient planes in the air. Other customers canceled their orders. In 2012, Australia's Qantas Airways canceled an order for 35 airplanes and received $433 million from Boeing, which included returned deposits and compensation for delays. The company also lost an estimated $450 million in revenue

[1] *Sources:* "Boeing 787 Faces Limits on Extended Range," *CNBC.com* (March 27, 2013); "Dreamliner Ready for Phase II After Successful Test Flight," *Chicago Tribune* (March 26, 2013); Dominic Gates, "Boeing Dreamliner on Track, but Rework May Stretch to 2015," *Seattle Times* (November 26, 2012); Ross Kelly, "Qantas Deals New Blow to Boeing Dreamliner," *Wall Street Journal* (August 23, 2012); Peter Sanders, "At Boeing, Dreamliner Fix Turns Up New Glitch," *Wall Street Journal* (November 13, 2009); Karen West, "Boeing Has Much to Prove with 787," *MSNBC.com* (December 16, 2009).

and compensation payments to airlines while revamping the battery system. It appears that overall rework on the Dreamliner may stretch to 2015.

Like Boeing, companies are increasingly focused on improving the quality of, and reducing defects in, their products, services, and activities. A rate of defects regarded as normal in the past is no longer tolerable, and companies strive for ongoing improvements in quality. Firms in industries as varied as construction (Skanska), aeronautics (Lockheed Martin), product development software (Dassault Systemes), and specialty food (Tate & Lyle) have set zero-defects goals. In this chapter, we focus on three types of costs that arise as a result of defects—spoilage, rework, and scrap—and ways to account for them. We also describe how to determine (1) the cost of products, (2) cost of goods sold, and (3) inventory values when spoilage, rework, and scrap occur.

Defining Spoilage, Rework, and Scrap

Learning Objective 1

Understand the definitions of spoilage,

...unacceptable units of production

rework,

...unacceptable units of production subsequently repaired

and scrap

...leftover material

The following terms used in this chapter may seem familiar to you, but be sure you understand them in the context of management accounting.

Spoilage refers to units of production—whether fully or partially completed—that do not meet the specifications required by customers for good units and are discarded or sold at reduced prices. Some examples of spoilage are defective shirts, jeans, shoes, and carpeting sold as "seconds" and defective aluminum cans sold to aluminum manufacturers for remelting to produce other aluminum products.

Rework refers to units of production that do not meet the specifications required by customers but that are subsequently repaired and sold as good finished units. For example, defective units of products (such as smartphones, tablets, and laptops) detected during or after the production process but before the units are shipped to customers can sometimes be reworked and sold as good products.

Scrap is residual material that results from manufacturing a product. Examples are short lengths from woodworking operations, edges from plastic molding operations, and frayed cloth and end cuts from suit-making operations. Scrap can sometimes be sold for relatively small amounts. In that sense, scrap is similar to byproducts, which we studied in Chapter 16. The difference is that scrap arises as a residual from the manufacturing process and is not a product targeted for manufacture or sale by the firm.

A certain amount of spoilage, rework, or scrap is inherent in many production processes. For example, semiconductor manufacturing is so complex and delicate that some spoiled units are inevitable due to dust adhering to wafers in the wafer production process and crystal defects in the silicon substrate. Usually, the spoiled units cannot be reworked. In the manufacture of high-precision machine tools, spoiled units can be reworked to meet standards, but only at a considerable cost. And in the mining industry, companies process ore that contains varying amounts of valuable metals and rock. Some amount of rock, which is scrap, is inevitable.

Decision Point

What are spoilage, rework, and scrap?

Learning Objective 2

Identify the differences between normal spoilage

...spoilage inherent in an efficient production process

and abnormal spoilage

...spoilage that would not arise under efficient operation

Two Types of Spoilage

Accounting for spoilage includes determining the magnitude of spoilage costs and distinguishing between the costs of normal and abnormal spoilage.[2] To manage, control, and reduce spoilage costs, companies need to highlight them, not bury them as an unidentified part of the costs of good units manufactured.

To illustrate normal and abnormal spoilage, consider Mendoza Plastics, which uses plastic injection molding to make casings for the iMac desktop computer. In January 2014, Mendoza incurs costs of $3,075,000 to produce 20,500 units. Of these 20,500 units, 20,000 are good units and 500 are spoiled units. Mendoza has no beginning inventory and no ending inventory that month. Of the 500 spoiled units, 400 units are spoiled because the injection molding machines are unable to manufacture good casings 100% of the time. That is, these units are spoiled even though the machines were run carefully and efficiently. The remaining 100 units are spoiled because of machine breakdowns and operator errors.

Normal Spoilage

Normal spoilage is spoilage inherent in a particular production process. In particular, it arises even when the process is carried out in an efficient manner. The costs of normal spoilage are typically included as a component of the costs of good units manufactured because good units cannot be made without also making some defective units. For this reason, normal spoilage costs are inventoried, that is, they are included in the cost of the good units completed. The following calculations show how Mendoza Plastics accounts for the cost of the 400 units normal spoilage:

Manufacturing cost per unit, $3,075,000 ÷ 20,500 units = $150	
Manufacturing costs of good units alone, $150 per unit × 20,000 units	$3,000,000
Normal spoilage costs, $150 per unit × 400 units	60,000
Manufacturing costs of good units completed (includes normal spoilage)	$3,060,000

$$\text{Manufacturing cost per good unit} = \frac{\$3,060,000}{20,000 \text{ units}} = \$153$$

Normal spoilage rates are computed by dividing the units of normal spoilage by total *good units completed*, not total *actual units started* in production. At Mendoza Plastics, the normal spoilage rate is therefore computed as 400 ÷ 20,000 = 2%. There is a tradeoff between the speed of production and the normal spoilage rate. Managers make a conscious decision about how many units to produce per hour with the understanding that, at the chosen rate, a certain level of spoilage is unavoidable.

Abnormal Spoilage

Abnormal spoilage is spoilage that is not inherent in a particular production process and would not arise under efficient operating conditions. At Mendoza, the 100 units spoiled due to machine breakdowns and operator errors are abnormal spoilage. (If Mendoza had set 100% good units as its goal, then all 500 units of spoilage would be considered abnormal.) Abnormal spoilage is usually regarded as avoidable and controllable. Line operators and other plant personnel generally can decrease or eliminate abnormal spoilage by identifying the reasons for machine breakdowns, operator errors, and so forth, and by taking steps to prevent their recurrence. To highlight the effect of abnormal spoilage costs, companies calculate the units of abnormal spoilage and record the cost in the Loss from Abnormal Spoilage account, which appears as a separate line item in the income statement. That is, unlike normal spoilage, the costs of abnormal spoilage are not considered inventoriable and are written off as a period expense. At Mendoza, the loss from abnormal spoilage is $15,000 ($150 per unit × 100 units).

Decision Point

What is the distinction between normal and abnormal spoilage?

Issues about accounting for spoilage arise in both process-costing and job-costing systems. We discuss both instances next, beginning with spoilage when process costing is used.

[2] The helpful suggestions of Samuel Laimon, University of Saskatchewan, are gratefully acknowledged.

Spoilage in Process Costing Using Weighted-Average and FIFO

Learning Objective 3

Account for spoilage in process costing using the weighted-average method

...spoilage cost based on total costs and equivalent units completed to date

and the first-in, first-out (FIFO) method

...spoilage cost based on costs of current period and equivalent units of work done in current period

How do process-costing systems account for spoiled units? We have already said that units of abnormal spoilage should be counted and recorded separately in a Loss from Abnormal Spoilage account. But what about units of normal spoilage? The correct method is to count these units when computing both physical and equivalent output units in a process-costing system. The following example illustrates this approach.

Count All Spoilage

Example 1: Chipmakers, Inc., manufactures computer chips for television sets. All direct materials are added at the beginning of the production process. To highlight issues that arise with normal spoilage, we assume there's no beginning inventory and focus only on the direct materials costs. The following data are for May 2014.

	A	B	C
1		Physical Units	Direct Materials
2	Work in process, beginning inventory (May 1)	0	
3	Started during May	10,000	
4	Good units completed and transferred out during May	5,000	
5	Units spoiled (all normal spoilage)	1,000	
6	Work in process, ending inventory (May 31)	4,000	
7	Direct material costs added in May		$270,000

Spoilage is detected upon completion of the process and has zero net disposal value.

An **inspection point** is the stage of the production process at which products are examined to determine whether they are acceptable or unacceptable units. Spoilage is typically assumed to occur at the stage of completion where inspection takes place. As a result, the spoiled units in our example are assumed to be 100% complete for direct materials.

Exhibit 18-1 calculates and assigns the cost of the direct materials used to produce both good units and units of normal spoilage. Overall, Chipmakers generated 10,000 equivalent units of output: 5,000 equivalent units in good units completed (5,000 physical

Exhibit 18-1

Using Equivalent Units to Account for the Direct Materials Costs of Good and Spoiled Units for Chipmakers, Inc., for May 2014

	A	B
1		Approach Counting Spoiled Units When Computing Output in Equivalent Units
2	Costs to account for	$270,000
3	Divide by equivalent units of output	÷ 10,000
4	Cost per equivalent unit of output	$ 27
5	Assignment of costs:	
6	Good units completed (5,000 units × $27 per unit)	$135,000
7	Add normal spoilage (1,000 units × $27 per unit)	27,000
8	Total costs of good units completed and transferred out	162,000
9	Work in process, ending (4,000 units × $27 per unit)	108,000
10	Costs accounted for	$270,000

units × 100%), 4,000 units in ending work in process (4,000 physical units × 100%), and 1,000 equivalent units in normal spoilage (1,000 physical units × 100%). Given total direct material costs of $270,000 in May, this yields an equivalent-unit cost of $27. The total cost of good units completed and transferred out, which includes the cost of normal spoilage, is then $162,000 (6,000 equivalent units × $27). The ending work in process is assigned a cost of $108,000 (4,000 equivalent units × $27).

Notice that the 4,000 units in ending work in process are not assigned any of the costs of normal spoilage because they have not yet been inspected. Undoubtedly some of the units in ending work in process will be found to be spoiled after they are completed and inspected in the next accounting period. At that time, their costs will be assigned to the good units completed in that period. Notice too that Exhibit 18-1 delineates the cost of normal spoilage as $27,000. By highlighting the magnitude of this cost, the approach helps to focus management's attention on the potential economic benefits of reducing spoilage.

Five-Step Procedure for Process Costing with Spoilage

Example 2: Anzio Company manufactures a recycling container in its forming department. Direct materials are added at the beginning of the production process. Conversion costs are added evenly during the production process. Some units of this product are spoiled as a result of defects, which are detectable only upon inspection of finished units. Normally, spoiled units are 10% of the finished output of good units. That is, for every 10 good units produced, there is 1 unit of normal spoilage. Summary data for July 2014 are as follows:

Home | Insert | Page Layout | Formulas | Data | Review | View

	A	B	C	D	E
1		Physical Units (1)	Direct Materials (2)	Conversion Costs (3)	Total Costs (4) = (2) + (3)
2	Work in process, beginning inventory (July 1)	1,500	$12,000	$ 9,000	$ 21,000
3	Degree of completion of beginning work in process		100%	60%	
4	Started during July	8,500			
5	Good units completed and transferred out during July	7,000			
6	Work in process, ending inventory (July 31)	2,000			
7	Degree of completion of ending work in process		100%	50%	
8	Total costs added during July		$76,500	$89,100	$165,600
9	Normal spoilage as a percentage of good units	10%			
10	Degree of completion of normal spoilage		100%	100%	
11	Degree of completion of abnormal spoilage		100%	100%	

We can slightly modify the five-step procedure for process costing used in Chapter 17 to include the costs of Anzio Company's spoilage.

Step 1: Summarize the Flow of Physical Units of Output. Identify the number of units of both normal and abnormal spoilage.

$$\text{Total Spoilage} = \left(\text{Units in beginning work-in-process inventory} + \text{Units started}\right) - \left(\text{Good units completed and transferred out} + \text{Units in ending work-in-process inventory}\right)$$

$$= (1{,}500 + 8{,}500) - (7{,}000 + 2{,}000)$$

$$= 10{,}000 - 9{,}000$$

$$= 1{,}000 \text{ units}$$

Recall that Anzio Company's normal spoilage is 10% of good output. So, the number of units of normal spoilage equals 10% of the 7,000 units of *good* output, or 700 units. With this information, we can then calculate the number of units of abnormal spoilage:

$$\text{Abnormal spoilage} = \text{Total spoilage} - \text{Normal spoilage}$$
$$= 1{,}000 \text{ units} - 700 \text{ units}$$
$$= 300 \text{ units}$$

Step 2: Compute the Output in Terms of Equivalent Units. Managers compute the equivalent units for spoilage the same way they compute equivalent units for good units. All spoiled units are included in the computation of output units. Because Anzio's inspection point is at the completion of production, the same amount of work will have been done on each spoiled and each completed good unit.

Step 3: Summarize the Total Costs to Account For. The total costs to account for are all the costs debited to Work in Process. The details for this step are similar to Step 3 in Chapter 17.

Step 4: Compute the Cost per Equivalent Unit. This step is similar to Step 4 in Chapter 17.

Step 5: Assign Costs to the Units Completed, Spoiled Units, and Units in Ending Work-in-Process Inventory. This step now includes computing of the cost of spoiled units as well as the cost of good units.

We illustrate these five steps of process costing for the weighted-average and FIFO methods next. *The standard-costing method is illustrated in the appendix to this chapter.*

Weighted-Average Method and Spoilage

Exhibit 18-2, Panel A, presents Steps 1 and 2 to calculate the equivalent units of work done to date and includes calculations of equivalent units of normal and abnormal spoilage. Exhibit 18-2, Panel B, presents Steps 3, 4, and 5 (together called the production-cost worksheet).

In Step 3, managers summarize the total costs to account for. In Step 4, they calculate the cost per equivalent unit using the weighted-average method. Note how, for each cost category, the costs of beginning work in process and the costs of work done in the current period are totaled and divided by equivalent units of all work done to date to calculate the weighted-average cost per equivalent unit. In the final step, managers assign the total costs to completed units, normal and abnormal spoiled units, and ending inventory by multiplying the equivalent units calculated in Step 2 by the cost per equivalent unit calculated in Step 4. Also note that the $13,825 costs of normal spoilage are added to the costs of the good units completed and transferred out.

$$\text{Cost per good unit completed and transferred out of the process} = \frac{\text{Total costs transferred out (including normal spoilage)}}{\text{Number of good units produced}}$$

$$= \$152{,}075 \div 7{,}000 \text{ good units} = \$21.725 \text{ per good unit}$$

This amount is not equal to $19.75 per good unit, the sum of the $8.85 cost per equivalent unit of direct materials plus the $10.90 cost per equivalent unit of conversion costs. That's because the cost per good unit equals the sum of the direct materials and conversion costs per equivalent unit, which is $19.75, plus a share of normal spoilage, $1.975 ($13,825 ÷ 7,000 good units), for a total of $21.725 per good unit. The $5,925 costs of abnormal spoilage are charged to the Loss from Abnormal Spoilage account and do not appear in the costs of good units.[3]

[3] The actual costs of spoilage (and rework) are often greater than the costs recorded in the accounting system because the opportunity costs of disruption of the production line, storage, and lost contribution margins are not recorded in accounting systems. Chapter 19 discusses these opportunity costs from the perspective of cost management.

Exhibit 18-2 Weighted-Average Method of Process Costing with Spoilage for the Forming Department for July 2014

PANEL A: Summarize the Flow of Physical Units and Compute Output in Equivalent Units

Home Insert Page Layout Formulas Data Review View

	A	B	C	D	E
1					
2			(Step 1)	(Step 2)	
				Equivalent Units	
3		**Flow of Production**	**Physical Units**	**Direct Materials**	**Conversion Costs**
4		Work in process, beginning (given, p. 710)	1,500		
5		Started during current period (given, p. 710)	8,500		
6		To account for	10,000		
7		Good units completed and transferred out during current period	7,000	7,000	7,000
8		Normal spoilage[a]	700		
9		(700 × 100%; 700 × 100%)		700	700
10		Abnormal spoilage[b]	300		
11		(300 × 100%; 300 × 100%)		300	300
12		Work in process, ending[c] (given, p. 710)	2,000		
13		(2,000 × 100%; 2,000 × 50%)		2,000	1,000
14		Accounted for	10,000		
15		Equivalent units of work done to date		10,000	9,000
16					
17	[a]Normal spoilage is 10% of good units transferred out: 10% × 7,000 = 700 units. Degree of completion of normal spoilage				
18	in this department: direct materials, 100%; conversion costs, 100%.				
19	[b]Abnormal spoilage = Total spoilage − Normal spoilage = 1,000 − 700 = 300 units. Degree of completion of abnormal spoilage				
20	in this department: direct materials, 100%; conversion costs, 100%.				
21	[c]Degree of completion in this department: direct materials, 100%; conversion costs, 50%.				

PANEL B: Summarize the Total Costs to Account For, Compute the Cost per Equivalent Unit, and Assign Costs to the Units Completed, Spoiled Units, and Units in Ending Work-in-Process Inventory

23			**Total Production Costs**	**Direct Materials**	**Conversion Costs**
24	(Step 3)	Work in process, beginning (given, p. 710)	$ 21,000	$12,000	$ 9,000
25		Costs added in current period (given, p. 710)	165,600	76,500	89,100
26		Total costs to account for	$186,600	$88,500	$98,100
27	(Step 4)	Costs incurred to date		$88,500	$98,100
28		Divide by equivalent units of work done to date (Panel A)		÷10,000	÷ 9,000
29		Cost per equivalent unit		$ 8.85	$ 10.90
30	(Step 5)	Assignment of costs:			
31		Good units completed and transferred out (7,000 units)			
32		Costs before adding normal spoilage	$138,250	(7,000[d] × $8.85) +	(7,000[d] × $10.90)
33		Normal spoilage (700 units)	13,825	(700[d] × $8.85) +	(700[d] × $10.90)
34	(A)	Total costs of good units completed and transferred out	152,075		
35	(B)	Abnormal spoilage (300 units)	5,925	(300[d] × $8.85) +	(300[d] × $10.90)
36	(C)	Work in process, ending (2,000 units)	28,600	(2,000[d] × $8.85) +	(1,000[d] × $10.90)
37	(A)+(B)+(C)	Total costs accounted for	$186,600	$88,500 +	$98,100
38					
39	[d]Equivalent units of direct materials and conversion costs calculated in Step 2 in Panel A.				

Exhibit 18-3 First-In, First-Out (FIFO) Method of Process Costing with Spoilage for the Forming Department for July 2014

PANEL A: Summarize the Flow of Physical Units and Compute Output in Equivalent Units

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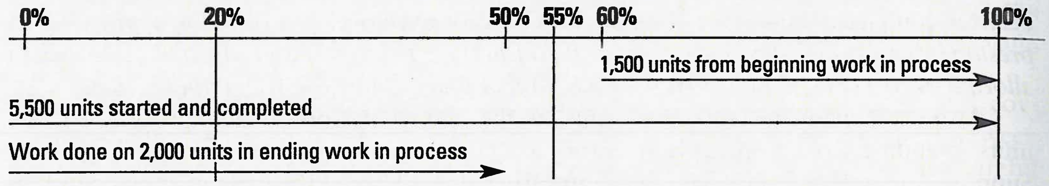
	A	B	C	D	E
1			(Step 1)	(Step 2)	
2				Equivalent Units	
3		Flow of Production	Physical Units	Direct Materials	Conversion Costs
4		Work in process, beginning (given, p. 710)	1,500		
5		Started during current period (given, p. 710)	8,500		
6		To account for	10,000		
7		Good units completed and transferred out during current period:			
8		From beginning work in process[a]	1,500		
9		[1,500 × (100% − 100%); 1,500 × (100% − 60%)]		0	600
10		Started and completed	5,500[b]		
11		(5,500 × 100%; 5,500 × 100%)		5,500	5,500
12		Normal spoilage[c]	700		
13		(700 × 100%; 700 × 100%)		700	700
14		Abnormal spoilage[d]	300		
15		(300 × 100%; 300 × 100%)		300	300
16		Work in process, ending[e] (given, p. 710)	2,000		
17		(2,000 × 100%; 2,000 × 50%)		2,000	1,000
18		Accounted for	10,000		
19		Equivalent units of work done in current period		8,500	8,100
20					
21	[a]Degree of completion in this department: direct materials, 100%; conversion costs, 60%.				
22	[b]7,000 physical units completed and transferred out minus 1,500 physical units completed and transferred out from beginning work-in-process inventory.				
23	[c]Normal spoilage is 10% of good units transferred out: 10% × 7,000 = 700 units. Degree of completion of normal spoilage in this department: direct materials, 100%; conversion costs, 100%.				
24	[d]Abnormal spoilage = Actual spoilage − Normal spoilage = 1,000 − 700 = 300 units. Degree of completion of abnormal spoilage in this department: direct materials, 100%; conversion costs, 100%.				
25	[e]Degree of completion in this department: direct materials, 100%; conversion costs, 50%.				

PANEL B: Summarize the Total Costs to Account For, Compute the Cost per Equivalent Unit, and Assign Costs to the Units Completed, Spoiled Units, and Units in Ending Work-in-Process Inventory

			Total Production Costs	Direct Materials		Conversion Costs
26						
27	(Step 3)	Work in process, beginning (given, p. 710)	$ 21,000	$12,000		$ 9,000
28		Costs added in current period (given, p. 710)	165,600	76,500		89,100
29		Total costs to account for	$186,600	$88,500		$98,100
30	(Step 4)	Costs added in current period		$76,500		$89,100
31		Divide by equivalent units of work done in current period (Panel A)		÷ 8,500		÷ 8,100
32		Cost per equivalent unit		$ 9.00		$ 11.00
33	(Step 5)	Assignment of costs:				
34		Good units completed and transferred out (7,000 units)				
35		Work in process, beginning (1,500 units)	$ 21,000	$12,000		$9,000
36		Costs added to beginning work in process in current period	6,600	(0[f] × $9)	+	(600[f] × $11)
37		Total from beginning inventory before normal spoilage	27,600			
38		Started and completed before normal spoilage (5,500 units)	110,000	(5,500[f] × $9)	+	(5,500[f] × $11)
39		Normal spoilage (700 units)	14,000	(700[f] × $9)	+	(700[f] × $11)
40	(A)	Total costs of good units completed and transferred out	151,600			
41	(B)	Abnormal spoilage (300 units)	6,000	(300[f] × $9)	+	(300[f] × $11)
42	(C)	Work in process, ending (2,000 units)	29,000	(2,000[f] × $9)	+	(1,000[f] × $11)
43	(A)+(B)+(C)	Total costs accounted for	$186,600	$88,500	+	$98,100
44						
45	[f]Equivalent units of direct materials and conversion costs calculated in Step 2 in Panel A.					

The following diagram shows the flow of physical units for July and illustrates the normal spoilage numbers in the table. Note that 7,000 good units are completed and transferred out—1,500 from beginning work in process and 5,500 started and completed during the period—while 2,000 units are in ending work in process.



To see the number of units passing each inspection point, consider in the diagram the vertical lines at the 20%, 55%, and 100% inspection points. Note that the vertical line at 20% crosses two horizontal lines—5,500 good units started and completed and 2,000 units in ending work in process—for a total of 7,500 good units. (The 20% vertical line does not cross the line representing work done on the 1,500 good units completed from beginning work in process because these units are already 60% complete at the start of the period and, hence, are not inspected this period.) Normal spoilage equals 10% of 7,500 = 750 units. On the other hand, the vertical line at the 55% point crosses just the second horizontal line, indicating that only 5,500 good units pass this point. Normal spoilage in this case is 10% of 5,500 = 550 units. At the 100% point, the normal spoilage is 10% of 7,000 (1,500 + 5,500) good units = 700 units.

Exhibit 18-4 shows how equivalent units are computed under the weighted-average method if units are inspected at the 20% completion stage. The calculations depend on the direct materials and conversion costs incurred to get the units to this inspection point. The spoiled units have 100% of their direct materials costs and 20% of their conversion costs. Because the ending work-in-process inventory has passed the inspection point, these units are assigned the normal spoilage costs, just like the units that have been completed and transferred out. For example, the conversion costs of units completed and transferred out include the conversion costs for 7,000 good units produced plus

Exhibit 18-4

Computing Equivalent Units with Spoilage Using the Weighted-Average Method of Process Costing with Inspection at 20% of Completion for the Forming Department for July 2014

	A	B	C	D
1		(Step 1)	(Step 2)	
2			Equivalent Units	
3	Flow of Production	Physical Units	Direct Materials	Conversion Costs
4	Work in process, beginning[a]	1,500		
5	Started during current period	8,500		
6	To account for	10,000		
7	Good units completed and transferred out:	7,000	7,000	7,000
8	Normal spoilage	750		
9	(750 × 100%; 750 × 20%)		750	150
10	Abnormal spoilage	250		
11	(250 × 100%; 250 × 20%)		250	50
12	Work in process, ending[b]	2,000		
13	(2,000 × 100%; 2,000 × 50%)		2,000	1,000
14	Accounted for	10,000		
15	Equivalent units of work done to date		10,000	8,200
16				
17	[a]Degree of completion: direct materials, 100%; conversion costs, 60%.			
18	[b]Degree of completion: direct materials, 100%; conversion costs, 50%.			

$20\% \times (10\% \times 5{,}500) = 110$ equivalent units of normal spoilage. *We multiply by 20% to obtain the equivalent units of normal spoilage because the conversion costs are only 20% complete at the inspection point.* The conversion costs of the ending work-in-process inventory include the conversion costs of 50% of 2,000 = 1,000 equivalent good units plus $20\% \times (10\% \times 2{,}000) = 40$ equivalent units of normal spoilage. Thus, the equivalent units of normal spoilage accounted for are 110 equivalent units related to the units completed and transferred out plus 40 equivalent units related to the units in ending work in process, for a total of 150 equivalent units, as Exhibit 18-4 shows.

Early inspections can help prevent any further costs being wasted on units that are already spoiled. For example, suppose the units can be inspected when they are 70% complete rather than 100% complete. If the spoilage occurs prior to the 70% point, a company can avoid incurring the final 30% of conversion costs on the spoiled units. While not applicable in the Anzio example, more generally a company can also save on the packaging or other direct materials that are added after the 70% stage. The downside to conducting inspections at too early a stage is that units spoiled at later stages of the process may go undetected. It is for these reasons that firms often conduct multiple inspections and also empower workers to identify and resolve defects on a timely basis.

Decision Point

How does inspection at various stages of completion affect the amount of normal and abnormal spoilage?

Job Costing and Spoilage

Learning Objective 5

Account for spoilage in job costing

...normal spoilage assigned directly or indirectly to job; abnormal spoilage written off as a loss of the period

The concepts of normal and abnormal spoilage also apply to job-costing systems. Companies attempt to identify abnormal spoilage separately so they can work to eliminate it altogether. The costs of abnormal spoilage are not considered to be inventoriable costs and are written off as costs of the accounting period in which the abnormal spoilage is detected. Normal spoilage costs in job-costing systems—as in process-costing systems—are inventoriable costs, although increasingly companies are tolerating only small amounts of spoilage as normal. When assigning costs, job-costing systems generally distinguish *normal spoilage attributable to a specific job from normal spoilage common to all jobs.*

We describe accounting for spoilage in job costing using the following example.

> Example 3: In the Hull Machine Shop, 5 aircraft parts out of a job lot of 50 aircraft parts are spoiled. The costs assigned prior to the inspection point are \$2,000 per part. When the spoilage is detected, the spoiled goods are inventoried at \$600 per part, the net disposal value.

Our presentation here and in subsequent sections focuses on how the \$2,000 cost per part is accounted for.

Normal Spoilage Attributable to a Specific Job

When normal spoilage occurs because of the specifications of a particular job, that job bears the cost of the spoilage minus the disposal value of the spoilage. The journal entry to recognize the disposal value is as follows (items in parentheses indicate subsidiary ledger postings):

Materials Control (spoiled goods at current net disposal value): 5 units × \$600 per unit	3,000	
Work-in-Process Control (specific job): 5 units × \$600 per unit		3,000

Note that the Work-in-Process Control (for the specific job) has already been debited (charged) \$10,000 for the spoiled parts (5 spoiled parts × \$2,000 per part). So, the net cost of the normal spoilage is \$7,000 (\$10,000 − \$3,000), which is an additional cost of the 45 (50 − 5) good units produced. Therefore, total cost of the 45 good units is \$97,000: \$90,000 (45 units × \$2,000 per unit) incurred to produce the good units plus the \$7,000 net cost of normal spoilage. Cost per good unit is \$2,155.56 (\$97,000 ÷ 45 good units).

Normal Spoilage Common to All Jobs

In some cases, spoilage may be considered a normal characteristic of the production process. The spoilage inherent in production will, of course, occur when a specific job is being worked on. However, the spoilage is not attributable to, and hence is not charged directly to, the specific job. Instead, the spoilage is allocated indirectly to the job as manufacturing overhead because the spoilage is common to all jobs. The journal entry is as follows:

Materials Control (spoiled goods at current disposal value): 5 units × $600 per unit	3,000	
Manufacturing Overhead Control (normal spoilage): ($10,000 − $3,000)	7,000	
Work-in-Process Control (specific job): 5 units × $2,000 per unit		10,000

When normal spoilage is common to all jobs, the budgeted manufacturing overhead rate includes a provision for the normal spoilage cost. The normal spoilage cost is spread, through overhead allocation, over all jobs rather than being allocated to a specific job.[5] For example, if Hull produced 140 good units from all jobs in a given month, the $7,000 of normal spoilage overhead costs would be allocated at the rate of $50 per good unit ($7,000 ÷ 140 good units). Normal spoilage overhead costs allocated to the 45 good units in the job would be $2,250 ($50 × 45 good units). The total cost of the 45 good units is $92,250: $90,000 (45 units × $2,000 per unit) incurred to produce the good units plus $2,250 of normal spoilage overhead costs. The cost per good unit is $2,050 ($92,250 ÷ 45 good units).

Abnormal Spoilage

If the spoilage is abnormal, the net loss is charged to the Loss from Abnormal Spoilage account. Unlike normal spoilage costs, abnormal spoilage costs are not included as a part of the cost of good units produced. The total cost of the 45 good units is $90,000 (45 units × $2,000 per unit). The cost per good unit is $2,000 ($90,000 ÷ 45 good units).

Materials Control (spoiled goods at current disposal value): 5 units × $600 per unit	3,000	
Loss from Abnormal Spoilage ($10,000 − $3,000)	7,000	
Work-in-Process Control (specific job): 5 units × $2,000 per unit		10,000

Even though, for external reporting purposes, abnormal spoilage costs are written off in the accounting period and are not linked to specific jobs or units, companies often identify the particular reasons for the abnormal spoilage and, when appropriate, link it with specific jobs or units for cost management purposes.

The accounting treatment described above highlights the potential impact of misclassifying the nature of the spoilage. Normal spoilage costs are inventoriable and are added to the cost of good units produced, while abnormal spoilage costs are expensed in the accounting period in which they occur. So, when inventories are present, classifying spoilage as normal rather than abnormal results in an increase in current operating income. In the above example, if the 45 parts remain unsold at the end of the period, such misclassification would boost income for that period by $7,000. As with our discussion of completion percentages, it is important for managers to verify that spoilage rates and spoilage categories are not manipulated by department supervisors for short-term benefits.

Decision Point

How do job-costing systems account for spoilage?

Learning Objective 6

Account for rework in job costing

...normal rework assigned directly or indirectly to job; abnormal rework written off as a loss of the period

Job Costing and Rework

Rework refers to units of production that are inspected, determined to be unacceptable, repaired, and sold as acceptable finished goods. We again distinguish (1) normal rework attributable to a specific job, (2) normal rework common to all jobs, and (3) abnormal rework.

[5] Note that costs already assigned to products are charged back to Manufacturing Overhead Control, which generally accumulates only costs incurred, not both costs incurred and costs already assigned.

Consider the Hull Machine Shop data in Example 3 on page 717. Assume the five spoiled parts are reworked. The journal entry for the $10,000 of total costs (the details of these costs are assumed) assigned to the five spoiled units before considering rework costs is as follows:

Work-in-Process Control (specific job)	10,000	
Materials Control		4,000
Wages Payable Control		4,000
Manufacturing Overhead Allocated		2,000

Assume the rework costs equal $3,800 ($800 in direct materials, $2,000 in direct manufacturing labor, and $1,000 in manufacturing overhead).

Normal Rework Attributable to a Specific Job

If the rework is normal but occurs because of the requirements of a specific job, the rework costs are charged to that job. The journal entry is as follows:

Work-in-Process Control (specific job)	3,800	
Materials Control		800
Wages Payable Control		2,000
Manufacturing Overhead Allocated		1,000

Normal Rework Common to All Jobs

The costs of the rework when it is normal and not attributable to a specific job are charged to manufacturing overhead and are spread, through overhead allocation, over all jobs.

Manufacturing Overhead Control (rework costs)	3,800	
Materials Control		800
Wages Payable Control		2,000
Manufacturing Overhead Allocated		1,000

Abnormal Rework

If the rework is abnormal, it is charged to a loss account.

Loss from Abnormal Rework	3,800	
Materials Control		800
Wages Payable Control		2,000
Manufacturing Overhead Allocated		1,000

Accounting for rework in a process-costing system also requires abnormal rework to be distinguished from normal rework. Process costing accounts for abnormal rework in the same way as job costing. Accounting for normal rework follows the accounting described for normal rework common to all jobs (units) because masses of identical or similar units are being manufactured.

Costing rework focuses managers' attention on the resources wasted on activities that would not have to be undertaken if the product had been made correctly. The cost of rework prompts managers to seek ways to reduce rework, for example, by designing new products or processes, training workers, or investing in new machines. To eliminate rework and to simplify the accounting, some companies set a standard of zero rework. All rework is then treated as abnormal and is written off as a cost of the current period.

Decision Point

How do job-costing systems account for rework?

Accounting for Scrap

Learning Objective 7

Account for scrap

...reduces cost of job either at time of sale or at time of production

Scrap is residual material that results from manufacturing a product; it has low total sales value compared with the total sales value of the product. No distinction is made between normal and abnormal scrap because no cost is assigned to scrap. The only distinction made is between scrap attributable to a specific job and scrap common to all jobs.

There are two aspects of accounting for scrap:

1. Planning and control, including physical tracking
2. Inventory costing, including when and how scrap affects operating income

Initial entries to scrap records are commonly expressed in physical terms. In various industries, companies quantify items such as stamped-out metal sheets or edges of molded plastic parts by weighing, counting, or some other measure. Scrap records not only help measure efficiency, but also help keep track of scrap, and so reduce the chances of theft. Companies use scrap records to prepare periodic summaries of the amounts of actual scrap compared with budgeted or standard amounts. Scrap is either sold or disposed of quickly or it is stored for later sale, disposal, or reuse.

To carefully track their scrap, many companies maintain a distinct account for scrap costs somewhere in their accounting system. The issues here are similar to the issues in Chapter 16 regarding the accounting for byproducts:

- When should the value of scrap be recognized in the accounting records—at the time scrap is produced or at the time scrap is sold?
- How should the revenues from scrap be accounted for?

To illustrate, we extend our Hull example. Assume the manufacture of aircraft parts generates scrap and that the scrap from a job has a net sales value of $900.

Recognizing Scrap at the Time of Its Sale

When the dollar amount of the scrap is immaterial, it is simplest to record the physical quantity of scrap returned to the storeroom and to regard the revenues from the sale of scrap as a separate line item in the income statement. The only journal entry is as follows:

Sale of scrap:	Cash or Accounts Receivable	900	
	Scrap Revenues		900

When the dollar amount of the scrap is material and it is sold quickly after it is produced, the accounting depends on whether the scrap is attributable to a specific job or is common to all jobs.

Scrap Attributable to a Specific Job

Job-costing systems sometimes trace scrap revenues to the jobs that yielded the scrap. This method is used only when the tracing can be done in an economically feasible way. For example, the Hull Machine Shop and its customers, such as the U.S. Department of Defense, may reach an agreement that provides for charging specific jobs with all rework or spoilage costs and then crediting these jobs with all scrap revenues that arise from the jobs. The journal entry is as follows:

Scrap returned to storeroom:	No journal entry.		
	[Notation of quantity received and related job entered in the inventory record]		
Sale of scrap:	Cash or Accounts Receivable	900	
	Work-in-Process Control		900
	Posting made to specific job cost record.		

Unlike spoilage and rework, there is no cost assigned to the scrap, so no distinction is made between normal and abnormal scrap. All scrap revenues, whatever the amount, are credited to the specific job. Scrap revenues reduce the costs of the job.

Scrap Common to All Jobs

The journal entry in this case is as follows:

Scrap returned to storeroom:	No journal entry. [Notation of quantity received and related job entered in the inventory record]		
Sale of scrap:	Cash or Accounts Receivable	900	
	Manufacturing Overhead Control		900
	Posting made to subsidiary ledger—"Sales of Scrap" column on department cost record.		

Because the scrap is not linked with any particular job or product, all products bear its costs without any credit for scrap revenues except in an indirect manner: the expected scrap revenues are considered when setting the budgeted manufacturing overhead rate. Thus, the budgeted overhead rate is lower than it would be otherwise. This method of accounting for scrap is also used in process costing when the dollar amount of scrap is immaterial because the scrap in process costing is common to the manufacture of all the identical or similar units produced (and cannot be identified with specific units).

Recognizing Scrap at the Time of Its Production

Our preceding illustrations assume that scrap returned to the storeroom is sold quickly, so it is not assigned an inventory cost figure. Sometimes, as in the case with edges of molded plastic parts, the value of the scrap is not immaterial, and the time between storing it and selling or reusing it can be long and unpredictable. In these situations, the company assigns an inventory cost to scrap at a conservative estimate of its net realizable value so that production costs and related scrap revenues are recognized in the same accounting period. Some companies tend to delay selling scrap until its market price is attractive. Volatile price fluctuations are typical for scrap metal. In these cases, it's not easy to determine a "reasonable inventory value."

Scrap Attributable to a Specific Job

The journal entry in the Hull example is as follows:

Scrap returned to storeroom:	Materials Control	900	
	Work-in-Process Control		900

Scrap Common to All Jobs

The journal entry in this case is as follows:

Scrap returned to storeroom:	Materials Control	900	
	Manufacturing Overhead Control		900

Notice that the Materials Control account is debited in place of Cash or Accounts Receivable. When the scrap is sold, the journal entry is as follows:

Sale of scrap:	Cash or Accounts Receivable	900	
	Materials Control		900

Scrap is sometimes reused as direct material rather than sold as scrap. In this case, Materials Control is debited at its estimated net realizable value and then credited when the scrap is reused. For example, the entries when the scrap is common to all jobs are as follows:

Scrap returned to storeroom:	Materials Control	900	
	Manufacturing Overhead Control		900
Reuse of scrap:	Work-in-Process Control	900	
	Materials Control		900

Concepts in Action

American Apparel Turns Scrap into a Product for Sale

American Apparel is unique among clothing manufacturers in many ways. Known for its cutting-edge (and controversial!) advertising and product branding, the company employs a vertically integrated business model—American Apparel is its own manufacturer, wholesaler, and retailer, which minimizes the use of subcontractors. Knitting, dyeing, sewing, photography, marketing, distribution, and design all happen in the company's facilities in Los Angeles. American Apparel is also strongly committed to sustainability, with a goal of creating as little waste as it can.

One key way American Apparel reduces waste is by minimizing scrap, the residual material that results from manufacturing the company's clothing. As much as possible, the company minimizes the gaps between pattern pieces of cloth when cutting garments. Clothing styles are ranked by efficiency. For inefficient styles, American Apparel tries to find complementary styles that, when cut together, drastically reduce the amount of scrap generated. When the company has exhausted efficiency from the use of existing patterns, it turns much of the remaining material into yarn for new garments and, when possible, into smaller accessories. From these pattern gaps, American Apparel created its "Creative Reuse" line featuring 45 different items including scrunchies, hair bows, undergarments, and other accessories, with new products added regularly.

At this point, any scrap left over is... sold to American Apparel customers! In 2010, the company introduced its Bag-O-Scraps, a bag of scraps that sells for $8, along with a page of project suggestions. Overall, along with the traditional recycling of cutting and fiber scraps that are not reusable, American Apparel keeps more than 30,000 pounds of cotton cuttings per week out of landfills, or more than 1 million pounds annually.

Sources: Tice, Carol. 2010. American Apparel tries spinning straw into gold, sells scraps as econ-clothes. *CBS News*, May 11; American Apparel Inc., "Vertical Integration: Sustainability," http://www.americanapparel.net/verticalintegration/sustainability.html, accessed July 2013; "American Apparel takes environmental stand by recycling over 1 million pounds of cotton cuttings per year," American Apparel Inc. press release (Los Angeles, CA, August 13, 2002).

Accounting for scrap under process costing is similar to accounting under job costing when scrap is common to all jobs. That's because the scrap in process costing is common to the manufacture of masses of identical or similar units.

Decision Point
How is scrap accounted for?

Managers focus their attention on ways to reduce scrap and to use it more profitably, especially when the cost of scrap is high. For example, General Motors has redesigned its plastic injection molding processes to reduce the scrap plastic that must be broken away from its molded products. General Motors also regrinds and reuses the plastic scrap as direct material, saving substantial input costs. Concepts in Action: American Apparel Turns Scrap into a Product for Sale shows how a firm that is deeply committed to principles of environmental sustainability minimizes the waste and scrap from its processes.

Problem for Self-Study

Burlington Textiles has some spoiled goods that had an assigned cost of $40,000 and zero net disposal value.

Prepare a journal entry for each of the following conditions under (a) process costing (department A) and (b) job costing:

Required

1. Abnormal spoilage of $40,000
2. Normal spoilage of $40,000 regarded as common to all operations
3. Normal spoilage of $40,000 regarded as attributable to specifications of a particular job

Solution

(a) Process Costing			(b) Job Costing		
1. Loss from Abnormal Spoilage	40,000		Loss from Abnormal Spoilage	40,000	
Work in Process—Dept. A		40,000	Work-in-Process Control (specific job)		40,000
2. No entry until units are completed and transferred out. Then the normal spoilage costs are transferred as part of the cost of good units.			Manufacturing Overhead Control	40,000	
Work in Process—Dept. B	40,000		Work-in-Process Control (specific job)		40,000
Work in Process—Dept. A		40,000			
3. Not applicable			No entry. Normal spoilage cost remains in Work-in-Process Control (specific job)		

Decision Points

The following question-and-answer format summarizes the chapter's learning objectives. Each decision presents a key question related to a learning objective. The guidelines are the answer to that question.

Decision	Guidelines
1. What are spoilage, rework, and scrap?	Spoilage refers to units of production that do not meet the specifications required by customers for good units and that are discarded or sold at reduced prices. Spoilage is generally divided into normal spoilage, which is inherent to a particular production process, and abnormal spoilage, which arises because of operational inefficiency. Rework refers to unacceptable units that are subsequently repaired and sold as acceptable finished goods. Scrap is residual material that results from manufacturing a product; it has low total sales value compared with the total sales value of the product.
2. What is the distinction between normal and abnormal spoilage?	Normal spoilage is inherent in a particular production process and arises when the process is done in an efficient manner. Abnormal spoilage, on the other hand, is not inherent in a particular production process and would not arise under efficient operating conditions. Abnormal spoilage is usually regarded as avoidable and controllable.
3. How do the weighted-average and FIFO methods of process costing calculate the costs of good units and spoilage?	The weighted-average method combines the costs of beginning inventory with the costs of the current period when determining the costs of good units, which include normal spoilage, and the costs of abnormal spoilage, which are written off as a loss of the accounting period.

Decision	Guidelines
	The FIFO method keeps the costs of beginning inventory separate from the costs of the current period when determining the costs of good units (which include normal spoilage) and the costs of abnormal spoilage, which are written off as a loss of the accounting period.
4. How does inspecting at various stages of completion affect the amount of normal and abnormal spoilage?	The cost of spoiled units is assumed to equal all costs incurred in producing spoiled units up to the point of inspection. Spoilage costs therefore vary based on different inspection points.
5. How do job-costing systems account for spoilage?	Normal spoilage specific to a job is assigned to that job or, when common to all jobs, is allocated as part of manufacturing overhead. The cost of abnormal spoilage is written off as a loss in the accounting period.
6. How do job-costing systems account for rework?	Normal rework specific to a job is assigned to that job or, when common to all jobs, is allocated as part of manufacturing overhead. Cost of abnormal rework is written off as a loss of the accounting period.
7. How is scrap accounted for?	Scrap is recognized in a firm's accounting records either at the time of its sale or at the time of its production. If the scrap is immaterial, it is recognized as revenue when it's sold. If it's not immaterial, the net realizable value of the scrap when it's sold reduces the cost of a specific job or, when common to all jobs, reduces Manufacturing Overhead Control.

Appendix

Standard-Costing Method and Spoilage

The standard-costing method simplifies the computations for normal and abnormal spoilage. To illustrate, we return to the Anzio Company example in the chapter. Suppose Anzio develops the following standard costs per unit for work done in the forming department in July 2014:

Direct materials	$ 8.50
Conversion costs	10.50
Total manufacturing cost	$19.00

Assume the same standard costs per unit also apply to the beginning inventory: 1,500 (1,500 × 100%) equivalent units of direct materials and 900 (1,500 × 60%) equivalent units of conversion costs. Hence, the beginning inventory at standard costs is as follows:

Direct materials, 1,500 units × $8.50 per unit	$12,750
Conversion costs, 900 units × $10.50 per unit	9,450
Total manufacturing costs	$22,200

Exhibit 18-5, Panel A, presents Steps 1 and 2 for calculating physical and equivalent units. These steps are the same as for the FIFO method described in Exhibit 18-3. Exhibit 18-5, Panel B, presents Steps 3, 4, and 5.

The costs to account for in Step 3 are at standard costs and, hence, they differ from the costs to account for under the weighted-average and FIFO methods, which are at actual costs. In Step 4, cost per equivalent unit is simply the standard cost: $8.50 per unit for direct materials and $10.50 per unit for conversion costs. The standard-costing