Industry-specific

QAD SOLUTIONS

Manufacturing Applications

MFG/PRO eB2 User Guide Volume 3
Manufacturing

Product Structures
Routings/Work Centers
Formula/Process
Co-products/By-products
Work Orders
Shop Floor Control
Flow Scheduling
Kanban
Advanced Repetitive
Repetitive
Quality Management
Forecasting/Master Schedule Planning
Material Requirements Planning
Capacity Requirements Planning

QAD

78-0557A
MFG/PRO eB2
September 2002

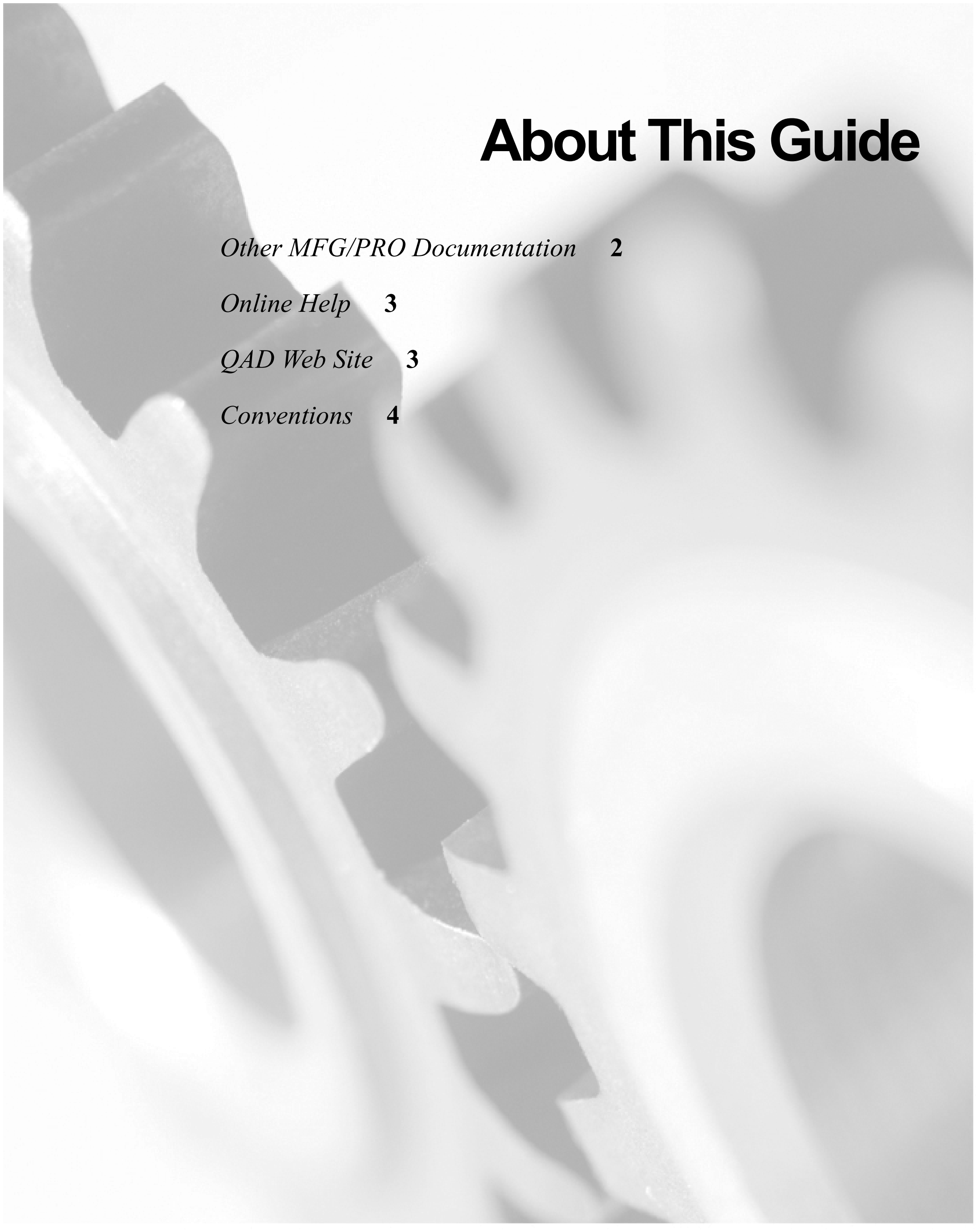
78-0557A

QAD Inc.
6450 Via Real
Carpinteria, California 93013
Phone (805) 684-6614
Fax (805) 684-1890
http://www.qad.com

Contents

QAD

About This Guide



This guide covers features of the MFG/PRO manufacturing modules.

Other MFG/PRO Documentation

- For an overview of new features and software updates, see the *Release Bulletin*.
- For software installation instructions, refer to the appropriate installation guide for your system.
- For conversion information, refer to the *Conversion Guide*.
- For instructions on navigating and using the QAD Desktop interface, see *User Guide: QAD Desktop.*
- For instructions on navigating the MFG/PRO Windows and character environments, refer to *User Guide Volume 1: Introduction*.
- For information on using MFG/PRO, refer to the *User Guides*.
- For technical details, refer to *Entity Diagrams* and *Database Definitions.*
- For information on using features that let MFG/PRO work with external applications, see the *External Interface Guides*. Each book in this set describes a separate interface such as the Warehousing application program interface (API) and Q/LinQ, the tool set for building and using data exchange tools.
- To view documents online in PDF format, see the *Documents on CD* and *Supplemental Documents on CD*. The CD-ROM media includes complete instructions for loading the documents on a Windows network server and making them accessible to client computers.

  Note MFG/PRO installation guides are not included on a CD. Printed copies are packaged with your software. Electronic copies of the latest versions are available on the QAD Web site.

Online Help

MFG/PRO has an extensive online help system. Help is available for most fields found on a screen. Procedure help is available for most programs that update the database. Most inquiries, reports, and browses do not have procedure help.

For information on using the help system in the different MFG/PRO environments, refer to *User Guide Volume 1: Introduction* and *User Guide: QAD Desktop*.

QAD Web Site

QAD's Web site provides a wide variety of information about the company and its products. You can access the Web site at:

http://www.qad.com

For MFG/PRO users with a QAD Web account, product documentation is available for viewing or downloading at:

http://support.qad.com/documentation/

You can register for a QAD Web account by accessing the Web site and clicking the Accounts link at the top of the screen. Your customer ID number is required. Access to certain areas is dependent on the type of agreement you have with QAD.

Most user documentation is available in two formats:

- Portable document format (PDF). PDF files can be downloaded from the QAD Web site to your computer. You can view them with the free Adobe Acrobat Reader. A link for downloading this program is also available on the QAD Web site.
- HTML. You can view user documentation through your Web browser. The documents include search tools for easily locating topics of interest.

Features also include an online solution database to help MFG/PRO users answer questions about setting up and using the product. Additionally, the QAD Web site has information about training classes and other services that can help you learn about MFG/PRO.

Conventions

MFG/PRO is available in several interfaces: Desktop (Web browser), Windows, and character. To standardize presentation, the documentation uses the following conventions:

- MFG/PRO screen captures show the Desktop interface.
- References to keyboard commands are generic. For example, choose Go refers to:
    - The forward arrow in Desktop
    - F2 in the Windows interface
    - F1 in the character interface

  In the character and Windows interfaces, the Progress status line at the bottom of a program window lists the main UI-specific keyboard commands used in that program. In Desktop, alternate commands are listed in the right-click context menu.

  For complete keyboard command summaries for each MFG/PRO interface, refer to the appropriate chapters of *User Guide Volume 1: Introduction* and *User Guide: QAD Desktop*.

This document uses the text or typographic conventions listed in the following table.

If you see:	It means:
`monospaced text`	A command or file name.
`italicized monospaced text`	A variable name for a value you enter as part of an operating system command; for example, *`YourCDROMDir`*.
`indented` `    command line`	A long command that you enter as one line, although it appears in the text as two lines.
Note	Alerts the reader to exceptions or special conditions.
Important	Alerts the reader to critical information.
Warning	Used in situations where you can overwrite or corrupt data, unless you follow the instructions.

Chapter 1

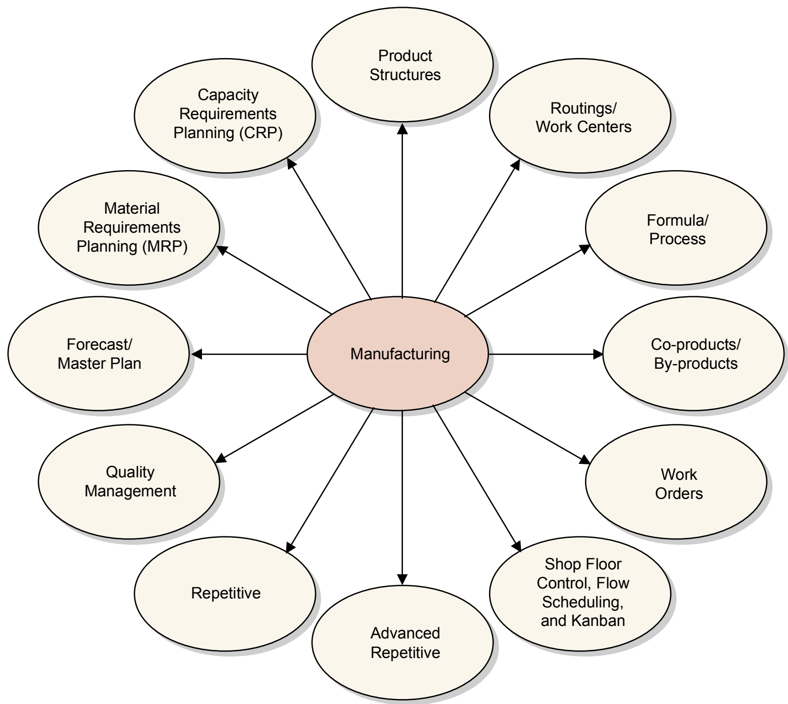
Introduction to Manufacturing

Manufacturing modules handle comprehensive functions of internal supply and demand.

Manufacturing modules handle internal supply and demand—material is moved out of inventory into production, or finished goods or components are moved from production into inventory. These modules are used by make-to-stock, assemble-to-order, process, batch process, flow, kanban, and repetitive operations.

Figure 1.1 illustrates the manufacturing modules.

Fig. 1.1
Manufacturing



Product Structures

See "Product Structures" on page 11.

Once items such as products, components, and materials are identified in your system, the Product Structures module adds and maintains the bills of material for each product, assembly, subassembly, intermediate, and fabricated part.

Routings/Work Centers

The Routings/Work Centers module defines the areas where manufacturing activities are performed (departments, work centers) and the manufacturing process itself (operations and routings).

See "Routings/ Work Centers" on page 25.

Formula/Process

The Formula/Process module defines and maintains the relationships between products and the ingredients that go into them, as well as the process by which they are created.

See "Formula/ Process" on page 45.

Other Formula/Process functionality is discussed in conjunction with co-products and by-products. Co-products/By-products is used to manage processes that create more than one product.

Co-products/By-products

Co-product/By-product features manage processes that create more than one product. The module includes tools for setting up items, structures, and routings and supports MRP, work orders, shop floor control, and costing.

See "Co-products/ By-products" on page 53.

Work Orders

The Work Orders module is used in discrete production environments to control manufacturing orders. Create work orders manually or generate them from MRP planned orders. Generate work orders for configured products directly from a sales order. The Work Orders module supports co-product and by-product manufacturing.

See "Work Orders" on page 99.

Shop Floor Control

The Shop Floor Control module tracks activities and records operation status and labor times for manufacturing jobs released through the Work Orders module.

See "Shop Floor Control" on page 137.

Flow Scheduling

See “Flow Scheduling” on page 151.

The Flow Scheduling module lets you create and manage the life cycle of time-phased production schedules for use in a flow-driven, lean manufacturing environment. Optionally, you can link flow scheduled orders with existing demand orders and work orders.

Kanban

See “Kanban” on page 213.

The Kanban module lets you identify items that are kanban controlled, maintain kanban-related data for these items, print kanban cards on demand, and use kanban transactions to track and manage the movement of kanban-controlled items in and out of the production process.

Advanced Repetitive

See “Advanced Repetitive” on page 261.

The Advanced Repetitive module supports high-volume manufacturing where lead times are more than a day and up to a month or more; where work is continuous and lines are dedicated to one item for days, weeks, or months; and where work in process (WIP) costs are either variable or high enough to track closely.

Repetitive

See “Repetitive” on page 311.

The Repetitive module supports high-volume manufacturing where lead times are one day or less, where WIP is complete at the end of each day, where WIP costs are tracked and batches do not overlap, or where WIP costs are insignificant or fairly constant.

Quality Management

See “Quality Management” on page 321.

The Quality Management module defines standard testing procedures, applies tests to work orders and repetitive schedules, records quality test results, and manages inventory sampling and quality work orders.

Forecasting/Master Schedule Planning

The Forecast/Master Schedule Planning module lets you create and maintain shipment forecasts and master production schedules. Using this module, you can analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP), creating a closed-loop system.

See "Forecasting/ Master Schedule Planning" on page 335.

Material Requirements Planning (MRP)

MRP is a key manufacturing planning function. It assesses supply and demand and generates planned order and action messages. For organizations with multiple sites, MRP can be used in conjunction with distributed requirements planning (DRP), which balances supply and demand among sites.

See "Material Requirements Planning" on page 371.

Capacity Requirements Planning (CRP)

The Capacity Requirements Planning (CRP) module uses MRP planned orders, other work orders, and repetitive schedules to determine work-center load and generate a capacity requirements plan for a department, work center, or machine.

See "Capacity Requirements Planning" on page 395.

Chapter 2

Product Structures

This chapter discusses how product structures—also known as bills of material—are defined and used during MRP and other planning activities to determine what materials are required for manufacturing.

Introduction

Product structures and formulas are much like the list of ingredients for a recipe—they indicate the components and quantities needed to make a product. Unlike a recipe, in many cases, these documents also list the ingredients for each component. Graphically, if a formula or product structure is considered in its entirety, it looks like a tree, with the parent item at the top (level 0) and all the components branching off down to the raw material level (levels 1, 2, 3, and so on).

See Chapter 4, "Formula/ Process," on page 45.

In MFG/PRO, product structures are recorded as single-level relationships between parent (or higher-level items) and component items. For formulas, these are the relationships between products and ingredients.

Product structures are modular. Separate structures are entered for finished goods and lower-level assemblies or intermediate products. So, a component in a higher-level structure might be a parent in a lower-level structure. Looking in the other direction, a parent in a lower-level structure can be a component in a higher-level structure. The system can display product structures as either indented, multilevel bills of material or as single-level bills.

This chapter uses an example of a manufactured product with both a product structure and a formula: sports sunglasses with specially coated lenses.

Viewed from the top, three components make up the parent product: a frame assembly, a left lens, and a right lens. Each component has its own structure. The frame assembly includes a lens frame, left and right sides, and so on. Table 2.1 illustrates this two-level product structure.

Table 2.1 Product Structure for Sunglasses with Coated Lenses

Frame Assembly	Left Lens	Right Lens
Lens frame	Lens blank	Lens blank
Left temple	Tint	Tint
Left hinge kit	Coating	Coating
Right temple		
Right hinge kit		
Screws (2)		
Adhesive		

If a single company manufactures the whole product, each structure has its own specific manufacturing steps:

- Assemble frames.
- Grind lenses to size, polish, tint, and coat.
- Assemble sunglasses from frames and lenses.

Or the company might buy the frames, only doing lens grinding, coating, and final assembly. Because it might be necessary to ensure a supply of spare screws, the frame can have its own product structure so the product structure reports show which frames require these screws.

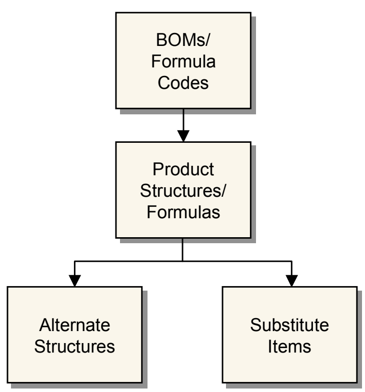
You can enter product structures for purchased products without affecting planning or product costing programs. This way, you can use all the product structure reporting tools for component and parent items, regardless of the source of the items.

The system also uses product structure records to store alternate bills of material, planning bills, and configuration bills. Separate these from standard bills by using a structure code.

See “BOM Codes” on page 14.

Figure 2.1 shows data records associated with product structures and formulas that are discussed in this chapter. Not every system uses all of these.

Fig. 2.1 Product Structure/ Formula Flow



BOM Codes

Sometimes, a single product structure or formula can produce more than one kind of product.

Example A company uses the same formula for a beverage or a cheese, but depending on how it is processed and aged, different products result. In this case, it does not make sense to define the formula with respect to one specific product.

In another case, one product can be produced with several different product structures or formulas.

Example A computer workstation is assembled in different countries around the world. Several different product structures use slightly different components produced by different manufacturers. No matter which product structure is used, the end product is functionally equivalent. Depending on where the product is manufactured, one structure may be more favorable as a result of cost differences due to price and/or tax considerations.

In both cases, enter product structures and formulas by using a product structure/formula—or bill of material (BOM)—code as the parent item instead of an item number. Use two programs to set up BOM codes:

- Product Structure Code Maintenance (13.1)
- Formula Code Maintenance (15.1)

Tip
The system automatically creates BOM codes for parent items that are defined in the item master when adding product structures and formulas.

BOM codes and item numbers are entirely independent. You can use the same product structure or formula for multiple items, and any one of several product structures or formulas to make the same item.

When an item number and its BOM code are the same, they are automatically linked. If an item's BOM code is blank, the item number is used as the BOM code. When they are different, you can change the BOM code in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Alternate Structures/Formulas

An item can use a product structure that is defined for a BOM code different from the item number. After you have defined a BOM code and a product structure or formula, link it to an item based on how it will be used.

- If the structure/formula should be the default for an item, update the BOM code in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). The system uses this BOM code for MRP, work orders, repetitive manufacturing, and costing.
- If the structure/formula should be the default for an item at a particular site, update the BOM code in Item-Site Planning Maintenance (1.4.17). The system uses this BOM code for MRP, work orders, repetitive manufacturing, and costing for an item at a site. This overrides the BOM code set up at the item level.
- If the structure/formula should be available as an alternate for an item at any site, use Alternate Structure Maintenance (13.15) to link the BOM code with an item. You can then change the BOM code on a work order to this alternate structure/formula.
- If the structure/formula should be available as an alternate for an item at a specific site when a specific routing is used, use Alternate Routing Maintenance (14.15.1) to link a BOM code and routing code to an item-site. You can then change the BOM code on a work order to this alternate structure/formula when using the specified routing code.

Phantoms

Sometimes engineering drawings and bills define transient product items that exist independently for a relatively short time and are not stocked. Instead, they are immediately consumed by higher-level products. These are called *phantom structures*.

Example Frames for sunglasses are assembled or purchased, but before final assembly, the company name is printed on the side. An engineering drawing specifies the exact location. The product structure now has one more level—a labeled frame. In practice, when the sunglasses are being manufactured, the labeling and final assembly processes may be so close together that the labeled frames (without lenses) exist only briefly.

A product that starts out as a normal subassembly that is kitted, manufactured, and stocked can later evolve into a phantom. If manufacturing engineering can support changes to the manufacturing flow, you can use phantoms to reduce inventory movement, shorten lead times, and effectively reduce the levels in a bill of material.

Using phantoms may require changes in manufacturing technology, or something as simple as introducing kanban to control the movement of components and phantoms.

Use Item Planning Maintenance (1.4.7) to identify an item as a phantom for all sites. When an item is a phantom at one site but not at another, indicate exceptions in Item-Site Planning Maintenance (1.4.17). Items that are marked as phantoms using either of these two programs are known as *global phantoms*.

If an item is a phantom only when assembled as a component of a specific parent item, use a structure type of X within the product structure or formula. Such a phantom is known as a *local phantom*, since its use as a phantom depends on a particular bill of material.

When Material Requirements Planning (MRP) plans requirements, it always ignores a local phantom and creates planned orders for its components. This process of driving requirements from the components is sometimes referred to as *blowing through* a phantom.

If there is a quantity on hand of a global phantom, MRP uses it to fill requirements before creating additional requirements for the components.

Simulated BOM Inquiries

Quantities-on-hand of local phantoms do not impact the Simulated Picklist Item Check (13.8.17) or the Simulated Batch Ingredient Check (15.7.17). Use-up logic is typically not applied to local phantoms. This is one reason to define them as local, rather than global. Quantities-on-hand of global phantoms still decrement quantity requirements when you select use-up logic by setting the Use up PH field to Yes on these two inquiries.

Setting Up a Product Structure

Define product structures in Product Structure Maintenance (13.5).

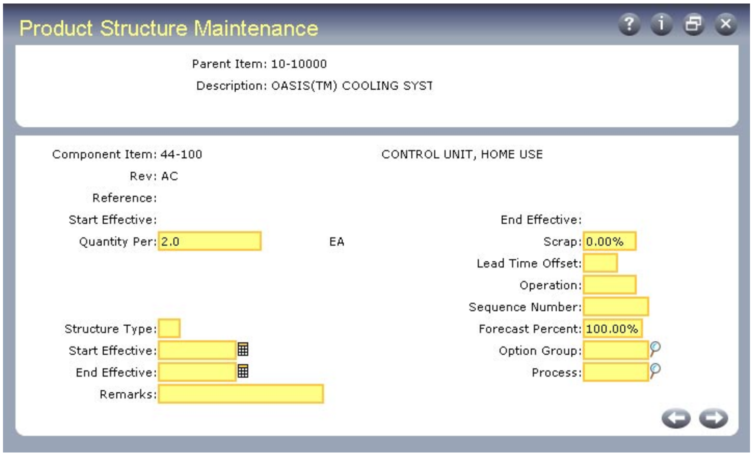


Fig. 2.2 Product Structure Maintenance (13.5)

Important fields include the following:

Reference. On a complex assembly that contains many components, an item may appear several times on the same drawing and product structure. Use Reference to identify a component that appears multiple times on the same parts list.

The reference code can be a drawing reference number that helps to relate a component to a specific position on a drawing, or a code associated with an engineering change order or an engineering change notice. The system uses parent, component, reference, and start date to define a unique product structure record. A component can have the same parent and same reference as long as the start dates are different.

Note If you use the Product Change Control (PCC) module, engineering change notice functions in Product Structures are disabled.

See *User Guide Volume 6: Master Data* for more information on PCC.

Since the system uses product structures to store configuration bills, you can also enter the feature code for configured products in Reference.

See "Engineering Effectivity" on page 23.

Start and End Effective. The way an item is manufactured can change over time. New components can be added or unnecessary ones deleted. Use effective dates to store relationships for historical, current, and future product structures.

Tip
A relationship is effective through the end date and becomes obsolete the next day.

All parent-component relationships are identified by a start and an end effective date. The start and end effective dates indicate when a relationship is active.

Example The hinges and fasteners for a frame are being upgraded. The existing components have an end effective date of March 14, and the new components have a start date of March 15. If an adhesive is added to prevent the screws from coming loose, you can also record the new product structure with the start date of March 15.

Quantity Per. Specify how much of this component is needed to make the parent item. In discrete manufacturing, items are made in individual units, and the component quantity is the amount needed for a single unit of a parent product. For example, two screws are required for one pair of sunglass frames.

In process manufacturing, products are made in batches and the component quantity per parent on a formula or recipe is stated with respect to a batch quantity for the parent product. Since the only economical way to coat lenses is in batches, the amount of a particular coating might be specified for a batch of several hundred lenses.

Scrap. Depending on the product, some components may be lost or unusable as a result of the manufacturing process. There are two ways to anticipate this loss:

- Use the scrap factor.
- Change the component quantity per.

The scrap factor is the percentage of a component expected to be lost during manufacturing. The system uses this with the quantity per to calculate component requirements for work orders and MRP. When a scrap factor is used, component quantities are almost always extended into fractional amounts and not whole units, making it difficult to use with items always handled in discrete quantities.

Example One left lens is required for a pair of sunglasses and the scrap factor is 5%. The system calculates a requirement for 105.2631 left lenses to make 100 sunglasses.

Using scrap percentages other than zero promotes waste and can conceal quality problems. If additional quantities are consistently required, consider changing the component quantity per directly. This avoids the problem of fractional quantities but may result in even greater waste than using the scrap factor. Continuing the example of the sunglasses, it is not realistic to change the quantity per on the left lens to 2. If you did so, the system would always plan that 200 left lenses would be necessary to make 100 pairs of sunglasses.

Structure Type. Product structure relationships normally have a blank structure type code. Other codes are used for special applications.

Table 2.2 Structure Type Codes

Code	Description
Blank	A normal product structure relationship.
X	A local phantom. Costed and exploded, but never planned as component requirements.
D	Document. Records miscellaneous expense items or documents associated with this bill that are not planned, exploded, or costed.
O	Option. An optional component. Normally defined using Configured Structure Maintenance (8.1), options may also be entered in planning bills.
P	Plan. Planning bill used for multilevel master scheduling. Not exploded or costed.
A	Alternate. Automatically created by the system for an alternate structure for this parent. Not planned, exploded, or costed.

Option and planning bills are used to create production forecasts.

See “Forecasting/ Master Schedule Planning” on page 335.

LT Offset. Not all of the components of a manufactured item are always required at the beginning. Normally, the differences in timing are not significant. However, if components are required long after the start date and/or the cost of those components is significant, consider using lead time offset.

Enter a positive or negative number, indicating the number of days after or before the start of an order when this component is required. MRP uses lead time offset to determine the need date for components and segregate them on separate picklists for individual work orders.

Op. Enter the number identifying the operation in the routing or process where this component is used. When specified, operation has the following effects:

See "Backflush Transaction" on page 296.

- Determines whether this component is backflushed in repetitive manufacturing operations. If you enter the operation number here, this component is automatically issued when you report quantities for the parent. If Op is blank or does not match a defined operation, this component is not backflushed.

See *User Guide Volume 4A: Financials*.

- Enables component yield cost calculations. Product Structure Cost Roll-Up (13.12.13) and Routing Cost Roll-Up (14.13.13) use this field when calculating material costs. If the operation yield is less than 100% in Routing Maintenance (14.13.1), then material costs are increased to reflect yield loss. If blank, the system assumes components are issued at the first operation.

See "Operation Based Yield" on page page 42.

- Enables operation-based yield calculations. If the parent item is defined with Operation Based Yield set to Yes in Item Master Maintenance and Enable Op Based Yield is Yes in MRP Control (23.24), MRP derives component yield percentages from the operations on the parent's routing. The same method is used when bills of material are exploded in work orders, repetitive, advanced repetitive, and configured products.
- Determines whether this component prints on Repetitive Picklist Print (18.22.3.5). If you enter an operation code, the component can be picked.

Related Topics

This section discusses a number of topics related to product structures and how they are used in the system.

Floor Stock

Continuing the example of the sunglasses, most items such as frame pieces and lenses are issued from an inventory location based on a formal document such as a work order picklist. However, some inexpensive, easily replenished components, such as the screws, may be held on the factory floor and used as needed. Such items are called *floor stock*.

Use Issues–Unplanned (3.7) to record floor stock issued from stores to a work-in-process expense account. To prevent these items from being picked, they should have an issue policy of No in the item master and item-site planning data.

Do not confuse floor stock with expensed items. Expensed items do not appear in the item master or product structure and are expensed immediately when they are received from the supplier. Enter expensed items on a purchase order as non-inventory (memo) purchases with type code M.

Relationship with Configured Products

Product structure records are also used to store information on product configurations. A configured product is defined in Item Master Maintenance with a purchase/manufacture code of C (configured). The system uses the Reference field to store the option's feature group, and the Structure Code field defaults to Option.

See *User Guide Volume 2A: Distribution* for information on configured products.

In some instances, it may be appropriate to change the structure code to Planning.

See "Forecasting/ Master Schedule Planning" on page 335.

Component Substitutions

When an item is not available, you can sometimes issue a different item. For example, for the sunglasses, it may be possible to substitute Phillips-head screws for slotted-head screws. Substitute components during work order issues or when modifying a backflush transaction. Before substituting components, use Item Substitution Maintenance (13.19) to define the relationships between standard items and substitute items.

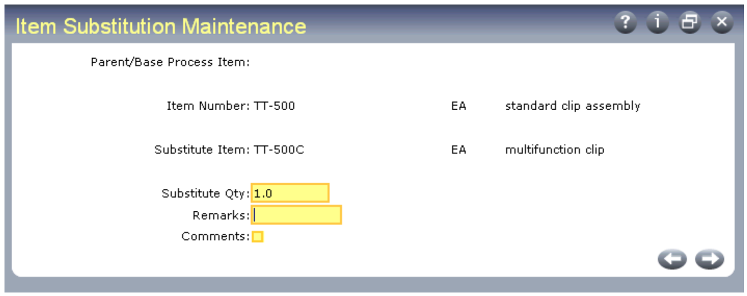
You can define a substitute item relationship for a component within a specific assembly as a global relationship. Specify a quantity of the alternate item that is equivalent to a single unit of the reference item. For example:

- Deionized water and sterile water can be defined as alternates for equivalent quantities of distilled water.
- Two 6-pin connectors can be defined as an alternate for a single 12-pin connector.

- A fast-setting adhesive can be defined as a substitute for a slower-setting adhesive for a specific assembly.

MRP and work order picking logic do not check substitute item relationships. Substitute items that are phantoms are not exploded when issued on an inventory transaction.

Fig. 2.3
Item Substitution Maintenance (13.19)



Cumulative Lead Time

When a product is planned, it is sometimes necessary to know its cumulative lead time—the longest time required to produce it. The cumulative lead time determines the minimum planning horizon for the master schedule and material requirements planning.

Cumulative lead time is calculated by first determining the composite lead times between the product and each of the lowest level components. The longest of these composite lead times determines the critical path and sets the cumulative lead time. When a product structure contains a BOM code in a lower level, the cumulative lead time of the end item includes lead times for components of the BOM code.

Example Sunglasses are manufactured from a purchased frame assembly. Table 2.3 shows the lead time for each item.

Table 2.3
Manufacturing Lead Times

Sunglasses with Coated Lenses (1)

Frame assembly	(28)	Left lens	(2)	Right lens	(2)
		Blank	(7)	Blank	(7)
		Tint	(28)	Tint	(28)
		Coating	(35)	Coating	(35)

The composite lead times for the sunglasses are calculated for each of the component lead time paths starting from the top-level assembly and going down to the component, as illustrated in Table 2.4.

Table 2.4 Composite Lead Times

Assembly or Component	Lead Time
Sunglasses with coated lenses	1
Frame assembly	29 (1 + 28)
Left or right lenses	3 (1 + 2)
Lens blank	10 (1 + 2 + 7)
Tint	31 (1 + 2 + 28)
Coating	38 (1 + 2 + 35)

The cumulative lead time, the longest of these lead time paths, is the lead time for coating (38 days). It could take up to 38 days to produce sunglasses if the critical components (left or right lenses and coating) are not available.

Use Cumulative Lead Time Roll-Up (13.12.14) to calculate and store the cumulative lead time in the item planning data for either the item master or the item-site.

Engineering Effectivity

In some instances, you can use an engineering change order or engineering change notice so that existing inventory of an old component is consumed before a new component can be used.

Note If you are using Product Change Control, you can use the Incorporation Planning Report (1.9.7.3) to determine the best time to introduce an engineering change.

Example A particular coating material is to be replaced by new coating material after the old material runs out.

- Set up the new material up as a component of the existing coating material.
- Change the existing coating material to a phantom item in Item Planning Maintenance (1.4.7) and/or Item-Site Planning Maintenance (1.4.17).

Work order picklists use phantom use-up logic to pick available inventory of the existing coating material until it runs out. Afterward, the system explodes the product structure/formula to pick the new coating material.

There are three trade-offs to doing this:

- Product costs and cumulative lead times are not calculated correctly.
- Phantom use-up logic is not used when backflushing components in the Repetitive module. However, it is used when backflushing work orders and in Receipts–Backward Exploded (3.12).
- The product structure will not conform to the engineering structure, so the where-used and product structure programs will be less accurate.

Avoid these potential problems by managing the use of effective dates for engineering changes.

Chapter 3

Routings/ Work Centers

This chapter discusses the elements associated with routings, including departments, standard operations, and work centers. Many of these concepts are also common to process definitions.

Introduction

To manufacture an item or product, you must complete one or more activities or operations. The list of required operations is called a routing, which basically defines the process needed to make the item. If a product structure is the list of ingredients in a recipe, a routing is the directions. The routing operations indicate the machines, expected times, and instructions for completing specific tasks.

For example, in manufacturing sunglass lenses, there might be a routing with four operations with instructions to grind, polish, tint, and coat the lenses. These would be separate operations because they involve different machines, tools, skills, and tasks.

Tip
Routings are required if you use the Repetitive module.

In the Shop Floor Control and Repetitive modules, you record actual statistics on what happens during production. This might include how long it takes to produce items, what quantities are produced and by whom, whether there was downtime or some other interruption to production, and so on. These statistics are always recorded against a routing operation.

In addition to providing manufacturing instructions, routings contain data used as a standard for evaluating production, operation times, yield percentages, the number of machines normally needed, and so on. The department and work center codes associated with routing operations link actual production results with capacity planning, cost accounting, and other programs.

Specifically, routings can be used to:

- Calculate the cost of producing an item.
- Calculate the time it takes to manufacture an item.
- Schedule operations for work orders and repetitive schedules.
- Backflush components in the Repetitive module.
- Calculate work center and department load.
- Print routings for work orders.
- Obtain operation feedback using programs in Shop Floor Control, Repetitive, and Advanced Repetitive.

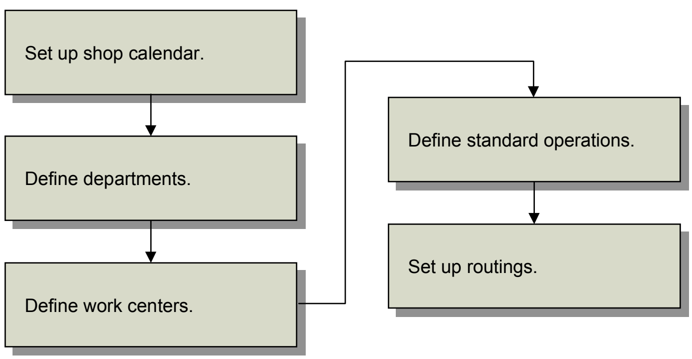
Some of these capabilities are especially important when there is a combination of medium to long operation lead times, a significant labor component of cost, many operations, and bottleneck operations.

Routing operations may not be necessary when:

- Item lead times are very short.
- Total item costs consist mostly of material and overhead and the labor component is relatively small.
- Capacity can be easily managed.
- Repetitive module is not used.

Figure 3.1 summarizes the steps required to set up routings.

Fig. 3.1
Routing Setup Work Flow



Important Work centers and operations work in conjunction with the shop calendar, which determines the work days and hours for the plant. Use Calendar Maintenance (36.2.5) to add work center-specific calendars. Before you begin defining the elements needed to create routings, make sure you set up the shop calendar.

See *User Guide Volume 9: Manager Functions* for more information on calendars.

Departments

In MFG/PRO, a department groups similar work centers. Departments are like product lines because they are used to organize information on planning reports and to determine the GL accounts on transactions. Each department is set up with a fixed daily labor capacity and a set of GL accounts.

Example A manufacturer of sunglasses has a department for lens fabrication with several work centers for lens grinding and lens polishing. A separate department does lens coating.

See Chapter 15, "Capacity Requirements Planning," on page 395.

The department load reports in the Capacity Requirements Planning (CRP) module use the department labor capacity when calculating the total department capacity for a period of time. The labor capacity should correspond to the sum of the total capacities of all work centers in the department.

Department account codes are similar to the GL account codes for product lines. They are used:

- When reporting labor and downtime in the Shop Floor Control and Repetitive modules
- When backflushing inventory and closing the accounting for completed work orders

A department code is independent of the GL accounts, sub-accounts, and cost centers defined for it. In the General Ledger module, cost center codes are often used to organize transactions by department. However, you do not have to use the same code for the cost center and department.

Table 3.1 lists the accounts for a department, the account type, and the transactions the accounts may appear on.

Table 3.1
Department GL Accounts

Account	Type	Use
Cost of Production	Expense	Non-Prod Labor, SFC Transfer
Labor (Absorbed)	Expense	SFC, Repetitive, WO Close
Burden (Absorbed)	Expense	SFC, Repetitive, WO Close
Labor Usage Variance	Expense	SFC, Repetitive
Labor Rate Variance	Expense	SFC, Repetitive, WO Receipt

Account	Type	Use
Burden Usage Variance	Expense	SFC, Repetitive
Burden Rate Variance	Expense	SFC, Repetitive, WO Receipt

Use Department Maintenance (14.1) to set up departments. You must define at least one department before setting up work centers or routings.

Account numbers default from System/Account Control (36.1). The Default Sub-Account/Cost Center and Override fields let you enter the same sub-account or cost center code for all accounts in a department. These fields are useful if you use standard account codes, but differentiate departments with sub-accounts or cost centers.

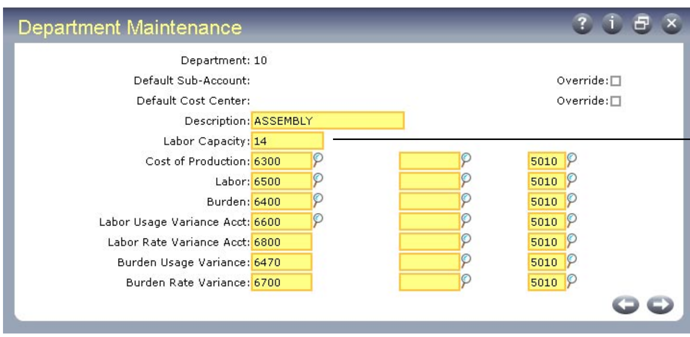


Fig. 3.2 Department Maintenance (14.1)

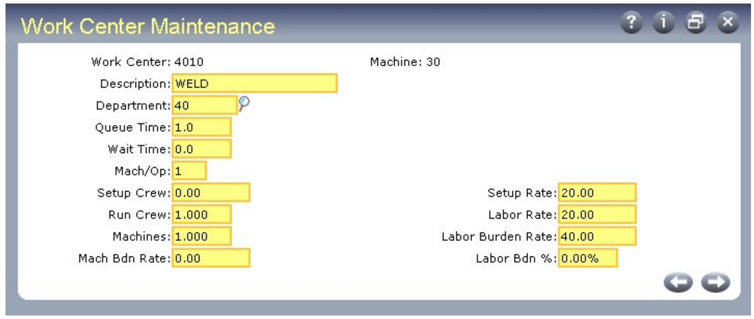
Work Centers

A work center is a group of people and/or machines. Work centers also link departments with routing operations.

Work centers are the basic unit for operation scheduling and CRP. Depending on how you plan and schedule work, you can set up work centers for an individual machine or for groups of similar machines. If, for example, there are separate machines for polishing plastic lenses and polishing glass lenses, they would be set up as separate work centers. The system uses work centers for scheduling, planning, and determining costs for GL transactions.

Use Work Center Maintenance (14.5) to set up work centers.

Fig. 3.3
Work Center Maintenance (14.5)



Work Center and Machine. Uniquely identify a work center by a work center code along with an optional machine code. Leave Machine blank if only one type of machine is in the work center. If there are multiple machine types or models, set up a different record for each machine, using the same work center ID.

Department. Enter a department code, set up in Department Maintenance (14.1). You must assign each work center to a department.

Queue and Wait Time. Enter the standard time, in decimal hours, a job normally spends waiting at this work center before it is set up and processed and after processing has been completed. These values display as defaults when you reference this work center as part of a standard, routing, or process operation.

See “Work Center Capacity” on page 31.

Machines/Op. Enter the number of machines at this work center that can work at the same time to process a given operation. CRP uses this number to calculate work center capacity. This value displays as the default when you reference this work center as part of a standard, routing, or process.

Setup and Run Crew. Optionally, enter the number of people required to set up and run this work center. These fields are for reference only.

Machines. Enter the number of machines or people in this work center. CRP calculates the total capacity for a work center by multiplying the number of working hours, defined in the shop calendar, by the number of machines.

Setup and Labor Rate. Enter the average labor rates paid per labor hour to set up and run this work center. These values are used by item cost calculations and by labor feedback functions to calculate and post actual costs and variances.

Mach and Labor Burden Rate. Enter the burden rates per hour applicable to machine and labor run time and setup at this work center. These values are used by item cost calculations and by labor feedback functions to calculate and post actual costs and variances.

Labor Burden %. Enter the labor burden percentage applicable to the total labor cost at this work center.

Tip
Rates apply to all operations carried out at this work center. You cannot change them for individual operations.

Important Changes to work center labor and burden fields affect how transaction amounts and product costs are calculated. They should be authorized by your cost accounting department.

Work Center Capacity

CRP uses work center capacity when evaluating work center load. It is the total number of hours the work center is available to do work. Capacity varies with the work center calendar or shop calendar and the number of machines or people in the work center.

The formula is:

*Work Center Capacity = Calendar Hours Available * Machines*

The work center number of machines should be at least as high as the number of machines per operation for this work center and for operations that use this work center.

Standard Operations

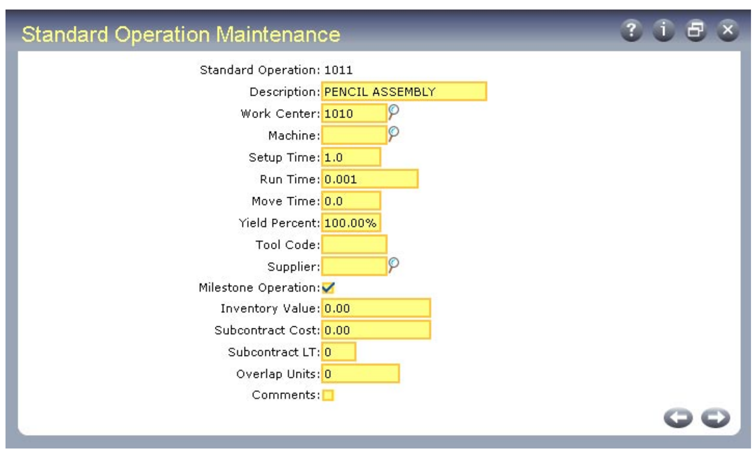
Often, routings share one or more operations that are essentially the same. For example, an automated packaging process may be the same regardless of the color of the products packaged. To save work when entering new routing operations, you can create template steps called *standard operations*.

When you enter a new routing operation, automatically copy the standard data to the routing by referencing the standard operation code. Then edit the standard information as needed. Changes apply only to the new routing—not to the standard operation you copied.

Note If you change a standard operation after referencing it on a routing, the changes do not automatically apply to the existing routing. Use Routing Update (14.13.7) to apply any changes you made to standard operations and work centers to existing routings.

Use Standard Operation Maintenance (14.9) to set up standard operations.

Fig. 3.4
Standard Operation Maintenance (14.9)



Work Center and Machine. Enter codes for the work center and machine that normally perform this operation.

See “Lead Times” on page 37.

Setup, Run, and Move Time. Enter the normal times, in decimal hours, to process items during this operation. Run time is per unit; setup and move time are independent of order size.

Yield %. Enter the order percentage expected to be in usable condition after this operation.

See "Yield" on page 41.

Tool Code. Optionally, enter the code for a tool normally used during this operation. This is for reference only. To standardize tool codes, set them up in Generalized Codes Maintenance (36.2.13) for field ro_tool.

Supplier. If this is a subcontract operation, enter the code of the supplier doing the work.

Milestone Operation. Enter Yes to define this as a repetitive labor reporting operation and to backflush all previous operations since the last milestone operation. The field only affects repetitive manufacturing operations.

See Chapter 11, "Repetitive," on page 311.

Inventory Value. Optionally, enter accumulated cost through this operation. Only this value is used by the Repetitive WIP Cost Report (18.4.12).

Subcontract Cost and LT. If this is a subcontract operation, enter the normal average cost per unit charged by the subcontractor and the normal number of calendar days the subcontractor takes to complete the operation.

Overlap Units. Enter the number of units that must be completed before they are moved to the next operation. When there are two consecutive operations, you can sometimes save time by moving partial quantities from one operation to the next before the first operation has been completed.

Operation Capacity

As the number of machines increases, work center capacity and the number of hours a work center is available for work also increases. If there are 8 hours in a work day and an operation has 2 machines per operation, the work center has 16 hours of capacity for that operation.

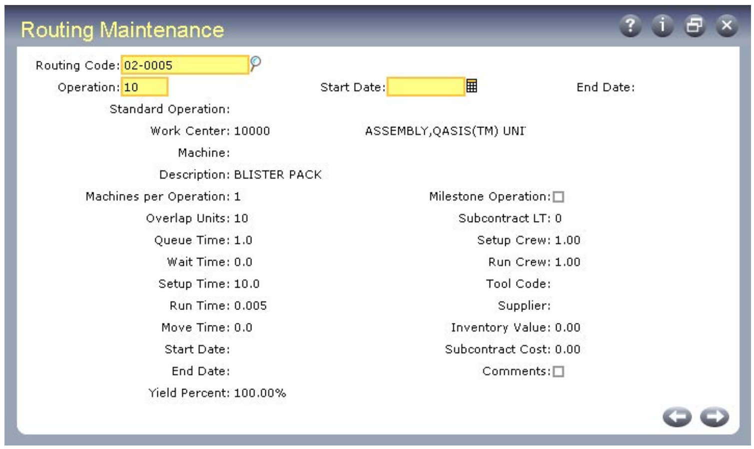
*Operation Capacity = Calendar Hours Available * Machines per Operation*

The number of machines per operation is also used for calculating the lead time and machine burden cost for an operation.

Routings

A routing consists of one or more operations—steps needed to make an item. Each operation is identified by a routing code and an operation number.

Fig. 3.5
Routing Maintenance (14.13.1)



See page 32.

Many of the fields in Routing Maintenance are the same as in Standard Operation Maintenance (14.9). Additional fields are described below.

See “Alternate Routings” on page 36.

Routing Code. This is typically the same as the item number, but routing codes and item numbers are entirely independent. This allows the same routing to be used for multiple items. One item can also be made using one of several routings.

A matching item number and routing code are automatically linked to each other. When an item’s routing code is blank in the item or item-site planning data, the system uses the item number as the routing code. If they are different, specify the routing code in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Tip
Number by 10s or 100s, so you can add new intermediate steps without renumbering existing ones.

Operation. Each routing consists of a series of steps. Enter a number to identify this step within this specific routing code. Operation numbers must be unique within a routing. Routing operations are always printed in ascending sequence by operation—operation 20 follows operation 10.

At least one operation is required to process repetitive labor feedback.

Start and End Date. Optionally, define effective dates for this operation. This lets you phase in engineering changes and maintain history online.

Functions that reference the routing always use the routing steps in effect on the current date. Most reports and inquiries can be selected for a specific effective date.

Standard Operation. Enter the code for the standard operation to use as the basis of this operation step. Many values then default from that standard operation. You can then modify them as needed to create the specific operation for this routing.

See “Standard Operations” on page 32.

Machines per Operation. Enter the number of machines that can process work at the same time at this operation. This value defaults from the work center machines per operation.

Queue and Wait Time. Enter the times, in decimal hours, a job normally waits at this work center before this operation is set up and processed and after this operation has been completed.

Setup and Run Crew. Enter the number of people normally required to set up and run this operation. These fields are for reference only.

Fig. 3.6
Routing Maintenance (14.13.1)

WIP Item. Optionally, enter an item number to represent work-in-process material for subcontract shipments.This field is used by Sub Shipper Print (18.22.5.9) when processing repetitive subcontracts. The description and unit weight of the WIP item display on the subcontract shipper.

See “Sub Shipper Print” on page 307.

Purchase Order, Line. If this operation is for subcontract services, enter the number of a scheduled purchase order and a corresponding line number. Schedule Update from MRP (5.5.3.1) uses this information when supplier schedules are generated for subcontract service suppliers. This value is also used by repetitive subcontract processing.

Tip
The system displays a warning if the PO and line do not exist.

Move Next Op. Enter Yes or No to determine the default for the same field in Backflush Transaction (18.22.13) and Move Transaction (18.22.19).

See "Automatic Labor Reporting" on page 274 for details.

Auto Labor Report. This field is used in the Advanced Repetitive module to determine if standard labor is reported automatically by Backflush Transaction (18.22.13).

Alternate Routings

After you enter a routing, you can link it to an item in several ways, depending on whether it should be used as the default routing code or available for use as an alternate routing.

- If the routing should be the default for an item, update the routing code in Item Planning Maintenance (1.4.7). This is the routing code used for CRP, work orders, repetitive, and costing.
- If the routing should be the default for an item at a particular site, update the routing code using Item-Site Planning Maintenance (1.4.17). This is the routing code used for CRP, work orders, repetitive, and costing for an item at a site. It overrides the routing code set up in Item Planning Maintenance.
- If the routing should be available as an alternate for an item at any site but not used as the default, use Alternate Routing Maintenance (14.15.1) to link it with an item. This allows the routing code on a work order to be changed to this alternate routing.
- If the routing should be available as an alternate for an item at a specific site, use Alternate Routing Maintenance to link a routing code to an item-site. This allows the routing code on a work order to be changed to this alternate routing.

Work Center Routing Standards

Sometimes work is actually performed at a different work center than appears on a routing operation. If the work center where the work was completed has different equipment, it may not be meaningful to compare actual hours with standard hours calculated using the normal work center.

When alternate work centers can be used for specific operations, you can use Work Center/Routing Standards Maintenance (14.17.1) to record the expected run times for the alternate work centers. This cross-reference is used for reporting actual run times on efficiency reports in the Repetitive module.

Routing Cost Roll-Up

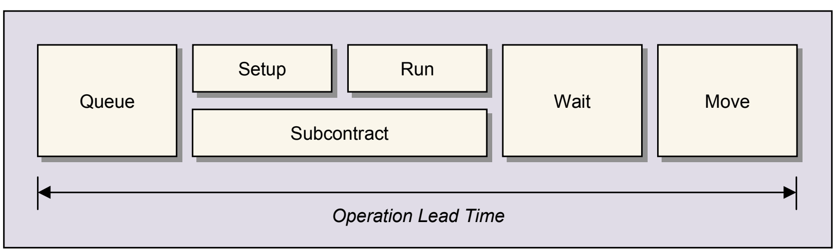
Use Routing Cost Roll-Up (14.13.13) to update the costs for items based on their routing (process) operations. This function can also update the Yield % field in the item planning data based on rolling up the percentages associated with each routing operation.

For details on costing, see *User Guide Volume 4A: Financials*.

Lead Times

In MFG/PRO, lead times for operations and manufacturing are expressed in terms of several components.

Fig. 3.7 Lead Time Components



- Queue. Amount of time a lot must wait at a work center before the operation is set up and production begins. Occurs when there is a backlog of jobs at a work center and is frequently the single longest component of manufacturing lead time.
- Setup. Time required to prepare a work center to process a lot or batch quantity for a specific operation.

- Run
  - In Routing Maintenance (14.13.1), the average time required to manufacture a single unit.
  - In Process Definition Maintenance (15.13), the average time to process an entire batch.
  - In Routing Maintenance (Rate Based) (14.13.2), run time is expressed in terms of an hourly production rate.

  In all cases, the system stores run time internally as the run time per unit.
- Wait. Amount of time a lot or batch must remain at a work center after production is completed before it can be moved to the next operation.
- Move. Time a lot or batch spends in transit from one operation to the next.
- Subcontract. Number of days required for an outside supplier to process the lot.

Operation Lead Time

Planning programs use these lead times to determine the duration of an operation and the time between successive operations. The amount of time a work center is actively involved in producing an item is determined by setup, run, and subcontract times. The time between operations—interoperation time—is determined by queue, wait, and move times. Most of these times are stated in hours, except for subcontract, which is stated in days.

The operation lead time is calculated using each of the lead time components, the number of machines per operation, and the item order quantity. The work center or shop calendar is used to convert queue, setup, run, and move times from hours to manufacturing days.

$$\text{Operation LT} = \frac{\text{Queue + Setup + Move}}{\text{Hours Available}} + \frac{\text{Run * Order Quantity}}{\text{Hrs. Avail. * Mach. per Op.}} + \frac{\text{Wait}}{24} + \text{Subcontract LT}$$

If you examine this formula, several concepts become apparent:

- Queue, setup, and move times are completely independent of the order quantity or lot size.
- Queue, setup, and move times are also independent of machines per operation, since these do not require that a machine be available.
- Queue, setup, and move times are a function of available work center or shop calendar hours since the operation can only be performed during working hours. If queue, setup, and move times add up to 16 hours and there are 8 working hours in a day, 2 manufacturing days are needed.
- The total run time for an operation is a function of order quantity. If the unit run time is 1 hour and the item order quantity is 48, a total of 48 hours of run time is needed.
- The run time for an operation is a function of total run time, work center or shop calendar hours, and the machines per operation. If a work center is open for 8 hours per day and there is one machine per operation, run time is 6 manufacturing days (48 hours over 6 days with 8 machine hours per day). However, if there are 3 machines per operation, run time will take only 2 days (48 hours over 2 days with 24 machine hours per day).
- Wait time is the amount of time a lot must remain at a work center after an operation is completed before it can be moved to the next operation. It is calculated from a straight 24-hour clock, since no machines or people are required.
- Subcontract lead time is stated in days. It is added directly to the other lead time components.

The system schedules work order and repetitive operations sequentially, assigning start and due dates for each operation. The duration of a specific operation—the time between its start date and due date—is determined by the setup, run, and subcontract times for the operation. The interoperation lead time—the time between the due date of one operation and the start date of the next operation—is calculated using the first operation's wait and move times and the following operation's queue time.

Note Setup and run times are used for operation scheduling, lead time calculations, product costing calculations, and GL transactions created by activities such as reporting labor and completing repetitive operations in the manufacturing modules. Changes to setup and run times should be coordinated to prevent adverse effects in any one of these areas.

Manufacturing Lead Time

The manufacturing lead time for an item is the sum of its operation lead times, stated in manufacturing days. Capacity planning uses manufacturing lead time, in conjunction with the work center or shop calendar, to determine order release dates.

There may be differences between operation schedules for an order and the manufacturing lead time for an item due to any one of several reasons:

- The item order quantity used to calculate the manufacturing lead time may be different than the actual order quantity for an operation, resulting in differences in the run time for an operation.
- The shop and/or work center calendars may be scheduled for more (or less) hours than the default calendars used to calculate manufacturing lead time.
- Queue time for the first operation does not affect its start date; therefore, it may fall after the release date of an order.
- Two successive operations may overlap.

Subcontract Operations

Some operations may be performed by an outside supplier or subcontractor rather than by a work center. This requires some special setup, particularly if you want to include subcontracted operations in supplier load and capacity reports.

Set up at least one department for outside processing and a separate work center for each type of subcontract operation. Each supplier or type of subcontract operation should have at least one work center defined for it. This lets you specify the work center on dispatch reports, which provide visibility of upcoming operations.

Set the work center labor and burden rates to zero to prevent GL transactions from being created. You can express work center lead times in subcontract days if load reporting is not a requirement. Otherwise, use queue, setup, run, wait, and move times in conjunction with a work center calendar.

You can also add one or more departments for specific suppliers for whom capacity is a major concern. Review capacity for these departments by printing the department load reports in the CRP module.

Yield

See “Scrap” on page 18 for a more detailed description of how the component scrap percentage is used.

Operation and item yield are different than the component scrap percentage in product structures. Component scrap results in additional requirements for individual components of a parent item. When an item’s yield is less than 100 percent, MRP creates additional scrap requirements for the item, causing the item and all of its components to be overplanned. Depending on the manufacturing process, the percentage of a lot expected to be of acceptable quality may also fall below 100 percent.

The system can calculate the total yield for an item in two ways, based on the values in two item planning data fields: Yield % and Op Based Yield.

Yield Percent

MRP can use the item yield percentage to plan additional supply. Using this method, the expected yield for an operation can be expressed as:

*Yield = Acceptable Units at Operation End * 100*

The total manufacturing yield for a product is determined by multiplying the yield percentages for each of its operations.

*Manufacturing Yield = Yield % for Op10 * Yield % for Op20 *...*

Take care when setting yield to anything but 100 percent—particularly when yield is used for multiple operations.

Example For four operations, each having a yield of 90 percent, the system calculates the item yield according to the following calculation:

*90% * 90% * 90% * 90%=66%*

This equation includes an expected loss of one in three units. If MRP plans this item for a demand of 100 units, the system creates a scrap requirement for 51 units and a planned order for 151 units, based on the following formula:

(100 / 66%)

With standard yield percentage, all component quantities use the same 66 percent item yield when MRP derives component requirements. For example, if this item has a requirement for one each of four components, each with a product structure quantity per of 1, MRP determines that 151 units are required for each component item, based on this calculation:

*(100 * 1) / 66%*

Operation-Based Yield

MFG/PRO also supports yield calculation for component requirements based on individual operations within a parent item's routing. To use this method, you must:

- Set Op Based Yield to Yes in Item Planning Maintenance (1.4.1 or 1.4.7) or Item-Site Planning Maintenance (1.4.17).
- Set Enable Op Based Yield to Yes in MRP Control (23.24).

When operation-based yield is in effect, the Yield % field associated with the item is not used to determine component requirements.

Operation-based yield affects the explosion of bills of material in work orders, repetitive, advanced repetitive, and configured products, as well as MRP.

Using this method typically results in more accurate calculations and prevents overplanning of components. This is especially true in a mature process where yield percentages are highly predictable.

Example

When subassemblies are scrapped at earlier operations, operation-based yield lessens component quantities required for later operations. Consider the following example:

- An order for 100 ITEM-A is entered in the system.
- ITEM-A has four components: COMP-1, COMP-2, COMP-3, and COMP-4.
- The quantity required for each component is one unit per completed assembly.
- Four operations are needed to build ITEM-A and one component is used at each operation. The first component is used at the first operation, the second component at the second operation, and so on for each component.
- Each operation has a yield of 90 percent.

Based on the demand for 100 ITEM-A, MRP generates a planned order for 151, based on the following calculations:

*Item Yield = (90% * 90% * 90% * 90%) = 66%*

Planned Order Quantity = 100 / .66 = 151 of ITEM-A

The system uses the same calculation for the parent item regardless of the yield calculation method in effect. However, when calculating component requirements, the different methods yield different results, as illustrated in Table 3.2.

Table 3.2 Operation-Based Yield Example

Operation	Component	BOM Qty	Op Yield	Eff Yield	Op Based Yield Yes Comp Qty Req	Op Based Yield No Comp Qty Req
10	COMP-1	1.0	90%	100%	151	151
20	COMP-2	1.0	90%	90%	135	151
30	COMP-3	1.0	90%	81%	122	151
40	COMP-4	1.0	90%	73%	110	151

Because Operation 10 is the first operation, it requires 100 percent of the components. When Op Based Yield is No, the component quantity is calculated from the yield percentage of the parent item. The system applies the same 66 percent item yield to each operation to determine component requirements of 151, according to the formula:

*(100 * 1) / 66%*

When Op Based Yield is Yes, the system uses the yield percentages of the parent's operation records to determine component quantities. Operation 10 has an effective yield of 90 percent. It is anticipated that 10 percent of the parent items are scrapped at this operation.

As a result, only 135 (151 * 90%) parent items are input to operation 20 and only 135 COMP-2 items are needed (135 * 1). Operation 20 also has a 90 percent yield. As a result, only 90 percent of the 135 parent items (122 units) survive to operation 30. This means only 122 COMP-3 items are required, and so on.

As this example indicates, operation-based yield calculation can have a dramatic effect on the requirement for the components associated with the final operations in a manufacturing process.

Important Operation-based yield modifies only the quantity planned for production. It does not modify the quantity of components consumed by work orders.

Chapter 4

Formula/Process

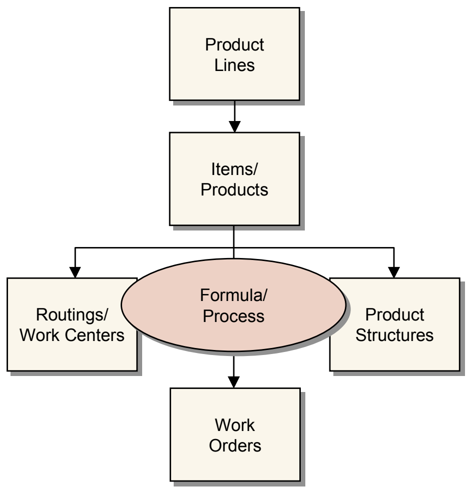
The Formula/Process module defines and maintains the relationships between products, ingredients, and materials, as well as the processes required to manufacture a product in a batch.

Introduction

See Chapter 3, "Routings/ Work Centers," on page 25.

A formula (or recipe) is another way to define a product structure. A process definition is identical to a routing. In fact, there is no difference to the system between defining a set of operations in Routing Maintenance (14.13.1) or Process Definition Maintenance (15.13). Before you set up a process definition, you must set up the shop calendar, departments, and work centers.

Fig. 4.1
Formula/Process Module



While Routing Maintenance sets up operation run time in hours per unit, and Routing Maintenance (Rate Based) (14.13.2) in terms of units per hour, Formula/Process lets you define a formula in terms of batch size and process it in hours per batch. The batch size is expressed in the parent item's unit of measure and represents the quantity in which the item is to be produced.

In Formula/Process, all definitions reference a specific batch size. You can specify ingredient quantities as a quantity per batch or as percent of a batch. Process definitions are always expressed as run times per batch. Unlike product structures, formulas relate to a particular batch size.

See Chapter 5, "Co-products/ By-products," on page 53.

The Formula/Process module also manages processes that create co-products and by-products, along with the base process that produces them.

The Formula/Process module works in conjunction with lot/serial control, which is sometimes necessary to comply with government regulations. Lot control can also help companies improve quality, process control, and inventory accuracy.

Defining Formulas

MFG/PRO stores formulas as parent item/component relationships. To define a formula for a product, enter the product as the parent, and the formula ingredients as components of the product.

Once a formula has been defined for a particular product, that product can produce a higher-level product. This is typical of a master batch or an oven heat, which processes other items.

When discrete components are issued—such as packaging and labels—closing the process batch work order and issuing the batch to a discrete packaging work order can be useful. The system offers process, discrete, and model/option work orders, or paperless repetitive scheduling in a single environment. You can backflush components for any of these types of production scheduling.

A formula—sometimes called a recipe—defines the ingredients for a manufactured item. Use Formula Maintenance (15.5) to define formulas. The system automatically assigns the item number to the BOM.

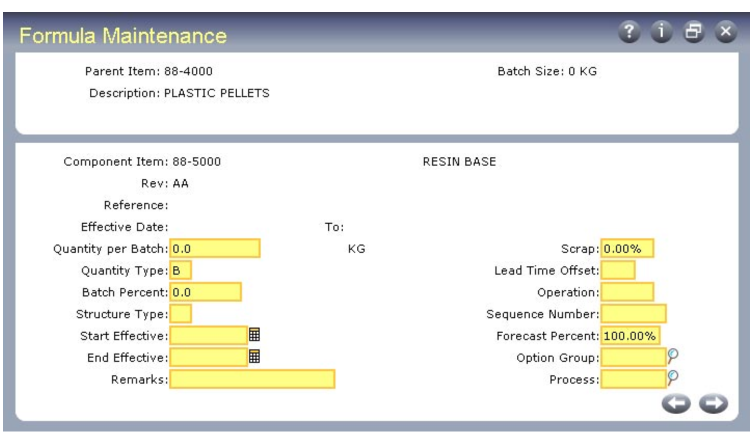


Fig. 4.2
Formula Maintenance (15.5)

This program is very similar to Product Structure Maintenance. Only additional fields are described here.

See page 17.

Batch Size. Enter the production batch quantity for this formula, usually the item batch quantity. This field lets you maintain multiple formulas for different production batch quantities of the same item.

Quantity Type. Specify how the component or co-product/by-product quantity is used for this formula or base process.

- Blank: parent unit of measure. Defines quantity in terms of a single unit of the parent, in the parent's unit of measure. For example, if the unit of measure of ink is liters and the quantity per of ink concentrate is 10g, 10 grams of concentrate are needed for each liter of ink.
- B: standard batch size. Defines quantity in terms of the parent's batch quantity. For example, if the batch size of ink is 50 liters and the quantity per of ink concentrate is 10g, 10 grams of concentrate are needed for each batch.
- P: percentage of batch. Defines quantity as a percentage of batch, specified in Batch Percent field. For example, if batch size of ink is 50 liters and water makes up 90% of the batch, 45 liters of water are needed for each batch.

Tip
If the batch and component quantities are not in the same unit of measure, set up a UM conversion.

Batch Percent. Enter the quantity of the component ingredient required to manufacture a batch of the parent item, expressed as a percentage of the batch. Use this field only if Quantity Type is P.

Use Formula Code Maintenance (15.1) to set up a BOM/Formula that is not an item number.

Tip
For simplicity, use the item number followed by site code.

- Site-specific formulas. Set up a BOM/Formula for each required site. Then use Formula Maintenance to attach the ingredients list. Finally, use Item-Site Planning Maintenance to assign the normal BOM/Formula to each item-site. This designates the formula used for planning and manufacturing at that site.
- Common formulas. Several products can use exactly the same ingredients, the only difference being processing or aging. Set up a BOM/Formula and attach the formula to it. Then assign that BOM/Formula to each of the items in Item Planning Maintenance as the default formula.
- Alternate formulas. One item can have several formulas, common for different batch sizes. Set up a BOM/Formula for each batch size and attach the formula to that BOM/Formula. Associate these with each

BOM/Formula as an alternate using Alternate Structure Maintenance, or link them to items and processes using Alternate Routing Maintenance. Designate one formula in Item Planning Maintenance as the default for planning.

- Co-product/by-product formulas. The BOM/Formula code or base process for a co-product/by-product structure is actually a component of the co-products and by-products that it produces. The unit of measure (UM) for the BOM/Formula when it is a base process item should be the same as the UM in the item master for the base process.

See Chapter 5, "Co-products/ By-products," on page 53.

Fig. 4.3
Formula Code Maintenance (15.1)

Formula Copy (15.8) creates a new formula by copying another one—useful when items share similar formulas or to create alternates. After copying, use Formula Maintenance to modify the new formula by adding, deleting, or changing requirements.

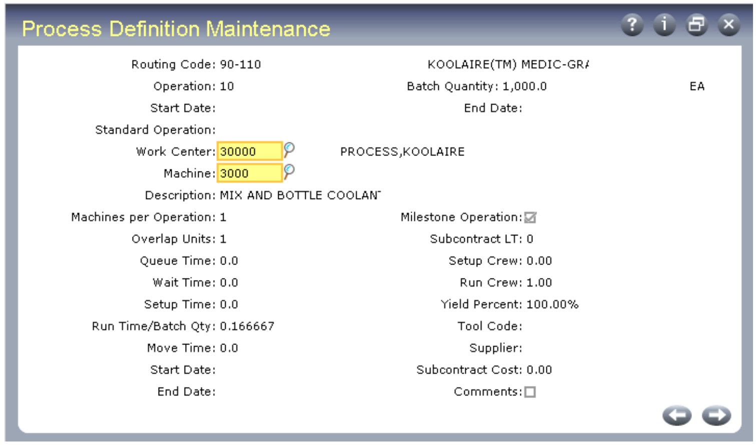
Defining Processes

A process, like a routing, is a sequence of steps to follow in the production of an item. A process definition, however, defines its control information in terms of a batch rather than a completed unit.

Process Definition Maintenance (15.13) is very similar to Routing Maintenance. Only a few fields are different.

See page 34.

Fig. 4.4
Process Definition Maintenance (15.13)



Batch Quantity. A system-maintained field recording the normal batch quantity for an item. If the formula was entered in Formula Maintenance, Batch Quantity defaults from the item master. Otherwise, it defaults from Formula Code Maintenance. Use Batch Quantity Change (15.9) to change the value.

Ingredient quantity per and process operation run times are stated in terms of this batch quantity.

Run Time/Batch Qty. Enter the process operation run time in terms of the batch quantity for the item.

To save data-entry time when defining processes for items that share similar operations or when creating alternates, copy an existing definition record with Process Definition Copy (15.16). Then add, change, or delete operations as needed.

Process/Formula Maintenance

Process/Formula Maintenance (15.18) lets you enter formula, batch, process, and co-product/by-product information from a single menu program. This is particularly useful when you are setting up processing for co-products/by-products.

See Chapter 5, “Co-products/ By-products,” on page 53.

Use this frame to specify which screens display.

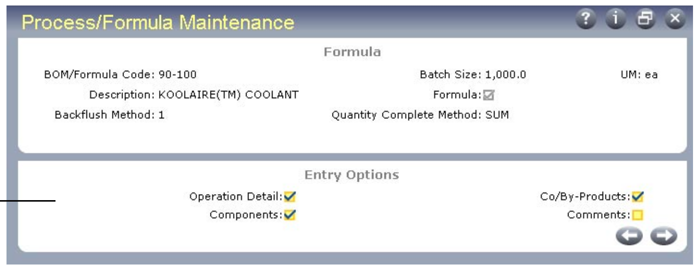


Fig. 4.5 Process/Formula Maintenance (15.18)

There are four main screens, in addition to a transactions comments screen:

- The Formula/BOM Code screen records the code for the parent item. It is the same as Formula Code Maintenance (15.1).
- The Process Operation Detail screen records information about the operations associated with the formula’s process definition. It is the same as Process Definition Maintenance (15.13).
- The Formula Components screen records information about the components used at each operation. It is the same as Formula Maintenance (15.5).
- The Co/By-Products screen records information about co-products and by-products. This is the same as Co/By-Product Maintenance (15.12.1).

See “Setting Up a Co/By-product Structure” on page 62.

Chapter 5

Co-products/ By-products

This chapter describes how to use MFG/PRO to manage processes that create more than one product. Topics related to material requirements planning (MRP) and work orders for co-products and by-products are also discussed.

Introduction

MFG/PRO provides a special set of features for managing processes that create more than one product. Such products are referred to as co-products or by-products. Processes that create only one product are supported by regular bills of material (BOM) and formulas.

Co-product/By-product features support a variety of manufacturing operations, including:

Batch processing. Production of items by mixing, blending, and refining component ingredients, such as pharmaceuticals, processed foods, and wine.

Sorting. Separation of items by characteristics such as size, weight, or quality, such as clothing, computer chips, and produce.

Disassembly. Separation of items from larger items, such as juice and seeds from oranges.

Molding. Production of items using multiple-cavity molds such as plastics and confections.

Features include support for MRP, work orders, shop floor control, and costing, as well as tools for setting up items, structures, and routings. Great flexibility is provided in defining alternate products structures and routings. As a result, perhaps even more than with regular processes, careful planning is critical.

Implementing and managing co-products/by-products involves:

- Setting up an operation for co-products and by-products
- Developing standard and simulation costs
- Implementing material requirements planning (MRP)
- Managing the work order life cycle for the related products

Overview

A *base process* is a manufacturing operation that creates more than one product. These products are called *co-products* or *by-products*. For this discussion, a co-product is an intended result of a base process and generally has significant value. In contrast, a by-product is an incidental result of a base process. Figure 5.1 illustrates a typical base process that produces two co-products.

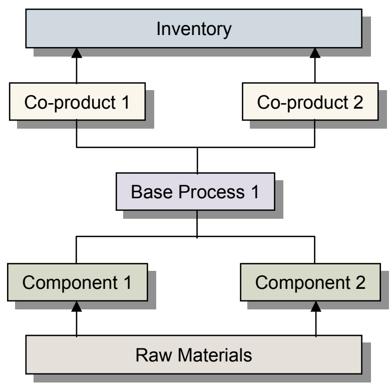


Fig. 5.1
A Base Process Produces Multiple Products

Example A sheet metal stamping process yields a piece of sheet metal used to make school bus window casings. The stamping process also yields two other products:

- Pieces of metal that are removed from the window hole and used to make seat brackets in another process
- Metal shavings that are swept up and disposed of at a cost

The pieces cut from the window hole have value, and are considered a co-product. The metal shavings have little value and an associated disposal cost, and are considered a by-product. If the shavings can be sold as scrap, the manufacturer may decide to define them as a co-product instead. See Figure 5.2.

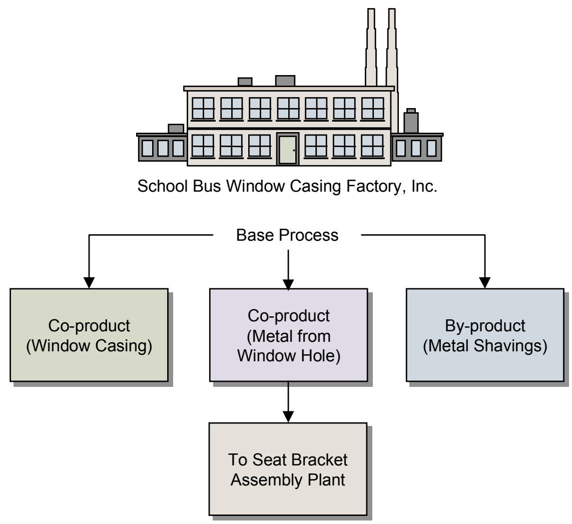


Fig. 5.2
Defining Co-products and By-products

The co-products and by-products of a base process do not have their own product structures or routings. These are defined in the base process. In MFG/PRO, base processes are items containing formulas for co/by-product operations, and are defined in the same way as regular items. A base process has:

- An associated item record
- A product structure listing its co-products and by-products
- A formula (product structure) listing its component requirements (optional)
- A routing listing its operations (optional)

The BOM/formula code for a co-product is the item number of the co-product's base process.

There are some important distinctions between base process items and regular items:

- Base process items are never regarded as items to be stocked. Item status codes are used to restrict inventory transactions related to base process items and to ensure that these items never appear on sales or purchase orders. Should base process items end up in inventory, or on sales or purchase orders, they are ignored by MRP.
- Base process items cannot be used as components in another process.

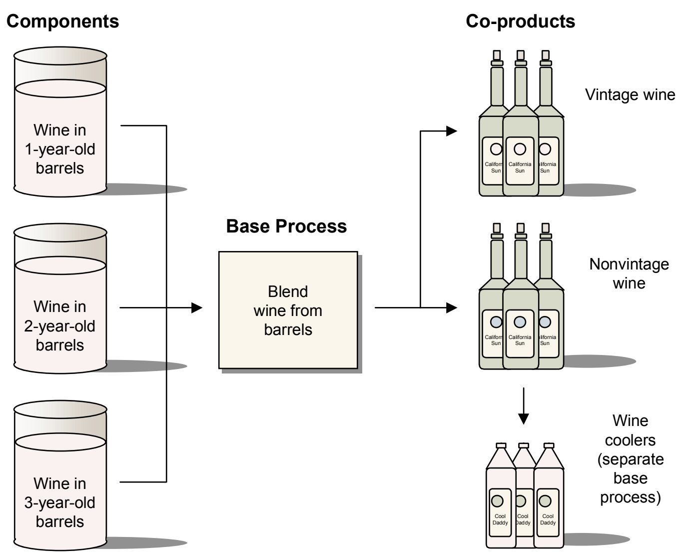
More About Co-products and By-products

Demand for co-products drives the planning of base processes, and the co-product that has the most demand is the one planned for.

Example Base process X produces two co-products, Y and Z. Since there is greater demand for Y than for Z, base process X is planned to produce the desired quantity of Y. The quantity of Z produced will therefore exceed demand.

A co-product can be a component of another process or product structure. For instance, for Company Q, nonvintage wine may be a co-product of the wine manufacturing process and a component of the wine cooler manufacturing process, as shown in Figure 5.3.

Fig. 5.3
A Co-product Used as a Component in Another Structure



By definition, demand for by-products is not expected. If demand for a by-product is generated, MRP treats it as demand for a normal item. MRP does not plan work orders to satisfy by-product demand.

Co-product/By-product Work Flow

Figure 5.4 shows steps for setting up and managing a typical operation involving a base process with co-products and by-products.

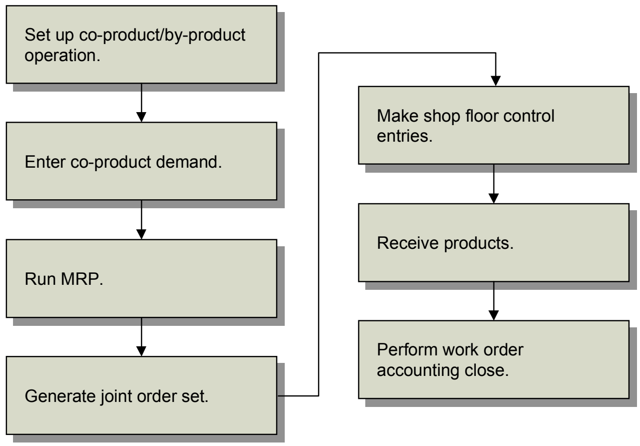


Fig. 5.4 General Work Flow for Co-products/By-products

Setting Up a Co/By-product Operation

Figure 5.5 shows steps for setting up a typical operation for co-products and by-products. Each step is discussed in detail in the following sections.

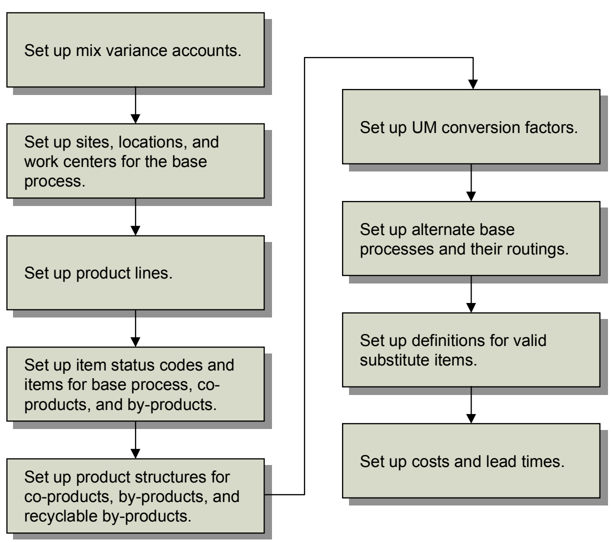


Fig. 5.5 Setting up for Co-products/By-products

Setting Up Mix Variance Accounts

If the quantity of a co-product or by-product received to stock differs from the quantity expected, a variance occurs. To record such variances properly, called *mix variances,* a Mix Variance account must be established. Even if you do not plan to use the co-product/by-product features, a Mix Variance account must be established before any work orders can be generated.

For more information on mix variances, see "Calculating Mix Variances for Joint Orders" on page 89.

1. Set up Mix Variance accounts and, optionally, sub-accounts and cost centers in the General Ledger (GL) setup functions (25.3).
2. Verify that Mix Variance account numbers appear in the variances frame of System/Account Control (36.1).
3. Set up Mix Variance accounts for specific product lines in Product Line Maintenance (1.2.1).
4. Associate product lines with co-products and by-products in Item Master Maintenance (1.4.1) or Item Data Maintenance (1.4.3).

Mix variances are generated when co-product and by-product work orders are processed by Work Order Accounting Close (16.21). Variance amounts are posted to the Mix Variance account on the applicable co-product or by-product work order and subtracted from the work-in-process (WIP) amount of the base process work order.

The work order close procedure can be performed more than once for a work order, and the variance amounts are cumulative.

Setting Up Sites and Locations for the Base Process

Establish sites for the base process in Site Maintenance (1.1.13). A location is an area within a site. A site can have an unlimited number of locations. You can use the same location code for different sites. Use Location Maintenance (1.1.18) to set up locations for the base process.

Setting Up Work Centers

A work center is a production facility capable of performing a certain task. A work center might be a place, a machine or group of machines, a person or group of people. In MFG/PRO, work centers are the most basic units used for operation scheduling, capacity requirements planning, and cost determinations for GL transactions.

In Work Center Maintenance (14.5), set up work centers by entering for each a unique work center code and a unique machine code.

Setting Up Product Lines

A product line is a group of similar items or products. At many companies, sales and operations are planned, reported, and analyzed by product line rather than by individual item or product. To establish a product line, use Product Line Maintenance (1.2.1).

Setting Up Item Status Codes for the Base Process

Tip
Item status codes are created and maintained in Item Status Code Maintenance (1.1.5).

Base process items are never stocked in inventory. As a result, although base processes are entered as regular items, they are not processed as inventory items. Use item status codes to prevent any inventory transactions related to base process items. Only two transactions should be allowed for the base item:

- ADD-PS, which occurs when the item is added to a product structure.
- ADD-WO, which occurs when the item is added to a work order.

Setting Up the Base Process Item

1. Create a base process item in Item Master Maintenance (1.4.1). Enter the unit of measure for each batch. Assign an item status that restricts inventory transactions.
2. Enter the following information in the Item Planning Data frame.

   Batch Qty. This is established in Formula Code Maintenance (15.1) or Process/Formula Maintenance (15.18)

   Plan Orders. Enter Yes

Order Policy. Enter POQ or FOQ. MRP does not use LFL or OTO for base processes.

Pur/Mfg Code. Enter M (manufactured) or leave blank.

BOM/Formula. Leave blank. A base process item cannot refer to another BOM/Formula.

Phantom. Enter No.

Setting Up Items for Co-products and By-products

Create items for co-products and by-products using standard procedures. For co-products, it is important to set the BOM/Formula field equal to a base process item number.

In Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17), enter the following for each co-product and by-product of a given base process.

Item Number. Enter an item number for the co-product or by-product.

Planning Parameters. Normally, you accept default values for these fields. MRP does not use planning parameters for co-products. Instead, it uses the parameters of the base process. MRP does not plan the base process to satisfy demand for a by-product. Rather, it plans by-products using the conventional method.

Pur/Mfg. Leave blank or enter M (manufactured) for co-products. Enter any value for by-products.

BOM/Formula. Enter the item number for the base process normally used to produce this co-product or by-product. This field is used for planning, work orders, and cost roll-up. An item can be a by-product and have a normal BOM/Formula code.

Note For items that are always by-products, BOM/Formula codes are optional. Entering the base process item number as the BOM/Formula code for by-products and co-products enables you to sort MRP Summary and Detail Reports by BOM/Formula code.

Routing Code. This should be left blank in most cases. If a co-product has a preferred routing different from the base process routing, enter that preferred routing. This routing must be set up as an alternate routing for the base process.

Phantom. Enter No. A co-product can be a component in a regular product structure, but the structure type cannot be X (phantom).

Setting Up a Co/By-product Structure

A co-product/by-product structure defines the items that result from a base process and specifies whether they are co-products or by-products. These product structures can be set up in several ways. The easiest way is through Process/Formula Maintenance (15.18), which combines the features of the following programs:

- Master Comment Maintenance (14.12)
- Routing Maintenance (14.13.1)
- Formula Code Maintenance (15.1)
- Formula Maintenance (15.5)
- Co/By-Product Maintenance (15.12.1)

Tip
You can have the system create BOM/formula codes automatically when you define formulas and product structures.

1 Set up BOM/formula codes using Process/Formula Maintenance (15.18) or Formula Code Maintenance (15.1).

BOM Code. Enter the base process item number.

Batch Size. Displays the batch quantity. The default is 0. To modify this field, use Batch Quantity Change (15.9).

UM. The BOM unit of measure. Should be the same as the item unit of measure for the base process item.

2 Set up the co/by-product structure using Process/Formula Maintenance (15.18) or Co/By-Product Maintenance (15.12.1).

See page 86.

Backflush Method. Enter 1 or 2. This determines the calculation method used to backflush base process components.

Quantity Complete Method. Enter one of five valid calculation methods. This method determines how the expected co-product and by-product receipt quantities used to calculate variances for joint order sets are determined. The default is from Work Order Control (16.24).

See page 89.

Co/By Type. Enter C for co-product or B for by-product.

Quantity. Enter the quantity per batch if Qty Type is Batch, or the quantity per base process unit if Qty Type is blank. The system calculates this field automatically when Qty Type is Percent.

Qty Type. Enter B for batch, P for percent, or leave blank to indicate per base process unit.

Process. Enter the percent per batch when Qty Type is Percent. This is calculated automatically when Qty Type is Batch.

Cost Allocation. Enter the percentage of base process cost to be allocated to this co-product. If Co/By Type is B, an allocation percentage cannot be entered.

Costs for co-products and by-products are calculated using the same programs that calculate regular costs. Once costs are rolled up for a base process (yielding gross cost), by-product costs are subtracted to arrive at the base process net cost. The entire net cost is then allocated to co-products of the base process. Allocation percentages for all co-products of a base process should add up to 100 percent.

See “Allocating Costs to Co-products” on page 69.

Structure Type. This field is display-only and always set to J (Joint).

3 Set up formulas or product structures used to define the ingredients or components required for a base process. You can use Process/Formula Maintenance (15.18) or Formula Maintenance (15.5). To enter a product structure, use Product Structure Maintenance (13.5).

Parent Item. Enter the base process item number.

Component Item. Enter components of the base process item.

When adding a formula, you can enter a batch size. Use Batch Quantity Change (15.9) to modify a formula’s batch size.

4 Set up routings for the base process using Process/Formula Maintenance (15.18), Process Definition Maintenance (15.13), or Routing Maintenance (14.13.1).

- In Process/Formula Maintenance, enter the base process in the BOM/Formula Code field.
- In Process Definition Maintenance or Routing Maintenance, enter the base process in the Routing Code field.

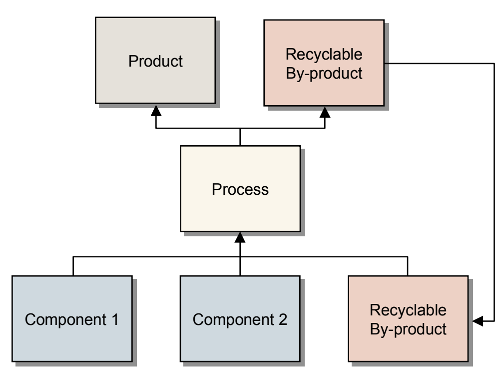
Setting Up Structures for Recyclable By-products

A recyclable by-product is reused in a manufacturing process.

Example In a manufacturing process, dry paint is sprayed onto charged sheet metal. The paint powder adheres to the metal and, after baking in a kiln, becomes a painted surface. Upon application, some of the dry paint falls to the floor, where it is collected by a vacuum funnel and eventually returned to the spraying machine.

Although recyclable materials are technically by-products, the system does not treat them as part of the co-product/by-product structure, but as regular components. Thus, they should be defined as regular components and managed accordingly. Figure 5.6 illustrates a recyclable by-product process.

Fig. 5.6
A Recyclable By-product Process



You set up a structure for a recyclable by-product by:

- Entering an item number for the recyclable item.
- Adding a recyclable item to a product structure/formula. Typically, you enter two product structure/formula records for each recyclable by-product:
  - One for the component requirement—a component going into the process—entered as a positive quantity.
  - One for a recyclable by-product—a component coming out of the process—entered as a negative quantity.

To set up a structure for a recyclable by-product, complete the following steps:

1 In Item Master Maintenance (1.4.1), enter:

Item Number. Enter an item number for each recyclable by-product. Use a single item number even if the item requires reprocessing after it is received as a by-product and before it is reintroduced as an ingredient of a process.

2 In Product Structure Maintenance (13.5) or Formula Maintenance (15.5), enter:

Component Item. Enter the item number of the recyclable material.

Reference. Enter a code to differentiate between a component requirement and a recyclable by-product. Typically, component requirements have blank reference codes. Recyclable by-product codes are user defined.

Qty Per. Enter a quantity for this product structure or formula. For a recyclable by-product, enter a negative number to indicate the quantity expected to be recovered from the process. For a component requirement, enter a positive number to indicate the full amount required.

LT Offset. Enter the number of days to be added to the work order start date to determine when the by-product is available for supply.

Op. Enter the operation for which the by-product is available or the operation for which the component is required.

Once these steps are complete, you can:

- Print work order picklists with component requirements summarized by operation.
- Roll up costs using the net material requirement for the component (quantity required less the quantity produced).
- Run MRP and have it recognize the demand and supply of the recyclable materials—by-product supply is negative demand.
- Receive by-products using Work Order Component Issue (16.10), Work Order Receipt Backflush (16.12), or Work Order Operation Backflush (16.19) for the operation where a by-product is expected, by entering a negative quantity to receive.

Setting Up Unit of Measure Conversion Factors

When the base process unit of measure (UM) differs from the UM for a co-product or by-product, UM conversion factors must be defined. Conversions are from the base process UM to the co-product or by-product UM.

Example If the base process UM is liters and the co-product UM is kilograms, a UM conversion is required where the UM is liters and the alternate UM is kilograms.

Set up UM conversion factors in Unit of Measure Maintenance (1.13).

Unit of Measure. Enter the base process unit of measure.

Alternate UM. Enter the co-product or by-product unit of measure.

Item Number. Enter the base process item number, or leave blank.

UM Conversion. Enter the conversion factor converting quantities from Alternate UM to Unit of Measure.

Setting Up Alternate Base Processes

An item can be a co-product or by-product of more than one base process. The base process for that item is its BOM/Formula code defined in Item Master Maintenance (1.4.1) or Item-Site Planning Maintenance (1.4.17).

Set up alternate base processes using Alternate Structure Maintenance (13.15).

Item Number. Enter the co-product item number.

BOM/Formula. Enter the base process item number.

Setting Up Alternate Base Process Routings

Alternate routings are useful for managing variations in the manufacturing process of an item. For example, a substitute machine is used while the primary machine for a process is being repaired. Like routings for regular items, alternate routings for co-products are assigned when work orders are generated. Routings are not required and are not used in MRP or for developing standard costs.

Only a base process can have alternate processes or routings. This is not true for co-products and by-products because they do not have a formula or process independent of the base process.

Define alternate routings for a base process in Alternate Routing Maintenance (14.15.1).

Item Number. Enter the base process item number.

Routing Code. Enter the alternate routing number previously defined in Routing Maintenance (14.13.1) or Process Definition Maintenance (15.13).

Bill of Material. Leave blank.

Setting Up Definitions for Valid Substitute Items

Tip
This feature is provided as a means of complying with FDA and other agency regulations. You can use co-products/by-products without setting this field.

Receipt of items on joint work orders is not limited to items set up as co-products or by-products of a base process. Set Modify Co/By Product Receipts in Compliance Control (1.22.24) to Yes to allow any item to be received on a joint work order. Set to No to have only valid substitutes received on a joint work order.

1 In Item Substitution Maintenance (13.19), do the following:

   Parent/Base Process Item. Enter the base process item number or leave blank.

   Item Number. Enter the co-product or by-product item number.

   Substitute Item. Enter the item number of valid substitutes for the standard co-product or by-product.

See *User Guide Volume 6: Master Data* for details on the Compliance module.

2 For users who have the Compliance module, go to Compliance Control (1.22.24).

   Modify Co/By-Product Receipts. The default is Yes. This allows receipt of any item from a base process work order. Enter No to restrict receipts to either items defined as part of the structure of the base process or to valid substitute items defined in Item Substitution Maintenance (13.19).

Calculating Costs and Lead Times

Co-product costs and lead times are calculated by the same programs that calculate regular costs. Figure 5.7 outlines some typical steps for calculating and allocating co-product costs and lead times. Each step is discussed in more detail in the sections that follow.

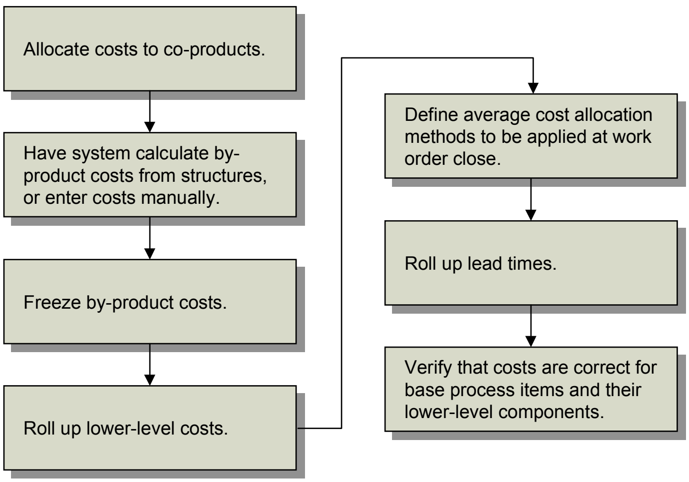


Fig. 5.7
Typical Cost Calculation Work Flow for Co-products

Allocating Costs to Co-products

Assign cost allocation percentages in Process/Formula Maintenance (15.18) or Co/By-Product Maintenance (15.12.1).

See “Setting Up a Co/By-product Structure” on page 62.

The same co-product can result from more than one base process, but only one base process determines a co-product’s cost at a particular site. That is, a co-product receives costs only from the base process specified in the BOM/Formula field of the co-product’s item record.

Example Base Process A produces three co-products—pitted prunes, prune juice, and prune purée used to make Danish pastry. It also produces one by-product, pits. The net cost calculation for Base Process A is as follows.

Gross Cost (Base Process A)	$105
By-product Costs	5
Net Cost (Base Process A)	$100

Although prune juice is a significant co-product of Base Process A, it is also a co-product of Base Process B and, as defined in the BOM/Formula field of Item Master Maintenance (1.4.1), takes its costs from Base Process B. For Base Process A, cost allocation percentages are:

Co-product 1 (Pitted Prunes)	80%
Co-product 2 (Prune Juice)	0%
Co-product 3 (Prune Purée)	20%

Final allocated costs are:

Co-product 1 (Pitted Prunes)	$100 * 80%	=	$80
Co-product 2 (Prune Juice)	$100 * 0%	=	$0
Co-product 3 (Prune Purée)	$100 * 20%	=	$20

By-product costs are calculated the same way as regular costs. That is, they are determined separately from the base process cost roll-up.

Once by-product costs are established, freeze them to ensure they are not changed during cost roll-up. Changing by-product costs after net base process costs have been calculated may result in unanticipated variances.

As in the previous example, the net cost for the base process should equal the sum of the costs allocated to the co-products. If these amounts are not equal, one or more of the following is likely:

- By-product costs were not frozen once subtracted from the base process gross cost. The system recalculated the by-product costs, changing the value of the base process net cost.
- Cost allocation percentages did not add up to 100%.
- Costs were allocated to a co-product whose cost was determined from a different base process than the one being rolled up. This can happen when a co-product is in the product structure of more than one base process.

If co-product costs do not add up to the base process net cost when work orders are closed, method change variances result.

The cost calculations related to base processes, by-products, and co-products are shown in the equations below.

Batch size	*	Base proc. unit cost	=	Base proc. batch cost
Batch size	*	By-prod. unit cost	=	By-prod. batch cost
Base proc. batch cost	–	By-prod. batch cost	=	Net base proc. batch cost
Net base proc. batch cost	*	Allocation %	=	Co-prod. batch cost
Co-prod. batch cost	÷	Quantity per batch	=	Co-prod. unit cost

Entering By-product Costs

By-product costs are calculated separately from the base process cost roll-up. You can enter by-product costs manually or have the system calculate them from regular product structures or formulas.

Since by-product costs are to be deducted from base process gross cost on an element-by-element basis, there must be sufficient cost in each cost element of the base process to cover the amounts established in corresponding cost elements of the by-product.

If by-product costs are to be entered manually, use Item Master Maintenance (1.4.1), Item Cost Maintenance (1.4.9), or Item-Site Cost Maintenance (1.4.18). Enter costs for by-products of a base process using the same cost elements as the base process item.

Tip
As an alternative to entering by-product costs manually, roll up by-product costs from normal product structures using Routing Cost Roll-Up (14.13.13).

Freezing By-product Costs

Freeze by-product costs using Roll-Up Freeze/Unfreeze (13.12.1).

Site. Enter the site to which these by-product costs apply.

Cost Set. Enter the cost set to be frozen.

Item Number. Enter item numbers for all by-products whose costs are to be frozen.

Freeze/Unfreeze. Enter Freeze.

Rolling Up Costs

Tip
During roll-up, the system calculates and updates base process item costs using the unit of measure (UM) of the BOM/Formula code for the base process. This UM must be the same as the item UM for the base process.

Roll up lower-level costs using Product Structure Cost Roll-Up (13.12.13) or Simulation Structure Cost Roll-Up (30.13.19). Keep in mind that the BOM/Formula code associated in the item master determines the base process for a co-product.

Item Number/To. Typically, this program is run for all items. The system only updates base process item costs when roll-up selection criteria include all items in the co/by-product structure.

Site. Enter the site to which these costs apply.

Cost Set. Enter the cost set to which these costs apply. This is normally the GL or current cost set at the selected site.

Choose Go to begin roll-up and End when roll-up is complete. To see the results of the roll-up, use Co/By-Products Cost Report (13.12.7).

Calculating Average Costs for Co-products

Cost averaging for co-products happens when you close a work order using the following programs:

- Work Order Receipt (16.11)
- Work Order Receipt Backflush (16.12)
- Work Order Accounting Close (16.21)

When you run Work Order Accounting Close, the following occurs:

- Co-product costs are re-averaged by taking any remaining positive or negative WIP costs and allocating them to the co-products. If additional costs are recorded for a work order after costs are allocated, the remaining costs can be reallocated by reopening the closed work order, applying the transaction, and closing it again.
- General ledger (GL) and current costs are updated.

Some typical steps for calculating average GL costs and average current costs for co-products follow:

1. Define the average cost allocation methods in Average Cost Method Maintenance (15.12.5).
2. Verify that the following are correct:
   - Co-product/by-product definitions
   - Prices for co-products, if allocation method involves price
   - By-product costs
   - Base process batch size
   - UM of the BOM/Formula code for the base process equals the item UM for the base process
   - Site setup for cost sets (GL Cost Set and Current Cost Set)
   - Unit of measure conversions from base process to co-products and by-products

Defining the Average Cost Allocation Methods

Define the average cost allocation methods using Average Cost Method Maintenance (15.12.5). The system provides three methods for allocating costs from a joint order set to co-products:

- Price
- Receipt Quantity
- Receipt Quantity and Price

If other methods are needed, users can provide their own programs. If no method is specified for a site, the Receipt Quantity method is used.

Allocation of base process costs to co-products is based on the cost of a standard batch size. All allocation percentages are calculated using equivalent units of measure based on the unit of measure for the base process. Where co-product units of measure differ from the unit of measure for the base process, the system employs conversion factors in order to express all costs in the base process unit of measure.

Allocation by Price

The percentage of cost to allocate to a co-product is determined by its price, relative to the prices for the other co-products from a base process. Table 5.1 shows how costs are allocated by price.

Table 5.1
Co-product Costs Allocated by Price

Item	UM	Conv	Price	Price (KG)	Price Based Allocation
P1	KG	1.00	2.00	2.00	25%
P2	KG	1.00	4.00	4.00	50%
P3	LT	0.50	1.00	2.00	25%

Allocation by Receipt Quantity

The percentage of cost allocated to a co-product is determined by the total quantity produced (plus reject) for the co-product, relative to the receipt (plus reject) quantities for other co-products of the base process. Table 5.2 shows how costs are allocated by receipt quantity.

Table 5.2
Co-product Costs Allocated by Receipt Quantity

Item	UM	Conv	Receipt Qty	Receipt Qty (KG)	Receipt Based Allocation
P1	KG	1.00	50.00	50.00	50%
P2	KG	1.00	30.00	30.00	30%
P3	LT	0.50	40.00	20.00	20%

Allocation by Receipt Quantity and Price

The percentage of cost allocated to a co-product is determined by the extended price of the total quantity received plus reject for that co-product, relative to the prices and receipt plus reject quantities for the other co-products from a base process. All quantities are converted to the base process unit of measure.

Table 5.3 shows how costs are allocated by receipt quantity and price.

Table 5.3
Co-product Costs Allocated by Price and Receipt Quantity

Item	UM	Conv	Rcpt Qty	Rcpt Qty (KG)	Price	Price (KG)	Price Qty	Price/Rcpt Allocation
P1	KG	1.00	50.00	50.00	2.00	2.00	100	38.48%
P2	KG	1.00	30.00	30.00	4.00	4.00	120	48.15%
P3	LT	0.50	40.00	20.00	1.00	2.00	40	15.38%

Average Cost Accounting

WIP costs are the sum of component costs and shop floor control costs, and are reduced by the cost of co-products and by-products received plus reject quantity. These transactions do not update GL or current costs.

Costs are averaged by taking the costs accumulated in WIP and adjusting the costs of items in inventory received from WIP. The system does this in two steps:

1. Co-products and by-products are received from work orders into inventory using their current average costs.
2. Average GL costs and average current costs are re-averaged based on the costs accumulated for an item's work order when the work order is closed. Co-product costs are re-averaged based on any WIP costs accumulated by this process. Costs can be accumulated when the Work Order Accounting Close program closes any work order operations that have not been closed.

Costs are not re-averaged for quantities received to sites other than the work order (WIP) site. Receipts are handled in two ways depending on whether the work order status is closed or not closed:

- *Not closed.* Co-product costs are not re-averaged. Items are received to the work order WIP site using current average costs. These costs are deducted from WIP. If quantities are received at a different site, they are received at the work order WIP site using current average costs, then transferred to the indicated site.

- *Closed.* Co-product costs are re-averaged. Items are received to the work order WIP site using current average costs. These costs are deducted from WIP. The re-averaging process takes into account quantities received during previous receipt transactions for the same work order.

If quantities are received to a different site than the work order WIP site, it is likely that the inventory quantity on hand is less than the quantity received. This increases the chance that some of the costs cannot be allocated and re-averaged at the WIP site and that costs will be booked to the Inventory Discrepancy account for the base process.

Tip
Re-averaging of co-product costs is time-sensitive. The greater the time between receipt and close, the greater the probability that some of the products produced have been consumed.

To maximize the accuracy of average costs and reduce costs booked to discrepancy accounts, the following should be emphasized:

- Complete reporting of co-product and by-product quantities when all quantities for all items are completed.
- Setting of work order status to Closed when receipt quantities are reported.
- Running of Work Order Accounting Close on a regular basis to process recently closed work orders.

The cost change taken to inventory is bounded as follows:

- *Upper limit.* Greater of the existing average cost or calculated work order unit cost.
- *Lower limit.* Lesser of the existing average cost or calculated work order unit cost.

Rolling Up Lead Times

The lead time to produce the co-products resulting from a base process is the same as the lead time for the base process. Cumulative Lead Time Roll-Up (13.12.14) copies the manufacturing lead time and the cumulative lead time for a base process to its co-products. Typically, the roll-up program is run for all items, not just those involved in co-product/by-product structures.

By-product lead times are not derived from the base process, but from roll-ups of regular product structures and routings. Enter by-product lead times in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Reviewing Product Costs

To verify that costs are correct for base process items and their lower-level components, review costs using one of the following:

- Product Structure Cost Report (13.12.4). This report identifies an item as a co-product or a base process.
- Co/By-Products Cost Report (13.12.7). This report shows you how co-product costs were calculated from a base process and its by-products.

MRP for Co-products/By-products

Because planned orders for co-products and by-products can be from more than one base process, overplanning of some items can result. This is because MRP plans each base process individually, based on unsatisfied demand for its co-products, rather than evaluating multiple base processes and delivering an optimum plan. Careful planning and setup of these operations by the manufacturer is therefore essential.

Planning for By-products

MRP plans orders for a by-product as a result of creating planned orders for a base process. By-product demand is not considered when planning a base process, but unsatisfied demand for a by-product can result in a normal planned order if the item is purchased, distributed, or has a BOM/Formula code for a regular formula or product structure.

Planning for Co-products

MRP creates base process demand records from the unsatisfied demand for a co-product. An item is a co-product if two conditions are met:

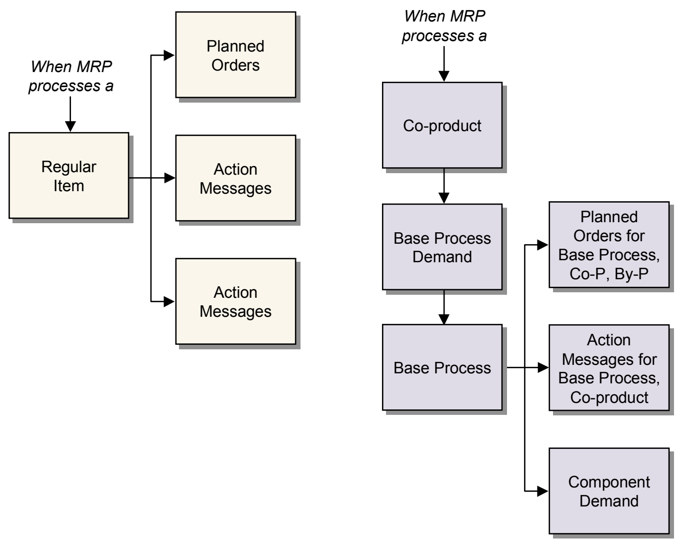
- It is manufactured—its Pur/Mfg code is Manufactured, Routable, or blank.
- Its BOM/Formula code is a base process that has the item as a co-product.

Tip
If these conditions are not met, the item is planned like a regular item.

MRP evaluates the beginning inventory, demand, supply, and safety stock for a co-product, and when there is unsatisfied demand, creates a demand record for its base process. This demand record reflects the amount of the base process required to meet the unsatisfied demand for the co-product.

As shown in Figure 5.8, MRP passes demand records directly from the co-product to the base process without using the co-product's order policy or related planning parameters.

Fig. 5.8
MRP Processing of Co-products



A co-product is like a parent of its base process. MRP plans all items in a site by low-level code, then by item number. Low-level codes are determined by parent/component relationships.

Planning for Base Processes

MRP plans for a base process by determining the unsatisfied co-product demand for all co-products that reference the base process as their BOM/Formula code. MRP then creates planned orders to fill the unsatisfied co-product demand without regard to projected quantities on hand for the base process.

Unlike the planning process for regular items, MRP does not consider base process inventory. There should never be an on-hand balance for a base process. Use item status codes to prohibit inventory movements, sales, purchases, and repetitive orders on base process items.

See "Setting Up Item Status Codes for the Base Process" on page 60.

MRP does use the order policy and order modifiers for the base process, except safety stock, when creating planned orders. If the order policy is not period order quantity (POQ) or fixed order quantity (FOQ), MRP uses an order policy of POQ. If no order period is specified, MRP uses an order period of seven days.

When MRP plans a base process, it searches for the first unsatisfied demand record for a co-product. Then, depending on whether the order policy is POQ or FOQ, MRP evaluates unsatisfied demand records for all co-products of the base process:

POQ. MRP searches from the first unsatisfied demand record through the end of the order period.

FOQ. MRP looks at all unsatisfied demand records for all co-products that fall on the same date as the first unsatisfied demand record.

MRP creates one or more planned orders to satisfy demand for the co-product that presents the greatest demand for the base process for a specific date or date range. As a result, planned orders for the other co-products of the base process are also created.

Reviewing, Updating, and Reporting Action Messages

MRP creates action messages for base processes and co-products, but not for by-products. Action Message Review/Update (23.5) and Action Message Report (23.7) allow reporting of action messages using various selection criteria, including BOM/Formula code. You can also exclude action messages for base process orders.

Approving Planned Work Orders

To approve planned work orders, use Planned Work Order Approval (23.10). Specify base processes by entering a BOM/Formula code range. This program changes the status on all orders in a joint set from Planned to Firm. The joint set is not updated based on effectivity dates for the co-product/by-product structure (as is done when using Work Order Maintenance or Multiple Work Order Status Change), and work order detail is not re-created.

When a planned purchase order is approved, the system creates a regular firm planned work order, even if the item has a BOM/Formula code for a base process. If an MRP-planned order is originally purchased, MRP does not create a joint order set when it is approved as a work order.

Creating Planned Order Reports

To create planned order reports, use Planned Order Report (23.12). To support features related to base processes, you can:

- Select planned orders by BOM/Formula code
- Include/exclude base process planned orders
- Include/exclude by-product planned orders
- Sort the report output by item number or BOM/Formula code

Creating MRP Summary Reports

To create MRP summary reports, use MRP Summary Report (23.14). To support features related to base processes, you can:

- Select planned orders by BOM/Formula code
- Include/exclude base process planned orders
- Sort the report output by item number or BOM/Formula code

Identifying the Source of Demand for a Co-product

To get detailed MRP information for co-products, by-products, and base processes, use MRP Detail Report (23.17). This feature provides pegging, which enables you to identify the source of demand for co-products. Indicate co-products by item number. You can also:

- Select planned orders by BOM/Formula code
- Include/exclude base process orders
- Sort the report by item number or BOM/Formula code within site

Managing Joint Work Order Sets

Figure 5.9 outlines some typical steps for managing joint work order sets.

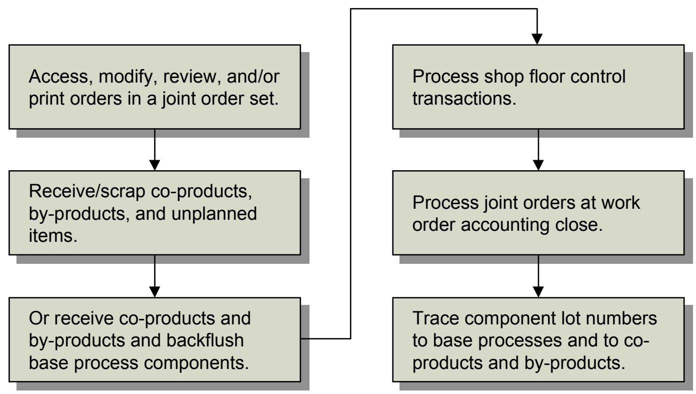


Fig. 5.9
Typical Work Flow for Joint Work Order Sets

Joint Work Order Sets

When you enter a work order for a base process or co-product, the system creates a *joint order set* comprised of a work order for the base process and one for each of its co-products and by-products. All work orders in the joint set (called *joint orders*) share the same work order number, site, and status, but have different work order IDs.

Tip
While Rework and Expense work orders may retain the work order number shared by the joint order set, they have a different status and are not considered part of the joint order set.

A joint order set consists of the following:

- A work order for the base process
- A work order for each co-product and by-product
- A work order bill for the base process
- A work order routing for the base process

Accessing and Modifying Joint Order Sets

Joint orders for co-products and by-products can be added or deleted from a joint set when the status of the set is Exploded, Allocated, or Released. Status codes determine when and how joint work orders can be modified relative to each other. Status codes are always the same for all orders in a joint set. The processing and restrictions applied are similar to those applied to work order bills.

Table 5.4 describes how work order status codes affect joint work orders.

Table 5.4
Effect of Work Order Status Codes

Code	Status	Description
P	Planned	MRP creates an imploded joint order set reflecting the base product structure as of the order release date.
B	Batch	An order is created for a single co-product or base process item. Orders are not imploded.
F	Firm	Orders are imploded to reflect the base product structure as of the order release date. You can modify co-product/by-product quantities and the base process quantity. All quantities are automatically rescaled. When an MRP-planned order in a joint order set is approved, all joint orders in the set are changed to status Firm.
E	Exploded	The same as Firm, except you can modify quantities for co-product or by-product orders without automatically rescaling other orders. You can add or delete orders from a joint order set. Delete is not allowed if quantities or costs have been received for an item on that order.
A	Allocated	Same as exploded.
R	Released	Same as exploded.
C	Closed	When the status of a joint order set is changed to Closed, and average cost method is used, updates are made to current AVG, current LAST, and GL average costs.

Joint order sets can be created for regular work orders (where Type is blank), but not for work order types such as Expense, Rework, Scheduled, Cumulative, and Final Assembly. Joint orders can be added to or deleted from a joint set when the status is Exploded, Allocated, or Released.

Note A joint order set must have only one base process order and at least one co-product order. If you delete the base process order or the only co-product order, the entire set is deleted.

To access and modify a joint order set, use Work Order Maintenance (16.1).

Item Number. Enter the item number for a base process or a co-product.

Type. Leave blank.

Routing Code. Optionally, enter an alternate routing code set up for the base process in Alternate Routing Maintenance (14.15.1).

BOM/Formula. Optionally, enter an alternate base process item number. To enter this field, the work order must be for a co-product, *and* the base process must be set up as an alternate product structure in Alternate Structure Maintenance (13.15).

Adjust Co/By Order Quantities. Enter Yes or No. This field does not appear on base process work orders.

If the order quantity changes, entering Yes automatically rescales all order quantities in the joint order set. The work order status must be E, A, R, or C to optionally rescale quantities. Joint order quantities are recalculated automatically when:

- Order quantity changes on a joint order whose status is Firm.
- Status of a work order changes from any status to Firm.
- Status of a work order changes from Batch, Planned, or Firm, to Exploded, Allocated, or Released.

The system calculates the quantities for joint orders from quantities entered in Co/By-Product Maintenance (15.12.1). Order quantities for a joint order set can be recalculated automatically or maintained manually, depending on the work order status.

Adjust Co/By Order Dates. Enter Yes or No. This prompt does not appear on base process work orders. If the order, release, or due date changes, entering Yes resynchronizes the dates for all orders in the joint order set. The work order status must be E, A, R, or C to optionally adjust dates. Firm status orders always resynchronize the dates for all orders in the set.

Default due dates for orders in a joint set are calculated using the manufacturing lead time for the base process.

Mix Variance Acct, Sub-Account, and Cost Center. Enter the account number for Mix Variance. Account defaults from the product line of the item and may be different for work orders within a joint order set. If this field is blank, you should define a default account in Product Line Maintenance (1.2.1).

See "Setting Up Mix Variance Accounts" on page 59.

Creating a Joint Order Set from an Alternate Base Process

To create a joint order set using an alternate base process, use Work Order Maintenance (16.1).

- Enter a work order using the item number for the alternate base process.
- Enter a work order for a co-product and specify an alternate base process as its BOM/Formula code. Define valid alternate base processes using Alternate Structure Maintenance (13.15). Enter the co-product item as the item number and the base process as the BOM/Formula.

Reviewing, Printing, and Releasing Joint Orders

To review joint work orders, use Joint Work Order Inquiry (16.3.13). Orders can be specified by item number, work order number, work order ID, BOM/Formula code, due date, site, or any combination of these.

To print a joint order set, use Work Order Release/Print (16.6) or Multiple Work Order Release/Print (16.7). Both programs release the joint order set, provided one order in the set is selected for processing. In addition to standard work order picklists and routings, you can also print documents listing the co-products and by-products expected for a base process. You can print the list of co-products and by-products before the picklist or after the routing operations.

- When a joint order's status changes to Released and the associated base process has a component that is routable (the Pur/Mfg Code for the component item is R), a routable work order is automatically created. When created, the routable work order's status is Batch.

  Routable work orders created from a joint order set use the joint set work order number, but are given a unique suffix. For example, a joint order set with work order number 1234 can create routable work orders 1234-1 and 1234-2.
- When a routable work order is created from a regular work order, the routable work order uses the work order number of the parent, but has a unique work order ID.

To select closed work orders and print summary data on each, use Work Order History Report (16.3.6). You have the option to print bill of material detail or routing detail. To print joint order sets, set Print Co/By-Product Orders to Yes. If Yes, the report displays information for each of the co-product and by-product orders for a base process work order.

To print information for each order related to a base process work order, use Work Order WIP Cost Report (16.3.5). To print information on items received and scrapped from a joint order set, use Work Order Cost Report (16.3.4). These reports show the costs for joint order sets once they have been closed in Work Order Accounting Close (16.21).

Receiving, Scrapping, and Backflushing

To receive and scrap co-product and by-products in a joint order set, use Work Order Receipt (16.11), Work Order Receipt Backflush (16.12), or Work Order Operation Backflush (16.19). You can initiate these programs using any work order in a joint order set.

In Work Order Receipt (16.11):

Work Order. Enter any work order number in the joint order set.

ID. Enter the specific ID desired, or leave blank to retrieve the first ID in the joint order set.

Receive All Co/By-Products. Enter Yes if all co-products and by-products are to be received. Enter No if only this particular order is to be received. This prompt only applies if the order being received is not for the base process. When the base process order is received, all related work orders are received by default.

Use Work Order Receipt Backflush (16.12) and Work Order Operation Backflush (16.19) to:

- Modify the backflush quantity and method.
- Initiate transactions to receive co-products and by-products.
- Backflush (issue) base process components. When components are backflushed, the receipt and scrapped quantities are used to calculate default issue quantities for the components.

Backflush Calculation Methods

Specify one of two backflush methods for the base process in Co/By-Product Maintenance (15.12.1) or Process/Formula Maintenance (15.18). The backflush quantity for the base process is used to calculate backflush (issue) quantities for the components of a joint order set.

In Work Order Receipt Backflush (16.12):

Work Order. Enter any work order number in the joint order set.

ID. Enter the specific ID desired, or leave blank to retrieve the first ID in the joint order set.

Receive All Co/By-Products. Enter Yes if all co-products and by-products are to be received. Enter No if only the items on this particular order are to be received.

Backflush Method. Enter 1 or 2. Method 1 backflushes based on the co-product and by-product quantities received. Method 2 backflushes based on the order quantity of the base process. The following two sections describe each method in more detail.

Backflush Method 1

The backflush (base process) quantity is calculated from the receipt quantities processed for all the co-products and by-products. Unit of measure conversion factors are used to express all item quantities in base process units.

Use Method 1 when the quantity for a batch is directly related to the sum of its output. For example, for a process that sorts fruit into different sizes and grades, the batch quantity can be calculated from the total amount of fruit processed for all sizes and grades. This method is generally used when there is greater variability in output percentages for products.

Backflush Method 2

The default backflush (base process) quantity is the order quantity for the base process work order. You can change the backflush quantity to reflect the actual quantity processed for a batch.

Use Method 2 when the batch quantity is closely related to the expected output of a particular co-product. For example, for a process that makes ice cream, the batch quantity can be calculated from the amount of ice cream processed. Any by-products, such as waste water, are not necessary for the calculation of the batch quantity.

Receiving Unexpected Items

Occasionally, an item produced from a joint order has a different grade or quality than expected. When this is the case, and the item assumes a different item number than the expected item, it can be received even without a joint order in the set for the unexpected item. These items are received as substitutes. A new order with a quantity of zero is added to the joint set.

Compliance Control (1.22.24) setting for Modify Co/By-Product Receipts determines what items can be received by:

See "Setting Up Definitions for Valid Substitute Items" on page 68.

- Work Order Receipt (16.11)
- Work Order Receipt Backflush (16.12)
- Work Order Operation Backflush (16.19)

When an item does not have a joint order in the joint order set being processed:

- Yes enables a receipt to be processed for any item number, even if it is not defined as a co-product or by-product of the base process.
- No enables you to receive only the expected items or valid substitute items. Valid substitute items are defined in Item Substitution Maintenance (13.19).

When a substitute item is received instead of an expected one, change the status of the joint set to Closed shortly after recording the receipt. The order and open quantities for the expected item remain unchanged when another item is received as an unplanned receipt. Closing the joint order set effectively changes the open or expected quantities for all items to zero.

Receiving Unplanned Items

Use Unplanned Receipts (3.9) to receive an item that has no work order. Related items in the co-product/by-product structure cannot be received with the item.

Processing Shop Floor Control Transactions

Shop floor control transactions are processed using the base process order for a joint order set.

Processing Joint Orders at Work Order Close

Use Work Order Accounting Close (16.21) to process joint orders when a base process order is selected to be closed. This procedure calculates mix variances, updates current average and last costs, and updates GL average costs for co-products and by-products.

Deleting and Archiving Joint Orders

Use Work Order Delete/Archive (16.23) to process all orders in a joint set when any one of the work orders in the set is selected for processing.

Tracing Lots

The lot number for a base process is its work order ID number or the lot number assigned to that order using Work Order Attribute Maintenance (1.22.4). The system automatically maintains lot-to-lot relationships for joint orders by creating receipt and issue transactions between a base process and its joint order set. These are memo transactions that do not update inventory or create GL transactions.

- Use Lot Where-Used Inquiry (3.22.4) to trace a component lot number to a base process and trace upward from the base process to the co-product and by-product lots produced from it.
- Use Lot Actual Bill Inquiry (3.22.3) to trace a co-product or by-product lot number to the base process that produced it and trace downward to the component lots for the base process.

Accounting for Joint Orders

All GL transactions for issues, receipts, and shop floor control transactions update the WIP account for the base process work order. Table 5.5 shows the origins of account, sub-account, and cost center information for work order transactions.

Table 5.5
Origins of Account, Sub-Account, and Cost Center Information

Account/Sub-Account/Cost Center	Base Process	Co-product By-product	Component
Inventory		Product Line	Product Line
Scrap		Product Line	
WIP	Work Order		
Material Usage Variance	Work Order		
Material Rate Variance	Work Order		
Subcontract Usage Variance	Work Order		
Mix Variance		Work Order	
Floor Stock	Work Order		

Calculating Mix Variances for Joint Orders

Mix, or yield, variance is the costed difference between the actual quantities received and scrapped for a co-product or by-product and the expected receipt quantity for that product.

Also see "Setting Up Mix Variance Accounts" on page 59.

For a co-product or by-product, the expected receipt quantity is not always the same as the quantity planned when the joint order set was created. For example, you may receive more or fewer co-product or by-product items than ordered because you issued fewer components than originally planned. In this case, you will probably want the system to consider actual product receipt quantities as part of the mix variance calculation.

Mix variance calculation methods for co-products and by-products can accommodate a wide range of base process types and receipt scenarios.

To determine the mix variance amount for a co-product or by-product work order, the system first calculates the expected receipt quantity for the order by multiplying the following two factors:

- The ratio between the co-product or by-product quantity ordered and the base process quantity ordered, expressed as a decimal value

- The base process quantity complete, which is variable and calculated based on the quantity complete method specified in the co/by-product structure

See "Setting Up a Co/By-product Structure" on page 62.

The base process quantity complete can be based on any one of the following, depending on the setting of Quantity Complete Method in Process/Formula Maintenance (15.18) or Co/By-Product Maintenance (15.12.1):

- The total quantity complete for all co-products and by-products in the joint order set (SUM)
- The total quantity complete for co-products only (SUMC)
- The base process quantity required to complete the co-product that consumed the greatest amount of the base process in proportion to the quantity ordered (MAX)
- The base process quantity required to complete the co-product that consumed the least amount of the base process in proportion to the quantity ordered (MIN)
- The quantity ordered on the base process order (ORD)

Note When method SUM or SUMC is used, the system converts co-product or by-product quantities to the base process unit of measure before adding them together.

The following equation is used to calculate the expected receipt quantity for a co-product or by-product:

*Expected Receipt Quantity = Base Process Quantity Complete * (Co-product or By-product Qty Ordered / Base Process Quantity Ordered)*

To calculate the mix variance amount for a co-product or by-product work order, the system compares the actual work order receipt quantity with what the system expected to receive based on the base process quantity complete. The equation used to calculate mix variance is as follows:

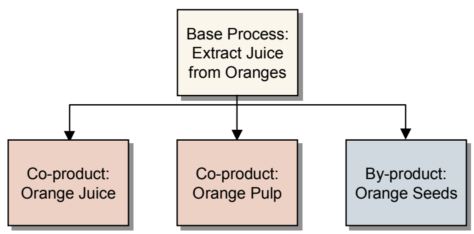
*Mix Variance = (Expected Receipt Quantity – Co/By-product Actual Receipt Qty) * Co/By-product Unit Cost*

The base process quantity complete, as determined by the quantity complete method, is also used in place of the work order quantity when calculating material and labor usage variances for a base process work order.

For more information on work order variances, see "Work Order Accounting Close" on page 134.

The following examples illustrate how the setting of Quantity Complete Method on the co/by-product structure determines how mix variances are calculated for co-products and by-product work orders. Each example uses the sample co/by-product structure shown in Figure 5.10.

Fig. 5.10 Sample Co/By-product Structure



The sample base process has only one component: oranges. Base process work orders have a batch quantity of 100 base-process units and the expected yield quantities per batch (order quantities) shown in Table 5.6.

Table 5.6 Sample Co-product and By-product Order Quantities

Co/By-product	Order Quantity
Orange Juice (Co-product)	50 liters
Pulp (Co-product)	30 kg
Seeds (By-product)	10 kg

The base process unit of measure (UM) is KG (kilograms). For the first co-product, orange juice, the conversion factor between the base process and co-product units of measure is 1.2 liters (LT) per 1.0 KG.

Co-product and by-product costs are shown in Table 5.7.

Table 5.7 Sample Co-product and By-product Costs

Co/By-product	Standard Cost
Orange Juice	$1.50 per LT
Pulp	$0.50 per KG
Seeds	$0.60 per KG

For a given joint order set, actual co-product and by-product yields are as shown in Table 5.8.

Table 5.8
Sample Co-product and By-product Yields

Order ID	Product	Qty Complete	Qty Rejected
1001	Orange Juice	55 liters	1 liter
1002	Pulp	25 kg	3 kg
1003	Seeds	15 kg	0 kg

Note Although a single example is used to illustrate all five quantity complete methods, some methods may be more appropriate to particular process environments than others.

To display numeric values in the following examples, these conventions are used:

- Currency amounts are rounded to the nearest hundreth.
- Non-currency decimal values are rounded to the nearest ten-thousandth.

Summarize

If Quantity Complete Method is set to SUM in the co/by-product structure, the following equation is used to determine the base process quantity complete:

*Base Process Quantity Complete = [(Co-prod1 Quantity Complete + Scrap) * Base Process UM Conversion Factor] + (Co-prod2 Quantity Complete + Scrap) + (By-prod1 Quantity Complete + Scrap)*

*Base Process Quantity Complete = [(55 + 1) * 1.2] + (25 + 3) + (15 + 0) = (56 * 1.2) + 28 + 15 = 67.2 + 28 + 15 = 110.2*

In this case, expected co-product and by-product order receipt quantities are calculated as shown in Table 5.9.

Table 5.9
Sample Expected Receipt Calculations for SUM Method

Order ID	Product	Expected Receipt Calculation
1001	Orange Juice	110.2 * (50 / 100) = 110.2 * 0.5 = 55.1
1002	Pulp	110.2 * (30 / 100) = 110.2 * 0.3 = 33.06
1003	Seeds	110.2 * (10 / 100) = 110.2 * 0.1 = 11.02

Based on these expected quantities, mix variance calculations are as shown in Table 5.10.

Table 5.10 Sample Mix Variance Calculations for SUM Method

Order ID	Product	Mix Variance Calculation
1001	Orange Juice	(55.1 – 56) * $1.50 = 0.9 * $1.50 = –$1.35
1002	Pulp	(33.06 – 28) * $0.50 = 5.06 * $0.50 = $2.53
1003	Seeds	(11.02 – 15) * $0.60 = –3.98 * $0.60 = –$2.39

The Summarize method may be appropriate for base processes in which the sum of the co-product and by-product output quantities is always close to or equal to the base process quantity. Examples of this type of base process include processes that involve sorting and separation of co-products and by-products, such as a process that sorts fruit by size and weight.

Summarize Co-products

If Quantity Complete Method is set to SUMC in the co/by-product structure, the following equation is used to determine base process quantity complete:

*Base Process Quantity Complete = [(Co-prod1 Quantity Complete + Scrap) * Base Process UM Conversion Factor] + (Co-prod2 Quantity Complete + Scrap)*

*Base Process Quantity Complete = [(55 + 1) * 1.2] + (25 + 3) = (56 * 1.2) + 28 = 67.2 + 28 = 95.2*

In this case, expected co-product and by-product order receipt quantities are calculated as shown in Table 5.11.

Table 5.11 Sample Expected Receipt Calculations for SUMC Method

Order ID	Product	Expected Receipt Calculation
1001	Orange Juice	95.2 * (50 / 100) = 95.2 * 0.5 = 47.6
1002	Pulp	95.2 * (30 / 100) = 95.2 * 0.3 = 28.56
1003	Seeds	95.2 * (10 / 100) = 95.2 * 0.1 = 9.52

Based on these expected quantities, mix variance calculations are as shown in Table 5.12.

Table 5.12 Sample Mix Variance Calculations for SUMC Method

Order ID	Product	Mix Variance Calculation
1001	Orange Juice	(47.6 – 56) * $1.50 = –8.4 * $1.50 = –$12.60
1002	Pulp	(28.56 – 28) * $0.50 = 0.56 * $0.50 = $0.28
1003	Seeds	(9.52 – 15) * $0.60 = –5.48 * $0.60 = –$3.29

Because it does not consider by-product quantities, the Summarize Co-products method may be appropriate in environments where completed by-products cannot always be traced to particular base process orders. For example, in some business environments, completed by-product quantities are reported in bulk at the end of each shift instead of in conjunction with work order operations.

Maximum

If Quantity Complete Method is set to MAX in the co/by-product structure, the system considers the quantity complete for each co-product and determines the quantity of the base process typically required to generate that co-product quantity.

The following calculation is performed for each co-product with a nonzero order quantity:

*(Co-product Quantity Complete + Scrap) * (Base Process Quantity Ordered / Co-product Quantity Ordered)*

The co-product that yields the highest result determines the base process quantity complete for the joint order set.

For the sample joint order set, calculations are as follows:

*Co-prod1 Quantity = (55 + 1) * (100 / 50) = 56 * 2 = 112*

*Co-prod2 Quantity = (25 + 3) * (100 / 30) = 28 * 3.3333 = 93.3324*

Since the calculation for co-product 1 (orange juice) yields the highest result, 112 is used as the base process quantity complete for the joint order set.

Expected co-product and by-product receipt quantities are calculated as shown in Table 5.13.

Table 5.13 Sample Expected Receipt Calculations for MAX Method

Order ID	Product	Expected Receipt Calculation
1001	Orange Juice	112 * (50 / 100) = 112 * 0.5 = 56
1002	Pulp	112 * (30 / 100) = 112 * 0.3 = 33.6
1003	Seeds	112 * (10 / 100) = 112 * 0.1 = 11.2

Based on these expected quantities, mix variance calculations are as shown in Table 5.14.

Table 5.14 Sample Mix Variance Calculations for MAX Method

Order ID	Product	Mix Variance Calculation
1001	Orange Juice	(56 – 56) * $1.50 = 0 * $1.50 = $0.00
1002	Pulp	(33.6 – 28) * $0.50 = 5.6 * $0.50 = $2.80
1003	Seeds	(11.2 – 15) * $0.60 = –3.8 * $0.60 = –$2.28

When the Maximum method is used, the co-product that consumed the largest quantity of the base process in proportion to the quantity ordered always has a zero mix variance. This is because the base process quantity complete is derived directly from the actual quantity complete for that co-product.

The Maximum and Minimum methods are most appropriate when a particular co-product in the co/by-product structure is considered the primary co-product for the base process. A primary co-product typically drives demand and determines the rate of production for the base process. Examples of production processes that involve a primary co-product include sheet-metal stamping and injection molding.

Minimum

If Quantity Complete Method is set to MIN in the co/by-product structure, the system performs the same calculations for each co-product in the joint order set as when Quantity Complete Method is MAX. However, the calculation that yields the lowest rather than the highest result is used to determine the base process quantity complete.

For the sample joint order set, calculations are as follows:

*Co-prod1 Quantity = (55 + 1) * (100 / 50) = 56 * 2 = 112*

*Co-prod2 Quantity = (25 + 3) * (100 / 30) = 28 * 3.3333 = 93.3324*

Since the calculation for co-product 2 (pulp) yields the lowest result, 93.3324 is used as the base process quantity complete for the joint order set.

Expected co-product and by-product receipt quantities are calculated as shown in Table 5.15.

Table 5.15 Sample Expected Receipt Calculations for MIN Method

Order ID	Product	Expected Receipt Calculation
1001	Orange Juice	93.3324 * (50 / 100) = 93.3324 * 0.5 = 46.6662
1002	Pulp	93.3324 * (30 / 100) = 93.3324 * 0.3 = 27.9997
1003	Seeds	93.3324 * (10 / 100) = 93.3324 * 0.1 = 9.3332

Based on these expected quantities, mix variance calculations are as shown in Table 5.16.

Table 5.16 Sample Mix Variance Calculations for MIN Method

Order ID	Product	Mix Variance Calculation
1001	Orange Juice	(46.6662 – 56) * $1.50 = –9.3338 * $1.50 = –$14.00
1002	Pulp	(27.9997 – 28) * $0.50 = 0.0003 * $0.50 = $0.00
1003	Seeds	(9.3332 – 15) * $0.60 = –5.6668 * $0.60 = –$3.40

For more information on when to use this method, see “Maximum” on page 94.

When the Minimum method is used, the co-product that consumed the smallest quantity of the base process in proportion to the quantity ordered always has a zero mix variance. This is because the base process quantity complete is derived directly from the actual quantity complete for that co-product.

Order

If the Quantity Complete Method for the co/by-product structure is ORD, the base process quantity complete is equal to the quantity ordered on the original base process work order (100).

In this case, expected co-product and by-product order receipt quantities are calculated as shown in Table 5.17.

Table 5.17 Sample Expected Receipt Calculations for ORD Method

Order ID	Product	Expected Receipt Calculation
1001	Orange Juice	100 * (50 * / 100) = 100 * 0.5 = 50
1002	Pulp	100 * (30 / 100) = 100 * 0.3 = 30
1003	Seeds	100 * (10 / 100) = 100 * 0.1 = 10

Based on these expected quantities, mix variance calculations are as shown in Table 5.18.

Table 5.18 Sample Mix Variance Calculations for ORD Method

Order ID	Product	Mix Variance Calculation
1001	Orange Juice	(60 – 56) * $1.50 = 4 * $1.50 = $6.00
1002	Pulp	(30 – 28) * $0.50 = 2 * $0.50 = $1.00
1003	Seeds	(10 – 15) * $0.60 = –5 * $0.60 = –$3.00

The Order method may be appropriate in environments where batch quantities for co-products and by-products are determined by some external factor such as the production equipment used and are, therefore, constant.

Restrictions

Inventory

Receipts–Backward Exploded (3.12). The inventory backflush program can be used to receive an item using a normal BOM/Formula code, but cannot be used to receive a base process item or process an item with a base process as its BOM/Formula code.

Purchasing

Purchase Order Maintenance (5.7). A subcontract purchase order line (Type is Subcontract) cannot reference a work order that is a co-product, by-product, or base process work order.

Purchase Order Receipts (5.13.1). A joint work order cannot be referenced when processing a receipt of an item on a subcontract purchase order line.

(Supplier) Schedule Update from MRP (5.5.3.1). A supplier schedule cannot be updated with an MRP-planned order for a co-product or base process from a joint order set.

Repetitive

The Repetitive module does not support joint schedules like the Work Orders module supports joint order sets.

Line Schedule Workbench (18.1.10). The line schedule (workbench) can be updated using normal MRP-planned orders for an item on a production line, but not using MRP-planned orders for a co-product or base process from a joint order set.

Schedule Maintenance (18.2.1) and Schedule Explosion (18.2.4).

A repetitive schedule can be entered for a co-product, but the schedule that is exploded from it does not include the other co-products and/or by-products for its base process.

Similarly, a repetitive schedule can be entered for a base process, but the schedule that is exploded from it does not include co-products or by-products.

Chapter 6

Work Orders

The Work Orders module enables you to manage manufacturing orders in discrete manufacturing environments.

Introduction

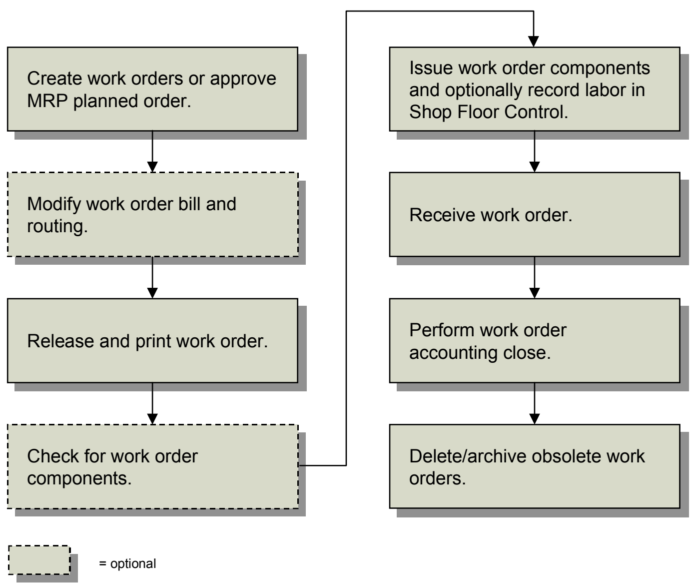
A work order is an authorization to produce a specific quantity of an item for a specific date. A work order may represent a manufacturing production order, a repetitive schedule, or a sequenced production line.

Work orders are typically created in response to current or projected demand for an item. You can also use them to build up inventory in anticipation of future demand when there is unused manufacturing capacity.

Work Order Life Cycle

Figure 6.1 illustrates a typical work order life cycle.

Fig. 6.1
Work Order Life Cycle



Work Order Operation Backflush (16.19) combines:

- The issuing functions of Work Order Component Issue (16.10)
- The labor reporting functions of Labor Feedback by Work Order (17.1)
- The receipt functions of Work Order Receipts (16.11)

If you use Work Order Operation Backflush, the typical work flow for work orders is simplified, since you can combine three separate steps into one.

Work orders are tightly integrated with other manufacturing modules:

- Define bills of material and product structures for work orders in the Product Structures module.
See page 11.
- Define routings and operations for work orders in the Routings/Work Centers module.
See page 25.
- Create planned orders to fill demand with Material Requirements Planning.
See page 371.
- Schedule operations with Capacity Requirements Plan.
See page 395.
- Monitor and report on the progress of a work order in the Shop Floor Control module.
See page 137.

Manufacturing Environments

MFG/PRO provides features that support different manufacturing environments. The Work Orders and Shop Floor Control modules are typically used to manage job shop manufacturing. The Advanced Repetitive or Repetitive modules manage manufacturing in an assembly line environment. Table 6.1 compares and contrasts the two types of environments.

See Chapter 10 and Chapter 11 for details.

Table 6.1 Manufacturing Environments

	Work Orders	**Repetitive**
Plant Organization	Variable by product	Fixed by assembly line
Routing	Functional departments	Fixed by line
Material Handling	Fork lifts, tote bins	Conveyors, containers
Product Mix	Many products	Similar products
Amount of Work in Process	High	Low
Time to Manufacture	Variable by product	Short
Examples	Tools, furniture	Auto assembly, tires

Work Order by Site Control

When two or more manufacturing sites exist within one physical database, they are often managed by different production controllers or planners.

Many work order programs let users select a range of orders to process. When a database has multiple sites, it is important that planners update only the orders for which they are responsible. In most cases this means restricting order update to a single site.

See *User Guide Volume 9: Manager Functions* for details on security.

Most work order update programs and reports include either a site selection or a site range selection. Site security, defined in the Manager Functions System Security menu (36.3) is checked for all programs that update the database. If the site selection is blank, the user must have access to all sites. Users with access to only specific sites must run the programs by limiting the site selection appropriately.

Effects of Optional Modules

See *User Guide Volume 6: Master Data* for details on the Compliance module.

Some features of work orders are affected if you are using the Compliance module. When compliance is active, you can assign batch numbers, restrict items issued to an order, restrict items received, and enforce stricter lot/serial control rules. These features are described in detail in the discussion of the Compliance module. The description of work orders in this chapter assumes that compliance features are not active.

For details, see *User Guide Volume 11: PRO/PLUS*.

The PRO/PLUS WIP Lot Trace module (WLT) affects some work order functions. When WIP Lot Trace is active, you can:

- Monitor and trace work in process (WIP) inventory.
- Track WIP material lot/serials processed by multiple subcontractors.
- Maintain detailed historical records, including which components produced a finished item and which finished items went to a customer.

If you are using the optional PRO/PLUS module, WIP Lot Trace is available as option 3.22.13. When activated, additional frames display in some work order programs. The discussion in this chapter assumes that WLT features are not active.

Defining Control Settings

Enter appropriate values in Work Order Control (16.24). Most settings affect numbering and comment defaults.

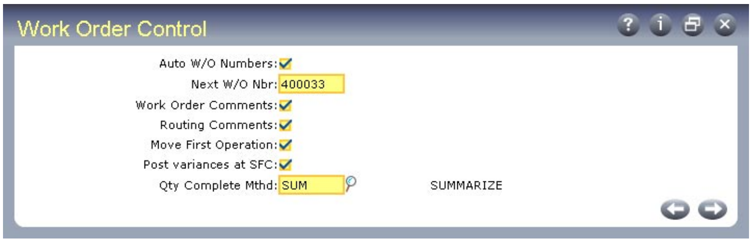


Fig. 6.2
Work Order Control (16.24)

Move First Operation. This field determines whether the work order release function sets the status of the first operation to Queue. If No, the operation status is left blank and must be changed manually.

This field is typically set to Yes. The released order then appears on the dispatch list for the specified work center and the Queue status indicates it is waiting to be started. If a lengthy picking effort is required, the work order may not be ready as soon as it is released. In this case, set this field to No. Use Operation Move to change the status later.

Post variances at SFC. This field sets the default for the same field in Work Order Maintenance.

Yes: Labor and burden variances are calculated and posted whenever shop floor labor feedback transactions are entered.

No: Variances are suppressed and not calculated or posted until the work order is received.

Setting this field to No reduces the number of variance transactions posted to the general ledger, particularly if there are many shop floor labor transactions processed before material receipts are recorded.

If you have very long run times, set this field to No, suppressing variance calculations until finished product is received. If you have short run times, set this field to Yes.

Quantity Complete Method. The value of this field defaults to Process/Formula Maintenance (15.18) and Co/By-Product Maintenance (15.12.1) and affects the calculation of mixed variances.

See “Calculating Mix Variances for Joint Orders” on page 89.

Creating Work Orders

Work orders are created directly using Work Order Maintenance (16.1). For convenience, you can also create them in Master Schedule Order Maintenance (22.13). The two programs are identical.

Work orders are also created as the result of executing other functions.

- Running MRP generates planned orders. Once approved in Planned Work Order Approval (23.10), these orders can be managed in the Work Orders module.
- Releasing a sales order or service return material authorization (RMA) for a configured item to a work order in Sales Order Release to Work Order (8.13).
- Releasing an RMA receipt line to a work order with RMA Release to Work Order (11.7.1.5).
- Releasing a parent work order for an item with a routable component creates a related work order for the component.

Some work orders are created and managed in other modules. These cannot be updated in Work Order Maintenance.

- Work orders created by entering repetitive schedules are managed in the repetitive module.

See *User Guide Volume 8A and B* for details.

- Work orders created to handle customer service activities are managed with Call Activity Recording (11.1.1.13) in the Service/Support Management module and Project Activity Recording (10.5.13) in the Project Realization Management module. Customer services work orders are included on standard work order reports.

See "Creating and Maintaining Flow Schedules" on page 186.

- Work orders created by entering flow scheduled orders in Flow Schedule Maintenance (17.21.3) that do not include references to existing work orders are managed in the Flow Schedule module.

Type determines how the order is processed.

Status indicates the position in the order life cycle.

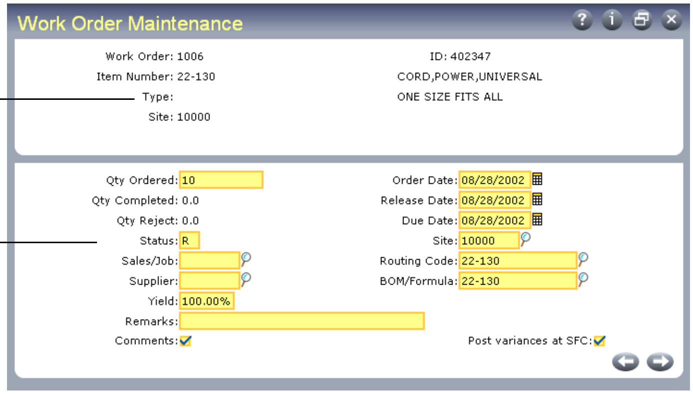


Fig. 6.3
Work Order Maintenance (16.1)

Important elements of a work order include:

- The type, which identifies the source of the order and indicates how it should be processed.
- The status, which determines where a work order is in its life cycle.
- The bill of material (BOM), which lists the quantities of components required to fulfill an order.
- The routing, which lists the operations required to complete the order.

Tip
The BOM and routing are also called a process sheet.

These elements are discussed in the following sections.

Work Order Type

Most work orders are entered with a blank type. These represent normal manufacturing orders with a standard product structure and routing. The other types indicate special kinds of work orders.

Table 6.2 lists work order type codes.

Table 6.2
Work Order Types

Type Code	Description	Type Code	Description
Blank	Standard	S	Scheduled
F	Final Assembly	C	Cumulative
R	Rework	W	Flow
E	Expense		

See "Work Order Status" on page 109 for more details.

All work order types are similar in terms of planning, inventory, and accounting. They differ in their default bills, routings, and status codes. These defaults are shown in Table 6.3 for each order type.

Note Scheduled and cumulative orders are managed using repetitive functions and are not included in this table.

Table 6.3
Work Order Type Defaults

Work Order Type	Type Code	Default Bill	Default Routing	Default Status
Standard	blank	Standard	Standard	Firm Planned
Rework	R	Parent Item	None	Allocated
Final Assembly	F	Sales Order	Standard	Exploded
Expense	E	None	None	Released
Flow	W	Standard	Standard	Exploded

Rework Work Orders

Use rework orders to manage repair, reprocessing, or completion of non-conforming items. A rework order has the parent item as its only component, and no routing.

After creating a rework order, you can modify its bill and routing by adding components and operations before it is released. If additional items are needed, use Work Order Component Issue (16.10) or directly modify the bill using Work Order Bill Maintenance (16.13.1).

If rework activity is a common procedure, consider establishing a rework routing in Routing Maintenance (14.13.1) and attaching it in Work Order Maintenance (16.1), or create one in Work Order Bill Maintenance (16.13.1).

If you are using the Service/Support Management module to receive items from customers and rework them, you can establish default service routings in Service Item Maintenance (11.3.7).

In Work Order Maintenance (16.1), set the WIP account, sub-account, cost center, and project to an appropriate expense account for posting rework costs.

Final Assembly Work Orders

Final assembly (FAS) orders are used to manufacture configured products of type assemble to order (ATO). Kit-configured items do not require a work order. These are indicated by a Pur/Mfg code of Configured in Item Master Maintenance (1.4.1). FAS orders are generated when a sales order for a configured product is released to manufacturing using Sales Order Release to Work Order (8.13).

See *User Guide Volume 2A: Distribution* for more information about configured items.

An FAS order uses the standard item routing, but its BOM contain only the items specified in the sales order configuration. Release and process FAS orders the same as regular work orders.

Expense Work Orders

Use expense work orders for non-inventory jobs, such as engineering prototypes or design projects. Expense work orders have no bill or routing, but you can attach these manually as needed.

Note You should define a separate site, item code, and product line for expense orders to keep their planning and manufacturing separate from regular manufacturing.

To separate cost accounting, specify an expense account rather than the default WIP account. Or use the Project field to track expenses in the GL.

If you process expense work orders frequently, streamline the process by:

1. Creating a product line with account numbers for this type of work.
2. Creating an item of type E to use for expense orders. Define a blank order quantity to prevent planning functions from treating it like a normal item.
3. Creating a status code that restricts all inventory transactions and assign it to the item.

Scheduled Work Orders

See Chapter 10, "Advanced Repetitive," and Chapter 11, "Repetitive," for more information on scheduled orders.

Scheduled work orders are generated by the system when repetitive schedules are entered. Like standard work orders, they have a standard work order bill and routing.

A scheduled work order cannot be processed as a standard work order unless you change its status to Allocated or Released. Changing a scheduled order to a regular order automatically updates the repetitive schedule to exclude it; however, the work order type remains Scheduled.

Cumulative Work Orders

See "Managing Cumulative Orders" on page 287.

Cumulative orders are generated by the system to track repetitive production costs. They cannot be processed using work order functions.

Routable Work Orders

The system manages one other kind of work order that is not represented by a separate type code. Subassemblies can be set up so that work orders are automatically created for them when a parent item is allocated or released using:

- Work Order Release/Print (16.6)
- Multiple Work Order Release/Print (16.7)

To do this, set the Pur/Mfg code for the item to Routable in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). A work order for a routable item has the same number as the parent work order, but a unique work order ID.

These work orders can be allocated, released, and used for processing component issues, inventory receipts, and shop floor control transactions. When the subassembly is finished:

- Process a work order receipt from the routable work order.
- Then issue the subassembly as a component to the parent work order.

Flow Work Order

Flow work orders are generated by the system when flow scheduled orders are entered and do not include a reference to an existing standard work order. Like standard work orders, they have a standard work order bill and routing.

A flow work order cannot be processed as a standard work order. It is automatically updated when you process the associated flow scheduled order.

Work Order Status

Work order status codes correspond to stages in a work order's life cycle:

- Planned
- Firm planned
- Batch
- Exploded
- Allocated
- Released
- Closed

The status of a work order determines how much control you have over its bill, routing, inventory allocations, inventory transactions, and labor feedback:

- You cannot make any changes to orders with status Planned. These are managed by MRP.
- For orders with status Firm Planned, you can change the dates and quantities as needed, and specify an approved alternate bill or routing.
- For orders with status Exploded, Allocated, or Released, bills and routings can be modified or alternate ones specified.

A work order progresses from one status code to the next and, unless prematurely released, does not return to an earlier status.

Table 6.4
Work Order Life Cycle

Type Code	Description	Life Cycle
Blank	Standard	Planned—Firm Planned—Exploded—Allocated—Released—Closed
F	Final Assembly	Exploded—Allocated—Released—Closed
R	Rework	Allocated—Released—Closed
E	Expense	Released—Closed
S	Scheduled	Exploded—Closed
C	Cumulative	Released—Closed
W	Flow	Exploded—Deleted (system action)

After entering an order, change its status to Firm Planned, Exploded, or Allocated using Multiple Work Order Status Change (16.8). Table 6.5 shows how the status changes affect a work order's BOM and routing.

Table 6.5
Effect of Status Change on Bill and Routing

	Planned	Firm Planned	Exploded	Allocated	Released	Closed
Bills	Bill created		Components frozen	Inventory allocated	Inventory picked	
Routings		Routing created and scheduled	Routing operations frozen			

Planned

See Chapter 14, "Material Requirements Planning," for more information about planned orders.

Planned orders are generated by MRP and are replanned as requirements change. You cannot record inventory transactions or labor feedback against them, or change quantities, dates, bills of material, or routings.

Approving a planned work order with Planned Work Order Approval (23.10) changes its status to firm planned.

Note Work orders with statuses other than Planned have fixed quantities and due dates and are therefore not replanned by MRP.

Firm Planned

A firm planned order has been approved. MRP does not replan these orders, but instead, generates action messages as needed.

Tip
This is the default status for an order you create in Work Order Maintenance.

A firm planned order has a work order bill and a routing with scheduled operations. These are not fixed. Bills are re-exploded by MRP, while routings are re-exploded by CRP. Both are re-exploded when the status is changed to Exploded, Allocated, or Released. This allows entry of a work order for a fixed quantity and date, while reflecting future engineering changes in the bill or routing as the order advances toward release.

You cannot record inventory transactions or labor feedback against firm planned orders.

Batch

A batch status indicates that this is a firm planned order entered in batch. This method speeds up processing for large numbers of orders. The system does not create and explode bills or routings for these orders until their status changes. As a result, MRP does not recognize any component demand.

Enter batch work orders manually as needed, or create them automatically for routable components when changing the order status to Allocated or Released. Use Multiple WO Status Change (16.8) to change order status at the appropriate time.

You cannot record inventory transactions or labor feedback against a batch order.

Exploded

Exploding a work order recalculates the work order bill and freezes the bill along with the routing. The bill and routing can only be changed manually—until the order is released.

Note When the explosion takes place, any requirements for phantom items are not exploded into requirements for their lower-level components.

You cannot record inventory transactions or labor feedback against work orders with status Exploded.

Allocated

Allocated orders are extensions of exploded orders and are used for inventory transactions. You cannot record labor feedback against orders with status Allocated. Allocated orders differ from exploded orders in the following ways:

- Inventory allocations are made for all of the required components.
- When the work order bill is created, the system explodes through the requirements for phantoms if needed, using up quantities of phantom items already in inventory before creating requirements for their components.
- Work orders are automatically created for components with Pur/Mfg codes set to Routable in Item Planning Maintenance (1.4.7). These orders normally have a status of Batch.

Released

A released order is like an allocated order except that detail allocations are made for its components and its operations are scheduled. Depending on which program is used, a picklist or routing can be printed when an order is released. The picklist uses detail allocations to indicate the specific inventory detail records to pick for the order.

You can record inventory transactions or labor feedback against work orders with status Released.

Closed

Tip
This status is useful for reporting.

Work orders are typically closed when the items are received. For most purposes, this ends the life cycle. You cannot process inventory transactions for closed orders. However, additional labor can be reported until either:

- The operations are closed in Shop Floor Control.
- Work Order Accounting Close (16.21) is executed.

Routing Code

Work order routings, identified by routing codes, specify the operations, or steps, required to manufacture an item. Set up routings and operations using the Routings/Work Centers module. Link routings to items using Item Master Maintenance (1.4.1) or Item Data Maintenance (1.4.3).

See "Routings/ Work Centers" on page 25.

When a work order is created, the standard routing is copied into it. As work progresses, required changes can be made to this copy using Work Order Routing Maintenance (16.13.13). This way, what actually happens can be compared to the standard. Monitor work order operations using the Shop Floor Control module.

See Chapter 7, "Shop Floor Control," on page 137.

Once the work order status is Exploded, Allocated, or Released, no more changes can be made to the routing.

If the operation-based yield calculation method is used for the item on the work order, any manual changes to the Yield field in the work order header have no effect on component requirements. When the work order is exploded, the system always uses the yield percentages from operations in the item's routing to determine component quantities.

See "Yield" on page 41.

BOM/Formula

The work order BOM is derived from the item's product structure, defined in Product Structure Maintenance (13.5) or Formula Maintenance (15.5), and the quantity ordered. Inventory allocations and issues are based on the bill. MRP uses the bill of material to calculate component demand.

See "Material Requirements Planning" on page 371.

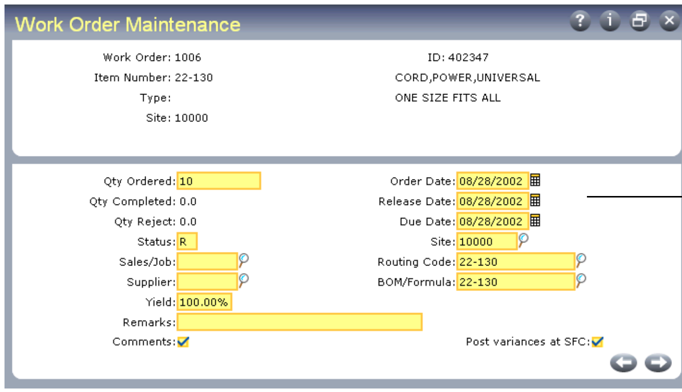
As work progresses, you can make any required changes to the work order BOM. This way, you can compare what you actually use with the standard. Item quantities allocated, issued, or picked are also maintained in the BOM.

Once the work order status is Exploded, Allocated, or Released, no more changes can be made to the BOM. However, you can reassign the picking location for items on the bill even if the work order status is Allocated or Released. Use Work Order Bill Maintenance (16.13.1) to make adjustments.

Scheduling Work Orders

MRP uses a combination of work order due date, release date, and manufacturing lead time to schedule work orders.

Fig. 6.4
Work Order Maintenance (16.1)



Release and Due Date are used in scheduling.

- The due date determines the date when inventory is needed and an order should be complete. MRP uses order due dates to determine when quantities will be available to replenish inventory.

For more details, see "Releasing Work Orders" on page 119.

- The release date is the date when an order is scheduled for release to the shop floor. MRP uses the release date to determine when components are required. When an order is released, the scheduled release date is changed to the date actually released.
- The release and due dates for an order are offset by the lead time for the item produced. For example, if it takes an average of five working days to manufacture an item, the release and due dates are separated by one week. This ensures that an order for that item will be completed on time provided that it is released on time.

Manually Controlling Due Dates

When you create an order in Work Order Maintenance, the due date is calculated from the release date. The calculation begins by setting the release date to the current date, then uses the manufacturing lead time and shop calendar to calculate the due date.

To define either the release or due date and have the program calculate the undefined date, enter the defined date and enter a question mark for the date you want calculated. The system calculates the date for the field containing the question mark using the date from the other field and the operation times from the item routing.

- If you enter a release date and enter a question mark in the Due Date field, the system calculates the due date by starting at the beginning of the release date and forward scheduling starting with queue time for the first operation.
- If you enter a due date and enter a question mark in the Release Date field, the system starts at the end of the due date and backward schedules by starting with the last move time for the last operation.
- If you leave both dates blank, the release date is set to today's date and forward scheduling is used.

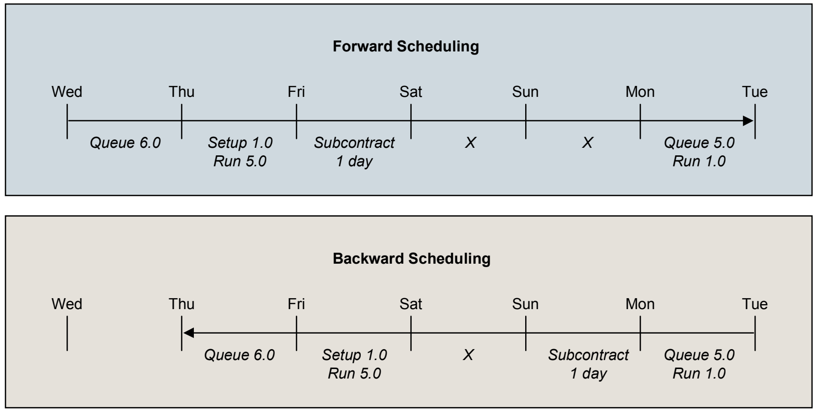
Tip
In all cases, the order quantity is used in calculating run time.

Example Figure 6.5 illustrates two schedules created based on the data listed in Table 6.6. The schedule is generated for 100 items, assuming six-hour shop days.

Table 6.6
Sample Schedule Setup

	Queue	Setup	Run	Subcontract
Operation 10	6	1	.05	
Operation 20				1 day
Operation 30	5		.01	

Fig. 6.5
Operation Times



Different release and due dates are possible using forward versus backward scheduling. This is because some lead time components are scheduled in shop days and some in calendar days. A shop day lead time component may be in effect over a weekend in one direction, whereas in the opposite direction, a calendar day component may be in effect.

Lead Time Calculations

See “Lead Times” on page 37 for details.

The system uses an average manufacturing lead time calculated from averages of queue, setup, run, subcontract, wait, and move times for routings. The calculation assumes the average order quantity for the item-site or item.

The operation start and stop dates indicate when an order will occupy a work center. Queue time precedes the start date. Setup, run, and subcontract times fall between the start and stop dates. Wait and move times follow the stop date.

When an order quantity differs significantly from the average order quantity, the system may allow too little or too much time to complete the order. The greater the difference between the actual quantity ordered and the average order quantity, the less likely it is that these dates will be realistic or reasonable.

Scheduling Operations

The distinction between setup and run time is important when more than one machine is used to perform an operation.

Example Each machine takes four hours to perform an operation on 100 units and each requires an hour of setup time.

Table 6.7 Operation Lead Time with Multiple Components

	Setup	Run	Packaging	Inspection
One Machine	1 hour	8 hours	16 hours	8 hours
Two Machines	1 hour	4 hours	16 hours	8 hours
	1 hour	4 hours		

In Table 6.7, if you decide to make 200 units with one machine, it takes nine hours (setup plus run). If you then decide to use two machines, it takes five hours for each machine, because the setup time is the same for each, but the run time is halved.

Some adjustments may be necessary when operations overlap. This occurs when some units proceed from one operation to the next before all units for that operation are complete. This reduces the aggregate lead time for completing multiple operations. Specify the number of overlap units in Routing Maintenance (14.13.1).

Rescheduling Operations

If you modify the operation start and end dates, changes are reflected on CRP and work order dispatch reports. However, executing Recalculate Capacity Plan (24.1) will return the schedule to the original dates.

To prevent this, do not recalculate Exploded, Allocated, or Released orders. You can also modify the queue or wait time for the operation, rather than its start date.

See "Executing CRP" on page 396 for more details.

Modifying Work Orders

Tip
When a routing or BOM code is blank, it defaults to the item number value.

Every work order has a BOM and a routing code, which determine the order's product structure and routing. You can specify these for each daily scheduled requirement. Modify these codes as needed in Work Order Maintenance (16.1) and then re-explode the order.

Re-explode Planned, Firm Planned, or Batch orders as needed by running MRP or by changing the work order status to Exploded, Allocated, or Released.

Modifying Work Order Bills

Often you must modify the bill of a rework order by adding components. Sometimes, as well, you must modify the bill of a regular work order. For example, there may be an engineering change order needing immediate implementation for all work-in-process, including orders that have been exploded, allocated, or released.

How you make a replace an existing component with a new one depends on the work order status.

- If an order has been released, you can issue the new component and return the old one. This results in an unfavorable material usage variance for the new component and a favorable usage variance for the old one. Use Work Order Bill Maintenance (16.13.1) to add the new component to the work order before issuing it.
- If an order is allocated or exploded, use Work Order Bill Maintenance to add the new component, updating the quantity required and quantity allocated, and delete the old one.

After modifying a work order bill, you should not change the status back to Firm Planned, since that causes the standard bill to be re-exploded.

Modifying Work Order Routings

Use Work Order Routing Maintenance (16.13.13) to add, delete, or change the routing of a work order that is exploded, allocated, or released.

In general, the start and stop dates for work order operations are not frozen. The system automatically reschedules the operations from the due date in any of the following situations:

- A work order is processed in Work Order Maintenance (16.1) and the initial status is Batch, Planned, or Firm Planned.
- A work order is processed using Work Order Maintenance and the final status is Firm Planned.
- A work order's due date changes.
- A work order is replanned by CRP.

Note If you are using the Advanced Repetitive module, you cannot add a routing operation to a cumulative order using Work Order Routing Maintenance. Instead, you must change the routing and roll up the cost again.

See "Advanced Repetitive" on page 261.

Releasing Work Orders

Inventory can only be issued or received against a released work order.

- Release orders one at a time using Work Order Release/Print (16.6).
- Release multiple orders at the same time using Multiple Work Order Release/Print (16.7).
- Release orders in Work Order Maintenance (16.1) by changing their status to Released. This method does not let you print a picklist or routing, but it still explodes phantom components and creates work orders for routable components.

Releasing a work order has the following effects:

- Items not previously allocated are detail allocated. The system uses the default picking logic defined in Inventory Control (3.24).
- The picklist is printed, showing the location and quantity of the material in Picked status for this order.
- The first operation is moved to the queue status if Move First Operation is Yes in Work Order Control (16.24).

See page 103.

Key Items

If there are shortages of important work order components, you can prevent the system from releasing an order or printing a picklist. Do this by designating these items as key items in:

- Item Master Maintenance (1.4.1)
- Item Inventory Data Maintenance (1.4.5)
- Item-Site Inventory Data Maintenance (1.4.6)

You can also change any component on a work order bill to a key item using Work Order Bill Maintenance (16.13.1).

If detail allocations cannot be made for the total quantity required for a key item, the order is not released. To check availability of non-key items before releasing an order, use Work Order Component Check (16.5).

Splitting Work Orders

Even if you check for potential shortages before an order is released, quality problems and inaccurate inventory balances may result in a shortage of components. These shortages can be monitored using Work Order Bill Shortage Report (16.16) and Work Order Bill Shortage by Item Report (16.17).

If necessary, use Work Order Split (16.9) to move part of a work order through remaining operations, while the rest waits for needed components. You can split open operations between the original and new work order.

Tip
Labor is tracked separately for each ID on the work order.

When an order is split, each portion keeps the same work order number, but has a unique ID. Component costs are typically tracked under the original ID. However, when you split the order, you are prompted to divide the components between the original work order and the new work order. You can divide component only if they have not been issued. Use Work Order Bill Maintenance (16.13.1) to adjust the bills as required.

Creating Picklists

After you release a work order, you can print its picklist. The picklist lists the component requirements and the sites, locations, lot/serial numbers, and reference numbers for the items to be issued. The system creates detail allocations when an order is released, regardless of whether or not you print a picklist. Detail allocations reserve specific quantities in inventory for a work order.

The picking logic used is determined by settings in Inventory Control.

See *User Guide Volume 6: Master Data* for details.

You can release an order without printing a picklist and routing, but you cannot print a picklist for an order without releasing it.

In a picklist, floor stock appears separately, without site or location. Floor stock should have issue policy set to No for the item-site or item.

For an order with several operations, components can be grouped together on separate picklists by setting their lead time offset (LT Offset) to indicate when they are required with respect to the release date. Define lead time offset in Product Structure Maintenance (13.5) or Formula Maintenance (15.5).

Reprinting Picklists

You may need to reprint a picklist if not all items were available when it was first issued. Use Work Order Release/Print (16.6) and set Reprint Picked Quantities to No (the default). All items that were not available before are listed.

Another way to reprint a picklist while tracking components already issued to an order is to change the status to Allocated, then re-release the order.

Changing the status to Exploded is possible, but this can cause differences in how phantom use-up logic is applied. If no components have been issued and no changes made to the work order bill or routing, then the status can be changed to Firm Planned, Exploded, or Allocated before re-releasing. Changing the status to Firm Planned eliminates changes entered manually to the work order bill or routing.

Issuing Components

See Chapter 7, “Shop Floor Control,” on page 137.

For more on using Work Order Receipt Backflush, see “Subcontract Operations” on page 125.

Work order operations begin when a work order is released and its components issued. Monitor operations using the Shop Floor Control module.

There are three ways to issue inventory to a work order:

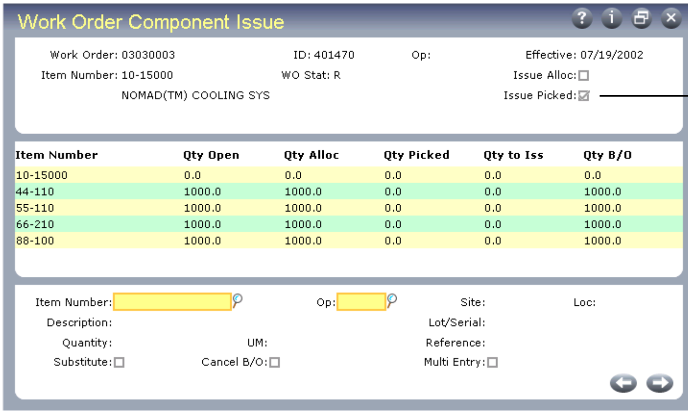
- Issue inventory directly with Work Order Component Issue (16.10).
- Issue inventory as completed products are received with Work Order Receipt Backflush (16.12).
- Issue inventory, report labor, and receive items with Work Order Operation Backflush (16.19).

Inventory transactions occur at different points depending on which method you use. Component QOH is reduced at a later time using the backflush method.

Work Order Receipt Backflush combines the functions of Work Order Component Issue and Work Order Receipt. You can also backflush quantities different from those received. Either method keeps track of the inventory transactions used to issue components to a work order and excludes floor stock, which is issued using an unplanned issue transaction.

Work Order Component Issue

If all components were picked from the locations printed on the work order picklist, they can be issued automatically by setting Issue Picked to Yes. This reduces manual entry because it sets the default sites, locations, lot/serial numbers, references, and quantities from the detail allocations on the picklist.



Yes streamlines data entry.

Fig. 6.6
Work Order Component Issue (16.10)

Issues are not restricted to what the system has allocated. You can override the selections manually. The work order and inventory balances are updated only after approval of the quantities to issue from inventory.

The system does not prohibit shipments from using inventory already allocated to another order. This makes timing important. The longer the period between the time a picklist is printed and the time it is picked for shipment, the greater the chances inventory will not be available when you finally try to pick it.

In some instances, when an item is not available, it is possible to substitute a different item—Philips head screws for slotted head screws, for example. When this is required, first set up valid substitute relationships in Alternate Structure Maintenance (13.15) or Item Substitution Maintenance (13.19). When a substitute item is issued to a work order, the requirement for the original component item is reduced.

Note If you enter additional quantities or negative quantities for an item during Work Order Component Issue or a Work Order Receipt Backflush, the quantity allocated cannot become more than the quantity required or less than zero (0). It is set to the quantity required or the quantity open, whichever is less.

Components issued to a work order are posted to WIP at GL cost.

Issuing and Receiving Between Sites

You can receive or issue items at a site other than the order creation site. There are two basic scenarios:

- Receive completed items at a site other than the order.
- Issue items to a site other than the order site.

In the first scenario, you receive at Site 2 a work order created at Site 1. First, a receipt transaction is created at Site 1, the order site. Then an issue transfer transaction is created at Site 1, subtracting the received quantity. A balancing receipt transfer transaction is then created at the receiving site, Site 2. Table 6.8 shows this transaction for a quantity of 100.

Table 6.8
Scenario One

Site 1		Site 2	
RCT-WO	100.0		
ISS-TR	–100.0		
		RCT-TR	100.0

In the second scenario, if you issue components from Site 2 for an order created at Site 1, an issue transfer is first created at Site 2, the issuing site. Then a receipt transfer is created at the order site, Site 1, and then the issue work order transaction is created, again at Site 1.

Table 6.9
Scenario Two

Site 1		Site 2	
		ISS-TR	-100.0
		RCT-TR	100.0
ISS-WO	-100.0		

You can specify the issue or receipt location and site on any of these transactions. However, if the order site is defined with automatic locations set to No, the item's default location—defined in Item Master Maintenance—must exist at the order site. For example, if the part master site and location are Site 3 and Location 99, you would need to create Location 99 at the order site, Site 1, before you could execute the issue or receipt transaction.

Subcontract Operations

Work orders with subcontract operations can be used in conjunction with special subcontract purchase orders. When units are returned from a supplier with a subcontract purchase order, the system recognizes the value added to the work order, completes units for that operation, and debits the WIP account.

Separate departments, and possibly work centers, should be set up for outside processing to distinguish them from internal operations. For example, if all subcontract work center codes begin with a common character such as S, it is easy to identify them on Work Order Dispatch Report (16.18) and other reports. Departments and work centers can be defined more specifically for individual suppliers, depending on whether operations are performed by a single supplier.

See "Subcontract Operations" on page 40 for more setup details.

Subcontract Life Cycle

When the Work Orders, Shop Floor Control, and Purchasing modules are used together, the subcontract cycle includes the following steps:

- Work Order Maintenance (16.1) or Planned Work Order Approval (23.10)
- Work Order Component Check (16.5)
- Work Order Release/Print (16.6)
- Work Order Component Issue (16.10)
- Work Order Dispatch Report (16.18)
- Purchase Order Maintenance (5.7)
- Purchase Order Receipts (5.13.1)
- Labor Feedback by Work Center (17.1) (optional)
- Work Order Receipt (16.11)
- Work Order Accounting Close (16.21)

Requirements for Subcontract Purchase Orders

Use Work Order Dispatch Report (16.18) and Work Center Dispatch Report (18.4.8) to determine when purchase orders for subcontract operations should be released.

The Work Order Dispatch Report displays the operations scheduled at a work center, sorted by start date. The report includes the item being built, the work order that authorizes the work, standard setup and run times, and the open quantity on the order at that work center.

Use this report to provide work visibility for a specified number of days, determined by the Window Days field. Also use it as a measurement tool for comparing production progress with production plans.

Receiving Work Orders

When a work order is completed on the shop floor, the items are typically sent to the stockroom.

- Use Work Order Receipt (16.11) to receive items, close the order, and backflush components of final assembly work orders.
- If you did not issue items previously, issue them when completed products are received with Work Order Receipt Backflush (16.12).
- Use Work Order Operation Backflush (16.19) to issue items, report labor, and receive completed items at an operation.

If you use the Shop Floor Control module, you can enter labor feedback and test results at receipt, and report individual operations as completed.

When a work order is received:

- Inventory increases by the amount of the receipt.
- The open order quantity decreases by the amount of the receipt.
- Any reject quantity is written off to the Scrap account and not placed in inventory.

If Auto Lot Numbers is Yes in Item Inventory Data Maintenance (1.4.5), the system automatically assigns the work order ID as the lot number for inventory received from a work order. This is true regardless of the value of Lot/Serial Control for the item.

Note If you are using the Compliance module, you can set up lot groups for assigning automatic numbers. If defined, lot groups are used rather than the work order ID.

See *User Guide Volume 6: Master Data*.

During receipt, you can set the work order status to Closed. Once closed, no further component issues or completions can be recorded against the order.

See "Closing Work Orders" on page 133.

The system captures the receipt and close date as well as the user ID of the person who received or closed the work order. This information automatically appears on two reports:

- Work Order Status Report (16.3.3)
- Work Order History Report (16.3.6)

Closing a work order does not clear the balance in WIP. This action is done by using Work Order Accounting Close (16.21).

Receiving and Backflushing

When you backflush components at work order receipt, the system explodes the item product structure by the quantity of the parent item received to calculate the standard component quantities used.

Two fields in Work Order Receipt Backflush (16.12) enable you to control the default values for quantity to issue, depending on the history of the work order.

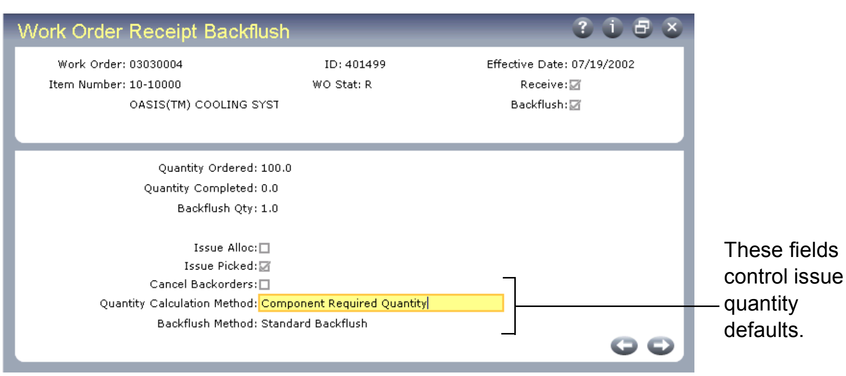


Fig. 6.7
Work Order Receipt Backflush (16.12)

Quantity Calculation Method. Sets the calculation method used to determine the quantity to issue for all components. The default is Component Required Quantity. Other valid choices are Work Order Bill Qty Per and Phantoms First. You can still adjust each issue quantity on a line-by-line basis in the detail screen.

Backflush Method. Defines whether to use the backflush quantity you entered (the default standard backflush) or to include prior issues and receipts against this order.

The two fields work in conjunction with each other. In most cases, you should accept the default. However, in three instances, you obtain more accurate issue quantities by resetting these values:

- The first instance occurs when you issued components to the order or made a partial receipt without issuing all components. In this instance, set the backflush method to Net of Prior Issues and Receipts. This setting factors in prior receipts and issues to derive the Quantity to Issue value.

  Example If you issue all of a component or more than you need, the quantity to issue is 0. If, however, you receive and backflush 50 out of 100 parents and then receive the remaining 50, the quantity to issue for a component with a Qty Per of 1 is 50. When this is the only special condition, leave Quantity Calculation Method set to Component Required Quantity.

- A variation on the previous example occurs when you complete a partial receipt and then modify the Qty Required and/or the Qty Per values for a component in Work Order Bill Maintenance (16.13.1). For the quantity to issue calculation to take into account full requirements for prior completions, use Net of Prior Issues and Receipts in the Backflush Method field. Otherwise, the quantity to issue reflects component requirements for the open order quantity only.

- The last instance occurs when you change the work order bill Qty Per for a component without recalculating the quantity required. To recalculate the quantity to issue including the revised component Qty Per, use the Work Order Bill Qty Per in the Quantity Calculation Method field.

Example The work order bill quantity is reset from 1.0 to 1.5 on an order for 100. With a calculation method of Work Order Bill Qty Per, the quantity to issue is 150. Otherwise, it remains 100. If this is the only special condition on an order, leave Backflush Method set to Standard Backflush.

If you have a combination of the two circumstances, use Net of Prior Issues and Receipts and Work Order Bill Qty Per.

Use the Component Required Quantity option for the Quantity Calculation Method field when rounding or truncation errors may occur during backflush as a result of a component having a small or non-evenly divisible quantity relative to the bill.

If you are completing a partial receipt and want to use up global phantoms before issuing components for the phantom, enter Phantoms First in the Quantity Calculation Method field.

Example Ten phantoms are in stock. If you complete a partial receipt backflush for 10 items and the phantom and its components have a quantity per of 1, the phantom quantity to issue is 10. Otherwise, the phantom and its components are calculated proportionally, each with a quantity to issue of 5.

Since phantoms are not defined as phantoms in the work order bill, the Phantoms First option uses the current product structure to identify phantom items.

When you use Work Order Backflush Receipt to receive or close work orders, the system records the system date as the receipt or close date and your user ID. These items appear on two work order reports.

See “Closing Work Orders” on page 133.

Managing Scrap

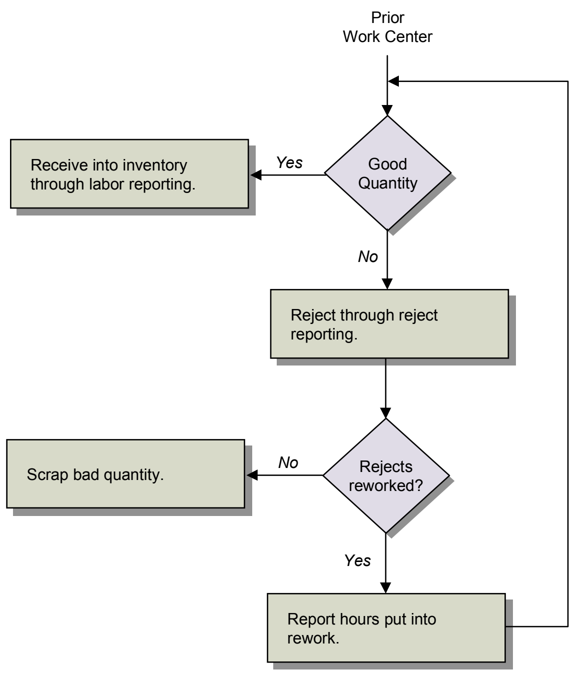
Scrap refers to unusable items. In the manufacturing process, there can be two kinds of scrap:

- Components issued to the work order
- Items built by the work order that are unusable

Component Loss

When additional components are required for a work order because items were lost or unusable, the replacement components should be issued to the work order. This results in an unfavorable material usage variance for the order.

Fig. 6.8
Scrap Cycle



Product Loss

When products are lost during manufacturing, you can record the loss for the work order when it is received. For an operation, you can record the loss using Shop Floor Control, but this is for reporting only. Shop Floor Control creates WO-SCRAP operation history records but does not update the general ledger.

Only units recorded as rejects during work order receipt affect the general ledger, debiting scrap and crediting WIP. You can use Work Order Receipt, Work Order Receipt Backflush, or Work Order Operation Backflush to update the general ledger.

Note Another way to scrap items is by using an unplanned issue and changing the default account debit account to the Scrap account.

Scrap Quantities by Order

To view scrap quantities by order, regardless of costing method, use Work Order by Order Report (16.3.1).

Generating Reports

Many of the Work Order Reports (16.3) reflect activities supported by the Repetitive module.

Table 6.10 Work Order Reports

Menu	Report	Description
16.3.1	Work Order by Order Report	Designed for managers who need the information available in Work Order Maintenance (16.1), without work order bill or routing details.
16.3.2	Work Order by Item Report	Designed for managers who need the information available in Work Order Maintenance (16.1), without work order bill or routing detail.
16.3.3	Work Order Status Report	Designed for managers who need information on the current status of work orders, including bills and routings, receipt and close dates, and the user ID of the person who receives or closes them.
16.3.4	Work Order Cost Report	Designed for accountants and managers who need to analyze the costs and variances associated with work orders. This report is normally used for closed work orders. It identifies work order costs, grouping them into five categories: material, labor, burden, subcontract, and method change. Material costs are supported by inventory transaction data for work order components. Labor, burden, and subcontract costs are supported by transactions for operations. If this report is run for work orders that have not been processed by Work Order Accounting Close (16.21), the variances calculated may be incomplete.

Menu	Report	Description
16.3.5	Work Order WIP Cost Report	Designed for accountants who need to see how the WIP balance is supported by work order activity. It sorts first by WIP account, then work order, displaying the accumulated material, labor, burden, and subcontract costs, and the cost of receipts and rejects, to arrive at the cost currently in WIP for each order and each WIP account. Activities affecting these costs include component issues, labor feedback, operation completions, purchase order receipts (for subcontract orders), and work order receipts.
16.3.6	Work Order History Report	Designed for managers and accountants who need to see closed work orders with their bills, routings, date of closure, and user ID of the person who closed them. Components are reported with the quantities required and issued. Operations are reported with the number of units completed, and the expected and actual hours for setup and run time.
16.18	Work Order Dispatch Report	In a job shop, it is important to know which work orders will arrive at a work center and which orders are already there. This information helps you determine priorities and anticipate work load. This report groups this type of information by work center. The Window field lets you control and filter incoming orders based on the start date of the operation and today's date. For example, when the window is three days, the report includes open work order operations that should be started within three days of today.

Note Most of the reports in the Work Orders and Shop Floor Control modules can also be used for Repetitive. In particular, Work Order Cost Report (16.3.4), Work Order WIP Cost Report (16.3.5), and Work Order History Report (16.3.6) play an important role in reporting activity against cumulative work orders.

Closing Work Orders

To close a work order, complete the following steps:

1 Change the order's status to Closed. You can do this by setting Close to Yes when completed units are received, or by using Work Order Maintenance (16.1).

   Note When a work order is referenced by a flow scheduled order and you close the flow scheduled order using Flow Schedule Close (17.21.19), the system automatically changes the work order's status to Closed. You can reopen it using Work Order Maintenance.

See "Closing Flow Scheduled Orders" on page 210.

2 Run Work Order Accounting Close (16.21) to post variances, clear WIP, and close outstanding operations. Execute this program regularly, at least at the end of each fiscal month, for completed orders.

The system prevents component issues and work order receipts for a closed work order. If you want to process inventory for a closed work order, you must change its status back to Released.

The system records the work order close date (the system date). The system also records the user ID of the person who closed the work order.

The work order close date and user ID are captured when the work order is closed through the following:

- Work Order Maintenance (16.1)
- Multiple WO Status Change (16.8)
- Work Order Receipt (16.11)
- Work Order Receipt Backflush (16.12)
- Work Order Operation Backflush (16.19)

Although you are not prompted to enter the work order close date or your user ID, these items are captured by the system and appear automatically on two work order reports:

- Work Order Status Report (16.3.3)
- Work Order History Report (16.3.6)

Work order close and receipt dates are recorded on discrete work orders only. Scheduled and cumulative work orders, created through Repetitive and Advance Repetitive, do not include this functionality.

See "General Ledger Period End" on page 135.

The work order close and receipt dates do not affect the effective date of the accounting close function. GL period control does not apply to the work order and receipt dates.

Work Order Accounting Close

Work Order Accounting Close (16.21):

- Completes open work order operations.
- Calculates and posts work order variances for material, labor, burden, and subcontract costs.
  - Calculates and posts usage variances when the labor quantity used differs from the standard.

    For example, if it took six hours to complete an operation scheduled for five hours, a labor usage variance of one hour is posted.
  - Calculates and posts rate variances for material and subcontract when cost used differs from standard cost. If pay rates are defined in Actual Pay Rate Maintenance (14.13.21), rate variances are also calculated for labor.

    For example, when the standard subcontract cost is $10 and the PO cost is $12, the subcontract rate variance is $2.
- Reconciles the WIP account for closed work orders by calculating and posting method change variances for any residual variances. WIP balances cannot be changed after the work order variances are posted.
- Updates current labor and subcontract costs.
- Posts floor stock amounts.

For Repetitive programs, Cumulative Order Accounting Close (18.9) performs the same operations, but only for repetitive work orders. Work Order Accounting Close (16.21) closes both repetitive work orders and standard work orders.

General Ledger Period End

Since you can enter a GL effective date on work order, shop floor control, and repetitive transactions, a strict procedure is not required to account correctly for activity in the general ledger. Some reports, such as Work Order WIP Cost Report (16.3.5), are sensitive to period-end procedures. Use the following outline to write a procedure that fits your needs.

1. All work order, shop floor control, and repetitive transactions should be completed and reviewed before starting the new period, including the following:
   - Work Order Component Issues (16.10)
   - Work Order Receipts (16.11)
   - Work Order Receipt Backflush (16.12)
   - Work Order Operation Backflush (16.19)
   - Labor Feedback by Work Order (17.1), by Employee (17.2), by Work Center (17.3)
   - Operation Complete Transaction (17.5)
   - Repetitive Setup Transaction (18.13)
   - Repetitive Labor Transaction (18.14)
   - Non-Productive Labor Feedback (17.4)
2. The status of all closed work orders should be changed to Closed.
3. All open cumulative work orders in the Repetitive module should be changed to Closed.
4. Run WIP Material Cost Revaluation (16.22) to update allocated, released, and closed work orders.
5. Run Work Order Accounting Close (16.21) and Cumulative Order Accounting Close (18.9).
6. Print Work Order WIP Cost Report (16.3.5) and any other time-sensitive reports required.
7. After reviewing these reports, proceed with the new period.

Deleting Work Orders

You can delete work orders using Work Order Maintenance under two conditions:

- They have a status of P (Planned), B (Batch Input Firm Planned), or F (Firm Planned) with a WIP total of zero.
- They have a status of C (Closed), a WIP total of zero, and a valid accounting close record.

Obsolete work orders can also be deleted and/or archived with Work Order Delete/Archive (16.23). Only orders closed with Work Order Accounting Close can be deleted.

Chapter 7

Shop Floor Control

The Shop Floor Control module tracks activities and records operation status and labor times for manufacturing jobs released using the Work Orders module.

Introduction

Use Shop Floor Control to report setup time, hours worked, material scrapped, and the number of units completed for a specific work order operation. This information is used to track the status of work order operations, monitor performance of work centers, and update the general ledger (GL) for manufacturing costs.

The Repetitive and Advanced Repetitive modules contain reports and transactions similar to those in Shop Floor Control. Review Chapter 10 and Chapter 11 for information on these modules.

For details, see *User Guide Volume 11: PRO/PLUS*.

The optional PRO/PLUS WIP Lot Trace (WLT) module affects some features of the Shop Floor Control module. If you are using PRO/PLUS, WIP Lot Trace is available as menu option 3.22.13. When activated, additional frames display in some programs. The discussion in this chapter assumes that WLT features are not active.

Reporting Labor by Operation

You can report labor in Shop Floor Control by work order, employee, or work center, using:

- Labor Feedback by Work Order (17.1)
- Labor Feedback by Employee (17.2)
- Labor Feedback by Work Center (17.3)

For each feedback transaction, you must specify an employee code, a department code, and a work center or production line code.

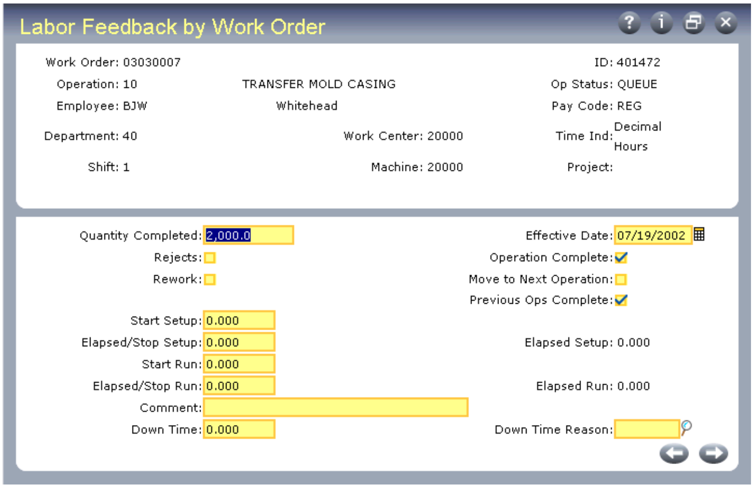


Fig. 7.1
Labor Feedback by Work Order (17.1)

Employee

Some companies summarize the hours worked by all employees for an operation and record them in a single transaction. Others record the hours worked by each employee. Use the second method if you want to report on employee efficiency or examine labor rate variances.

You can calculate employee efficiency when you report labor by employee, provided that only one employee works on any given operation.

See "Utilization and Efficiency" on page 149 for more information.

The system calculates labor rate variances by comparing the labor rate defined for an employee in Actual Pay Rate Maintenance (14.13.21) to the standard labor rate for the operation's work center, defined in Work Center Maintenance (14.5).

Note The employee code specified for a transaction does not need to correspond to an actual person. You can set up an employee code in Employee Maintenance (2.7.1) to be used for reporting purposes only.

Department

The department code defaults from the work order routing. The system creates GL transactions using the accounts associated with this department code. Changing the department code changes the accounts used for the GL transactions created by these programs.

Work Center

The work center code defaults from the work order routing. The system uses the work center setup, labor, and burden rates to calculate costs and create GL transactions. Changing the work center code results in method change variances when the work center rates differ.

Item Quantities

For each work order operation, you can record the item quantities completed, rejected, and reworked.

Note Labor feedback transactions cannot be modified or deleted once they have been processed. To reverse the effect of incorrect transactions, you can enter transactions for negative values.

When you enter a transaction, the system moves either the quantity ordered or the quantity reported complete at the last operation to the operation being reported. Which quantity displays depends on the setting of Move Next Operation for the previous operation. The quantity open for an operation is this starting quantity minus the quantities completed and rejected at that operation.

Quantity Completed. The number of acceptable units produced at this operation, used to calculate variances, work center efficiency, and GL transactions:

- If Move Next Operation is Yes, the quantity completed for an operation automatically moves to the next operation. This occurs regardless of whether the previous operation is complete.
- If Move Next Operation is No, the quantity completed for an operation does not affect the quantity open at the next operation.

Set the default value for this field in Shop Floor Control (17.24).

Quantity Rejected. The number of unacceptable units produced at this operation that cannot be moved to the next operation.

Quantity Reworked. The number of unacceptable units requiring additional processing produced at this operation. These do not all need to result in good units that can be moved to the next operation.

Quantities reported as completed, rejected, and reworked do not affect the quantity open for a work order. If the reject quantity significantly reduces the expected receipt quantity for an order, you should use Work Order Maintenance (16.1) to reduce the order quantity to the expected quantity so that MRP plans based on the correct order quantity.

Rejected and reworked quantities are independent of each other. For example, if you report 25 units as rejected and later report 25 units as reworked, the system shows both the reject and rework quantities as 25. If you want to change the reject quantity to zero, you must specify a reject quantity of –25 units.

Reject and rework quantities have no impact on GL, since no transactions are created when they are reported. They are not used to calculate variances or work center efficiency.

Times

You can enter setup times, run times, and downtimes in decimal hours (D) or clock hours (H). For example, an hour and 15 minutes can be entered as 1.25 decimal hours or 01:15:00.

Enter elapsed setup and run times directly, or let the system calculate them from the start and stop times. For example, for a start time of 08:00:00 and a stop time of 14:45:00, the system calculates an elapsed time of 6.75 decimal hours.

Operation Status

Operation status codes indicate the detailed status of individual operations. The system automatically assigns status codes to operations as transactions are processed.

Queue. An operation's status is automatically set to Queue when material is moved to that operation, either by releasing a work order, entering labor feedback for that operation, or using Operation Move Transaction (17.6) to manually move material.

When Move Next Operation is Yes in a labor feedback transaction, the next operation is automatically set to status Queue and quantities reported complete are moved to that operation.

Setup. An operation's status changes to Setup when you report setup time for that operation.

Running. An operation's status changes to Running when you report run time for that operation. This is not affected by the number of units reported as completed, rejected, or reworked.

For more information, see "Closing Operations" on page 144.

Complete. An operation's status changes to Complete when you:

- Report it as completed using one of the labor feedback transactions or Work Order Operation Backflush (16.19).
- Close it using Operation Complete Transaction (17.5).
- Run Work Order Accounting Close (16.21).

When an operation is complete, you cannot process additional transactions against it. However, you can reopen operations if required using Work Order Routing Maintenance (16.13.13).

Hold. Indicates the operation is on hold. This status can only be set manually in Work Order Routing Maintenance.

A blank status indicates an inactive operation. An operation's status is blank when the work order routing is first exploded and remains blank until you record activity for it.

Use Work Order Routing Maintenance to manually change an operation's status, if required.

Recording Nonproductive Labor

Shop floor control functions let you record nonproductive or indirect labor for employees—for example, preventive maintenance and meetings—and downtime for work centers—for example, machine failures. Shop floor reports use this information when calculating utilization and efficiency.

For nonproductive labor or downtime not associated with a specific work order, use Non-Productive Labor Feedback (17.4). Otherwise, record nonproductive labor and downtime using the Down Time field in standard labor feedback transactions.

Nonproductive labor transactions reference reason codes set up in Reason Codes Maintenance (36.2.17) with a reason type of Down.

Note Many types of nonproductive labor, such as paid vacations, paid holidays, and paid sick leave, should be handled in a payroll system.

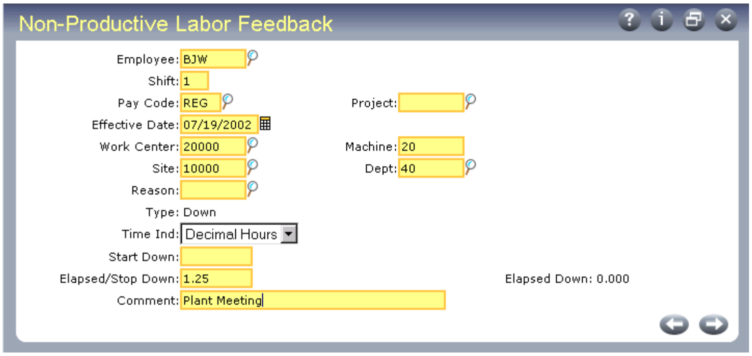


Fig. 7.2
Non-Productive Labor Feedback (17.4)

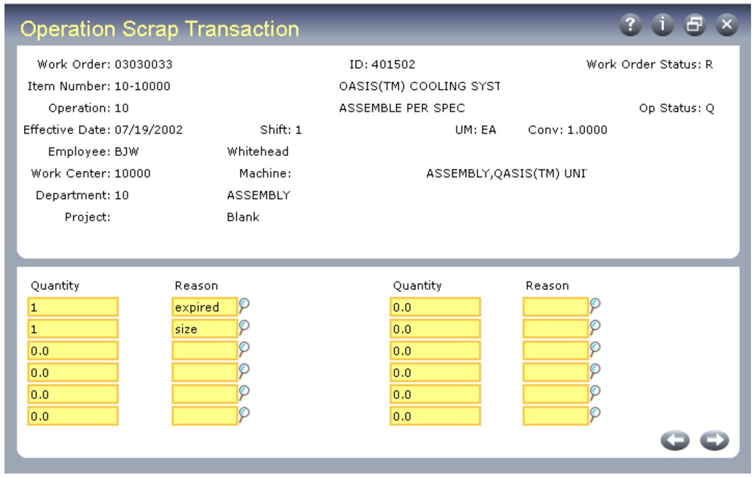
You can review recorded downtime using Down Time Report (17.16) or Down Time by Reason Report (17.17).

Reporting Scrap

You can use Operation Scrap Transaction (17.7) to report scrap component material at a work order operation. This program generates WO-SCRAP operation history records for transactions and has no effect on GL accounts.

The first frame is used to identify the work order operation. Use the last frame to enter quantities scrapped and the corresponding reason codes.

Fig. 7.3
Operation Scrap Transaction (17.7)



Closing Operations

You can close an operation by running Operation Complete Transaction (17.5). Quantity completed for an operation needs to be entered in any of the Labor Feedback Transactions (by Work Order, Employee, or Work Center).

Setting Previous Ops Complete to Yes closes all previous open operations. For these operations, the system reflects quantity completed at the current operation being closed. The system calculates labor using the standard setup and run times for the change in completed quantity in prior operations.

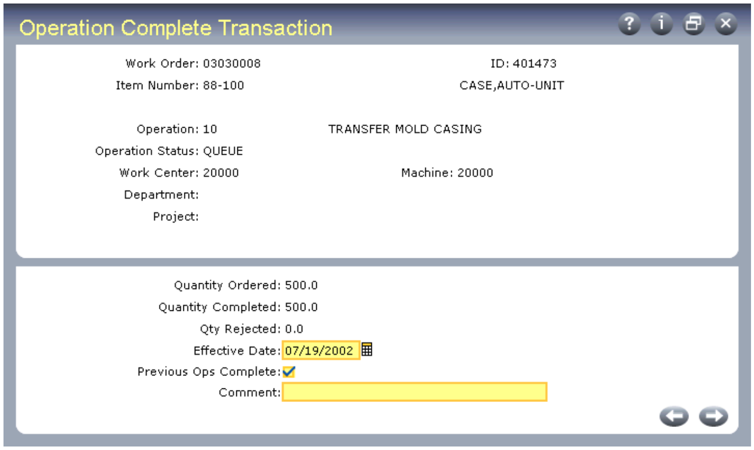


Fig. 7.4 Operation Complete Transaction (17.5)

For example, if a work order has five open operations: 10, 20, 30, 40, and 50, and no completions were reported for any of these operations, when operation 50 is closed for a quantity of 100, the system optionally closes operations 10, 20, 30, and 40 for 100 units. However, if operation 50 is closed for 75 units and 90 units had been previously reported as complete at operation 20, the system closes operations 10 and 20 for a quantity of 90 units, and operations 30 and 40 for a quantity of 75 units.

Operation	Previously Completed	Completed
10	0	90
20	90	90
30	0	75
40	0	75
50	0	75

If operation 40 was closed for a quantity of 85 units, the system closes operation 30 for a quantity of 85, and operations 10 and 20 for a quantity of 90.

Operation	Previously Completed	Completed
10	0	90
20	90	90
30	0	85

Operation	Previously Completed	Completed
40	85	85
50	0	75

Note Work Order Accounting Close (16.21) closes open operations using the same logic.

Closed operations do not contribute to the projected load for a work center.

Generating Reports

Shop floor control reports display data based on the following:

- Transactions
- Downtime
- Input and output
- Utilization and efficiency

Transactions

Transactions are created when you record labor feedback, nonproductive labor, downtime, and operation completions. You can review these transactions by work center, work order, or employee.

The system automatically assigns a transaction number and transaction type that identifies the operation history record. Table 7.1 lists the system-generated types and the name of one or more of the programs that creates the transaction.

Note Many of these transactions are created in more than one program. In this case, the table simply indicates one or more typical programs associated with the transaction and is not intended to be a complete list.

Table 7.1
Operation History Transaction Types

Transaction Type	Description	Program
BACKFLSH	Advanced Repetitive labor and material usage.	Backflush Transaction (18.22.13)
CLOSE	Operation closed.	Cumulative Order Close (18.22.10)
DOWN	Non-productive labor reported for Shop Floor Control functions.	Labor Feedback by Work Order (17.1)
DOWNTIME	Downtime hours reported for Repetitive and Advanced Repetitive functions.	Repetitive Labor Transaction (18.14) Down Time Transaction (18.22.20)
EXPENSE	Expense consumed for Customer Services functions.	Call Activity Recording (11.1.1.13) Project Activity Recording (10.5.13)
FLOORSTK	Floor stock inventory expense posted at order close.	Post Accumulated Usage Variance (18.22.9)
LABOR	Labor hours reported for Repetitive, Advanced Repetitive, and Customer Services functions.	Repetitive Labor Transaction (18.14) Run Labor Transaction (18.22.14) Call Activity Recording (11.1.1.13) Project Activity Recording (10.5.13)
MOVE	Moved to next operation.	Labor Feedback by Work Order (17.1)
MUV-CMP	Material usage variance posted for component usage variance at order close.	Post Accumulated Usage Variance (18.22.9)
MUV-WIP	Material usage variance posted for WIP material scrap usage variance at operation close.	Post Accumulated Usage Variance (18.22.9)
RBUV	Run labor burden usage variance posted at operation close.	Post Accumulated Usage Variance (18.22.9)
REWORK	Quantity reworked and labor hours posted.	Rework Transaction (18.22.17)
RLUV	Run labor usage variance posted at operation close.	Post Accumulated Usage Variance (18.22.9)
SBUV	Setup labor burden usage variance posted.	Post Accumulated Usage Variances (18.22.9)
SCRAP	Quantity scrapped at an operation.	Operation Scrap Transaction (17.7)
SETUP	Setup hours recorded.	Setup Labor Transaction (18.22.15)

Table 7.1 — *Operation History Transaction Types* — (Page 1 of 2)

Transaction Type	Description	Program
SLUV	Setup labor usage variance posted.	Post Accumulated Usage Variances (18.22.9)
SUBCNT	Subcontract quantity received or returned at an operation.	Purchase Order Receipts (5.13.1) Purchase Order Returns (5.13.7)
SUBSHIP	Quantity of WIP shipped to a subcontractor.	Sub Shipper Issue (18.22.5.11)
SUV	Subcontract processing usage variance posted at operation close.	Post Accumulated Usage Variance (18.22.9)
TRANSFER	Quantity of WIP transferred to another cumulative order at operation close.	Cumulative Order Close (18.22.10)
VAR-POST	Labor variance posted at work order receipt.	Work Order Receipt Backflush (16.12)
WIPADJ-I	Quantity adjusted for input queue.	WIP Adjust Transaction (18.22.21)
WIPADJ-O	Quantity adjusted for output queue.	WIP Adjust Transaction (18.22.21)
WIPADJ-R	Quantity adjusted for reject queue.	WIP Adjust Transaction (18.22.21)
WO-CLOSE	Work order accounting close post.	Work Order Accounting Close (16.21)

Table 7.1 — *Operation History Transaction Types* — (Page 2 of 2)

Use either of the following reports to review operation history records:

- Operation Transaction Browse (17.8)
- Operation Transaction Detail Inquiry (17.9)

Downtime

See "Recording Nonproductive Labor" on page 142.

Review recorded downtime by work center or reason code using the following reports:

- Down Time Report (17.16)
- Down Time by Reason Report (17.17)

Input and Output

Use Input/Output Report (17.12) to review the load at work centers. You can use this function to compare planned input and output with actual input and output for a given period. The planned input and output data are based on work order operation start dates, standard setup and run times, and the work center or shop calendar. Actual input is based on the quantities moved to a work center, while actual output is based on the quantities completed at a work center.

Utilization and Efficiency

Two key measures of performance are utilization and efficiency. Utilization is the ratio of the total number of hours worked to the total number of hours available to be worked, as defined in the shop calendar.

*Utilization % = Actual Hours Worked/Clock Time Scheduled * 100*

Use Work Center Utilization Report (17.18) to review this information.

Efficiency is the ratio of the total number of standard hours earned by completing units at operations to the total number of hours worked.

*Efficiency = Standard Hours Earned/Actual Hours Worked * 100*

Productivity is the ratio of standard hours earned divided by the number of available hours. It is not reported, but can be manually calculated by multiplying utilization by efficiency.

*Productivity % = Standard Hours Earned/Clock Time Scheduled * 100*

Use any of the following reports to review efficiency data:

- Efficiency by Work Center Report (17.19)
- Efficiency by Work Order Report (17.20)
- Efficiency by Employee Report (17.21)

Deleting and Archiving Transactions

Depending on the volume of transactions, you may only want to maintain one to three months of history online. Use Operations History Delete/Archive (17.23) to archive old transactions and delete them from the database.

Use this programs carefully to prevent deleting data or archiving data that may be needed online. While recovery of archived data is relatively easy, it is not possible to recover deleted data that has not been archived.

Chapter 8

Flow Scheduling

This chapter discusses how to create and maintain production line schedules in a flow manufacturing environment.

Introduction

Flow manufacturing represents a relatively simple path of production processes chained together in an uninterrupted work flow that follows the natural flow of the product. Each step is evaluated for the amount of value added to a customer—regardless of whether that customer is an end user or the next sequential step in the process. Each step in the process produces only the amount needed at the time it is needed—with minimum materials, equipment, labor, time, and space.

An important goal is to minimize or eliminate nonvalue-added work in the production process. Machines and people are arranged to maintain a steady and efficient flow of work. There is minimal external subassembly work, and completed work typically is not returned to a storage location. Quality is integrated into the flow process. The workers at each step are responsible for meeting quality standards for the current activity as well as previous steps. Defective parts are not set aside for rework—they are either fixed within the process or scrapped.

Visibility within the production process is an extremely important concept in flow manufacturing, where agility to adjust to real demand is critical. To respond quickly and effectively to changes in demand without maintaining overly redundant equipment and extra labor resources, production line managers need fast, accurate information on how different resource scenarios will make the production lines meet current schedules more effectively.

Additionally, the line managers need to know how their lines are performing in relationship to schedules so that they can refine resource configurations to achieve the highest possible performance.

Flow scheduling provides tools for line managers to use in making their lines more effective.

Overview of Flow Scheduling

A flow schedule is a statement of planned output for a production line for a defined period of time. It consists of a sequenced collection of flow scheduled orders, each of which is represented by a schedule detail record in the database. Based on your business methods, a flow scheduled order can include a reference to a work order that can be processed using standard tools in the Work Orders module.

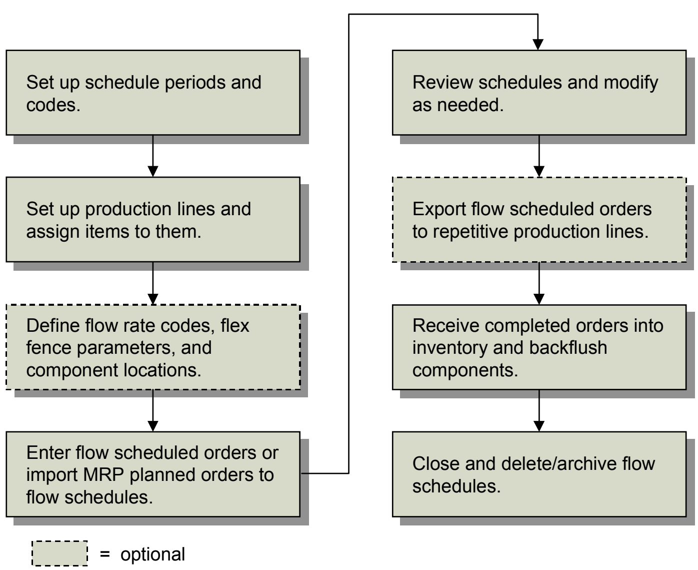
Parts are processed in the natural flow of tasks required to create the finished product. Items are not made in batches in separate functional departments, and the production of subassemblies is incorporated into the production of the final part. This eliminates the need to prepare schedules for any items other than the finished parts.

Because a flow schedule is used for continuous process manufacturing, components are issued to production by backflushing. This method deducts the required quantities from inventory when order quantities are reported as complete.

Flow Scheduling Life Cycle

Figure 8.1 summarizes the steps for setting up and using flow schedules.

Fig. 8.1
Flow Scheduling Work Flow



Setting Up Required Data

Along with standard MFG/PRO base data, such as sites, items, and locations, you must define several additional types of data specific to flow schedules using the following programs:

See page 166.

- Set up generalized codes for validated fields in Generalized Codes Maintenance (36.2.13).

See page 166.

- Define schedule periods in Schedule Period Maintenance (17.21.1.1).

See page 168.

- Set up information related to dates, rate expressions, and data displays in Schedule Code Maintenance (17.21.1.19).

See page 172.

- Set up production lines in Production Line Maintenance (17.21.1.4).

See page 176.

- Associate items with production lines in Production Line Item Maintenance (17.21.1.7).

Depending on how you use flow schedules, you can also define several kinds of optional data:

See page 178.

- Set up flex fence parameters in Flex Fence Maintenance (17.21.1.10).

See page 181.

- Define rates used in alternative production line scenarios in Rate Code by Item Maintenance (17.21.1.13) or Rate Code by Type/Group Maintenance (17.21.1.16). Specify in Flow Control (17.21.24) whether the latter program uses item types or item groups.

See page 184.

- Set up links between work centers and the locations that supply them with component materials in Work Center/Location Maintenance (17.21.1.22).

See page 163.

- Use Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17) to specify a purchase/manufacture code of W (flow) for items that are typically produced using flow schedules.

Creating Flow Scheduled Orders

You can initially enter flow scheduled orders in three ways:

- Manually, using Flow Schedule Maintenance (17.21.3). You can optionally add references to existing work orders and demand orders, including sales orders, customer scheduled orders, return material authorization (RMA) issue lines, and material orders. See page 186.
- Automatically, using Import MRP Orders to Schedule (17.21.9). You can optionally limit the import to items that have a purchase/ manufacture code of W (flow). See page 198.
- By copying an existing schedule to a new date range using Flow Schedule Copy (17.21.5). See page 199.

Analyzing and Adjusting the Flow Schedule

Once the schedule for a planning period has been entered, use Flow Schedule Maintenance to adjust the sequence in which the flow production line will schedule work for each day in the period.

Based on settings defined in Schedule Code Maintenance, the system can display a variety of calculated data when you enter or maintain flow schedules: See page 168.

- On all schedules, the system calculates and displays physical usage—the percentage of overall production line target and maximum capacity represented by the requirements of the current schedule. See page 158.
- When the associated schedule code has Display Flex Fence Recap set to Yes and appropriate setup records are available in Flex Fence Maintenance, the system calculates whether the production rate for the current schedule is within a user-defined variance from the overall schedule. See page 161.
- The system can display calculated usage statistics based on alternate resource scenarios, such as an increase in the flow rate that would result from adding an extra machine or person to the production line. Alternate flow rates are set up using Rate Code by Item Maintenance or Rate Code by Type/Group Maintenance. Depending on the results, you can adjust your production line resources as needed before committing to a production schedule. See page 159.

Associating System-Maintained Work Orders

See “Work Orders” on page 163.

The system automatically associates system-maintained type W work orders with flow scheduled orders for the following:

- Orders that were entered directly in Flow Schedule Maintenance and do not reference a valid existing work order number and ID. The system creates a new type blank work order for each such flow scheduled order.
- Orders that were added to the flow schedule by running Import MRP Orders to Schedule. The system changes the work order type from blank to W.

The status of the type W work orders is set to E (exploded), and the system creates work order bill and routing records based on item setup data just as it does in standard work order processing.

Completing Flow Scheduled Orders

Depending on your company’s manufacturing process, the life cycle of flow scheduled orders then takes one of the following paths:

See “Receiving Completed Flow Scheduled Orders” on page 202.

- For a flow scheduled order that does not reference a standard work order:
  - Use Flow Schedule Receipts (17.21.7) to receive the quantity completed into inventory, as well as to backflush components used to manufacture the completed items and record labor based on routings. The system updates the Completed field on flow schedule records with the quantity received.
  - When the entire quantity has been completed, close the orders using Flow Schedule Close (17.21.19).
  - Closed orders continue to display in Flow Schedule Maintenance until you run Flow Delete/Archive (17.21.23).

  Note You cannot make changes to system-generated type W orders or record completion data using any of the programs on the Work Orders or Shop Floor Control menus.
- For a flow scheduled order that references an existing work order, use standard work order processing to release work orders to production. You can change the quantity either in Flow Schedule Maintenance or Work Order Maintenance (16.1). The system synchronizes changes

made in either program with the other. However, due dates can be modified only in Flow Schedule Maintenance, which also updates Work Order Maintenance.

- If you use the Repetitive or Advanced Repetitive module, use Export Schedule to Repetitive (17.21.10) to transfer open flow scheduled orders with a quantity greater than zero to repetitive schedules. Optionally, you can limit the export to items with a purchase/ manufacture code of L (line manufactured). Once you have exported a flow scheduled order, the system sets the Posted to Rep field to Yes, and you can no longer use flow scheduling functions for that order. All receiving and reporting transactions use programs in the Repetitive or Advanced Repetitive module.

See “Exporting Flow Schedules to Repetitive” on page 200.

Schedule Periods

Schedule periods define the period of time in which you want to schedule production. A period may be a single shift, a day, a week, or any period of time applicable to your manufacturing environment.

See “Defining Schedule Periods” on page 166.

A schedule period defines not only a period of time in terms of calendar and working days, but also the total number of production hours available for that period. Although an employee may be scheduled to work an 8-hour day, the total production hours may be less.

Example An employee is scheduled to work an 8-hour shift, with 30 minutes for lunch and two 15-minute breaks.

8 – .5 – .25 – .25 = 7 total production hours

If the schedule period is defined as a 7-day calendar week with 5 working days, the total production hours are 35.

Flow Rates

Work in a manufacturing environment can be scheduled for different levels of throughput, or flow rates. When demand increases, management may add more machines or more workers to a production line, increasing the flow rate. You can use flow rates to evaluate different scenarios of increased or decreased machine use or labor to find the optimum level of output for a production line.

Flow rates can be expressed as production output per period of time, such as 50 units per week, or in Takt time.

Takt Time

Takt time is a measurement of the pace at which parts must be manufactured to satisfy the demand represented by the current schedule.

Takt time = customer demand rate / operational available time

Example You have orders for 225 items per day. The available time to produce those items is 7.5 hours (450 minutes). 225 units divided by 450 minutes equals a Takt time of 2 minutes. One unit must be manufactured every two minutes in order to meet customer demand.

Takt time is a goal. It must be reached to satisfy demand. After Takt time is calculated, you can evaluate the number of machines and operators needed to achieve the required output.

See page 195.

When you complete a flow schedule using Flow Schedule Maintenance, the summary frame includes a Takt time calculation based on the total quantity of items to be produced.

Physical Usage and Time Usage in a Schedule

Two capacity constraints on a production line are the total quantity of parts that can be produced and the amount of time available to make those parts. When flow rates are used in a schedule, you can compare the sum of all scheduled orders to these two constraints.

Checking Physical Usage in a Schedule

You can associate target and maximum flow rates either with a production line or with a schedule code. The target rate is the optimal rate where production is the most efficient. The maximum rate is the absolute maximum rate that the production line can support.

See “Physical Usage Data” on page 196.

As orders are entered into a schedule, the schedule order quantity is accumulated and compared to the schedule target and maximum. By viewing the percentage displayed before you actually add the schedule to the database, you can determine if the schedule exceeds the target or maximum.

Example A production line has a target rate of 500 units per week and a maximum rate of 575 per week. When 250 units have been entered into the schedule, you are at 50% physical usage. When 501 units are entered, you can see that usage is more than 100% of the target rate. When 600 units are entered, value of the maximum rate will be greater than 100%.

Checking Time Usage in a Schedule

Table 8.1 shows three different flow rates for parts A, B, and C. Normal represents a typical level of production. NewMach represents typical labor usage plus the use of a new machine. MoreLbr represents the use of additional labor on a production line.

Assigning flow rate codes to items lets you evaluate the most effective use of time and machines for a particular schedule. Changing the flow rate code for an item may not automatically increase the production for that part. For example, the NewMach code has no affect on part B because it cannot be produced on that machine, and part C is totally constrained by machine capacities, so using the MoreLbr code has a minimal effect.

See "Defining Flow Rate Codes" on page 181.

Table 8.1 Production Quantities for Different Flow Rates

Part	Normal Units/Hour	NewMach Units/Hour	MoreLbr Units/Hour
A	10	15	20
B	10	10	20
C	10	15	11

In the following examples, the same schedule is used with different rate codes. The target rate for this production line is 500 units per 40 hour work week. The total scheduled orders are for 490 units, so the physical usage is 490 / 500, or 98%. There is enough physical capacity on this line to make the parts.

Table 8.2 shows how the mix of parts A, B, and C would fit into the 40-hour work week.

Table 8.2
Time Usage for Normal Rate Code

Part	Qty Ordered	Normal Units/Hour	Hours Needed
A	150	10	15
B	140	10	14
C	200	10	20
Totals:	490		49

Using the Normal rate code, time usage is 49 / 40, or 122.5%. You would need to schedule 9 hours of overtime or handle the overcommitment of time in some other way. You could use a new machine and implement the NewMach rate code or you could add more operators and implement the MoreLbr rate code.

Table 8.3
Time Usage for NewMach Rate Code

Part	Qty Ordered	NewMach Units/Hour	Hours Needed
A	150	15	10
B	140	10	14
C	200	15	13
Totals:	490		37

Implementing the NewMach rate code where an additional machine is used results in a time usage of 37 / 40, or 92.5%.

Table 8.4
Time Usage for MoreLbr Rate Code

Part	Qty Ordered	MoreLbr Units/Hour	Hours Needed
A	150	20	08
B	140	20	07
C	200	11	18
Totals:	490		33

Implementing the MoreLbr rate code where more labor is used results in a time usage of 33 / 40, or 82.5%.

When you enter flow scheduled orders, the system calculates the effects of each flow rate on the overall schedule. You can view the calculations in two ways:

- By total schedule period
- By each day in the schedule period

See "Time Usage Data" on page 196.

Flex Fences

Flex fences let you determine if the total amount entered in a schedule for a future period is within a realistic variance from the total amount scheduled for the current period. This lets you see if schedules are maintaining a reasonably constant level of production over several periods.

See "Defining Flex Fences" on page 178.

Flex fences are based on the scheduled load for the current period, so the allowed variances in scheduled quantities for future periods does not remain static. As production levels rise and fall over time, so does the flex fence.

Flex fence data is assigned as a percentage value for allowable variances in future periods. Flex fence percentages apply to minimum and maximum scheduled load. For example, a 10% flex fence measures if the total schedule entered is within plus or minus 10% of the production line's scheduled load for the current period.

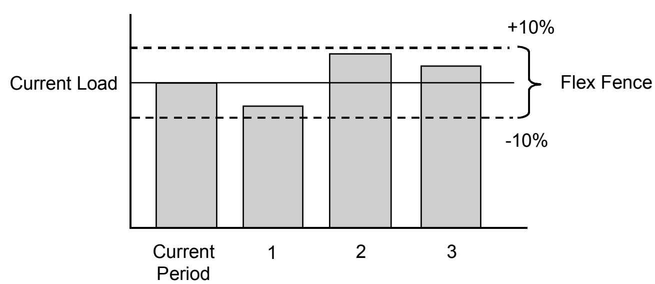


Fig. 8.2 Flex Fence Example

Typically, flex fence percentages increase over time. You may assign an allowable variance of plus or minus 5% for one week in the future and 20% for any periods more than four weeks in the future.

See "Flex Fence Data" on page 195.

When you enter flow scheduled orders for a future period in Flow Schedule Maintenance, the system can calculate how the requirements compare with those of the current period and display a warning if they are outside the specified time fence.

Flow Linearity

Linearity is the relationship between scheduled production rates and actual production. Linearity is calculated by comparing the daily scheduled production with daily completed production. The aggregation of all days in a selected period is then used to determine linearity.

It is important to enter production receipts on a daily basis so that the application of receipts to the scheduled orders is correct.

Example Production is scheduled in 5-day periods. The planned production rate is 20 units per day, and the actual production for the five days is as follows: 19, 20, 23, 21, and 19. Although the planned and actual production for the period result in a total of 100 units, this is not a good indication of the daily deviations that occurred.

Table 8.5
Planned versus Actual Production

Production	Day 1	Day 2	Day 3	Day 4	Day 5	Totals
Scheduled	20	20	20	20	20	100
Actual	19	20	23	21	17	100
Deviation	1	0	3	1	3	8

The formula for a linearity index is:

*Linearity Index% = (1 - (Sum of absolute deviations / Total rate)) * 100*

In the above example, the linearity index is:

*(1 - (8 / 100)) * 100 = 92.0%*

A linearity index is intended to provide an indication of the success of actual production rates to the planned rates. A consistent level of daily production tends to promote consistent product quality and eliminates the costs associated with unplanned overtime.

See "Flow Schedule Reports" on page 212.

After you have entered flow schedules and record completions by receiving completed orders, you can generate linearity summaries to judge the efficiency of your production lines.

Purchase/Manufacture Codes

Purchase/manufacture (Pur/Mfg) codes are used throughout MFG/PRO to identify how items are typically obtained; for example, items you ordinarily purchase from another company typically have a code of P, and those you manufacture yourself may have a code of M. Specify purchase/manufacture codes for items in one of the following programs:

- Item Master Maintenance (1.4.1)
- Item Planning Maintenance (1.4.7)
- Item-Site Planning Maintenance (1.4.17)

Two purchase/manufacture codes have special significance in flow scheduling:

- W (Flow manufactured). When you add an item to a production line in Production Line Item Maintenance (17.21.1.7) with a purchase/manufacture code other than W, the system displays a warning message.

  See page 176.

  Additionally, when you add MRP-planned orders to flow schedules using Import MRP Orders to Schedule (17.21.9), you can optionally limit the selection to items with a W purchase/manufacture code.

  See page 198.

- L (Line manufactured). When you export a flow scheduled order to a Repetitive or Advanced Repetitive production line using Export Schedule to Repetitive (17.21.10), you can optionally limit the selection to items with this code. They are normally manufactured on a repetitive line.

  See page 200.

  Additionally, when you import an MRP-planned order for one of these items to a flow schedule, the system updates the associated work order to change it to type W. This means the flow schedule can be selected for export to a repetitive production schedule.

  See “Work Orders” on page 163.

Work Orders

The flow schedule process can involve two kinds of work orders:

- Standard work orders
- Flow work orders

Standard Work Orders

See "Using Flow Schedule Maintenance" on page 186.

Standard work orders are created in Work Order Maintenance (16.1) and have the Type field set to blank. Optionally link an existing work order to a flow scheduled order by referencing it in the Work Order and ID fields in Flow Schedule Maintenance (17.21.3).

See "Importing MRP Planned Orders to a Flow Schedule" on page 198.

Additionally, when you add an order to a flow schedule using Import MRP Orders to Schedule for an item with a purchase/manufacture code other than W (Flow manufactured) or L (Line manufactured), the system automatically links the work order to the flow schedule. The number displays in the Work Order field in Flow Schedule Maintenance.

You can update some of the information on referenced work orders using both flow scheduling and work order programs. The system synchronizes information between the two modules.

When you record completions for a referenced work order in the Work Orders module, the quantity complete is also updated on the flow schedule. If you delete a work order, the associated flow scheduled order is also deleted, although deleting a flow scheduled order does not delete an associated non-type W work order. When you close an order either in Flow Schedule Close or using a program in the Work Orders module, the update is made in both programs. Changing the Closed status in Work Order Maintenance also reopens the flow order.

See page 99.

Chapter 6, "Work Orders," provides more information on standard work order processing.

Flow Work Orders

The system generates a type W (Flow) work order each time you enter a flow scheduled order that does not reference an existing work order. Additionally, when you add an order to a flow schedule using Import MRP Orders to Schedule (17.21.9) for an item that is ordinarily made on a production line and has a purchase/manufacture code of W or L, the system changes the work order type from blank to W.

Type W work orders are system maintained. They are not shown in the Work Order field in Flow Schedule Maintenance. You cannot update or process them using any of the programs in the Work Orders module.

The system uses standard work order defaulting logic for determining such data as accounts when creating type W work orders.

Setting Up Flow Scheduling

Flow scheduling requires the following setup information:

- Generalized codes
- Scheduling periods
- Flow schedule codes
- Flow production lines and items

Optionally, depending on how you use flow scheduling data, you can set up additional data:

- Flex fence data
- Flow rate codes
- Links between flow line work centers and work order backflush locations

Flow Setup Menu

Table 8.6 lists the programs used to set up Flow Scheduling.

Table 8.6 Flow Setup Programs

Menu Number	Description	Program
17.21.1	Flow Setup Menu...	
17.21.1.1	Schedule Period Maintenance	kbppmt.p
17.21.1.2	Schedule Period Browse	kbbr001.p
17.21.1.4	Production Line Maintenance	flplmt.p
17.21.1.5	Production Line Browse	flbr004.p
17.21.1.7	Production Line Item Maintenance	flplimt.p
17.21.1.8	Production Line Item Browse	flbr006.p
17.21.1.10	Flex Fence Maintenance	flffmt.p
17.21.1.13	Rate Code by Item Maintenance	flcimt.p
17.21.1.14	Rate Code by Item Browse	flbr011.p
17.21.1.16	Rate Code by Type/Group Maintenance	flrcgmt.p
17.21.1.17	Rate Code by Item Type Browse	flbr012.p

Menu Number	Description	Program
17.21.1.18	Rate Code by Item Group Browse	flbr013.p
17.21.1.19	Schedule Code Maintenance	flscmt.p
17.21.1.22	Work Ctr/Location Maintenance	pppoulmt.p

Setting Up Codes for Validated Fields

You can use generalized codes, which you define in Generalized Codes Maintenance (36.2.13), to specify valid values for some fields. They give you flexibility in organizing and implementing functions, since you can define values that are meaningful in your own business environment.

Table 8.7 lists the fields using generalized codes referenced by flow scheduling functions. Use this table to plan which codes to set up for your implementation.

Table 8.7
Generalized Codes in Flow Scheduling

Field	Label	Where Used
flcr_rate_code	Rate Code	Production Line Maintenance Rate Code by Item Maintenance Rate Code by Type/Group Maintenance Flow Schedule Maintenance Flow Schedule View
pt_part_type	Item Type	Rate Code by Type/Group Maintenance
pt_group	Item Group	Rate Code by Type/Group Maintenance

Defining Schedule Periods

Use Schedule Period Maintenance (17.21.1.1) to create period codes, which include day and hour parameters used throughout flow schedule processing. Schedule periods must be set up before you can define schedule codes in Schedule Code Maintenance (17.21.1.19).

See page 224.

Note This program is also used to define schedule periods used in the Kanban module. This section discusses only the way it is used with flow scheduling functions.

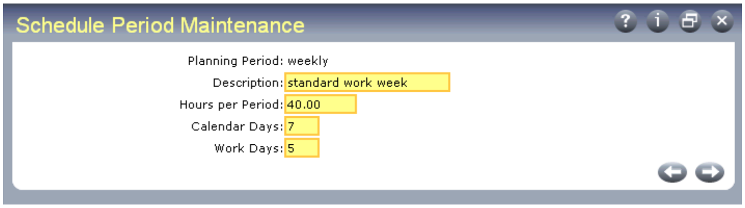


Fig. 8.3 Schedule Period Maintenance (17.21.1.1)

Planning Period. Enter a code identifying a period to be used on a flow schedule.

Because scheduling periods are used by both flow scheduling and kanban functions, you cannot delete a scheduling period that is either:

- Referenced by a production line schedule code record defined in Schedule Code Maintenance
- Associated with an existing maximum demand record in Maximum Demand Maintenance (17.22.10)

Description. Enter a brief description of this planning period (24 characters).

Hours per Period. Enter a decimal greater than 0 (zero) indicating the total number of production hours in the scheduling period.

Calendar Days. Enter the number of calendar days in this planning period. This must be greater than or equal to the value of Work Days.

Flow Schedule Maintenance uses this value in combination with the start date of the associated schedule code to determine a date range for the schedule.

Work Days. Enter the number of work days in this planning period. This cannot exceed the value of Calendar Days.

The system uses this field in combination with Hours per Period to calculate the number of hours available during each day. This is a simple average; the system does not use the shop calendar or repetitive shift calendar to determine actual work days and hours. If different hours are worked on certain days in your manufacturing environment, you should set up separate periods for the differing work schedules.

Defining Schedule Codes

Use Schedule Code Maintenance (17.21.1.19) to specify codes that define basic information about a schedule.

After you define scheduling periods, you can create scheduling codes for periods using different start dates. For example, based on a scheduling period named WEEK, you can define schedule codes for WEEK1, WEEK2, and so on.

The system uses schedule codes to determine default settings and base data in the following programs:

- When you set up flow production lines in Production Line Maintenance, you can optionally specify default schedule and rate codes that are used whenever you enter a flow schedule for that production line.
- When you create a schedule using Flow Schedule Maintenance, the specified schedule code determines the period and start date that the system uses in date calculations, as well as unit of measure information. Additionally, the schedule code includes recap settings that control which data summary screens display during schedule maintenance.

Note You cannot control the recap display on individual schedules from Flow Schedule Maintenance. Be sure to set the appropriate display settings for each schedule code you will use.

See “Flow Schedule Reports” on page 212.

An additional use for schedule codes is to view flow schedule data in different ways. For instance, when you use Flow Schedule Detail View (17.21.13.10) to look at a flow schedule that was produced by week, you can change the schedule code to one with a different value in Period that lets you see the data summarized in monthly increments.

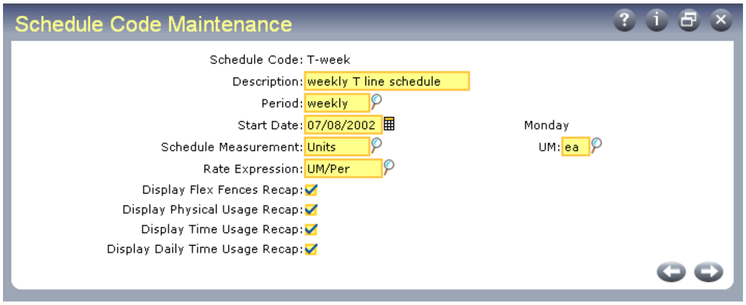


Fig. 8.4
Schedule Code Maintenance (17.21.1.19)

Schedule Code. Enter an alphanumeric code representing this set of schedule information. This can be up to eight characters.

Description. Optionally enter an alphanumeric description (24 characters) of this flow schedule code. This field is for reference and displays in other programs when you reference the schedule code.

Period. Enter the scheduling period associated with this schedule code. This value must already be defined in Planning Period Maintenance (17.21.1.1).

When you reference this schedule code in Flow Schedule Maintenance, the system uses the associated period information from Planning Period Maintenance in date calculations. It is also used to determine date displays in some reports and inquiries.

Start Date. Enter the starting date for flow schedules that use this code.

This field cannot be blank. When you enter a date, the system displays the day of the week next to the field.

Flow scheduling functions throughout the system use this value to verify that schedule dates are accurate. For example, you cannot enter a due date in Flow Schedule Maintenance using this schedule code if it is earlier than this date.

Schedule Measurement. Enter the type of measurement associated with flow schedules that use this code. Valid values are:

- Units
- Weight
- Volume

If you enter Weight or Volume, you must enter a valid weight or volume unit of measure in the UM field. UM is optional if you enter Units.

The system uses this setting together with the value of UM when it performs physical and time usage calculations for flow schedules referencing this code. When a unit of measure is specified, all items on the flow schedule are converted to that UM. If Schedule Measurement is Units and UM is blank, the system uses the stocking UM of all items on the schedule and combines them, even if the values are different. For example, it would combine one of a unit defined as EA (each) with one of a unit defined as DZ (dozen) for a total of two, even though the actual physical number of items is 13.

UM. Enter the unit of measure associated with flow schedules that reference this code.

When Schedule Measurement is Units, you can leave this field blank or specify a valid UM. When Schedule Measurement is Weight or Volume, a valid UM is required.

See “Flow Rates” on page 157.

Rate Expression. Specify the method used to express the flow rate of a production line that references this schedule code. Valid values are:

- UM/Per: Number of UMs made in one period
- UM/Hours: Number of UMs made in one hour
- UM/Day: Number of UMs made in one day
- Per/UM: Periods required to make one UM
- Hours/UM: Hours required to make one UM
- Day/UM: Days required to make one UM

See “Takt Time” on page 158.

The first three options express flow rate in terms of the production output per period of time. The other three define the rate in terms of *Takt time*—the rate at which parts must be manufactured to satisfy demand.

The following fields control the display of flow schedule data when schedules are entered in Flow Schedule Maintenance (17.21.3).

Display Flex Fences Recap. Specify whether Flow Schedule Maintenance displays the Flex Fences Data frame after you complete data entry on schedules that reference this code. The system also displays a warning message if the scheduled quantity for the period is outside the flex fence parameters.

See "Flex Fences" on page 161.

Regardless of the value of this field, the system calculates and displays flex fence information only if records have been set up for the production line in Flex Fence Maintenance (17.21.1.10).

Display Physical Usage Recap. Specify whether Flow Schedule Maintenance displays the Physical Usage frame after you complete data entry on schedules that reference this code.

See "Checking Physical Usage in a Schedule" on page 158.

Physical usage is expressed as the percentage of the maximum production rate and target production rate represented by actual production for the period.

Display Time Usage Recap. Specify whether Flow Schedule Maintenance displays the Time Usage frame after you complete data entry on schedules that reference this code. When this field is Yes, the system displays time usage data for all flow rate codes associated with the site, production line, and schedule code.

See "Checking Time Usage in a Schedule" on page 159.

Time usage is expressed as the percentage of the available hours for a given flow rate represented by the hours used in the schedule.

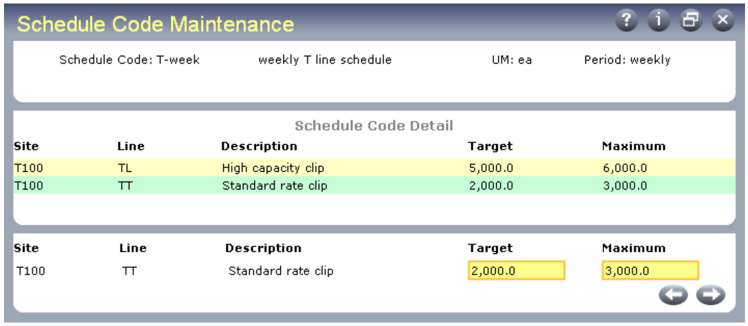
Display Daily Time Usage Recap. Specify whether Flow Schedule Maintenance displays the Time Usage by Day frame after you complete data entry on schedules that reference this code.

Time usage by day is expressed as the percentage of the available hours for each day represented by the hours used on that day.

Optionally, you can use this program to associate target and maximum production rates with specified sites and production lines that use this schedule code. When you complete basic data entry in the first frame and press Go, the system prompts you to modify schedule code detail. Specify Yes to access another data entry frame for entering flow rates.

Tip
You can also enter flow rates for schedule codes in Production Line Maintenance.

Fig. 8.5
Schedule Code Maintenance, Schedule Code Detail Frames



Tip
Flow Schedule Maintenance uses these quantities to calculate physical usage.

Target. Enter the optimum number of units produced by this line during the schedule period when it uses this schedule code.

This cannot be greater than the value entered in Maximum.

Maximum. Enter the absolute maximum number of units produced by this line during the schedule period when it uses this schedule code.

This cannot be smaller than the value entered in Target.

Setting Up Flow Production Lines

Use Production Line Maintenance (17.21.1.4) to define a production line at a specific site that will be used to manufacture items according to quantities and sequences specified by flow schedules.

Flow Schedule Maintenance uses the information from this program, along with information from Schedule Code Maintenance, to calculate production capacity and other data that can be used to analyze whether the production line can meet current and upcoming schedule requirements.

Important Flow production line records are stored in the same table as production lines used by the Repetitive, Advanced Repetitive, and Operations Planning modules. However, the records created with this program include some data used only in flow scheduling. For example, flow rates defined here apply only to flow schedules.

Delete existing production line records by pressing Delete when the cursor is in any field below the Production Line field. Before deleting the record, the system verifies that the production line is not used by a schedule in the Flow Scheduling, Repetitive, or Operations Planning modules. The system deletes schedule code detail records associated with the production line.

Note If you have also defined this production line in the Repetitive or Advanced Repetitive module, that production line record is not affected.

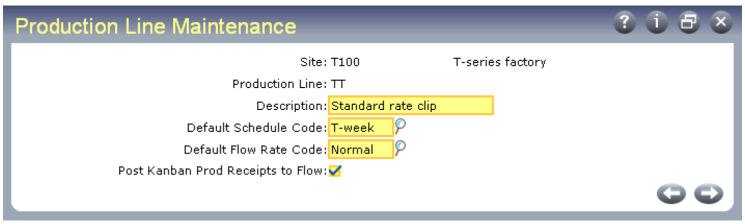


Fig. 8.6 Production Line Maintenance (17.21.1.4)

Site. Enter an alphanumeric code representing the site where this production line is located. This site must be defined in Site Maintenance. You must have security access to the site, and it must be in the current database.

Line. Enter an alphanumeric code for a production line used for manufacturing flow-scheduled items.

Description. Optionally enter an alphanumeric description of this production line. Some programs, including reports and inquiries, display this description when you enter the production line code.

Default Schedule Code. Optionally enter a default schedule code for this production line. This value must be defined in Schedule Code Maintenance.

See “Defining Schedule Codes” on page 168.

If you enter a value, it defaults to the Schedule Code field when you create a new schedule for this production line in Flow Schedule Maintenance. Otherwise, that field is blank. Additionally, when you use Production Line Item Maintenance to identify items that can be produced on a flow production line, that program gets the default unit of measure from the default schedule code.

In Flow Schedule Maintenance, flow schedule codes are used to convey basic data about a flow schedule, including such information as periods, start dates, and unit of measure data.

Default Flow Rate Code. Optionally enter a default flow rate code for this production line. If you enter a value, it is validated against codes entered in Generalized Codes Maintenance (36.2.13) for field flcr_rate_code.

If you enter a valid value, it defaults to the Flow Rate field when you create a new schedule for this production line in Flow Schedule Maintenance. Otherwise, that field is blank.

In Flow Schedule Maintenance, flow rate codes are associated with a specific production rate on a specific production line.

Post Kanban Production Receipts to Flow. Indicate whether production receipts recorded using Kanban transactions are also recorded as completions for flow scheduled orders on this production line.

No: Kanban production receipts are not recorded as flow schedule completions.

See “Executing Kanban Transactions” on page 247.

Yes: When you record a production receipt in Execute Kanban Transaction (17.22.19.1) with an effective date that corresponds to a flow schedule due date for the item, the system updates the Completed field on the flow scheduled order with the quantity received.

See “Application of Received Quantities” on page 205.

When more than one order is available to record completions, the system applies the same logic used when you receive completed quantities in Flow Schedule Receipts (17.21.7).

Note When this field is Yes, the system applies completions only to flow scheduled orders that do not reference an existing, non-type W work order.

Tip
You can also associate flow rates with production lines in Schedule Code Maintenance.

Optionally, you can associate target and maximum production flow rates with specific schedules when they are referenced in Flow Schedule Maintenance on a schedule for this production line. When you complete basic data entry in the first frame and press Go, the system prompts you to modify schedule code detail. Specify Yes to access another data-entry frame for entering flow rates. A frame displays existing production line records. Use the bottom frame to update these or enter new records.

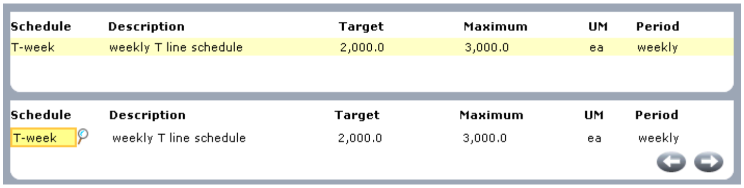


Fig. 8.7 Production Line Maintenance, Schedule Code Detail Frames

Schedule. Enter a flow schedule code to be associated with this production line. This must be defined in Schedule Code Maintenance.

When you enter a valid value, the system displays the description and rate expression defined for the code in Schedule Code Maintenance. You can then specify target and maximum production rates for this production line.

Target. Enter the optimum number of units produced by this line during the schedule period when it uses this schedule code.

This cannot be greater than the value entered in Maximum.

When you create a schedule using this schedule code for this production line in Flow Schedule Maintenance, the system calculates physical usage relative to this value.

You can delete schedule code detail records by pressing Delete from this field.

Maximum. Enter the absolute maximum number of units produced by this line during the schedule period when it uses this schedule code.

This cannot be smaller than the value entered in Target.

When you create a schedule using this schedule code for this production line in Flow Schedule Maintenance, the system calculates physical usage relative to this value.

You can delete schedule code detail records by pressing Delete from this field.

Associating Items with Production Lines

Use Production Line Item Maintenance (17.21.1.7) to identify items that can be scheduled for a flow production line.

Important In Flow Schedule Maintenance, you can enter an item on a flow schedule for a production line only when it has been associated with that production line using this program. Additionally, Import MRP Planned Orders selects orders only for items that have been defined in this program.

A preference value assigned to each item allows the system to determine priorities for assigning MRP-driven demand for items that can be produced by multiple lines. When you import planned orders for such items, the system selects the production line with the lowest value in the Preference field as the primary line for producing the item.

You cannot update information about the production line itself in this program. Instead, use Production Line Maintenance (17.21.1.4).

In the first frame, enter the site and production line code for a line already defined in Production Line Maintenance. The system displays the schedule measurement and UM values from the default schedule code for the production line, if one is defined.

Fig. 8.8
Production Line Item Maintenance (17.21.1.7)

In the center frame, the system displays any existing items assigned to this production line. Use the bottom frame to edit existing item records or enter new ones.

Item Number. Enter the number of an item that can be manufactured on this flow production line. This must be a valid item defined in Item Master Maintenance (1.4.1).

An item can be associated with more than one production line.

A unit of measure conversion must be defined in Unit of Measure Maintenance (1.13) when:

- The production line is associated with a default schedule code in Production Line Maintenance.
- The default schedule code has a schedule unit of measure specified in Schedule Code Maintenance.

In this case, a UM conversion record must exist between the schedule UM and the item's stocking UM. Otherwise, the system displays an error.

Preference. Indicate the relative priority the system should assign to this production line when you use Import Flow Schedules from MRP (17.21.9) to create flow scheduled orders for this item based on MRP-generated data.

Valid values are integers greater than 0 (zero). A lower value indicates a higher preference.

When determining which production line should be used to fill MRP-generated demand for a flow-scheduled item, the system looks at all production lines for the site that can produce the item. If it finds more than one, the system considers the instance with the lowest Preference value as the primary line.

A primary line must exist during data entry. If a record exists for the same item-site combination on a different production line, you can enter the same Preference value here only if a third line has a lower value so that it can be used as the primary production line. Otherwise, you cannot complete line entry without assigning a different Preference value.

Similar logic applies when you delete an item from a production line. For example, you can produce the same item on production lines 100, 200, and 300. Production line 100 has Preference for the item set to 1; for lines 200 and 300, it is set to 2. If you delete the item from production line 100, the system cannot resolve which should be the primary line for this item. In this case, a warning message displays when you delete the item from production line 100.

To delete an existing item record from this production line, press Delete when the cursor is in the Preference field. The system verifies that the item is not included on a flow schedule for this production line with a due date later than today. If it is, a warning message displays.

Defining Flex Fences

Use Flex Fence Maintenance (17.21.1.10) to define flex fence parameters for flow schedules.

See "Flex Fences" on page 161.

Flex fences are tools for determining if the total schedule being entered or maintained is within a realistic, specified variance from the current period's total schedule. This lets you verify that schedules are maintaining a reasonably constant level of production over several periods, or warns you of large changes in production requirements in an upcoming period.

When you set up flex fence parameters and Display Flex Fence Recap is Yes in Schedule Code Maintenance for the code specified on the flow schedule header, the system displays two kinds of flex fence data after you complete data entry in Flow Schedule Maintenance:

- A summary frame of flex fence data
- A warning message when the variance for a period on the schedule is outside the specified percentage

Note When the system does not find flex fence parameters for the production line and schedule code, the flex fence recap frame and warning messages do not display regardless of the setting of Display Flex Fence Recap.

In the first frame, enter the combination of site, production line, and schedule code associated with the flex fence parameters. When you enter a schedule code, the system displays the period associated with the code in Schedule Code Maintenance.

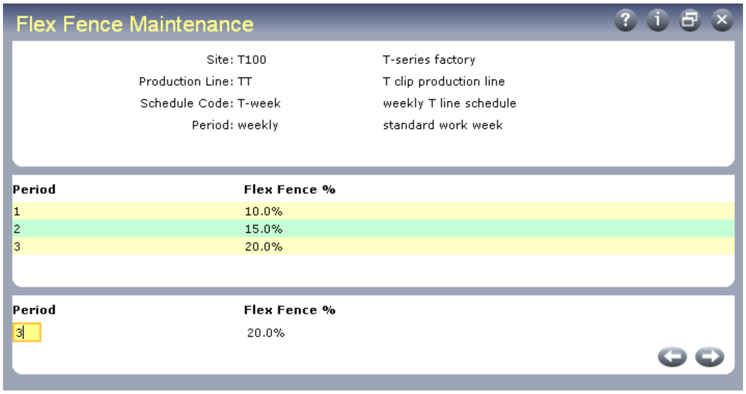


Fig. 8.9
Flex Fence Maintenance (17.21.1.10)

You can apply flex fences more generally by leaving one of the first three fields in the program blank. For example, if you leave Production Line blank, the flex fence parameters apply to all flow orders that specify this combination of site and schedule code, regardless of the production line.

Tip
Only one of the three fields can be blank.

In the center frame, the system displays any existing flex fence values. Use the bottom frame to edit existing flex fence periods or define new ones.

Period. Enter the relative number of the period for which the system will use the specified percentage in flex fence calculations.

This period is relative to the current date. For example, when you are using weekly schedules, period 1 covers the schedule for the week immediately following this one.

To determine the period in which the schedule being maintained falls, the system:

- Reads all existing flow schedule master records backwards, beginning with the one being maintained.
- Counts the number of records read with the appropriate site and production line until it finds the one that includes today’s date. This is the number the system uses as a period to select a flex fence percentage.

Numbers in this field do not have to be consecutive. If there is a gap in the sequence, the system uses the value for the previous period until it reaches the next specified period. For example, if you have percentages defined only for periods 1 and 4 and you are entering a schedule for what the system calculates to be period 3, it will continue to use flex fence parameters specified for period 1 until you maintain the schedule for period 4.

Flex Fence Percentage. Enter the percentage the system should use in comparing a production line's resource usage for the period being maintained with a baseline period. For example, if you enter 5, the system measures whether calculated usage is within –5 or +5 percent of the baseline period's scheduled usage.

Typically, flex fence percentages increase over time. If you enter a percentage that is less than a previous period's value, the system displays a warning. You can disregard this message.

When you access a schedule in Flow Schedule Maintenance, the system obtains the total schedule usage from the schedule that includes today's date. This is the baseline value used in the flex fence calculation. It then determines the period for the schedule being maintained and uses the associated percentage to calculate minimum and maximum values. If the current schedule's resource usage is outside that range, the system displays a warning message.

Use of Flex Fences

When you enter a flow schedule in Flow Schedule Maintenance for a period after the current one, the system searches for flex fence records in the following order:

1. One that matches site, production line, and schedule code
2. One that matches site and production line, with a blank schedule code
3. One that matches site and schedule code, with a blank production line
4. One that matches production line and schedule code, with a blank site

When it finds a match, the system calculates which period applies to the future schedule being maintained, using the current period as 0. It then uses the associated percentage to calculate flex fence variances for that future schedule based on the scheduled quantity for the current period.

Note All flex fence calculations are based on comparisons between future periods and the current period. When you enter schedules for the current period, flex fence parameters are not applicable.

If the variance is not within the specified percentage, the system displays a warning message.

Defining Flow Rate Codes

In addition to the standard target and maximum production rates you can associate with a production line in either Production Line Maintenance or Schedule Code Maintenance, you can also optionally define flow rate codes that can then be associated with numeric flow rates in two ways:

- For specific items using Rate Code by Item Maintenance (17.21.1.13)
- For item types or groups using Rate Code by Type/Group Maintenance (17.21.1.16)

Flow rate codes let you measure physical and time usage in a schedule. You can check to see if the total production output or hours in a new schedule do not exceed production capacity.

See "Flow Rates" on page 157.

Before setting up flow rate data, you must first define flow rate codes in Generalized Codes Maintenance (36.2.13) for field flcr_rate_code.

When you enter or maintain flow schedules using Flow Schedule Maintenance (17.21.3) for items that have flow rates defined, the system displays resource usage data based on different scenarios.

See "Time Usage Data" on page 196.

Flow Rate Codes for Items

Use Rate Code by Item Maintenance (17.21.1.13) to associate optional flow rate codes with numeric production rates for specific items on a production line.

In the first frame, enter the combination of site, production line, schedule code, and item number to which the flow rate codes apply. The system displays the rate expression associated with the code in Schedule Code Maintenance.

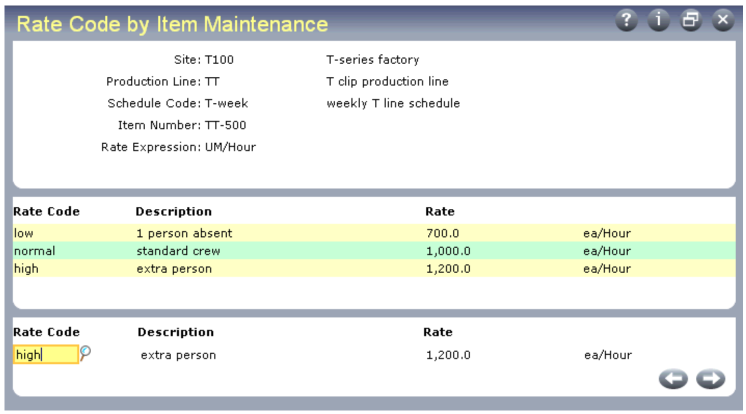
You can apply flow rate codes more generally by leaving either Site, Production Line, or Item Number blank. For example, if you leave Production Line blank, the flow rate codes apply to all flow orders that specify this combination of site, schedule code, and item number regardless of the production line being used.

Tip
Only one of the three fields can be blank.

Note Schedule Code is always required because the system uses it to determine the rate expression that applies to flow rates.

The system validates unit of measure (UM) conversions for the item if you enter a value in Schedule Code that has a schedule UM specified in Schedule Code Maintenance. In this case, a UM conversion record must already be set up in Unit of Measure Maintenance between the schedule UM and the item's stocking UM. Otherwise, the system displays an error.

Fig. 8.10
Rate Code by Item Maintenance (17.21.1.13)



The center frame displays existing flow rate code records, if any have been defined. Records are listed in ascending numeric sequence based on the rate, rather than by flow rate code. Use the bottom frame to edit existing flow rate records or enter new ones.

> *Rate Code.* Enter the flow rate code for this item. Values are validated against codes entered in Generalized Codes Maintenance for field flcr_rate_code. The system displays the description associated with the generalized code.
>
> In Flow Schedule Maintenance, flow rate codes are associated with a specific production rate on a specific production line. When Display Time Usage Recap is Yes in Schedule Code Maintenance for the schedule code specified in the flow schedule header, the system displays time usage data for each flow rate code defined for items on the production line.

Rate. Enter the production rate represented by this flow rate code when it is used with the specified item. When Display Time Usage Recap is Yes for the schedule code on a schedule being entered in Flow Schedule Maintenance, the system displays time usage data based on this rate.

Important This rate should be in terms of the displayed rate expression, which is associated with the schedule code specified in the first frame. For example, if the rate expression is units/hour, you might enter a flow rate of 100. However, the same rate for a rate expression of hours/unit would be 0.01.

Flow Rate Codes for Item Types or Groups

Use Rate Code by Type/Group Maintenance (17.21.1.16) to specify production line flow rate data unique to item types or groups. Items are optionally associated with types or groups in one of the following programs:

- Item Master Maintenance (1.4.1)
- Item Data Maintenance (1.4.3)

This program is very similar to Rate Code by Item Maintenance. However, instead of specifying an individual item, you can apply the defined flow rates to item types or groups.

See page 181.

Label and validation vary depending on control setting.

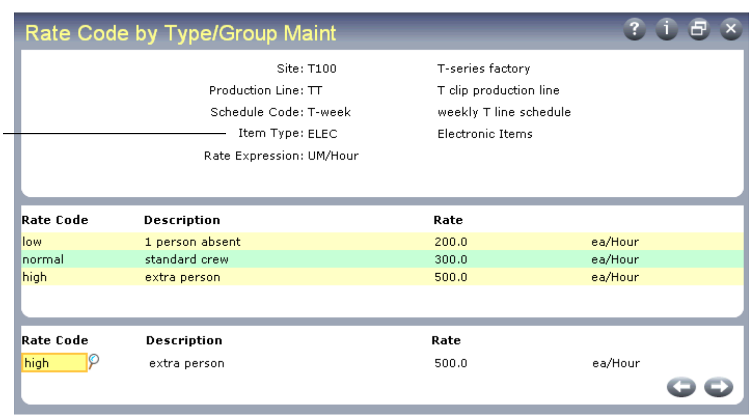


Fig. 8.11
Rate Code by Type/Group Maintenance (17.21.1.16)

Indicate how you want to apply these rates in the Enter Flow Rate Code by Item Type/Group field in Flow Control (17.21.24). The field label and generalized codes validation in Rate Code by Type/Group Maintenance change based on that setting, as shown in Table 8.8.

Table 8.8
Effects of Flow Control Setting

Flow Control Value	Field Label	Generalized Codes Validation
Type	Item Type	pt_part_type
Group	Item Group	pt_group

Use of Flow Rate Records

Flow Schedule Maintenance uses the following search sequence to determine which flow rate record to use in its calculations:

1. Search for the specific site, production line, schedule code, and item number (from Rate Code by Item Maintenance).
2. Search for specific site, production line, schedule code, and item type or group associated with the item number entered (from Rate Code by Type/Group Maintenance).
3. Search for specific site, production line, schedule code and a blank item number (from Rate Code by Item Maintenance).
4. Search for specific site, blank production line, schedule code, and item number (from Rate Code by Item Maintenance).
5. Search for blank site, production line, schedule code, and item number (from Rate Code by Item Maintenance).

Linking Work Centers to Locations

See "Receiving Completed Flow Scheduled Orders" on page 202.

Optionally, you can set up a link between a flow production line work center and the location from which it backflushes components used to produce items on flow scheduled orders. By associating one or more locations with a work center and specifying a preference value for each, you can control the order in which the system selects backflush locations when you receive a flow scheduled order into inventory.

Use Work Center/Location Maintenance (17.21.1.22) to set up these links.

In the first frame, enter the combination of site, work center, and machine that will backflush components from the specified locations. You must enter at least a valid Work Center. To create more general records, you can leave Site or Machine blank.

Fig. 8.12 Work Center/Location Maintenance (17.21.1.22)

The center frame displays existing flow rate code records, if any have been defined. Use the bottom frame to edit existing records or enter new ones. If this work center consumes components from more than one location, you can enter multiple locations. Use the Preference field to specify the priority the system should use in backflushing required components from each location.

Use of Work Center/Location Records

When you record completions using Flow Schedule Receipts and Modify Backflush is set to No, the system uses the following sequence to find locations that can provide the total quantity of components used by the completed flow schedules.

1. Based on the routing, use locations associated with a specified site, work center, and machine code.
2. Based on the routing, use locations associated with a specified site, specified work center, and blank machine code.
3. Based on the routing, use locations associated with a blank site, specified work center, and specified machine code.
4. Based on the routing, use locations associated with a specified work center only.

5. Based on item master data, use the location associated with the item.
6. Use blank location.

If a matching record has more than one location specified, the system consumes components in the order specified in Preference. When locations in one record do not provide sufficient components for the entire quantity received, the system consumes available components and searches for another appropriate location.

If backflush requirements still are not met, the system displays a warning message and a data-entry frame for the backflush location.

Creating and Maintaining Flow Schedules

You can create schedules to produce items on a specific flow production line within a site. A flow schedule consists of a group of flow scheduled orders, each with a required quantity and a due date within the planning period associated with the schedule, as well as an optional reference to a demand order and existing work order.

There are three ways to create flow scheduled orders:

- Enter them manually using Flow Schedule Maintenance (17.21.3). You can also use this program to update existing flow schedules—for example, to modify the sequence in which the production line completes its work on a given day or move orders from one day to another as priorities change.
- Create flow scheduled orders from MRP-generated planned work orders using Import MRP Orders to Schedule (17.21.9).
- Copy existing orders from an existing flow schedule to a new date range using Flow Schedule Copy (17.21.5).

Using Flow Schedule Maintenance

Use Flow Schedule Maintenance (17.21.3) to enter or update flow scheduled orders for a production line over a specified planning period.

You can optionally reference existing demand orders and work orders on flow scheduled orders. The system synchronizes due dates and quantities between the flow schedule and referenced work orders. If you do not reference a work order, the system automatically creates a type W (Flow) work order. Type W work orders cannot be updated or processed using any of the programs in the Work Orders module.

After you enter or update schedules, the system calculates production line resource usage based on setup data. Depending on records defined for the schedule code associated with the flow schedule, the system displays resource usage and flex fence data. Additionally, if you have defined one or more flow rate codes for items on the production line, the system optionally displays usage data based on different scenarios; for example, the effect of adding a machine or an extra worker to the production line. You can use these displays to determine how effectively your production line can meet the requirements of the schedule.

See "Flow Schedule Analysis" on page 194.

Important To avoid locking a large number of records during flow schedule entry or maintenance and to provide a method of viewing a schedule before updating the database, the system uses temporary tables to record transactions. Data is not written to the database until you are finished and are ready to save the schedule. Since no records are locked, it is possible for two users to make conflicting changes to the same schedule. While the system in most cases can detect whether existing records have been modified, it is safer to implement a business process that prevents multiple users from maintaining schedules for the same production line at the same time.

This program consists of the following three frames:

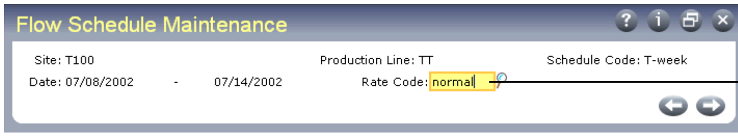
- A header frame, which lets you specify which production line will use the flow schedule, the due date for which you want to enter or update orders, and information used to calculate usage data.
- A display frame, which lets you select existing orders on the flow schedule for maintenance.
- A data-entry frame, which lets you enter new orders on the flow schedule or update existing orders.

Additional warnings, prompts, and summary frames may display, based on header settings and base data setup.

Flow Schedule Header

In the first frame, enter basic data to identify the flow schedule and determine how the system displays data while you are maintaining it.

Fig. 8.13
Flow Schedule Maintenance (17.21.3), Header Frame



Rate Code is optional.

Site. Enter the site where this flow scheduled order will be produced.

This must be a valid site defined in Site Maintenance, and it must be a site for which the production line has been defined in Production Line Maintenance.

Production Line. Enter the production line that will produce the items on this flow scheduled order.

This must be a valid production line defined for this site in Production Line Maintenance.

Schedule Code. Enter the schedule code that applies to this flow scheduled order. This must be a valid schedule code defined in Schedule Code Maintenance.

If a default schedule code has been defined for this production line in Production Line Maintenance, that value defaults to this field. You can change it as needed.

Schedule codes determine basic information about the schedule that the system uses to calculate dates, determine production rates, and control which types of data display in Flow Schedule Maintenance.

Date. Enter the date this flow schedule applies to. The field defaults to the current date. The system uses this date to determine the schedule to be created or modified.

You can change the field as needed, but it cannot be earlier than the starting date for the schedule specified in Schedule Code Maintenance.

After you complete the flow schedule header, the system uses the following setup data to calculate the date range in which this schedule falls:

- The start date specified in Schedule Code Maintenance
- The number of calendar days in the planning period associated with the schedule code, specified in Planning Period Maintenance

That range then displays in this field.

Rate Code. Optionally enter the code representing the flow rate for the items on this schedule. If this is a new schedule, the field defaults from the production line, if it specifies a default rate code. Otherwise, the default for a new schedule is blank. On an existing schedule, the value defaults from when you entered or last modified the schedule.

If you enter a value, it is validated against codes entered in Generalized Code Maintenance for field flcr_rate_code.

To determine the effects of alternate production scenarios, such as adding or subtracting machines from the production line, associate flow rates with rate codes in Rate Code by Item Maintenance or Rate Code by Type/Group Maintenance. When you enter a valid value in Rate Code and Display Physical Usage Recap is Yes for the schedule code specified, the system displays the effects of each flow rate associated with items on the schedule.

See “Defining Flow Rate Codes” on page 181.

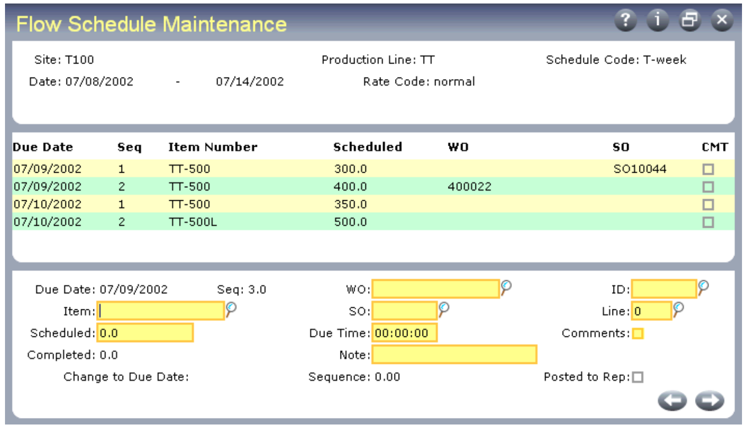
Note If you enter a value in this field and rate codes have not been defined for all the items on the schedule, the system displays an error message during processing.

Scheduled Order Details

After you complete these fields, the system lists the existing orders for the scheduling period. To update an order, select it and choose Go. You can then update many of the fields in the bottom frame.

To enter a new order, select any line and change the Date and Seq fields to a unique combination. The system clears the fields so you can enter a new order assigned to that date and sequence.

Fig. 8.14
Flow Schedule Maintenance (17.21.3), Display and Entry Frames



Due Date. Enter the due date for this item. This cannot be earlier than the first day of the period being maintained.

If the due date is later than the end of the period you are maintaining, the system displays a warning. Although information entered for such a date is stored, it is not used in usage calculations during the current session. Next time you access the schedule for this period, that detail record does not display. Instead, open the schedule that includes the specified date to view or modify that record.

You can enter the same due date for an item more than once on a schedule. However, each instance must have a different sequence number to indicate the production line's priorities.

If you enter an existing date/sequence number combination, the system displays data for that record. You can update most of the fields. The Change to Due Date and Seq fields are also enabled so that you can update the due date and sequence for this record.

If you enter a valid value in Work Order, the system validates that this is the same as the work order due date. If it is not, a warning message displays. The system updates the work order to match the flow schedule due date.

After a work order is linked to a flow schedule, the system synchronizes the schedule due date. You can update it here, and changes are reflected in Work Order Maintenance. However, you cannot update it in that program.

Sequence. Enter a sequence number indicating the order in which this production line will perform the scheduled activities on this day. You can update these numbers when priorities change; for example, in response to a rush sales order from a key customer.

Each due date on a flow schedule must have a unique series of sequence numbers; a number cannot be repeated on the same date.

To have the system assign the next available sequence number on this due date, enter 0 (zero).

If you enter an existing date/sequence number combination, the system displays data for that record. You can update most of the fields. The Change to Due Date and Seq fields are also enabled so that you can update the date and sequence fields.

The field accepts a decimal value, which you can use to insert a new schedule between two existing entries. For example, if you already have entries for item A on 5/25 with sequence numbers 1 and 2, but you want to resequence the schedule by adding another item A order before the current sequence 2, enter 1.5 in Sequence. After you complete the schedule, the system updates the sequence numbers in the middle frame to 1, 2, and 3.

Item. Enter the number of the item to be produced. This must be valid item for this site and production line, already defined in Production Line Item Maintenance.

An item number can be included on a flow schedule more than once, as long as each instance has a different due date/sequence combination.

If you enter a valid value in Work Order, the system verifies that this is the item on the work order. If you enter a sales order and line, the system also validates the item number.

Scheduled. Enter the quantity of the item to be produced by this production line on the specified date.

The scheduled quantity must be expressed in the stocking unit of measure for the item. If this is different from the unit of measure, weight, or volume specified in Schedule Code Maintenance for the schedule code referenced on this flow scheduled order, a conversion factor must exist in Unit of Measure Maintenance. Otherwise, the system displays an error message.

If you enter a valid value in Work Order, the system validates that this is the same as the work order quantity. If it is not, a warning message displays. The system updates the work order to match the flow schedule quantity.

After a work order is linked to a flow schedule, the system synchronizes the schedule quantity. You can update it either here or in Work Order Maintenance.

See "Receiving Completed Flow Scheduled Orders" on page 202.

Completed. This system-maintained field displays the quantity received for this flow scheduled order.

Work Order and ID. Optionally enter the number or ID of an existing work order to be associated with this flow scheduled order.

The work order must be for the same item or the system displays an error. In addition, if the work order due date and quantity are not the same as the flow schedule due date and quantity, warning messages display. The system then updates the work order record to match the due date and quantity on the flow schedule.

Additionally, the system automatically references a work order when you use Import MRP Orders to Schedule to add a scheduled order for an item with a purchase/manufacture code other than W (Flow manufactured) or L (Line manufactured). You cannot update the displayed values.

When you enter both work order and sales order numbers, the system determines whether the sales order is for a configured item that has been released to a type F (final assembly) work order using Sales Order Release to Work Order (8.13). If so, the work order must be the one associated with the sales order. Otherwise, an error message displays.

When you reference a work order on a flow schedule, the system synchronizes data between the Flow Scheduling and Work Orders modules. For example, you can receive completed orders using Work Order Receipt (16.11), Work Order Receipt Backflush (16.12), or Flow Schedule Receipts (17.21.7). Each program updates the Completed field in both Flow Schedule Maintenance and Work Order Maintenance.

These fields are enabled only when you are entering a new scheduled order. You cannot update them later.

Sales Order. Optionally enter the number of the demand order that created the demand to be filled by this flow scheduled order. This can be a sales order, a return material authorization (RMA) issue, a customer scheduled order, or a material order.

If you enter a value in this field, the system validates it against existing values in the sales order master table. It confirms that the specified item is included on the demand order only if you also specify a line number. Otherwise, it just validates that the order exists.

When you enter both work order and sales order numbers, the system determines whether the sales order is for a configured item that has been released to a type F (final assembly) work order. If so, the work order must be the one associated with the sales order. Otherwise, an error message displays.

Line. Optionally enter the line number of the specified demand order.

If you enter a line number, the system validates the following:

- That the line item exists on the specified demand order
- That the line is for the specified item

Due Time. Optionally enter the time of day that this flow scheduled order should be completed.

Enter the time in HH:MM:SS format based on a 24-hour clock. For example, enter 1:30 p.m. as 13:30:00.

This field is for reference. It appears on some reports and inquiries, and can be used to introduce a greater level of detail into the sequence of activities on a production line.

Comments. Indicate whether you want to enter comments related to this flow scheduled order.

When this field is Yes, the system displays a standard transaction comments screen when you press Go. You can enter unlimited comments, with each comment up to 99 pages long.

You can also use the Note field to enter a brief comment up to 24 characters long without using the transaction comments screen.

Note. Optionally enter a brief text comment associated with this flow scheduled order.

This field is limited to 24 characters. To enter more extensive text, set Comments to Yes.

See "Exporting Flow Schedules to Repetitive" on page 200.

Posted to Repetitive. This system-maintained field indicates whether an order has been exported for scheduling with the Repetitive or Advanced Repetitive module using Export Schedule to Repetitive (17.21.10). When it is Yes, you can no longer process this flow scheduled order using programs on the Flow menu.

Two additional fields can be updated only when you are modifying an existing flow scheduled order:

Change to Due Date. Enter a new due date for this flow scheduled order. This cannot be earlier than the first day of the period being maintained.

If the date you enter is later than the period you are maintaining, the system displays a warning. Although information entered for such a date is stored, it is not used in usage calculations during the current session. Next time you access the schedule for this period, that flow schedule does not display. Instead, open the schedule for the appropriate period to view or modify it.

Sequence. Enter a new sequence number for this flow scheduled order.

The sequence number can be a decimal. For example, to resequence an order to fall between existing order sequence numbers 1 and 2, set this field to 1.5. After you press Go, the system renumbers the order lines as 1, 2, and 3.

Flow Schedule Analysis

See "Defining Schedule Codes" on page 168.

When you finish entering or updating data, press End when the cursor is in the Due Date field to return to the second frame, and then press End again. Based on setup data and settings in Schedule Code Maintenance, you can use these frames to analyze how well the production line can meet the requirements shown in the schedule before you write the schedule to the database.

If the setup data is not available for a recap frame, the system does not display the frame regardless of the setting in Schedule Code Maintenance. For example, if you have not set up appropriate flex fence parameters in Flex Fence Maintenance, the recap frame and warning messages do not display.

Schedule Summary

The system first displays a frame of summary data that includes the following:

- Basic schedule information from the header.
- Number of hours on the schedule.
- Scheduling rate expression associated with the schedule code used; for example, tons per week.
- Quantities scheduled and completed.
- Takt time, also known as operational cycle time, for the current schedule on the production line. In this frame, Takt time is always displayed as the number of minutes needed to make one unit. This indicates the pace at which the production line operates to meet the current schedule.

See "Takt Time" on page 158.

```
     Site: t100    Production Line: tt     T clip production line
 Schedule Code: T-week   weekly T line schedule
Scheduled Hours: 40.00   Schedule Period: 07/15/02 - 07/21/02
   Scheduled: 26,500.00  ea/weekly   Takt Time: 0.09     Min/ea
   Completed: 0.00
```

Fig. 8.15
Schedule Summary Frame

Flex Fence Data

Flex fences are tools for determining whether the total required quantity to be produced on the schedule you are entering is within a specified percentage of the current period's requirements.

See "Flex Fences" on page 161.

A flex fence data frame displays under these circumstances:

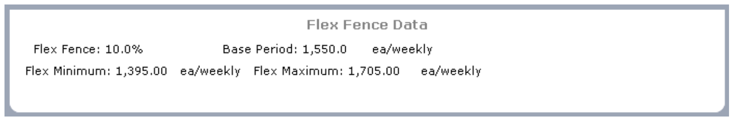
- The schedule you are maintaining is for a future planning period, rather than the current one.
- You have specified flex fence parameters that apply to this flow schedule.

See page 178.

- Display Flex Fences Recap is Yes for the applicable schedule code record in Schedule Code Maintenance.

When production requirements are outside the percentage specified in Flex Fence Maintenance, the system also displays a warning message in addition to the flex fence data summary.

Fig. 8.16
Flex Fence Data Frame



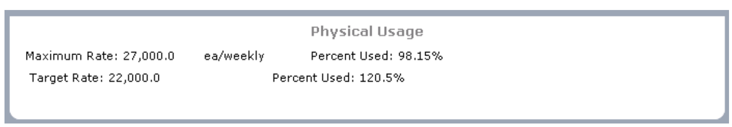
Physical Usage Data

See "Checking Physical Usage in a Schedule" on page 158.

The system displays a frame of physical usage data, expressed as the percentage of target and maximum production line capacity represented by total requirements for the planning period, under the following circumstances:

- You have associated target and maximum rates either with the applicable schedule code in Production Line Maintenance, or with the production line in Schedule Code Maintenance.
- Display Physical Usage Recap is Yes for the applicable schedule code record in Schedule Code Maintenance.

Fig. 8.17
Physical Usage Frame



Time Usage Data

See "Checking Time Usage in a Schedule" on page 159.

You can use time usage calculations to determine the effects of alternate resource scenarios on the production line's ability to meet schedule requirements effectively.

The system displays time usage data in two formats—for the entire schedule period or for each individual day in the period—only under the following circumstances:

- You have associated flow rate codes with items in either Rate Code by Item Maintenance or Rate Code by Type/Group Maintenance.

- You enter a valid rate code in the header of Flow Schedule Maintenance.
- The appropriate field—Display Time Usage Recap or Display Daily Time Usage Recap—is Yes for the applicable schedule code record in Schedule Code Maintenance.

Fig. 8.18
Time Usage Frame

Time Usage

Rate Code	Available Hours	Hours Used	% Used
high	40.00	29.52	73.81%
low	40.00	61.67	154.2%
normal	40.00	39.00	97.5%

Fig. 8.19
Time Usage by Day Frame

Time Usage by Day

Due Date	Available Hours	Hours Used	% Used
07/15/2002	8.00	20.00	250.0%
07/16/2002	8.00	2.50	31.25%
07/17/2002	8.00	3.00	37.5%
07/18/2002	8.00	10.00	125.0%
07/19/2002	8.00	3.50	43.75%
07/20/2002	0.00	0.00	0.0%
07/21/2002	0.00	0.00	0.0%

Completing the Flow Schedule

After displaying the appropriate data summaries, the system prompts you to take an action regarding the flow schedule by entering one of following values:

1: Accept new flow schedules and changes to existing schedules. The system displays a status screen during processing, followed by a summary of the number of schedules processed for each day of the period. Updated records are written to the database from the temporary table used during data entry.

2: Edit the schedule. The system returns to the summary frame so you can continue to enter or update records. Changes made or new records entered during this session are not yet saved in the database.

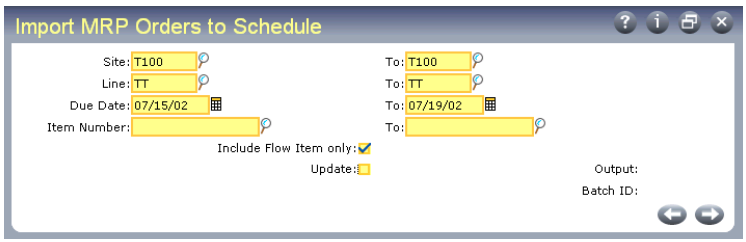
3: Cancel. The system clears the temporary table created during this session, and the program returns to the header frame. No changes are saved in the database. Any new or modified data you entered in the program is discarded; existing schedules saved during earlier sessions are not affected.

Note Pressing End also clears the temporary table and returns the program to the header frame.

Importing MRP Planned Orders to a Flow Schedule

Use Import MRP Orders to Schedule (17.21.9) to select planned work orders for specified items and add them to flow schedules for the appropriate production lines.

Fig. 8.20
Import MRP Orders to Schedule (17.21.9)



Enter selection criteria for the items that will have planned orders added to flow schedules. To limit the selection to items that are usually produced on a flow line, set Include Flow Items Only to Yes. Set Update to No to review a report on the effects of running this program before updating the database.

See "Associating Items with Production Lines" on page 176.

When you press Go, the system looks for MRP-planned (status P) work orders for the items matching the selection criteria. If the item is not assigned to a production line in Production Line Item Maintenance, it is skipped. If it is assigned to multiple production lines, the system uses the Preference value from Production Line Item Maintenance to determine the production line where the order will be scheduled.

Based on the planned order due date, the system assigns each work order to the production line flow schedule for the appropriate period. If a schedule already exists for that date, the system assigns the next available sequence number. After importing the orders to flow schedules, you can update sequence and date information using Flow Schedule Maintenance.

See "Purchase/ Manufacture Codes" on page 163.

If the item on an imported schedule has a purchase/manufacture code of W (flow), the system changes the work order type to W. Otherwise, the work order type is left blank. In either case, the system sets the work order status to E (exploded). It then follows standard work order processing: Bill of material (BOM) and routing records are created based on item master data, and the product structure is re-exploded using the latest BOM and routing information available. The release date is calculated based on the due date.

After importing MRP planned orders to flow schedules, process them the same way you do other flow scheduled orders.

Copying Flow Schedules

Use Flow Schedule Copy (17.21.5) to copy existing flow scheduled orders to new flow schedules.

The copied order includes much of the same data as the original, such as site, production line, item number, and schedule quantity. The due date is modified based on the specified target date range. Other values in the new record are blank even if the source order included values in the corresponding fields; for example, the system does not copy references to sales orders or work orders, and the Completed field is set to 0 (zero).

For each flow scheduled order copied, the system creates a new type W (flow) work order just as it does when you enter a new order using Flow Schedule Maintenance.

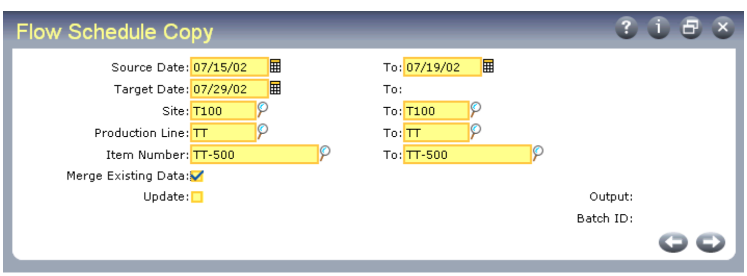


Fig. 8.21 Flow Schedule Copy (17.21.5)

Enter the range of dates you want schedules to be copied from, as well as the target start date for the newly created schedules. Using the specified selection criteria and a calculated target date range based on due dates for existing schedules, the system copies existing flow schedules to the corresponding dates in the target date range.

For example, you enter a source date range of 5/15/02 to 5/22/02 and a target date of 6/15/02. The systems finds schedules with due dates of 5/16, 5/19 and 5/20 that match the selection criteria. It copies the data from those schedules into new schedules with due dates of 6/16, 6/19, and 6/20.

To see the effects of this program without actually copying orders, set Update to No. Then review the output report, adjust selection criteria as required, and run the program again with Update set to Yes.

Merging Data

In some cases, you might be copying a scheduled order to a new date range that already includes a matching record for the item.

Use the Merge Existing Data field to indicate how the system should manage a copied order when this occurs.

No: The system does not create a new schedule for that order. On the output report line for that order, Source From Due Date is blank and Existing Schedule displays Yes.

Yes: The system adds the quantity from the copied order to the existing flow scheduled order. On the output report line for that order, the same due date displays in both Source From Due Date and Schedule Due Date. Additionally, Existing Schedule displays Yes.

See “Work Orders” on page 163.

The system also adds the quantity to the associated work order for the target date. This can be either the system-generated type W work order or the standard work order referenced in the Work Order field.

Exporting Flow Schedules to Repetitive

Use Export Schedule to Repetitive (17.21.10) to select flow scheduled orders for specified items and add them to line schedules. You can then place the orders on repetitive schedules in the Repetitive and Advanced Repetitive modules.

See “Purchase/ Manufacture Codes” on page 163.

Enter selection criteria for the items that will have flow scheduled orders exported to repetitive schedules. To limit the selection to items that are usually produced on a repetitive line, set Include Repetitive Items Only to

Yes. Set Update to No to review a report on the effects of running this program before updating the database.

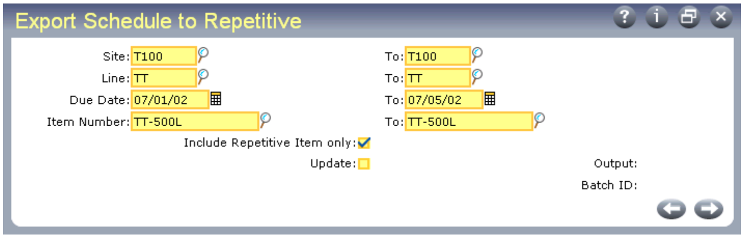


Fig. 8.22
Export Schedule to Repetitive (17.21.10)

When you press Go, the system searches for flow scheduled (type W) work orders that have no completions recorded for the items matching the selection criteria. If the item is not assigned to the repetitive production line in Production Line Maintenance (18.1.1 in Repetitive; 18.22.1.1 in Advanced Repetitive) or if the flow scheduled order has completions recorded, it is skipped.

Note Only system-generated type W work orders are included in the search. If you created a flow scheduled order and manually entered a reference to a work order, you cannot export that flow scheduled order to Repetitive.

Based on the planned order due date, the system assigns the quantity of the item to the production line schedule for the appropriate date. If a line schedule already exists for a due date, the system adds the quantity from the flow scheduled order to that day's requirement. You can then use Line Schedule Workbench (18.1.10 in Repetitive; 18.22.1.10 in Advanced Repetitive) and Repetitive Schedule Update (18.1.18 in Repetitive; 18.22.1.18 in Advanced Repetitive) to add them to repetitive schedules.

Important When you export the flow scheduled order, the system automatically deletes the system-generated type W work order that was created with the flow scheduled order, along with the associated MRP detail record. Once the order is moved to the repetitive schedule by way of Line Schedule Workbench, a new MRP detail record is then created to reference that work order.

It is important to understand that if a planned work order is moved into flow using Import MRP Orders to Schedule (17.21.9), that planned work order is deleted and replaced with the flow work order—which becomes the only order visible to MRP. If you then move that same work order to repetitive (specifically the repetitive workbench), MRP no longer has knowledge of that work order. If MRP is run while the work order is still in the workbench, MRP may reschedule the requirements from the original planned work order that was moved to flow, then to repetitive—resulting in the same requirement being planned twice.

See Chapter 10, "Advanced Repetitive," on page 261 or Chapter 11, "Repetitive," on page 311.

When you export a flow scheduled order, the system sets the Posted to Rep field in Flow Schedule Maintenance to Yes. You can no longer update the schedule or record completions for it in the Flow Scheduling module. Instead, process exported schedules just as you would any line on a repetitive schedule.

Receiving Completed Flow Scheduled Orders

Use Flow Schedule Receipts (17.21.7) to receive completed products made on a flow production line and backflush the items used to make them at the same time. The quantity received is applied to flow scheduled orders and any associated work orders. Optionally, you can update component backflush information.

Note Depending on how the flow schedule order is entered, you may be able to use alternative methods to receive completed quantities:

- When a flow schedule references a non-type W (flow) work order, you can receive the items in two ways:
  - Using Flow Schedule Receipts. The system updates the Completed field in both Flow Schedule Maintenance (17.21.3) and Work Order Maintenance (16.1).

See "Receiving Work Orders" on page 126.

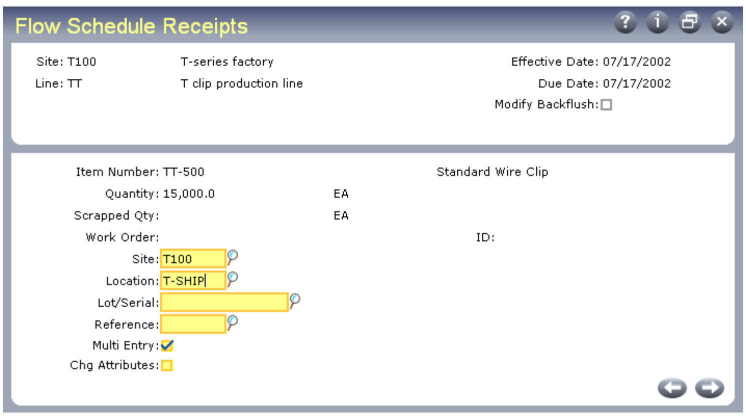
  - Using Work Order Receipt (16.11) or Work Order Receipt Backflush (16.12) as part of your standard work order processing tasks. The system also updates the Completed field in Flow Schedule Maintenance for that schedule.
- When the Work Order field is blank in Flow Schedule Maintenance, you can record receipts for the flow scheduled order only in Flow Schedule Receipts.

Important Regardless of the method you use, your work procedures should require receipts to be entered as close to completion as possible. When you analyze production performance data using Linearity Summary Inquiry (17.21.13.1), recording timely receipts allows completion information to be up-to-date. Linearity is an important concept in flow manufacturing because it lets you measure planned flow rates against actual rates and adjust your production methods accordingly.

See "Flow Linearity" on page 162.

In the first two frames of Flow Schedule Receipts, provide basic data for the receiving process. Based on the settings in some of the fields, additional frames may display.

Fig. 8.23 Flow Schedule Receipts (17.21.7)



Site and Line. Identity the site and production line that produces the item to be received.

Due Date. Specify the due date associated with flow scheduled orders that the system will consider first in applying completions based on the quantity entered in this program.

Using this date as a starting point, the system applies the quantity to orders on the specified production line. No receipts are recorded against orders with due dates later than this.

See "Application of Received Quantities" on page 205.

Modify Backflush. When this field is Yes, additional screens let you update information on the quantity and location of components used during production.

See "Receiving and Backflushing" on page 127.

When you modify backflush while receiving flow scheduled orders, the system uses the same process as when you receive standard work orders using Work Order Receipt Backflush (16.12).

See "Linking Work Centers to Locations" on page 184.

Otherwise, the system uses default information in determining how to issue components. If you have defined component issue locations in Work Center/Location Maintenance (17.21.1.22), it uses those locations first.

Item Number. Enter the number of the item being received. This must be a valid item associated with this production line in Production Line Maintenance.

Quantity. Enter the completed quantity of the item being received.

Note If the production line flow schedule for the due date does not include open scheduled quantities for this item, the system displays an error message.

After this quantity has been received, it displays in the Completed field in Flow Schedule Maintenance. If a work order is referenced in the flow schedule, the quantity completed is also recorded on that work order.

If you receive an incorrect quantity using Flow Schedule Receipts, you can reverse it by running the program again with a negative quantity. Be sure to enter the same site, location, lot/serial, and lot reference numbers as you entered on the original transaction. After you reverse the original entry entirely, run the program again with the correct quantity. This maintains a complete audit trail.

Scrapped Quantity. Enter the number of items scrapped while producing the quantity being received.

Scrapped quantity displays on work order history and cost reports. The total GL cost of the rejected items posts to the scrap account.

Work order reject items have usually completed the entire process before being rejected, so their entire standard cost is written off to Scrap. Items rejected part way through the process should be rejected at that operation. Then only the excess costs incurred to process the rejected item up through that operation are written off to the Method and Material Usage Variance accounts.

Work Order. Optionally enter the number of a work order referenced on a flow scheduled order.

If you enter a value, it must be a valid non-type W (flow) work order. The work order status cannot be F (firm planned) or C (closed).

The system applies the entire quantity to the associated flow scheduled order. This quantity is added to the Completed field for the flow schedule in Flow Schedule Maintenance and for the referenced work order in Work Order Maintenance.

ID. If you entered a value in Work Order, enter the associated ID number.

This must be a valid ID associated with the work order number.

Multi Entry. Specify whether you want to receive quantities into more than one site or location. When this is Yes, an additional data-entry frame displays.

Change Attributes. Specify whether you want to modify the default inventory attributes of the items being received.

No: Received items are assigned the default inventory attributes.

Yes: The system prompts you to enter the Inventory Status, as well as Assay%, Grade, Expire Date, and Active settings.

Application of Received Quantities

A one-to-one correspondence does not necessarily exist between required quantities on flow scheduled orders and quantities received. You can specify which flow schedule should have the quantity applied to it if it is associated with an existing work order. However, a schedule can include orders without referenced work orders.

When a work order is specified during receipt, the system applies the entire quantity to the associated flow scheduled order, even if it is greater than the open quantity. This also updates the Quantity Completed field for the specified order in Work Order Maintenance.

When you leave the Work Order field blank in Flow Schedule Receipts, the system uses this logic:

Note Receipts are applied to a flow scheduled order with an associated work order only when you enter the work order number in Flow Schedule Receipts. This logic never applies completed quantities to orders that include a value in the Work Order field.

- First, apply the receipt to flow schedules with open quantities where the flow schedule due date is the same as the receipt due date.
- If no flow schedules with open quantities exist with that due date or if those that do have total open quantities less than the amount being received, begin with the earliest due date and sequence number showing an open quantity and move forward until the entire receipt quantity is applied.
- If the receipt still has an unapplied quantity:
  - If the receipt process filled open quantities for the receipt due date, apply any remaining receipt quantity to the last sequence number for that date, even if the quantity completed is greater than the order quantity.
  - If the receipt date does not match the due date for any flow schedules that have had completions applied, create a new flow schedule for the receipt due date. Set the quantity scheduled to 0 (zero) and apply the entire remaining amount as completions for this new schedule.

Note Receipts are never to applied to orders with due dates later than the value you specify in Due Date.

Inventory Effects of Flow Schedule Receipts

Receiving and backflushing increases end-item inventory quantities at designated sites and locations and decreases component inventory. It also updates the work order to reflect quantities completed and scrapped, decreases quantities open for MRP, and adjusts work in process (WIP).

MRP plans for open component requirements. Issuing a required component or an approved substitute decreases the quantity required of that item for planning. It also increases the value of WIP. Issuing a component not listed on the work order also increases WIP.

Recording a receipt or scrap decreases the scheduled receipt quantity for planning. Receipts and scrap can total more than order quantity. Receipts and scrap decrease the value of WIP.

You can change the quantity to issue for any item when Modify Backflush is Yes in the first frame of Flow Schedule Receipts. When you do not need the entire quantity of an item, issue the quantity you need and set Cancel B/O to Yes to cancel the excess requirement for MRP.

The system maintains a complete audit trail of inventory transactions in transaction history (tr_hist). Review these with Transactions Detail Inquiry (3.21.1). Each transaction is identified by a transaction number and a transaction type. Five types of transactions can be created:

- ISS-WO for component material issues
- RCT-WO for finished material receipts
- RJCT-WO for material rejected
- ISS-TR for material issue transfers
- RCT-TR for material receipt from an inventory transfer

When an inventory transaction references a different site than the originating order, the system processes this transaction in two steps.

- On an issue transaction, the inventory is transferred to the order site and then issued.
- On a receipt transaction, the inventory is received and then transferred.

This generates additional transaction types ISS-TR and RCT-TR.

General Ledger (GL) Effects of Flow Schedule Receipts

GL transactions are stored in the unposted transaction table until they are posted. Review unposted transactions with Unposted Transaction Inquiry (25.13.13). Review and delete transactions created in modules other than GL with GL Transaction Delete/Archive (36.23.2). GL transactions are recorded as the following types:

- WO or Work Order
- IC or Inventory

Inventory receipts, apply this-level overhead amount:

- Debit the WIP account from the work order.
- Credit the Overhead Applied account for the product line of the item.

Inventory receipts, receive the finished item:

- Debit the Inventory account defined in Inventory Account Maintenance (1.2.13) for the product line, receiving site, and receiving location.
- Credit the WIP account from the work order.

Rejects (scrap):

- Debit the Scrap account defined in Inventory Account Maintenance for the product line and receiving site.
- Credit the WIP account from the work order.

Component issues:

- Debit the WIP account from the work order.
- Credit the Inventory account defined in Inventory Account Maintenance for the product line, issue site, and issue location.

When inventory transactions affect more than one site, costs may differ between the two sites. Cost variances are posted to the Transfer Variance account defined in Site Maintenance (1.1.13). The system automatically generates the appropriate balancing transactions in the GL for each site.

- When the transfer-from and transfer-to sites are in different entities, a balancing entry is posted to the appropriate Intercompany Inventory Control debit and credit account defined in Entity Code Maintenance (25.3.1).
- When the two sites are in the same entity, a balancing debit or credit is posted to the Transfer Clearing account defined in Inventory Control (3.24).

Note For component issues, rather than post differences in cost between two sites to the Transfer Clearing account, differences are posted to the work order, crediting Material Rate Variance.

Labor Reporting

The backflush transaction that runs when you receive flow scheduled orders automatically reports the standard number of hours specified in routing data for the quantity processed.

Usage variances are calculated on earned hours based on the standard hours to complete the number of units reported complete.

Rate variances are calculated as the difference between the employee pay rate and the standard rate for the work center where the labor was reported.

Labor:

- Debits the WIP account from the work order.
- Credits the Labor account for the department.
- Debits/credits the Labor account and credits/debits the Labor Rate Variance account for the department.
- Debits/credits the Labor account and credits/debits the Method Variance account for the department.

Burden:

- Debits the WIP account from the work order.
- Credits the Burden account for the department.
- Debits/credits the WIP account.
- Credits/debits the Burden Usage Variance and the Burden Rate Variance accounts for the department.

Downtime:

- Debits the Cost of Production account for the department.
- Credits the Labor and Burden accounts for the department.

Closing Flow Scheduled Orders

When flow scheduled orders are completely filled or are no longer needed, you can close them. For example, you might want to do this so that additional completions cannot be recorded for an order with an open quantity that is no longer required.

Note Before you record any completions for an order, you can simply delete it using Flow Schedule Maintenance (17.21.3). However, you cannot use that method to delete an order that includes a value in the Completed field. Instead, close the order and then delete it using Flow Delete/Archive (17.21.23).

The methods you can use to close an order depend on whether it references a standard work order:

- When the flow scheduled order has a value in the Work Order field in Flow Schedule Maintenance, you can update the associated work order using programs on the Work Orders menu. The system synchronizes the changes on the flow scheduled order. For example, when you change the Status field in Work Order Maintenance (16.1) to C (closed), the system displays CLOSED next to the Completed field in Flow Schedule Maintenance. Reopening the work order also reopens the flow scheduled order.

  The system also synchronizes changes in the other direction. When you close the flow scheduled order, the Status field on the associated work order in Work Order Maintenance is automatically set to Yes.
- Although flow scheduled orders with a blank Work Order field are associated with a system-maintained type W work order, you cannot close that work order with any programs on the Work Orders menu. Use Flow Schedule Close (17.21.19).

In Flow Schedule Close, enter selection criteria to identify flow scheduled orders to be closed. To review a report on the effects of the selection criteria before updating the database, first run the program with Update set to No.

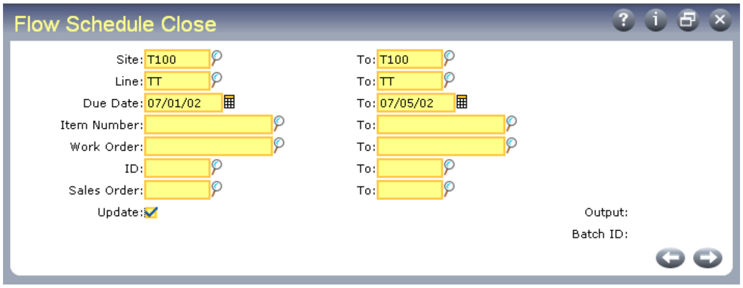


Fig. 8.24
Flow Schedule Close (17.21.19)

System-generated type W work orders are automatically deleted when you close the associated flow schedule with this program. This action has no accounting effects, since these take place when you record completions using Flow Schedule Receipts.

After you run this program, the system displays CLOSED next to the Completed field in Flow Schedule Maintenance. You cannot update closed orders, export them to the Repetitive module, or record receipts for them, even if they have open quantities. Closed flow scheduled orders remain in the system until you run Flow Delete/Archive, which gives you the option of selecting only closed scheduled orders.

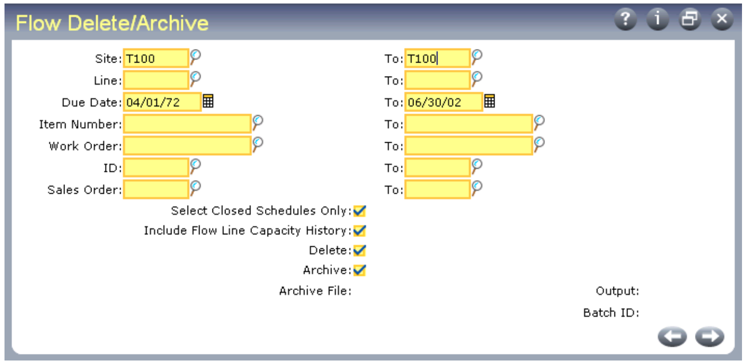
Deleting and Archiving Flow Scheduled Orders

Use Flow Delete/Archive (17.21.23) to delete and archive flow schedule detail and flow line capacity history records when online history is no longer needed.

This program deletes work orders associated with flow schedules only if they are type W (flow). On non-type W work orders, only the associated reference in the schedule detail record is deleted.

You should run this function twice. First, run it with Delete set to No and review the report to see the effects of the selection criteria. Then, make necessary adjustments and run it with Delete set to Yes.

Fig. 8.25
Flow Delete/
Archive (17.21.23)



Flow Schedule Reports

Table 8.9 lists programs on the Flow Inquiry and Reports Menu, with a brief description of how each is used.

Table 8.9
Flow Inquiry and Reports Programs

Menu Number	Program	Description
17.21.13.1	Linearity Summary Inquiry	Compares production line actual completions with scheduled requirements in both tabular and barchart formats. See “Flow Linearity” on page 162.
17.21.13.2	Linearity Summary Report	Outputs a report comparing production line actual completions with scheduled requirements in tabular format. See “Flow Linearity” on page 162.
17.21.13.7	Flow Schedule View	Displays information on existing flow scheduled orders for a specific production line. Optionally displays usage data based on different flow rates.
17.21.13.10	Flow Schedule Detail View	Displays detailed information about flow scheduled orders for multiple production lines, with options for grouping data by production line, item, and due date.
17.21.13.11	Flow Schedule Detail Report	Outputs a detailed report about flow scheduled orders for multiple production lines, with options for grouping data by production line, item, and due date.

Chapter 9

Kanban

Use Kanban to identify items that are kanban controlled, maintain kanban-related data for these items, print kanban cards on demand, and use kanban transactions to track and manage the movement of kanban-controlled items in and out of the production process.

Introduction

Kanban is a method of just-in-time (JIT) production that uses standard containers or lot sizes with a single card attached to each. It is a pull system in which work centers use a card to signal that items are to be withdrawn from suppliers. The Japanese word *kanban*, loosely translated, means card, billboard, or sign. The term is often used synonymously for the specific scheduling system developed and used by the Toyota Corporation in Japan.

The kanban system is conceptually very simple. It defines a communication signal or card indicating that items need replenishment.

Traditional production processes rely on schedules to push inventory into stocking locations. Kanban pulls material through the manufacturing process based on the actual demand from customer orders or production consumption. Kanban is an integral component of demand pull manufacturing, where material is pulled to where it is needed, when it is needed—and no sooner.

Kanban Signals

Kanban cards provide visual signals to replenish empty kanban containers. Kanban cards communicate who is going to produce or provide the product, where it is going to be used, and it signals that the time has come to begin production.

Kanban provides two options: one-card or two-card systems.

Figure 9.1 illustrates a single-card system using the withdrawal principle. For example, work center A produces a part used by work center B. Work center B pulls a container from work center A when it needs material and may return an empty container. When B pulls the container, the kanban card is removed from the container and placed in the card rack at A. The kanban in A indicates an authorization for A to produce another container of parts.

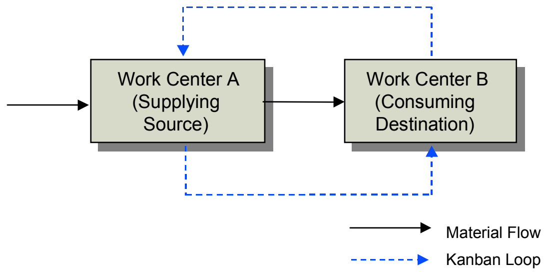


Fig. 9.1
One-Card Example

A two-card system, illustrated in Figure 9.2, has a move kanban and a production kanban. A two-card system is used when the movement of a container of parts may not trigger an immediate replenishment of that part. Items are pulled in one (move) quantity and replenished in another (production) quantity. For example, items are moved to a consuming destination in quantities of 10 and only produced at the supplying source in quantities of 50.

Suppose that work center B is using a container of parts that is next to B. The move card pulled from the kanban container goes to the storage area. A full container is found, the production card is removed, and the move card is placed in the container. This authorizes movement of the container from storage to work center B.

The production card is then placed near work center A as an authorization to produce another container of parts. When work center A is finished producing a full container of parts, the production card is placed in this container and moved to storage.

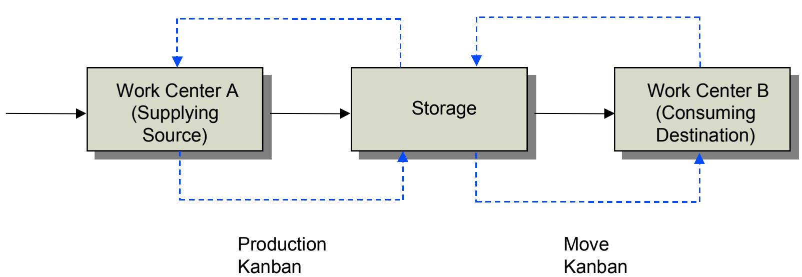


Fig. 9.2
Two-Card Example

The number of kanbans needed for a given part is determined by usage of finished goods and the replenishment time. For example, if your company uses 500 of a given part per day and it takes 3 days to replace the stock, then you need a minimum of 1,500 parts in the production process. For practical purposes, you should also have a small safety stock in the process as well.

If you frequently run out of stock, there are not enough kanbans in the process and you should add more. If you regularly have an overabundance of stock, there are too many kanbans in the process and some should be deactivated.

It is usually better to have more kanbans with fewer parts in each than a few kanbans with a large number of parts. Smaller kanban sizes make it easier to adjust the number of kanbans in the process to satisfy demand. In this example, you could have 15 kanbans containing 100 parts each. When demand for the part increases or decreases, you can adjust the number of kanbans in increments of 100.

Kanban Transactions

Kanban transactions convert visual replenishment signals to electronic signals. Kanban transactions track the movement of components into the production process and the movement of final products out of the production process. While in the production process, the movement of material from one point to another is typically not tracked.

When materials or components are required in the production process, they are pulled from raw material inventory or received directly from an external supplier. At the end of the production process, final products are transferred to finished goods inventory where they are available for shipment.

MFG/PRO processes kanban transactions in two modes:

- Execute
- Return

Execute Transactions

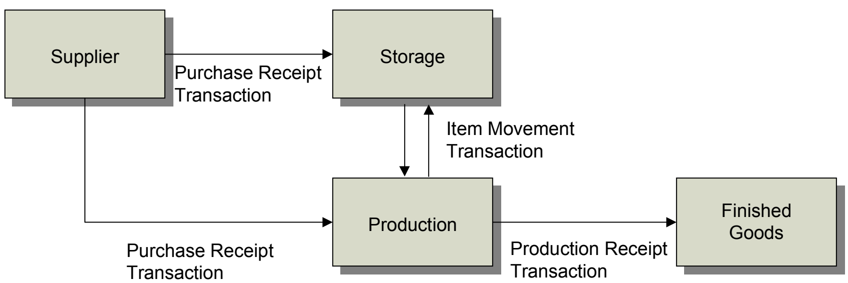
Execute transactions are used to move full kanban containers from a supplying source to a consuming destination. A *supplying source* can be an item supplier or the point of replenishment for a kanban-controlled item. A *consuming destination* is the point of usage for a kanban-controlled item.

You can execute the kanban signal for the following types of kanban transactions:

See "Processing Kanban Transactions" on page 246 for details.

- Purchase receipts
- Item movement
- Production receipts

Fig. 9.3 Kanban Transaction Flow



The system can automatically create the appropriate inventory and general ledger (GL) transactions for each type of execute transaction.

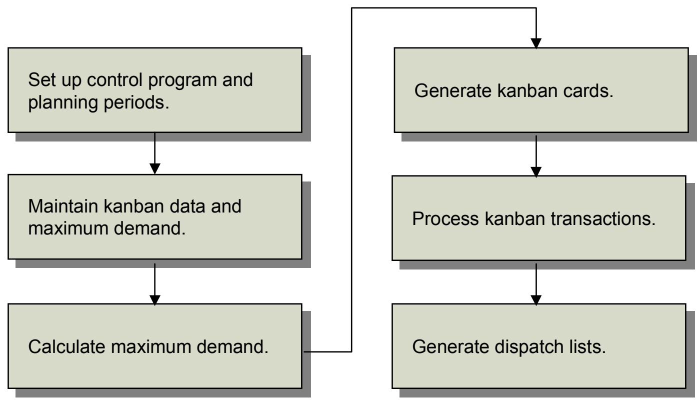
Return Transactions

Return transactions are used to record that empty kanban containers are ready to be moved from a consuming destination back to the supplying source for replenishment. When items from an external supplier are consumed, you can send a kanban order in the form of a dispatch list to replace what was used. Return transactions do not impact inventory balances or the GL.

Kanban Work Flow

Figure 9.4 summarizes the steps for setting up and managing Kanban.

Fig. 9.4
Kanban Work Flow



Set Up Control Program and Planning Periods

See "Setting Up Kanban" on page 220 for details.

Kanban requires the following setup information:

- Settings in Kanban Control
- Planning periods

Maintain Kanban Data

After the control program and planning periods have been defined, you can begin managing kanban data, including the following:

- Enter and maintain kanban data
- Copy kanban information from one kanban loop to another
- Maintain maximum demand per planning period

Calculate Maximum Demand

See "Calculating Maximum Demand" on page 236 for details.

This function lets you calculate the maximum demand per hour for all kanban-controlled items for sizing calculations.

Print Cards

Kanban lets you print, size, and simulate cards that reflect the maximum demand.

Process Kanban Transactions

Track and manage the movement of kanban-controlled items in and out of the production process using kanban transactions.

See "Processing Kanban Transactions" on page 246 for details.

Generate Kanban Dispatch Lists

Return groups of empty kanban containers to their supplying source for replenishment using dispatch lists. Dispatch lists are generated from selected kanban transaction records.

See "Viewing Kanban Transactions" on page 251.

Kanban Programs

Table 9.1 lists the programs used in Kanban.

Table 9.1
Kanban Programs

Menu Number	Description	Program
17.22.1	Kanban Master Maintenance	kbkbmt.p
17.22.2	Kanban Master Inquiry	kbkbiq.p
17.22.3	Kanban Master Report	kbkbrp.p
17.22.5	Kanban Master Copy	kbkbcp.p
17.22.7	Planning Period Maintenance	kbppmt.p
17.22.8	Planning Period Browse	kbbr001.p
17.22.10	Maximum Demand Maintenance	kbmdmt.p
17.22.11	Maximum Demand Browse	kbbr002.p
17.22.12	Maximum Demand Report	kbmdrp.p
17.22.13	Maximum Demand Calculation	kbmdclc.p
17.22.15	Kanban Card Size/Print	kbszmt.p
17.22.16	Kanban Card Inquiry	kbsziq.p
17.22.17	Kanban Card Reprint	kbszrp01.p
17.22.19.1	Execute Kanban Transactions	kbextr.p
17.22.19.2	Return Kanban Transactions	kbrttr.p
17.22.19.4	Transaction Inquiry by Trans Nbr	kbtriq.p

Menu Number	Description	Program
17.22.19.5	Transaction History Browse	kbbr008.p
17.22.19.7	View Transactions by Item	kbtriq1.p
17.22.19.8	View Transactions by Kanban Mstr	kbtriq2.p
17.22.19.9	View Transactions by Kanban Card	kbtriq3.p
17.22.19.13	Kanban Dispatch List Processing	kbdlrp.p
17.22.19.15	Kanban Transactions Audit Report	kbtrrp.p
17.22.19.18	Missing Kanbans Report	kbmirp.p
17.22.19.23	Transaction Delete/Archive	kbtrup.p
17.22.21	Kanban Card Activate/Inactivate	kbcdmt.p
17.22.22	Kanban Card Audit Report	kbcdrp.p
17.22.24	Kanban Control	kbpm.p

Setting Up Kanban

Before you can use Kanban, you must define the following:

- Validated fields
- Settings in Kanban Control
- Planning periods

Validated Fields

You can use generalized codes, which you define in Generalized Codes Maintenance (36.2.13), to specify valid values for some fields. They give you flexibility in organizing and implementing functions, since you can define values that are meaningful in your own business environment.

Table 9.2 lists the fields using generalized codes referenced by kanban functions. Use this table to plan which codes to set up for your implementation.

Table 9.2
Generalized Codes in Kanban

Field	Label	Where Used
kbmd_pattern	Demand Pattern	Kanban Control Maximum Demand Maintenance Kanban Master Maintenance Maximum Demand Calculation Kanban Size/Print
knbl_cont_type	Container Type	Kanban Master Maintenance Kanban Master Copy
knbl_type	Kanban Type	Kanban Master Maintenance Kanban Master Copy

Demand Pattern

The demand for kanban-controlled items can increase or decrease depending on predictable patterns. For example, production levels can change during certain seasons or sales promotions.

Container Type

A kanban container could be a box, pallet, bin, tank, and so on. Designate codes to identify the different types of kanban containers.

Kanban Type

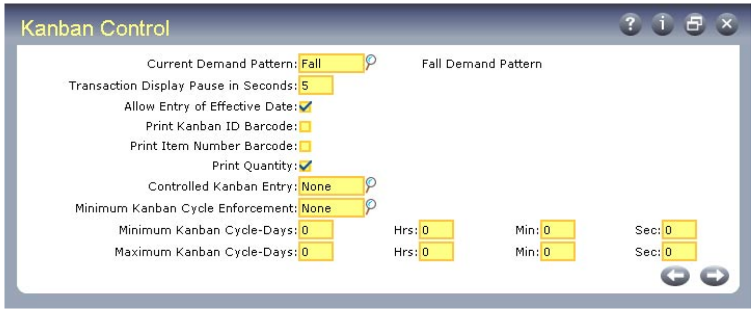
You can define codes that identify different types of kanbans. On several reports and inquiries you can select kanbans by type. Use kanban types to group kanbans in some meaningful way. For example, a code could represent a group of kanban-controlled items used for similar purposes.

Setting Up Control Program

Use Kanban Control (17.22.24) to specify the current demand pattern, the frames displayed during kanban transaction sessions, default print settings for kanban cards, and default minimum and maximum kanban cycle times.

Kanban Master Maintenance (17.22.1) uses the print settings and cycle times as defaults when you create a new kanban master record.

Fig. 9.5
Kanban Control
(17.22.24)



Current Demand Pattern. Enter the demand pattern you are currently using (for example, fall, winter, spring, summer). Maximum Demand Calculation (17.22.13) and Kanban Card Size/Print (17.22.15) use this field to determine the demand pattern.

This field is validated against codes set up in Generalized Codes Maintenance for field kbmd_pattern.

Transaction Display Pause in Seconds. Enter the period of time, in seconds, to display a frame containing kanban card information during a kanban transaction session. The information frame displays for the number of seconds specified before the system prompts for the next kanban ID. The kanban information is used for verification purposes only. Enter 0 (zero) if you do not want to display the kanban information frame.

Allow Entry of Effective Date. This field indicates whether the system prompts for an effective date at the beginning of a kanban transaction session. Enter Yes to allow the entry of an effective date for a kanban transaction session. Enter No to use the system date for kanban transactions.

Print Kanban ID Barcode. This field indicates the default print setting for new kanban records. Enter Yes to print kanban ID barcodes on kanban cards.

See *User Guide Volume 9: Manager Functions* for details.

To implement barcodes, you must have a barcode-capable printer. You may also need to add printer-control codes in the Bar Code Control frame in Printer Setup Maintenance (36.13.2).

Print Item Number Barcode. This field indicates the default print setting for new kanban records. Enter Yes to print item number barcodes on kanban cards.

Print Quantity. This field indicates the default print setting for new kanban records. Enter Yes to print the kanban container quantity on each kanban card.

Controlled Kanban Entry. Specifying control data during a kanban transaction session lets you prevent the entry of any kanban that does not match the specified criteria, such as transaction type or supplying source. Indicate the level of control placed on kanban data during a transaction session.

0: None. Kanban data entry is not controlled.

1: Warning. When the kanban data does not match the selection criteria, a controlled entry violation displays as a warning. The warning can be accepted or overridden.

2: Error. A controlled entry violation displays as an error and the kanban entry is automatically rejected.

When this field is set to Warning or Error, a frame displays during each kanban transaction session that lets you define control data for that particular session.

Minimum Kanban Cycle Enforcement. Minimum kanban cycle is used to control how rapidly the same kanban card can be entered into the system. Enforcing a minimum cycle prevents the problem of inadvertently entering the same kanban card twice during a transaction session. Indicate the default enforcement level of minimum kanban cycles during kanban data entry.

0: None. A minimum kanban cycle is not enforced, regardless of the time period specified in the Minimum Kanban Cycle fields.

1: Warning. A warning displays when the time cycle for a kanban card entry is less than the specified minimum cycle for that card. The warning can be accepted or overridden.

2: Error. An error displays and the kanban entry is automatically rejected when the cycle time for a kanban entry is less than the minimum cycle for that card.

Minimum Kanban Cycle Days, Hrs, Min, Sec. A minimum kanban cycle is the sum of the days, hours, minutes, and seconds entered in these fields. These fields are used as the default for new kanban records.

See "Generating Reports" on page 258.

Maximum Kanban Cycle Days, Hrs, Min, Sec. Maximum kanban cycle is used by Missing Kanbans Report (17.22.19.18) to determine whether a kanban card is misplaced. A kanban card is considered missing when the elapsed time between the last transaction for that card and the current date and time exceeds the maximum kanban cycle.

The maximum kanban cycle is the sum of the days, hours, minutes, and seconds entered in these fields. These fields are used as the default for new kanban records. A maximum kanban cycle is not enforced when a maximum cycle time is not specified.

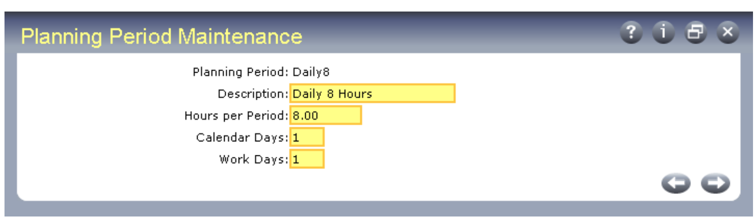
Defining Planning Periods

After defining generalized codes and setting up the control program, define the planning periods.

See "Calculating Maximum Demand" on page 236.

Use Planning Period Maintenance (17.22.7) to define planning periods. Assign planning periods to combinations of item/consuming site/demand patterns in Maximum Demand Maintenance (17.22.10). The system uses planning periods to calculate maximum demand.

Fig. 9.6 Planning Period Maintenance (17.22.7)



Planning Period. Enter a code identifying a planning period.

You cannot delete a planning period associated with an existing maximum demand record.

Description. Enter a brief description of this planning period (24 characters).

Hours per Period. Enter a decimal greater than 0 (zero) indicating the number of hours in the planning period.

Calendar Days, Work Days. These fields are used for flow scheduling and do not affect the maximum demand calculation.

See “Defining Schedule Periods” on page 166 for details on setting up planning periods for flow schedules.

Maintaining Kanban Data

After setting up the planning periods and control program, you can begin entering kanban data using Kanban Master Maintenance (17.22.1).

Some kanban data values are for reference only. Others are used in the calculations performed by Kanban Card Size/Print (17.22.15), including replenishment time, variability factor, container capacity, quantity per kanban, number of cards, and the setting of calculate cards or quantity.

See “Sizing and Printing Kanban Cards” on page 240.

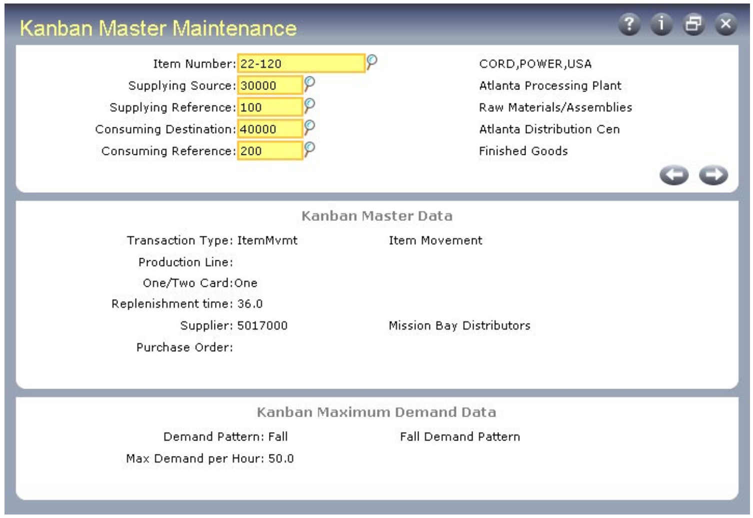
You can define kanban data used during kanban transactions, including the type of transaction to execute, whether the transaction impacts inventory balances, and whether to automatically backflush components when production is received.

See “Executing Kanban Transactions” on page 247.

Dispatch lists are used to notify a supplying source that a kanban needs replenishment. Dispatch lists can be sent to the supplying source, consuming destination, or both. You can define whether to include a kanban when dispatch lists are processed and how the supplying source or consuming destination will be notified—by fax, e-mail, or both.

See “Generating Kanban Dispatch Lists” on page 253.

Fig. 9.7
Kanban Master Maintenance (17.22.1)



Item Number. Enter the kanban-controlled item number. The item number must be defined in Item Master Maintenance (1.4.1).

The item cannot:

- Be a base process
- Be lot/serial controlled (including components)
- Have a Purchase/Manufacture code of F (family) or C (configured)

Phantom must be set to No at both the item and item/site level.

Supplying Source. Enter the item supplier or site from which the item will be transferred. The site must belong to the current database.

Set up suppliers in Supplier Maintenance (2.3.1).

Supplying Reference. For purchased items, enter a purchase order (PO) or blanket order. For all other items, enter the location of the inventory at the supplying site.

See "Viewing Kanban Transactions" on page 251.

When a PO or blanket order is entered, the system can automatically release a PO when a dispatch list is generated for this item. The PO or blanket order entered in this field must reference the item and the supplier entered in Supplying Source.

Consuming Destination. Enter the site where the item will be consumed. The site must belong to the current database.

Consuming Reference. Enter the location of the inventory at the consuming site.

Kanban Master Data Frame

Transaction Type. Enter a code indicating the type of transaction to associate with this kanban.

1: PurRcpt. Purchase receipt transactions are used to acknowledge the receipt of items from external suppliers. If a supplier code is specified in Supplying Source, you must select PurRcpt as the transaction type.

See "Processing Kanban Transactions" on page 246 for details.

2: ItemMvmt. Item movement transactions are used to transfer kanban-controlled items from a supplying source to a consuming destination.

3: ProdRcpt. Production receipt transactions are used to acknowledge the receipt of finished goods and optionally backflush components on the item bill of material.

Production Line. Enter an optional code identifying the production line where this item is used. When the production line is a flow production line, you can optionally apply ProdRcpt type kanbans to flow schedule orders.

See "Setting Up Flow Production Lines" on page 172.

One/Two Card. Enter either One or Two to indicate the number cards printed per container.

- In a one-card system, a card is printed for every container.
- In a two-card system, two cards are printed for every container. One card authorizes production; the other card authorizes the move.

Replenishment Time. Enter the number of hours and fractional hours required to replenish the item.

Replenishment Time includes the total time between recognizing that a product should be reordered and having the product supply available for use. This field represents a contract between supplying and consuming sites, reflecting maximum turnaround time.

Replenishment Time must be greater than 0 (zero).

Supplier. Enter an optional code identifying the supplier of this item. This field is for reference only.

Purchase Order. Enter an optional PO or blanket order for this item. If a PO was entered in Supplying Reference, it is displayed here and this field is for reference only.

Kanban Maximum Demand Data Frame

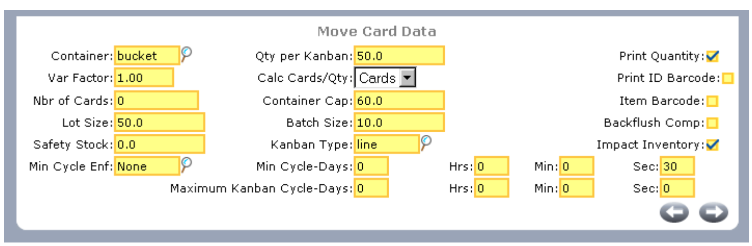
Demand Pattern. This display-only field shows the current value based on the last run of Maximum Demand Calculation (17.22.13).

Max Demand per Hour. This display-only field shows maximum demand per hour for this item based on the last run of Maximum Demand Calculation.

Kanban Card Data Frame

When One/Two Card is set to Two, you can define different kanban data for the move card and production card. For example, the move card may have a quantity of 100 and the production card a quantity of 25. The move card data is defined first, followed by production card data.

Fig. 9.8
Move Card Data Frame



Container. Enter a code identifying the type of container, such as bin or carton.

This field is validated against codes set up in Generalized Code Maintenance for field knbl_cont_type.

Variability Factor. Enter the variability factor for this item. This value is used in the calculations performed by Kanban Card Size/Print.

This field can be used to limit or increase the amount of inventory in Work in process (WIP). Variability factor is much like safety stock, but can be a more convenient means of communication. This is the case in environments where demand swings need to be estimated—for example, for seasonality or sales promotions.

This field shows percentages that belong to each production loop. A loop is the inventory traffic between a supplying location and a consuming location. Kanban loops consist of a specific number of containers and/or cards, as well as the quantities required to support the maximum demand of the consuming location.

If more than one loop exists for the item and consuming site, use Variability Factor to show the percentage belonging to each loop. This lets you control the number of cards per loop more effectively.

Variability Factor must be greater than 0 (zero). Default is 1.

Number of Cards. Enter the number of cards required and printed per loop. This field is affected by the two possible values of Calculate Cards/Qty:

See "Sizing and Printing Kanban Cards" on page 240.

Cards: This field is calculated and updated by Kanban Card Size/Print based on other kanban data fields. While you can manually override the calculated value, you can leave the field set to zero.

Qty: You must specify a value for Number of Cards. It cannot be zero. This number is used in the sizing calculations.

Lot Size. Enter the minimum quantity required to initiate production for this item. This value is used in the calculations performed by Kanban Card Size/Print.

This field is similar to Batch Size. For example, the supplying source for a kanban is a heat treating work center and each heat treat rack holds 10 items. The batch size is 10. However, since it is more efficient to run the heat treat when full, 50 items are heat treated at one time. The lot size is 50. It is recommended that lot size be divisible by batch size.

Safety Stk. This field can be used to increase the amount of inventory in work in process (WIP) to guard against an unforeseen change in demand. The value of safety stock is used in the kanban card sizing calculation.

See "Sizing and Printing Kanban Cards" on page 240.

This field must be greater than or equal to 0 (zero). The default is zero.

Minimum Cycle Check. Indicate the level of minimum kanban cycle enforcement. This field defaults from Kanban Control.

0: None. A minimum kanban cycle is not enforced, regardless of the time period specified in the Min-Cycle fields.

1: Warning. A warning displays when the time cycle for a kanban card entry is less than the specified minimum cycle for that card. The warning can be accepted or overridden.

2: Error. An error displays when the cycle time is less than the minimum cycle time and the kanban entry is automatically rejected.

Qty per Kanban. Enter the number of items per kanban.

This field is optional. If used, the field represents the actual quantity to be placed in each container, regardless of its capacity. For example, your standard container holds 100 items, but you only want 50 items at a time.

Qty per Kanban must be the same or less than Container Capacity.

Qty per Kanban is used by Kanban Card Size/Print when you set Calculate Cards/Qty to Cards in Kanban Master Maintenance. If Quantity per Kanban is 0 (zero), the value of Container Capacity is used instead.

Calculate Cards/Qty. Use this field to indicate whether you want to calculate the number of cards or the quantity per kanban in Kanban Card Size/Print (17.22.15).

Cards: Calculate number of cards.

Qty: Calculate quantity per kanban.

Container Capacity. Enter the physical constraint placed on the container or item, which could be any of the following:

- Maximum quantity held by a carton or container
- Production constraint, such as size of an oven tray
- Maximum amount of unwieldy or heavy items that can be handled

Container capacity must be greater than 0 (zero).

Container capacity is used in the calculations performed by Kanban Card Size/Print when:

- Calculate Cards/Qty is set to Cards in Kanban Master Maintenance, and
- Kanban Quantity is 0 (zero).

Batch Size. Enter the supplying source batch size for this item.

This field is optional and for reference only.

Kanban Type. Enter a code indicating the type of kanban. For example, this code could represent a group of kanban-controlled items. This field is for reference only and can appear on various reports and inquiries.

This field is validated against codes set up in Generalized Code Maintenance for field knbl_type.

Min-Cycle Days, Hrs, Min, Sec. The minimum cycle time is the sum of the days, hours, minutes, and seconds entered in these fields. These fields default from Kanban Control.

Max-Cycle Days, Hrs, Min, Sec. The maximum kanban cycle is the sum of the days, hours, minutes, and seconds entered in these fields. These fields are used by Missing Kanbans Report (17.22.19.18) to determine when a kanban card is missing. Leave these fields blank if you do not want to enforce a maximum cycle for this kanban.

Print Quantity. Enter Yes to print the kanban quantity on each kanban card.

Print ID Barcode. Enter Yes to print a kanban ID barcode on each kanban card.

Item Barcode. Enter Yes to print an item barcode on each kanban card.

Backflush Comp. When set to Yes, the components on the bill of material for the item are automatically backflushed from the supplying source when a kanban transaction is processed for this item.

You can update this field only when Transaction Type is ProdRcpt.

When this field is Yes, Impact Inventory must also be Yes.

See "Processing Kanban Transactions" on page 246 for details on inventory effects.

Impact Inventory. Indicate whether kanban transactions for this item will impact inventory and the GL.

Yes: The system automatically generates the appropriate inventory and GL transactions for each type of kanban transaction.

No: Kanban transactions do not affect inventory balances or the GL. Only a kanban transaction record is created. In a high-volume manufacturing environment where inventory is tracked on a summary level, you should set this to No.

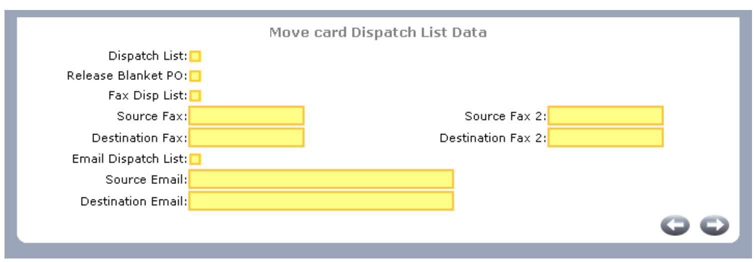
Kanban Card Dispatch List Data

See "Viewing Kanban Transactions" on page 251.

Define whether to include this kanban in dispatch list processing and, if so, what format to use. For example, you may want to generate dispatch lists for purchased items only. Dispatch lists are generated in report format and can also be printed in fax format and sent using e-mail. You can generate and send dispatch lists sorted by supplying source, consuming destination, or both.

When One/Two Card is set to Two, you can define separate dispatch list data for the move card and production card.

Fig. 9.9
Dispatch List Data Frame



Dispatch List. Indicate whether to allow selection of this kanban when dispatch lists are processed. When set to No, this kanban is ignored when dispatch lists are generated.

Release Blanket PO. Indicate whether dispatch list processing will attempt to automatically release a PO from the blanket order specified in Supplying Reference for this kanban-controlled item.

Fax Dispatch List. Indicate whether to allow selection of this kanban when dispatch lists are processed in fax format. When set to No, this kanban is not included in dispatch list fax reports.

Source Fax. Enter the fax number for the supplying source. This number is used when dispatch lists are reported by source. When this field is blank, the system uses the fax number defined in the supplier or site address. When a dispatch list is sorted by supplying source and printed in fax format, this fax number, preceded by a # symbol, is printed on the first line of the report.

Source Fax 2. Enter a optional secondary fax number for the supplier or supplying site. When Source Fax and Source Fax 2 are both specified, the two fax numbers, separated by a comma, are printed on the first line of the fax report.

Destination Fax. Enter the fax number for the consuming destination. This number is used when dispatch lists are reported by destination. When this field is blank, the fax number defined in the company address is used. When a dispatch list is sorted by consuming destination and printed in fax format, this fax number, preceded by a # symbol, is printed on the first line of the report.

Destination Fax 2. Enter an optional secondary fax number for the consuming site. When Destination Fax and Destination Fax 2 are both specified, the two fax numbers, separated by a comma, are printed on the first line of the fax report.

E-mail Dispatch List. Indicate whether to e-mail dispatch lists for this kanban. When set to No, this kanban is not e-mailed or included in dispatch list e-mail reports.

Source E-mail. Enter the e-mail address for the supplying source. This address is used when dispatch lists are reported by supplying source. When this field is blank and you are using the PRO/PLUS Supplier Performance module, the e-mail address defined for the supplier is used. Otherwise, the system does not search further.

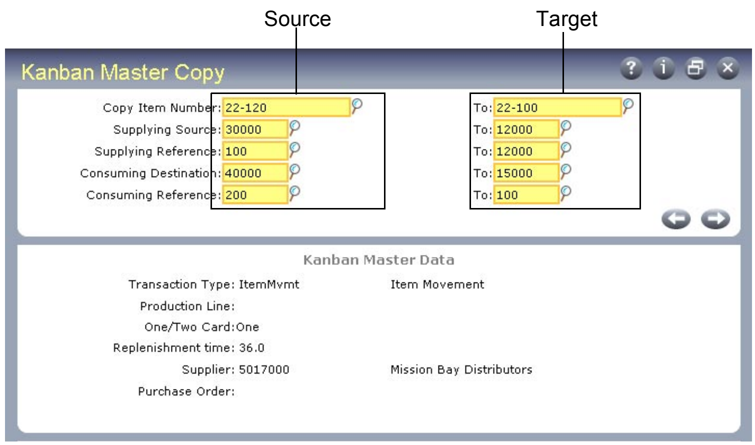
For details on Supplier Performance, see *User Guide Volume 11: PRO/PLUS.*

Destination E-mail. Enter the e-mail address for the consuming destination. This address is used when dispatch lists are reported by consuming destination. When this field is blank, the system does not search further.

Copying Kanban Data

Use Kanban Master Copy (17.22.5) to copy and modify kanban data for an item related to one supplying source/reference and consuming destination/reference to another item or set of supplying sources and consuming destinations. Use the copy program to set up data quickly when you have different loops for the same item.

Fig. 9.10
Kanban Master Copy (17.22.5)



The first frame contains the source and target data to be copied.

Copy Item Number/To. Enter the source and target item numbers. The item number must be defined in Item Master Maintenance. It cannot be a base process or be lot/serial controlled (including components) or have a Purchase/Manufacture code of F (family) or C (configured). Phantom must be set to No at both the item and item/site level.

Supplying Source/To. Enter the source and target suppliers or supplying sites.

Sites must belong to the current database.

Supplying Reference/To. Enter the source and target supplying locations or PO numbers.

Consuming Destination/To. Enter the source and target consuming sites. The site must belong to the current database.

Consuming Reference/To. Enter the source and target consuming locations.

Note The combination of the To item, supplying source, supplying reference, consuming destination, and consuming reference cannot already exist.

If you need to modify any kanban values for the target record, enter data in the Kanban Data, Kanban Card, and Kanban Card Dispatch List frames. These frames and fields are exactly the same as the ones in Kanban Master Maintenance.

See "Maintaining Kanban Data" on page 225.

Maintaining Maximum Demand

Use Maximum Demand Maintenance (17.22.10) to define anticipated maximum demand quantities for end items for a specific combination of consuming site, planning period, and demand pattern.

Items defined in this program do not need to be kanban controlled. For example, you can define the maximum demand for a non-controlled end item so component requirements can be determined.

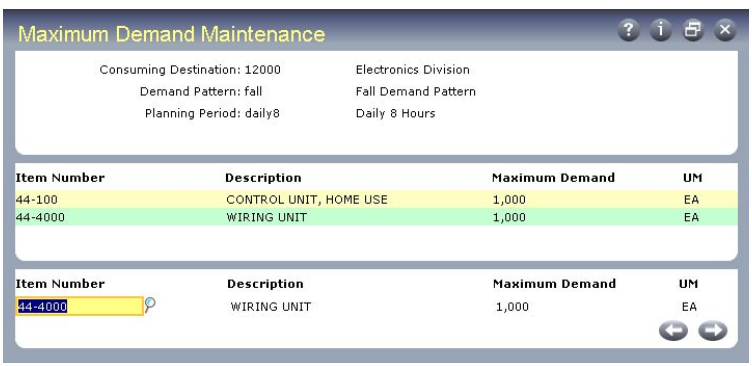


Fig. 9.11 Maximum Demand Maintenance (17.22.10)

Consuming Destination. Enter the site consuming the item.

Demand Pattern. Enter the demand pattern that applies to the quantities being defined.

This field is validated against codes set up in Generalized Codes Maintenance (36.2.13) for field kbmd_pattern.

See "Defining Planning Periods" on page 224 for details on setting up planning periods.

Planning Period. Enter a planning period previously defined in Planning Period Maintenance.

Item Number. Enter the number for an end item previously defined in Item Master Maintenance.

Description. The system displays the item description from Item Master Maintenance.

Maximum Demand. Enter the maximum number of items projected for this planning period and demand pattern at this consuming site.

This field must be greater than 0 (zero).

UM. The system displays the standard unit of measure from Item Master Maintenance.

Calculating Maximum Demand

Use Maximum Demand Calculation (17.22.13) to determine the maximum demand per hour for all kanban-controlled components of items defined in Maximum Demand Maintenance.

Maximum demand is the sum of:

- Independent demand entered into Maximum Demand Maintenance
- Dependent demand calculated by exploding the bill of material (BOM) of all maximum demand items

To determine maximum demand per hour, the maximum demand amounts are divided by the number of hours in the planning period specified in Maximum Demand Maintenance for the parent item.

The demand calculations are associated with the current demand pattern specified in Kanban Control.

The BOM codes associated with maximum demand items in Item Planning Maintenance determine the product structure to explode. The explosion does not include the following product structure types:

- Alternate product structures (A)
- Co/by-product structures (J)
- Document product structures (D)

Maximum demand for local phantoms is not included in the maximum demand per hour.

The system uses the date entered in the As Of field to select product structure records to explode by effective date. It also extends the component quantities by the appropriate quantity per specified in the product structure.

If the structure is configured, the BOM explosion is multiplied by the forecast percent. Yield from the item master or item-site record for the item and consuming site, if available, and scrap from the product structure are applied after the forecast percentage.

When Maximum Demand Calculation completes its calculation, it updates the maximum demand per hour and demand pattern for each kanban-controlled item. This data displays in the Kanban Maximum Demand Data frame of Kanban Master Maintenance and is used in Kanban Card Size/Print.

After all demand records are processed, an audit report is printed. If Update is Yes, the BOM explosion updates the maximum demand per hour and the demand pattern.

Sample Demand Calculation

Table 9.3 lists sample data used in a demand calculation. Parent items in this sample are designated K1 and K2. Note that for K2, both independent and dependent demand are calculated. The Demand column lists the demand per hour for each kanban-controlled part.

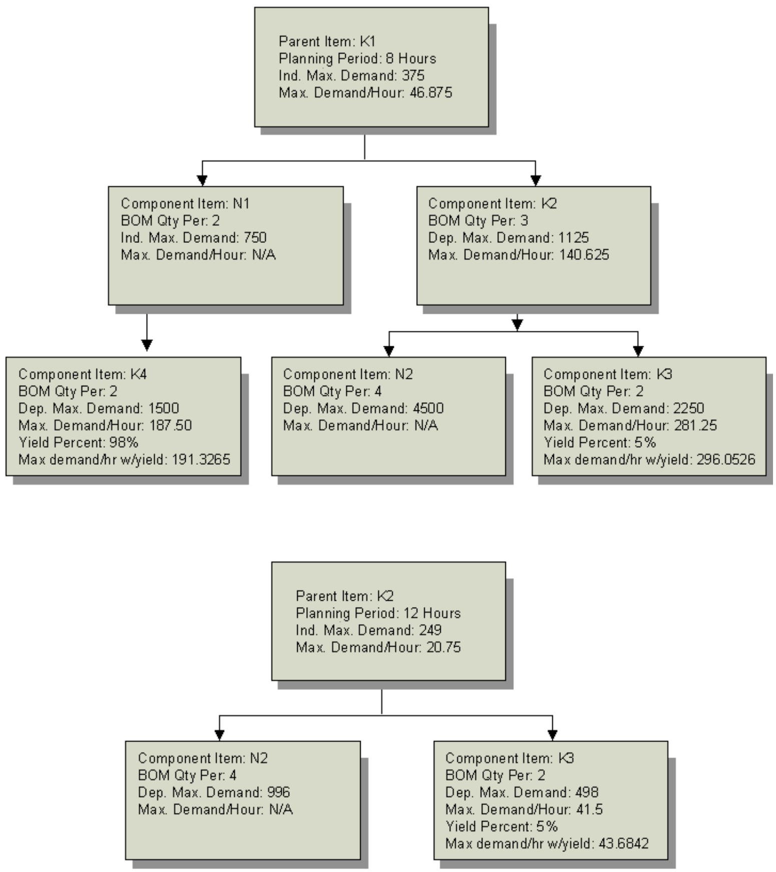
Table 9.3 Sample Calculation Data

Part	Demand	Calculation
K1	46.875/hour	
K2	161.375/hour	140.625 from K1 product structure plus 20.75 independent
K3	339.7368/hour	296.0526 from K1 product structure plus 43.6842 from K2 product structure
K4	191.3265.hr	

Figure 9.12 demonstrates how the calculation process works based on the sample data in Table 9.3. All kanban-controlled parts begin with K. The parent item is exploded into component parts for both K1 and K2. Non-kanban parts begin with N.

Note Independent maximum demand represents maximum demand for a single kanban item. Dependent maximum demand represents a parent item and all exploded items under it.

Fig. 9.12
Sample Demand Calculation



Maximum Demand Calculation

Figure 9.13 illustrates Maximum Demand Calculation.

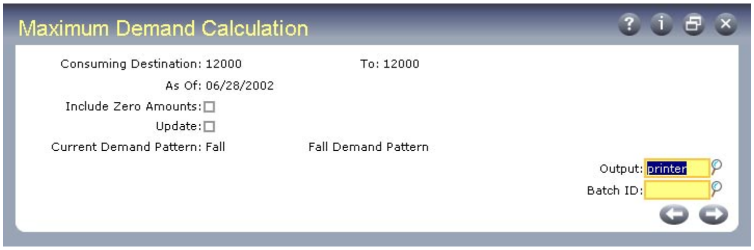


Fig. 9.13
Maximum Demand Calculation (17.22.13)

Consuming Destination. Enter the first consuming site in a range of sites to include in the calculation.

To. Enter the last consuming site to include in the calculation.

As Of. Enter the effective date to use for selecting active product structure components in the calculation. This field cannot be blank.

You can update this field only if Calculate Maximum Demand is Yes.

Include Zero Amounts. This field determines which lines are printed on the audit report.

No: A line is not included on the audit report when the maximum demand per hour is zero for an item.

Yes. A line prints for each item, regardless of the value of maximum demand per hour.

Update. Use this field to specify whether to update maximum demand per hour.

Yes: Update maximum demand per hour and demand pattern in the database.

No: Print an audit trail only.

Current Demand Pattern. This display-only field shows the current demand pattern from Kanban Control.

Sizing and Printing Kanban Cards

Use Kanban Card Size/Print (17.22.15) to size, print, and simulate the sizing of kanban cards using the following fields:

- Item
- Consuming Destination
- Item Group
- Buyer/Planner
- ABC Class

The demand pattern determines which kanban-controlled items to size. It defaults from the current demand pattern setting in Kanban Control.

The system calculates either the number of kanban cards or quantity per kanban based on the value of Calculate Cards/Qty specified for the item in Kanban Master Maintenance. The two equations are:

*Number of Cards = ({D * RT} + SS + LS) * V / Q*

*Quantity per Kanban = ({D * RT} + SS + LS) * V / C*

Table 9.4 describes each value in the equations.

Table 9.4 Sizing Formula Values

Code	Description
D	Demand for kanban-controlled item per hour, calculated by Maximum Demand Calculation
RT	Replenishment time
SS	Safety stock
V	Variability factor
Q	Container capacity or quantity per kanban. If a quantity per kanban is defined in Kanban Master Maintenance, this value is used and not container capacity.
C	Fixed number of cards if quantity per kanban is to be calculated.
LS	Lot size

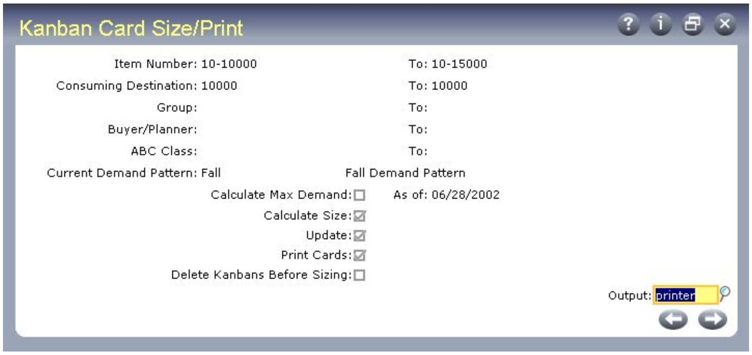


Fig. 9.14
Kanban Card Size/Print (17.22.15)

Item Number/To. Enter a range of item numbers for the system to use as selection criteria in choosing cards to size/print.

Consuming Destination/To. Enter a range of consuming sites for the system to use as selection criteria in choosing cards to size/print.

Group/To. Enter a range of item groups for the system to use as selection criteria in choosing cards to size/print.

Buyer/Planner/To. Enter a range of buyers or planners for the system to use as selection criteria in choosing cards to size/print.

The buyer is the person responsible for planning and ordering items.

If you specify a buyer/planner code, the system processes only items assigned to this person.

ABC Class/To. Enter a range of ABC classes for the system to use as selection criteria in choosing cards to size/print.

A blank in this field selects all records in the item range specified, regardless of the ABC code. Enter A, B, or C to select only those items with the specified ABC code.

Current Demand Pattern. The system displays the current demand pattern specified in Kanban Control. Demand pattern is used to select which kanban-controlled items to size.

Calculate Max Demand. Use this field to specify whether to calculate maximum demand.

No: Do not recalculate maximum demand per hour.

Yes: Recalculate the maximum demand per hour for each kanban-controlled item. The system runs Maximum Demand Calculation prior to re-sizing. This may take some time because maximum demand for all kanban-controlled components must be calculated, even if only the items entered in the item number range are used.

When Calculate Max Demand is Yes, you must enter a value in the As Of field.

As Of. Enter the effective date of the product structure components to use in Maximum Demand Calculation.

You can update this field only if Calculate Maximum Demand is Yes.

Calculate Size. Use this field to specify whether to perform sizing calculations.

No: Use the number of cards and quantity per kanban previously calculated or manually entered in Kanban Master Maintenance.

Yes: Calculate either the number of kanban cards or quantity per kanban, based on the setting of Calculate Cards/Qty for the item in Kanban Master Maintenance.

If you want the system to use a previously calculated value or a value you entered manually in Kanban Master Maintenance, set this field to No.

Tip
Update must be Yes to print cards.

Update. Enter Yes to update the database with changes generated by this program and print an audit trail report. Enter No to simulate the effects of a new calculation.

If Calculate Size is Yes, number of cards or quantity per kanban is updated. If Calculate Maximum Demand is Yes, maximum demand per hour and demand pattern is updated.

See Figure 9.16 for a sample audit report.

The audit trail report displays the sizing values of the last kanban cards printed for the item, consuming destination, and demand pattern (labeled Before in Figure 9.16) as well as the results of the new calculations (labeled After in Figure 9.16).

The system also calculates and prints extended cost based on either container capacity or quantity per kanban as follows:

*Container capacity or quantity per kanban * number of cards * unit cost*

Print Cards. Use this field to specify whether to print kanban cards. Update must be Yes to print cards.

No: Do not print kanban cards.

Yes: Print kanban cards. You are prompted to enter the output device. One card is printed per page to be attached to a container.

See Figure 9.15 for an illustration of kanban card output.

Delete Kanbans Before Sizing. Use this field to specify whether to delete and re-create existing kanban cards.

Yes: Delete all existing kanban cards for the item, consuming destination, and demand pattern prior to re-sizing.

No: Do not delete existing kanban cards. If the sizing calculation determines that fewer cards are required, a note is added to the audit trail report recommending the number of cards to inactivate.

See "Activating and Inactivating Kanban Cards" on page 245.

If the kanban is set to calculate quantity and the sizing calculation changes the quantity per kanban container, then the existing kanban cards are deleted regardless of this setting.

Output. Identify where to send the output for the audit trail report. When Print Cards is set to Yes, you are prompted to enter the output device for the cards in a separate frame.

Note If a kanban is set to calculate quantity—where the number of kanban cards remains constant and the kanban quantity is adjusted during the sizing calculation—it is possible for the calculated kanban quantity to exceed the kanban container capacity. In Kanban Master Maintenance, an error displays when the calculated kanban quantity for a kanban exceeds the container capacity. To correct this, you must increase the container capacity, manually adjust the quantity to a lower amount, or increase the number of cards.

The following illustrations provide a sample of kanban card output and an audit report.

Fig. 9.15
Sample Kanban Card Output

```
99999 99999

              Kanban ID: 229
            Item Number: 22-120            CORD,POWER,USA
                    Rev: AA

       Supplying Source: 30000      Supplying Reference: 300
   Consuming Destination: 40000     Consuming Reference: 100

        Production Line: Widgets    West Plant Hi Volume Line
       Transaction Type: ItemMvmt   Item Movement
              Card Type: Move
             Batch Size: 50
        Kanban Quantity: 50
         Container Type: bucket
     Container Capacity: 60

             Print Date: 06/24/02
         Calculate Date: 06/24/02
            Card Number: 1
```

Fig. 9.16
Sample Kanban Size/Print Report

```
kbszmt.p 2+                   17.22.15 Kanban Card Size/Print      Date: 08/28/02
Page:    1                        Quality Products Inc.            Time: 11:03:08
     Item Number: 22-120                 Wheel                     cost: 1.00
Supplying Source: 30000     Atlanta Processing Plant           Supplier: 5017000
   Supplying Ref: 100       Raw Materials/Assemblies              Group: DISCRETE
  Consuming Dest: 40000     Atlanta Distribution Cen      Buyer/Planner:
   Consuming Ref: 200       Finished Goods                    ABC Class:
  Demand Pattern: Fall      Fall Demand Pattern     Calculate Cards/Qty: Cards
             cardType: Move      Move Kanban Card

Before Max Demand Repl Safety   Lot   Var  Container   Kanban   Max   Act  Inact
/After per Hour   Time  Stock  Size Factor  Capacity Quantity Cards Cards  Card
------ ---------- ---- ------ ----- ------ --------- -------- ----- ----- -----
Before       37.5 36.0    0.0   1.0   1.00     139.0    104.0    24    27     0
After        37.5 32.0    0.0   1.0   1.00      60.0     50.0    24    27     0
     note: 3 Kanban cards should be inactivated

     Item Number: 22-130                 CORD,POWER,UNIVERSAL      cost: 1.00
Supplying Source: 10000     San Diego Main Plant               Supplier: 5017000
   Supplying Ref: 100       Raw Materials/Assemblies              Group: DISCRETE
  Consuming Dest: 12000     Electronics Division          Buyer/Planner:
   Consuming Ref: 12000     Materials Storage                 ABC Class:
  Demand Pattern: Fall      Fall Demand Pattern     Calculate Cards/Qty: Cards
        cardType: Move      Move Kanban Card
```

Reprinting Kanban Cards

Use Kanban Card Reprint (17.22.17) to reprint specific kanban cards.

Fig. 9.17
Kanban Card Reprint (17.22.17)

Kanban ID/To. Enter a range of kanban card IDs for the system to use as selection criteria in choosing cards to print.

Leave blank to include all codes up through the last kanban card ID.

Activating and Inactivating Kanban Cards

When kanban cards are sized in Kanban Card Size/Print, you have the option to keep or delete all existing kanban cards before the sizing calculation is performed. When you choose to keep all existing kanban cards and the sizing calculation determines that fewer kanban cards are required, the program recommends the number of cards to inactivate.

For example, assume 10 kanban cards exist for a kanban. Maximum demand for those items has decreased and now the sizing calculates that only 8 cards are needed. The program notifies you to inactivate 2 cards. If maximum demand for that kanban increases at a later date, you can activate and reprint previously inactive kanban cards.

Use Kanban Card Audit Report (17.22.22) to determine which kanban cards should be inactivated. The report lists kanbans where the number of system-recommended cards does not match the total number of active cards.

Use Kanban Card Activate/Inactivate (17.22.21) to activate or inactivate specific kanban cards. When a kanban card is inactive, the system does not recognize the card and you cannot process kanban transactions for it.

Fig. 9.18
Kanban Card Activate/Inactivate (17.22.21)

Before inactivating a kanban card, physically remove the card from production and then set Active to No to deactivate the removed card. To reactivate a kanban card, set Active to Yes. To reprint an activated kanban card, use Kanban Card Reprint (17.22.17).

Processing Kanban Transactions

Components and raw materials are pulled into production as they are needed. These items may be pulled from a storeroom or delivered directly to production from an external supplier. While in the production process, parts are typically not tracked. At the end of the production process, finished products are transferred to finished goods inventory.

Kanban transactions let you track the movement of kanban-controlled items in and out of the production process.

You can execute the following types of kanban transactions:

- Purchase receipt transactions are used to acknowledge the receipt of items from external suppliers
- Item movement transactions are used to transfer kanban-controlled items from the supplying source to the consuming destination

- Production receipt transactions are used to acknowledge the receipt of finished goods or subassemblies and optionally backflush components

Any or all of these kanban transactions can automatically update inventory balances and the GL, depending on how the kanban card is defined. Whether a kanban transaction for a particular kanban card affects inventory balances and the GL is defined by the Impact Inventory field in Kanban Master Maintenance. When Impact Inventory is No, only a kanban transaction record is created.

When Impact Inventory is Yes for a kanban card, additional processing occurs.

- Executing a purchase receipt transaction records the receipt of a purchased item at the consuming site and location (PO-RCT). The receipt increases the quantity on hand of the item at the consuming destination/reference. The system automatically generates the appropriate inventory and GL transactions.
- Executing an item movement transaction creates an inventory transfer from a supplying source/reference to a consuming destination/reference (ISS-TR and RCT-TR) and generates the appropriate GL transaction.
- Executing a production receipt transaction records the receipt of a production item at the consuming site and location. Quantity on hand for the item decreases at the supplying source/reference and increases at the consuming destination/reference. They system automatically generates the appropriate inventory and GL transactions.

  If the kanban is set up to backflush components, the components on the bill of material for the item are backflushed from the supplying source/reference (ISS-WO) and the appropriate GL transaction is generated.

Executing Kanban Transactions

Use Execute Kanban Transactions (17.22.19.1) to receive and transfer kanban-controlled items. Execute Kanban Transaction has two optional frames that display depending on the settings in Kanban Control. The first allows entry of an effective date and the second lets you define data used to control kanban data entry.

Effective Date

Entry of an effective date is optional. When Allow Entry of Effective Date is Yes in Kanban Control, a frame displays letting you enter an effective date used for all transactions entered during the current kanban transaction session. When Allow Entry of Effective Date is No, the frame does not display and the system date is used as the effective date for the session.

Controlled Entry Frame

See “Setting Up Control Program” on page 221.

The controlled entry of kanban data is optional. When Controlled Kanban Entry is set to Warning or Error in Kanban Control, a frame displays that lets you define control data for the duration of a kanban transaction session. For example, you can limit kanban entry to only PurRcpt type kanbans for a specific supplier.

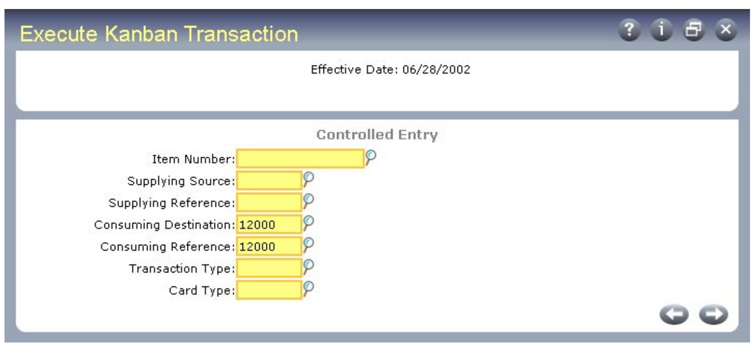


Fig. 9.19 Controlled Entry Frame

If a kanban is entered that does not match the controlled entry criteria, either a warning or an error displays depending on the setting in Kanban Control. A warning can be accepted or overridden. When an error displays, the kanban entry is automatically rejected.

Transaction Frame

Use this frame to begin entering kanban IDs for a transaction session.

Fig. 9.20 Kanban Transaction Frame

The kanban ID can be entered manually or scanned using a barcode reader. After each entry, a kanban card information frame displays for the number of seconds specified in the Transaction Display Pause in Seconds field in Kanban Control. This frame is for reference only. You can press Spacebar to return to the kanban entry frame.

The Transaction Log displays a list of each transaction entered. The last kanban entry is always displayed at the top of the transaction log.

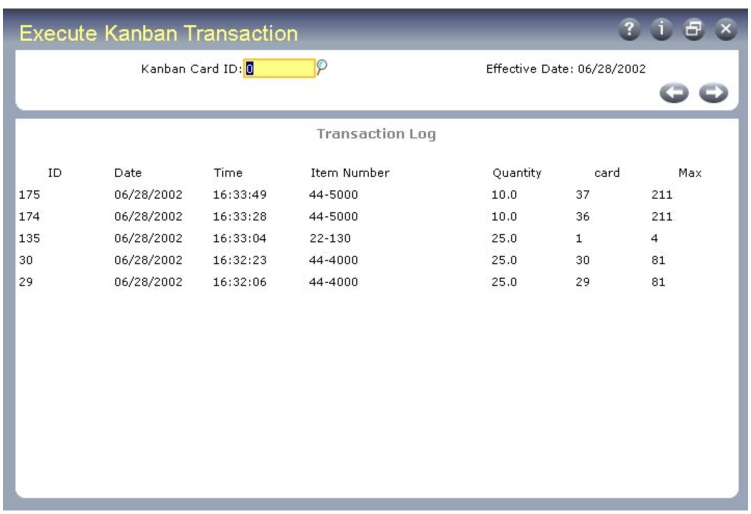


Fig. 9.21 Transaction Log Frame

If you enter a PurRcpt type kanban that does not have an associated PO or blanket order, the program prompts for a PO to use for the purchase receipt transaction. The transaction is rejected if a valid PO is not specified. You cannot enter a blanket order at this point. However, if a blanket order is associated with the kanban, the system attempts to find the oldest open released PO for the item and supplier.

See "Viewing Kanban Transactions" on page 251.

Once a kanban has been entered and accepted by the program, it cannot be retrieved for review. To review a kanban entry, use Transaction Inquiry by Trans Nbr (17.22.19.4) or use one of the programs that lets you view transactions by item number, kanban master record, or kanban card number.

Return Kanban Transactions

See "Generating Kanban Dispatch Lists" on page 253 for details.

When groups of empty kanban containers need to be returned to a supplying source for replenishment, you can create return kanban transactions for those containers and use them to generate dispatch lists. This is especially useful when returning groups of empty kanban containers to an external supplier or another site.

Use Return Kanban Transactions (17.22.19.2) to record that an empty kanban container is ready to be moved from the consuming destination back to the supplying source for replenishment. You can enter or scan a move or a production card. Return transactions have no effect on inventory balances.

The frames and fields in Return Kanban Transactions are the same as those for Execute Kanban Transactions.

Deleting and Archiving Kanban Transaction Records

The system keeps all of your kanban transaction records online for an unlimited time. There is no automatic purge of this information at period or year end. To delete kanban transaction records, use Transaction Delete/Archive (17.22.19.23).

First, run the program without actually deleting any records by setting Delete to No. Review the resulting report before setting Delete to Yes, then run the program again to delete the transaction records that match the selection criteria. When Archive is Yes, the system copies the selected records to an ASCII file that can be reloaded using Archive File Reload (36.16.5).

Viewing Kanban Transactions

You may want to review kanban transaction information, but not know the specific transaction number. The following programs let you start with known data, such as item number or kanban information, and use the system to search for transaction details.

- View Transactions by Item (17.22.19.7) lets you display kanban and inventory transaction data starting with a specific item. After entering the item number, all kanban master records associated with the item display. You can select a kanban record to display every kanban card that exists for that kanban. You can view kanban transactions for individual cards and any inventory transaction records that exist for the kanban transaction.
- View Transactions by Kanban Master (17.22.19.8) lets you display kanban and inventory transaction data starting with a kanban master record. You can enter selection criteria for item number, supplying source/reference, and consuming destination/reference to display all kanban master records matching the selection criteria. After you select a kanban master record, you can drill down to a specific kanban card and then the kanban and inventory transaction records associated with that card.
- View Transactions by Kanban Card (17.22.19.9) displays all kanban transactions associated with a specific kanban card. You can select a transaction to view the transaction details and optionally display inventory transactions created by the kanban transaction.

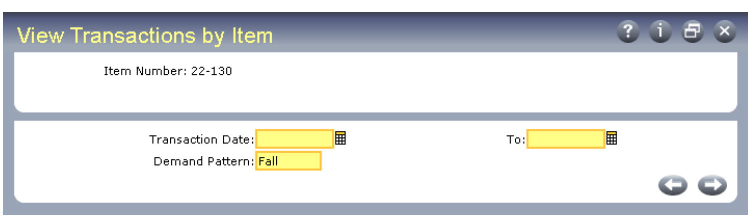


Fig. 9.22
View Transactions by Item (17.22.19.7)

Transaction Date/To. Enter a range of transaction dates for the system to use as selection criteria in choosing kanban transactions.

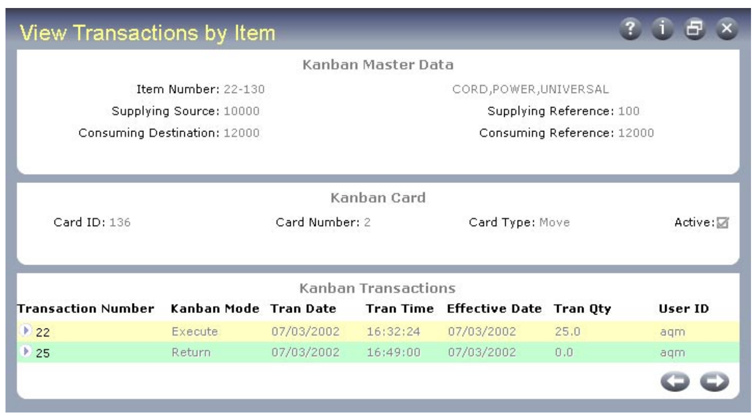
Leave blank to include all transaction dates up through the current date.

Demand Pattern. Enter a code identifying a demand pattern for the system to use as selection criteria in choosing kanban transaction records. The default is the demand pattern specified in Kanban Control.

Leave blank to include transactions for all demand patterns.

Fig. 9.23
View Transactions by Item, Kanban Cards (17.22.19.7)

Fig. 9.24
View Transactions by Item, Kanban Transactions



Generating Kanban Dispatch Lists

Use Kanban Dispatch List Processing (17.22.19.13) to select kanban transaction records and process all selected transactions from the last time a dispatch list was generated. A dispatch list is a report of empty kanban containers that need to be moved from a consuming destination back to a supplying source for replenishment. Dispatch lists can be sorted by supplying source, consuming destination, or both.

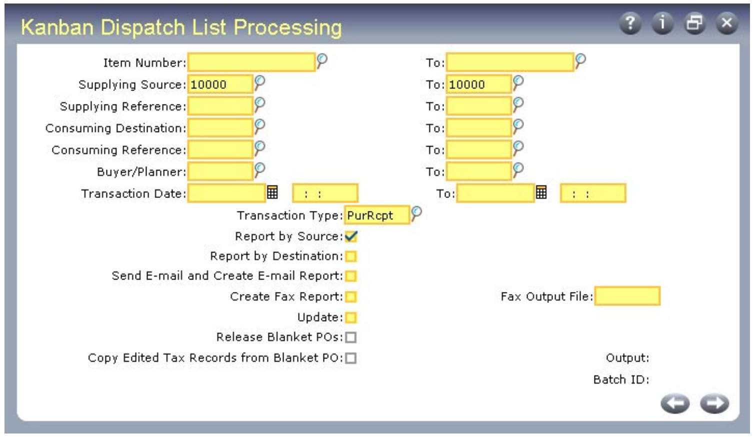
Typically, dispatch lists are generated from PurRcpt type kanbans to notify an external supplier that empty kanbans are being returned for replenishment. The system can automatically release blanket POs for purchased items when the dispatch list is processed. You can also generate dispatch lists for item movement and production receipt type kanbans.

Kanban Dispatch List Processing selects only return kanban transactions for move cards and execute or return transactions for production cards in a two-card loop. Use Return Kanban Transactions to indicate that the empty kanban container needs to be returned.

When dispatch lists are processed, you can:

- Print a report of all kanban transactions selected using the selection criteria. Only kanbans with Dispatch List set to Yes in Kanban Master Maintenance are selected.
- Create a report in fax format using the data from the original report. The program only selects kanbans with Fax Dispatch List set to Yes in Kanban Master Maintenance.
- E-mail a report to e-mail addresses using the data from the original report. The program only selects kanbans with E-mail Dispatch List set to Yes in Kanban Master Maintenance.
- Automatically release POs from blanket orders for purchased items. The system only releases POs for kanban records with Transaction Type set to PurRcpt and Blanket PO Release set to Yes in Kanban Master Maintenance.

Fig. 9.25
Kanban Dispatch List Processing (17.22.19.13)



Item Number/To. Enter a range of item numbers for the system to use as selection criteria in choosing kanban transaction records.

Supplying Source/To. Enter a range of suppliers or supplying sites for the system to use as selection criteria in choosing kanban transaction records.

Supplying Reference/To. Enter a range of supplying references for the system to use as selection criteria in choosing kanban transaction records.

If you specified suppliers in the supplying source range, enter a range of PO or blanket order numbers for the reference. If you entered supplying sites, enter a range of locations where inventory is held.

Consuming Destination/To. Enter a range of consuming sites for the system to use as selection criteria in choosing kanban transaction records.

Consuming Reference/To. Enter a range of consuming locations for the system to use as selection criteria in choosing kanban transaction records.

Buyer/Planner/To. Enter a range of buyers or planners for the system to use as selection criteria in choosing kanban transaction records.

The buyer is the person responsible for planning and ordering items.

If you specify a buyer/planner code, the system processes only items assigned to this person.

Transaction Date/Time. Enter a range of dates and times for the system to use as selection criteria in choosing kanban transaction records.

Transaction Type. Enter the kanban transaction type used to select kanbans for this dispatch list. Leave blank to select all transaction types.

1: PurRcpt

2: ItemMvmt

3: ProdRcpt

Report by Source. Enter Yes to sequence the selected kanban transactions by supplying source, supplying reference, and item number. Kanban master data is used to retrieve the fax number and e-mail address for the supplying source.

Report by Destination. Enter Yes to sequence the selected kanban transactions by consuming destination, consuming reference, and item number. Kanban master data is used to retrieve the fax number and e-mail address for the consuming destination.

When Create Report by Source and Create Report by Destination are both set to Yes, kanban records sorted by supplying source are printed first, followed by a second report sorted by consuming destination.

See Figure 9.26 and Figure 9.27 for illustrations of dispatch lists sorted by source and destination.

Send E-mail and Create E-mail Report. Enter Yes to e-mail dispatch lists and create an e-mail report. The selected records are grouped and e-mailed by e-mail address using the same sequencing as the printed report.

To determine the e-mail address or addresses to use, the program first looks at the source and destination e-mail address fields in Kanban Master Maintenance. If these fields are blank and this is a PurRcpt type kanban, then the e-mail address is retrieved from the address record of the vendor. If this is an ItemMvmt or ProdRcpt type kanban, the program does not search further. If an e-mail address cannot be determined, the program ignores the kanban transaction record.

Create Fax Report. Enter Yes to create a report in fax format. The selected records are grouped and printed by fax number using the same sequencing as the printed report.

See Figure 9.28 for an illustration of a dispatch list fax report.

To determine the fax number or numbers to use, the program first looks at the fax number fields in Kanban Master Maintenance. If these fields are blank, then the fax number is retrieved from the address record of the vendor for PurRcpt type kanbans or from the site record for any other kanban transaction type. If a fax number cannot be determined, the program ignores the kanban transaction record.

Fax Output File. Optionally, enter the name of the fax output file. The fax report is saved to a file without an extension in your working directory.

Update. Enter Yes to create a report of all kanban transactions selected using the selection criteria. The selected kanban transactions are updated with the current date and time to prevent them from being selected again the next time a dispatch list is processed.

Release Blanket POs. Enter Yes to automatically release POs from blanket orders associated with purchase receipt type kanbans during dispatch list processing.

You can update this field only if Update is Yes and Kanban Transaction Type is PurRcpt or blank.

When the supplying reference for a purchase receipt type kanban is a blanket order number, the system will attempt to automatically release a PO from that blanket order. If a kanban does not have a blanket order assigned, the program looks for the oldest open PO that can fulfill the entire kanban quantity for the item and supplier. If a PO cannot be found that fulfills the entire kanban quantity, an error displays and a PO is not released for that kanban.

Copy Edited Tax Records from Blanket PO. Enter Yes to copy any manually edited tax details from the blanket orders to the released POs. Otherwise, enter No to overwrite manually edited tax details with the current blanket order tax data. Tax data is defined for the entire blanket order, but the tax details for line items can be manually edited.

The following illustrations provide samples of a dispatch list sorted first by supplying source, then by consuming destination and a sample dispatch list fax report.

```
kbdlrp.p 99                   17.22.19.13 Kanban Dispatch List            Date: 05/23/02
Page:     1                            MFG/PRO Database                   Time: 12:57:18

                                     Reporting by Source

Supply  Supply                    Consume Consume     Transact  Transaction       ID/
Source  Ref     Item Number       Dest    Ref      UM Date/Time    Quantity Card Nbr Comments
------- ------ -------------      ------- -------- -- ---------  ----------- -------- --------
10000   WIP     10-10000          20000   FINGOODS EA 05/20/02         60.0      328
                                                      09:15:04                     2
10000   WIP     10-10000          20000   FINGOODS EA 05/22/02         60.0      371
                                                      11:10:01                     1
20000   WIP     22-100            20000   FINGOODS BL 05/22/02        100.0      421
                                                      14:15:30                     4
20000   WIPA    33-100            30000   LOC1     EA 05/23/02         50.0      355
                                                      08:24:56                     2
```

Fig. 9.26 Sample Dispatch List Reporting by Source

```
kbdlrp.p 99                   17.22.19.13 Kanban Dispatch List            Date: 05/23/02
Page:     1                            MFG/PRO Database                   Time: 12:57:18

                                  Reporting by Destination

Consume Consume                   Supply  Supply      Transact  Transaction       ID/
Dest    Ref      Item Number      Source  Ref      UM Date/Time    Quantity Card Nbr Comments
------- -------- -------------    ------- ------   -- ---------  ----------- -------- --------
20000   FINGOODS 10-10000         10000   WIP      EA 05/20/02         60.0      328
                                                      09:15:04                     2
20000   FINGOODS 10-10000         10000   WIP      EA 05/22/02         60.0      371
                                                      11:10:01                     1
20000   FINGOODS 22-100           20000   WIP      BL 05/22/02        100.0      421
                                                      14:15:30                     4
30000   LOC1     33-100           20000   WIPA     EA 05/23/02         50.0      355
                                                      08:24:56                     2
```

Fig. 9.27 Sample Dispatch List Reporting by Destination

Fig. 9.28
Sample Dispatch List Fax Report

```
#805 555-1212,805 555-1213
kbdlrp.p 99                 17.22.19.13 Kanban Dispatch List           Date: 05/23/02
Page:    1                          MFG/PRO Database                    Time: 12:57:18

                                      Fax Report

Supply  Supply Consume Consume                  Transact  Transaction      ID/
Source  Ref    Dest    Ref      Item Number   UM Date/Time    Quantity Card Nbr Comments
------- ------ ------- -------- ------------- -- --------- ----------- -------- --------
10000   WIP    20000   FINGOODS 10-10000      EA 05/20/02         60.0      328
                                                 09:15:04                     2
10000   WIP    20000   FINGOODS 10-10000      EA 05/22/02         60.0      371
                                                 11:10:01                     1




#805 555-2422
kbdlrp.p 99                 17.22.19.13 Kanban Dispatch List           Date: 05/23/02
Page:    1                          MFG/PRO Database                    Time: 12:57:18

                                      Fax Report

Supply  Supply Consume Consume                  Transact  Transaction      ID/
Source  Ref    Dest    Ref      Item Number   UM Date/Time    Quantity Card Nbr Comments
------- ------ ------- -------- ------------- -- --------- ----------- -------- --------
20000   WIP    20000   FINGOODS 22-100        BL 05/22/02        100.0      421
                                                 14:15:30                     4
20000   WIPA   30000   LOC1     33-100        EA 05/23/02         50.0      355
                                                 08:24:56                     2
```

Generating Reports

Table 9.5 lists kanban reports and inquiries with a brief description of their purpose.

Table 9.5
Kanban Reports

Report	Description
Kanban Master Inquiry (17.22.2)	Shows kanban data for a specific kanban master record.
Kanban Master Report (17.22.3)	Lists kanban data for a range of item numbers, supplying sources, consuming destinations, and kanban types.
Maximum Demand Report (17.22.12)	Shows maximum demand for each consuming destination, demand pattern, and planning period.
Kanban Card Inquiry (17.22.16)	Shows individual kanban card data.
Transaction Inquiry by Trans Nbr (17.22.19.4)	Shows kanban transaction history records by transaction number.
Kanban Transactions Audit Report (17.22.19.15)	Lists kanban transaction history records by item number, supplying source/reference, consuming destination/reference, and transaction date and time.

Report	Description
Missing Kanbans Report (17.22.19.18)	Kanbans are sized to print the exact number of cards that fulfill the maximum demand of the kanban-controlled item. When a kanban card is lost or destroyed, it can impact inventory levels negatively. This report determines the time elapsed between the last time a transaction was entered for a specific kanban card and the current date and time. If the amount of elapsed time is greater than the maximum kanban cycle specified for that kanban, the missing kanban card is included in the report. Use the Max-Cycle fields in Kanban Master Maintenance (17.22.1) to define the maximum kanban cycle for each kanban. Kanbans with blank Max-Cycle fields are ignored by this report.
Kanban Card Audit Report (17.22.22)	Compares the system-recommended number of kanban cards for a kanban loop to the actual number of active kanban cards in that loop. You can optionally print the report with a page break inserted at each different supplying source/reference so the report can be distributed to each site/location for verification of actual kanban card amounts.

Chapter 10

Advanced Repetitive

Repetitive schedules perform the same functions as work orders in a process environment. This chapter discusses how repetitive schedules are created and exploded, and how inventory is issued when the process is complete.

Introduction

Repetitive manufacturing is executed with schedules rather than work orders. Schedules require fewer steps and less paperwork to execute and are typical in manufacturing environments that use assembly lines to produce similar products using the same process. Since the same activities are repeated regularly, there is little variation.

Repetitive scheduling enables you to:

- Build to a repetitive schedule.
- Run a production line without finite schedules.
- Run a production line with repetitive schedules, forward scheduled to capacity limits.
- Report production and let MRP adjust inventory plans.

Advanced Repetitive and Repetitive

MFG/PRO provides two ways of managing repetitive production, appropriate in different business environments. The Repetitive module works well when one or more of the following is true:

- Manufacturing lead times are relatively short and batches do not overlap.
- All work in process is complete by the end of each day.
- Work-in-process (WIP) costs are either insignificant or fairly constant.
- The routing does not include subcontract operations.

The Advanced Repetitive module supports manufacturing environments where the following apply:

- Manufacturing lead times are long.
- Continuous processing is in use; lines are dedicated to one item for days, weeks, or months.
- WIP costs are variable or high.

- Subcontracting operations are managed in a release management (just-in-time) environment.
- Batches can overlap and visibility of and control over WIP are necessary.

Note The PRO/PLUS WIP Lot Trace (WLT) module affects some features of the Advanced Repetitive and Repetitive modules. If you are using the optional PRO/PLUS module, WIP Lot Trace is available as menu option 3.22.13. When activated, additional frames display in some programs. The discussion in this chapter assumes that WLT features are not active.

For details, see *User Guide Volume 11: PRO/PLUS*.

Distinctive Features of Advanced Repetitive

Advanced Repetitive provides features that are not available in the basic Repetitive module.

Cumulative Work Order Processing

- Ability to post usage variances without having to close a cumulative order.
- Ability to close a cumulative order and transfer work-in-process (WIP) balances to a new cumulative order for easy phase-in of product structure or routing changes. This also supports accounting period cutoffs.
- Automatic start and end effective date assignment for cumulative order expiration dates.
- Expanded WIP inventory visibility and control.
- Addition of WIP accumulators to track cumulative work moved, rejected, reworked, scrapped, and adjusted.

Scrap, Reject, Rework, and Adjustments Reporting

- Scrap or adjust from either the input, output, or reject queue.
- Record multiple scrap, reject, and rework quantities with reason codes.
- Generate analysis reports, scrap and adjustments usage variance reports, and scrap and adjustments valuation reports.

Subcontract Processing

- Integration of supplier scheduled orders with Advanced Repetitive supports repetitive purchasing of subcontract services.
- Subcontract shippers let you create shipment paperwork and register the physical shipment of materials to the subcontractor.
- Using EDI ECommerce to support electronic data interchange (EDI) transactions lets you receive an advance ship notice (ASN) from your supplier to register the receipt of processed materials.

Non-Milestone Operation Processing

Tip
This replaces the Repetitive Labor Transaction in basic Repetitive.

- The Backflush Transaction (18.22.13) and subcontract processing activities let you use non-milestone backflushing.
- Non-milestone backflushing uses a demand-pull strategy to determine the units needed from non-milestone operations. The amount depends on the net requirement of the processing milestone operations. The net requirement is satisfied by consuming units in the output and input queues of preceding non-milestone operations until either the requirement is satisfied or another milestone operation is encountered.
- You can use any repetitive transaction at a non-milestone operation.

Scheduling

- In Advanced Repetitive, the earliest open schedule is always consumed—not just completions over the scheduled quantity for that date.
- Cumulative Completed Maintenance (18.22.2.6) lets you modify the quantity completed on a repetitive schedule. Changes to a schedule's cumulative completed are reapplied to the schedule using the consume-earliest-open logic.
- WIP inventory is visible to the Schedule Explosion (18.22.2.4) and MRP programs. This prevents overplanning for components that might result from not including WIP.

- Schedule Delete (18.22.2.7) enables easy deletion of repetitive schedules and their planned work orders. Limit schedule consumption in the past by deleting schedules left open that fall before a specific date. In Schedule Delete, the date defaults to Monday's date. Use this to establish the earliest open schedule.

Many activities in the two modules are exactly the same or similar. This chapter describes how to use Advanced Repetitive. Chapter 11 describes the features of basic Repetitive that differ.

See "Repetitive" on page 311.

Setting Up Advanced Repetitive

Repetitive activities assume that base data is already set up. Much of this is the same data that is required by work orders.

- Define master data such as items, sites, and locations. Also set up each employee who will be reporting labor.
- Define bills of material and product structures in the Product Structures module for each item to be scheduled. Also associate each component in the product structure with a routing operation.

See page 11.

- Define departments and work centers, routings, and operations in the Routings/Work Centers module. Each work center must have a corresponding location with the same ID as the work center.

See page 25.

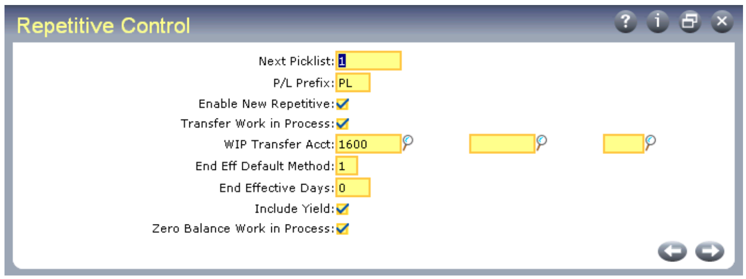
Within the Advanced Repetitive module, you must complete additional setup activities:

- Set up values in Repetitive Control.
- Set up production lines by defining line allocations, shifts (if you use them), production line capacities, and changeover times.

Defining Control Program Settings

If you have previously used the Repetitive module, you must run Cumulative Ord Accounting Close (18.9) to close any open cumulative orders. Then, set the Enable New Repetitive field in Repetitive Control (18.22.24) to Yes.

Fig. 10.1
Repetitive Control (18.22.24)



Next Picklist and P/L Prefix. Enter values to be used for automatic numbering of repetitive picklists.

Transfer Work in Process. Enter Yes or No to set the default for the same field in Cumulative Order Close (18.22.10).

WIP Transfer Account. Enter the GL account, sub-account, and cost center debited or credited when closing a cumulative order and transferring WIP to a new cumulative order.

End Eff Default Method. Specify the method you normally use to set end effective dates on cumulative orders. Choices are:

Blank: Start and end effective dates are not set.

1: Start and end effective dates match the dates of the GL period in effect during the transaction.

2: Start and end effective dates match the calendar start and end effective dates of the month of the transaction.

3: Start and end effective dates cover a number of days, so the transaction effective date falls in that interval.

The setting determines effective date calculation for orders created in the background by repetitive transactions or in batch using Cumulative Order Create (18.22.11).

End Eff Days. If End Eff Default Method is 3, specify the number of days that the start and end effective dates cover.

Figure 10.2 shows how the system uses the End Eff Days field to set the start and end effective dates on cumulative orders. In this example, an End Eff Days value of 10 days is entered, as indicated by the diagonally shaded boxes.

Fig. 10.2
Example of End Eff Days Use

Include Yield. Set this to Yes to have the system include the yield percent established in Routing Maintenance (14.13.1) in the cumulative order standard cost. It should match the setting for Include Yield % used normally when running other cost rollup functions.

For example, if there is a yield of less than 100% at an operation, this will cause the overall cost to manufacture to increase, since not all the material produced is expected to be good.

If No, then 100% is substituted for the Yield% field.

Zero Balance WIP. This field determines how queue quantities at non-milestone operations are affected when production is reported at subsequent operations. This setting affects:

For more information, see "Milestone and Non-Milestone Operations" on page 273.

- Quantities processed in Backflush Transaction (18.22.13)
- Subcontract shipper issues in Sub Shipper Issue (18.22.5.11)
- Receipts from subcontract shippers or purchase orders using PO Shipper Receipt (5.5.5.11) or Purchase Order Receipts (5.13.1)

When Zero Balance WIP is Yes, the system does the following after transferring the item quantity processed, issued, or received from the input queue of the reporting operation and, when needed, the queues of previous non-milestone operations:

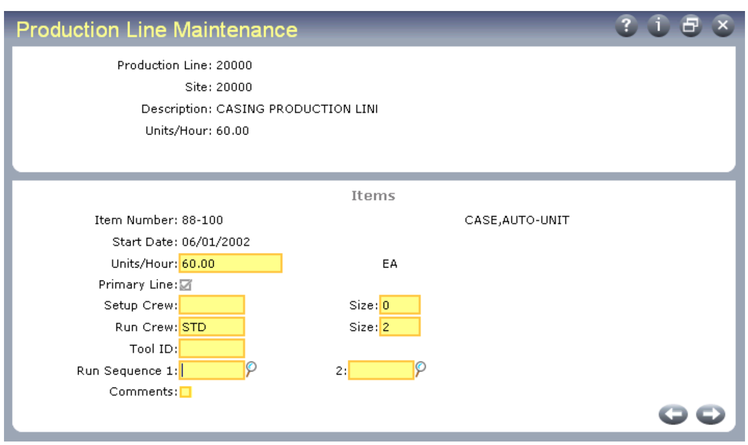
- Moves any leftover quantities from previous non-milestone operation queues to the input queue of the non-milestone operation that directly follows the previous milestone operation.
- Sets all other queue quantities to zero for previous non-milestone operations up to the preceding milestone operation.

When Zero Balance WIP is No, leftover quantities remain in non-milestone operation queues until they are moved to subsequent operation queues or manually deleted using WIP Adjust Transaction (18.22.21).

Setting Up Production Lines

A production line is defined at a site by specifying the hourly production rate for items produced on that line during a normal shift. One or more items can be made on the same production line, and the same item can be produced on several production lines, all at the same or at different production rates.

Fig. 10.3
Production Line Maintenance (18.22.1.1)



See “Setting Up Line Allocations” on page 269.

When an item is produced on one line only, this line can be assigned a primary line status for that item. A primary line produces all orders for an item. To indicate a primary line, set the Primary Line field to Yes. Optionally, orders for an item can be allocated to several different production lines. To set up multiple production lines for an item, set the Primary Line field to No and use Line Allocation Maintenance (18.22.1.11) to set the percent of an item's production for each line.

The production rate for an item on a production line is equal to that of the operation with the lowest production rate. A production line is no faster than its slowest operation.

Production rates can vary by shift or day. You can adjust the basic production rate for an item by changing the rate factor in the Productivity field in Shift Maintenance (18.22.1.22).

Use the effective date associated with the production rate to indicate changes in a line when items are phased in or out of production or when rates increase or decrease at a certain date.

Run sequence fields can be used to control the sequence in which planned orders for line-manufactured items are added to a production line schedule.

See "Run Sequences" on page 377.

When Sort by Run Sequence is Yes in Planned Repetitive Sched Approve (23.8), approved orders are sorted and sequenced in production line schedules using the following hierarchy:

See "Approving Planned Line Orders" on page 392.

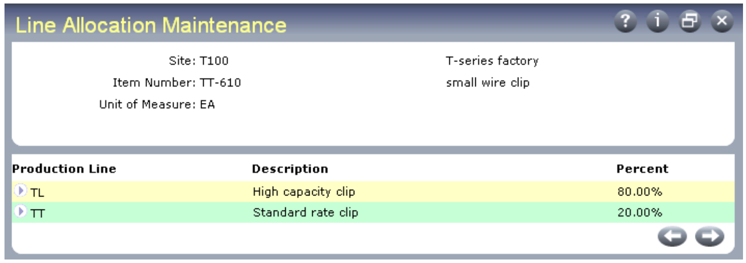
- Due date
- Primary run sequence
- Secondary run sequence
- Item number

Setting Up Line Allocations

Within a supply site, items can be produced on one or more production lines. The line allocation specifies how production is distributed among multiple lines.

To set up production line allocations, use Line Allocation Maintenance (18.22.1.11). Set up line allocations for items that can be produced on multiple production lines within a site. The line percentages must total 100%.

Fig. 10.4
Line Allocation Maintenance (18.22.1.11)



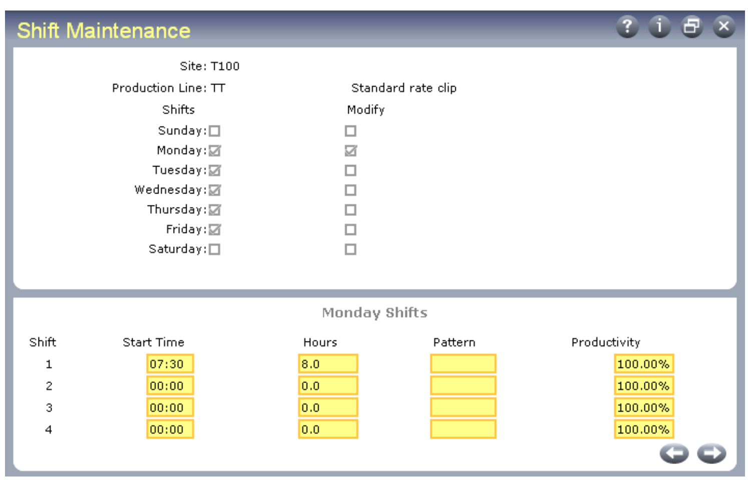
Use Line Allocation Inquiry (18.22.1.12) to view line allocations by site and item number.

Setting Up Shifts

Use Shift Maintenance (18.22.1.22) to define the normal hours and production rate factor for each shift during a day. You can also define any exceptions to that normal pattern.

Set up shifts for a site or for a production line at a site. You can define up to four shifts for a day of the week. A working day should have at least one shift with some number of hours greater than zero and a rate adjustment factor also greater than zero.

Fig. 10.5
Shift Maintenance (18.22.1.22)



The system rates shift capacity as:

*Shift Capacity = Production Rate * Hours * Productivity*

The hours per shift is the number of hours the shift is capable of producing, rather than the total number of working hours for the shift. Shifts can overlap—so the total number of hours for all shifts can exceed 24 hours.

When a shift is more or less productive than a normal shift, enter an adjustment factor in Productivity.

Tip
This Productivity field has no connection to productivity measures elsewhere in the system.

Example A production line has three shifts, and the third shift has only 20% of the employees of the first two shifts. Enter a shift adjustment factor of 20% for that shift.

If the production rate is 100 units per hour, a shift is capable of production for seven hours, and the productivity factor is 100.00%, then its capacity is 700 units per shift. If a second shift has a productivity factor of 50%, then its capacity is 350 units.

The hours worked by a particular shift can change because of holidays, planned shutdowns, or periods with planned overtime. Manage exceptions by adding reference hours to shifts by effective date, in the same way you modify the shop calendar.

Example A shutdown is planned for shifts 2 and 3, which normally work seven hours a day. Add –7 hours to those shifts for the affected date range. If overtime is planned for shift 4, then specify additional hours for that shift.

Unlike with the shop calendar, you can add shifts that do not fall on normal working days.

Use Shift Report (18.22.1.23) to see active shift status, exception dates, and shift hours.

Setting Up Changeover Times

Define changeover times for a production line in Line Changeover Maintenance (18.22.1.6). For the system to work correctly, you should define changeover times between each pair of items. For instance, on a line where red, green, and gray items are manufactured, the changeover time can vary depending on whether red is being switched to green or to gray.

Example If a line manufactures three items—A, B, and C—define changeover times for each of the following.

From	To
A	B
B	A
A	C
C	A
B	C
C	A

See *User Guide Volume 9: Manager Functions* for details on CIM.

A large number of changeover times might be more effectively managed outside of MFG/PRO using spreadsheet software. Use the CIM interface programs to load the data into Line Changeover Maintenance.

Setting Up Routings and Operations

See “Routings” on page 34 for more details.

Items on a repetitive schedule must have a routing. The operations of a routing are used to backflush components and receive completed products into inventory. When you define a routing, you do not have to specify every operation performed on a product. The manufacturing lead time, the length and number of operations, and capacity planning at work center operations must all be considered. Tracking, measuring, and accounting for labor by work center and operation are also factors to consider when specifying a routing.

In some cases, it is appropriate to set up a routing with a single operation used for backflushing and receiving material.

- Product lead times are short—less than two or three days.
- Capacity is planned by production line.
- Labor is collected and reported in aggregates, such as by department or production line.

The routing operations for an item must be integrated with the item’s product structure for components to be backflushed. All components backflushed from inventory must reference a routing operation. However, all components do not have to refer to the same operation number. With long lead times, different components can be backflushed when different operations are completed.

A number of fields in Routing Maintenance have special significance for repetitive processing.

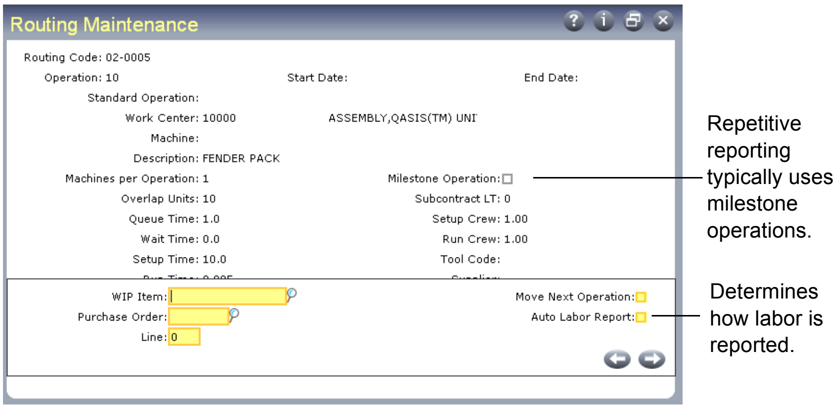


Fig. 10.6
Routing Maintenance (14.13.1)

Milestone and Non-Milestone Operations

Tip
The last operation is always treated as a milestone.

Milestone operations are routing operations where production counts are recorded. Milestone operations are normally used to report all labor and completions. However, you can also use non-milestone operations to report scrap, rejects, rework, or discrepant labor. In this case, you create WIP balances at non-milestones. This allows for more accurate tracking of WIP costs and quantities.

See “Zero Balance WIP” on page 267.

Normally, however, non-milestones are maintained at zero inventory. This can be done automatically by the system or manually, based on the setting of Zero Balance WIP in Repetitive Control (18.22.24).

When Zero Balance WIP is Yes, and you report a processed quantity or a subcontract issue or receipt at any repetitive operation, the system moves any quantities remaining at previous non-milestone operations to the input queue of the non-milestone operation that directly follows the closest preceding milestone operation.

Example Operation 10 is a milestone operation and operations 20 and 30 are non-milestones. You report a quantity complete at the next operation, 40. At this time, if an open quantity remains at operation 30, the system moves it into the input queue of operation 20 and the quantity at operation 30 is set to 0 (zero).

When Zero Balance WIP is No, the system does not automatically move quantities out of non-milestone operation queues when you report at subsequent operations. Rather, leftover quantities remain at these operations until you move them out or delete them manually using WIP Adjust Transaction (18.22.21).

Automatic Labor Reporting

The Auto Labor Report field determines if standard labor is reported automatically by Backflush Transaction (18.22.13).

If Yes, Backflush Transaction automatically reports the standard number of run hours for the quantity processed. Any hours specified directly are considered as additional to the standard. Negative numbers are subtracted from the standard. Backflush Transaction also automatically reports standard hours for each prior non-milestone operation that also has this field set to Yes.

Set this field to No if you do not want to generate labor reporting automatically. In this case, you should report labor explicitly in either the Backflush Transaction or the Run Labor Transaction (18.22.14).

In either case, all setup labor must be reported using the Setup Labor Transaction (18.22.15).

Subcontract Routings

See "Managing Subcontracting" on page 305 for more details.

The way the routing is defined affects subcontracting for repetitive operations, including subcontract lead time and subcontract cost. You can also specify an item to represent the material in WIP for subcontract shipments. The description and unit weight of this item are printed by Sub Shipper Print (18.22.5.9).

The Move Next Op field also affects subcontract operations.

- When Yes, the receipt of the subcontract PO or confirmation of the shipper moves WIP to the input queue of the next operation.
- When No, WIP is maintained in the output queue of the subcontract operation after the PO or shipper receipt.

Note Move Next Op at the milestone operation before the subcontracting operation must be No. Sub Shipper Issue (18.22.5.11) transfers items from the output queue of the previous milestone (reported) operation into the input queue of the subcontract operation.

Setting Up Locations

The locations used to backflush inventory vary depending on the number of production lines and how items are supplied. The flow of inventory to the production line usually follows one of two patterns:

- Inventory is received from a supplier or WIP into a central storage location, then transferred from storage to the production line as needed.
- Inventory is received directly from a supplier or WIP to the production line where it is consumed.

In the first, there is a primary stocking location and one or more locations where the item is eventually consumed. In the second, there may be a single stocking location on the production line.

Tip
An item's primary stocking location is defined in Item Data Maintenance (1.4.3).

A production line location, instead of the primary stocking location, can be set up to backflush material. To do this, set up an inventory location for the production line and give it a location code that is the same as the work center code for the backflush operation.

Simulating Schedules in the Workbench

You can use a single repetitive schedule for an item that is manufactured on a single production line with a known rate of production. However, consider using Line Schedule Workbench (18.22.1.10) to create simulated schedules when:

- Many different items are produced on a single line.
- Several different lines produce the same item.
- The production rate of a line varies.

You can use Line Schedule Workbench to:

- Create a simulated repetitive schedule (line schedule) for a specific production line and site combination.
- Have the system automatically modify line schedules based on the capacity constraints of the specified production line.

See "Approving Planned Line Orders" on page 392.

In addition, Line Schedule Workbench lets you update or create repetitive schedules from MRP planned orders. When planned orders for line-manufactured items are approved, these orders are added to the item's line schedule. The sequence in which orders are added to a schedule can be controlled using the Sort by Run Sequence field in Planned Repetitive Sched Approve (23.8). You can review and modify sequences, quantities, and dates as needed.

Simulation usually takes place during production planning. The planner creates a line schedule that meets production requirements and balances line utilization and then uses it to generate repetitive production schedules.

See "Updating a Repetitive Schedule from a Line Schedule" on page 280.

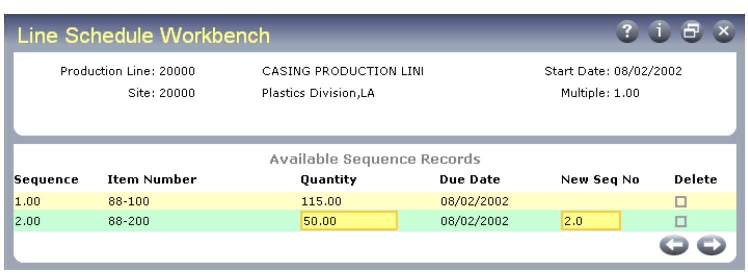
The line schedules you create in the workbench are simulations only and are not considered by MRP or other planning functions until you copy them to repetitive schedules using Repetitive Schedule Update (18.22.1.18).

To create a simulated schedule, specify the production line, site, and start date. Set the Multiple field to a positive number to limit the quantity for each line sequence record to multiples of that number.

Tip
Use Insert to create a new line sequence record in the workbench.

Then, enter production quantities and dates into the workbench or review and modify existing sequence records as needed. Each entry has a sequence (priority) number. By manipulating the sequence number, you can change the order in which items will be manufactured.

Fig. 10.7
Line Schedule Workbench (18.22.1.10)



Determining Order Multiples

The Multiple field controls the minimum divisible schedule quantity for a workbench session. The default setting of 1.00 lets you create schedules with whole integer quantities only. When set to zero, Line Schedule Workbench attempts to use all available time to manufacture scheduled quantities. As a result, it will schedule decimal quantities if necessary.

You can set Multiple to any other quantity, as needed. This is useful if you plan orders in single units and schedule in multiples. Or, you can set Multiple to any meaningful decimal quantity such as 0.5. Then, you can enter schedule quantities in units of 0.5. A negative value is not allowed.

You cannot change the value of Multiple on existing schedules if non-divisible quantities would result.

Sequence Numbers and Due Dates

The workbench uses sequence numbers and due dates to resolve scheduling conflicts. When two production runs are scheduled for the same due date but there is only enough capacity for one, the system gives priority to the one with the lower sequence number. After planning the first production run and making adjustments for changeover time, it plans output for the second production run. Because the system uses finite loading, the first scheduled due date for the second production run may be later than the date originally entered.

Whenever you create or modify a sequence record, the system automatically reschedules the production quantities and dates and reassigns new sequence numbers. To insert a new production quantity between two existing quantities, enter a sequence number with a value between the two and a due date equal to the earlier of the two dates.

Production Quantities

Add production quantities to the workbench directly or select from MRP planned orders. The system converts the quantities on the planned orders to schedule quantities and deletes the selected orders.

As a general rule, production quantities should be directly related to the period used for scheduling production. If production is scheduled by day, the production quantity should not be sufficient to cover an entire week. This becomes important when a production line is scheduled to process different products during a given week.

If MRP uses a POQ order policy and the period is a week or longer, the production quantities recommended by MRP planned orders might cover a week. In this case, separate the quantity recommended by MRP into smaller quantities.

One day is the shortest period you can use to schedule production. You can schedule multiple items each day, but if scheduled production is by shift, then you must summarize production into daily quantities before entering it into the workbench.

Scheduling and Lead Times

In some situations, different products manufactured on a line have significantly different lead times. Even if flow rates are similar through most of the line, some products might spend more or less time at an operation—for example, products that are burned-in, dried, aged, or cured.

When a line is changed over from processing one product to another with a significantly longer lead time, the line's output is interrupted by the changeover time plus the new lead time. This might not be important if you are manually determining the due date for expected output from a line. But if the system encounters a scheduling conflict and reschedules due dates, these dates will not take into account the new lead time.

There are two ways to avoid this:

- Assign due dates manually and then monitor the line schedule to see if any due dates following a changeover have been automatically rescheduled.

- Increase the changeover time to reflect the increased lead time between two products. This way the changeover time reflects the total time a line is disrupted between model changes.

Deleting Sequence Records

Delete records from the workbench in two ways:

- Select one or more records for deletion and choose Delete.
- Reverse the original production quantity by entering a negative value. For example, enter a quantity of –2000 for a production quantity of 2000. The system deletes all of the scheduled quantities and dates created by that entry.

Reviewing Line Schedules

Use Line Utilization Report (18.22.1.15) to review the results generated by the workbench. This report provides information for evaluating the load placed by a line schedule on a production line if it replaced the existing repetitive schedule. It also shows the changeover load between shifts, when appropriate.

Creating Repetitive Schedules

A repetitive schedule is a statement of planned output for a production line for one day. It consists of a list of scheduled quantities and due dates. A repetitive schedule controls the same activities as a work order. However, because it is used for continuous process manufacturing, it issues components from inventory by backflushing. This method deducts the required quantities from inventory when order quantities are reported as complete.

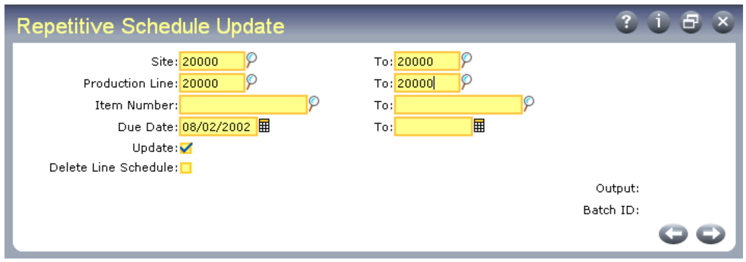
If you used Line Schedule Workbench (18.22.1.10) or Planned Repetitive Sched Approve (23.8) to create a line schedule, use Repetitive Schedule Update (18.22.1.18) to turn the line schedule into a repetitive schedule. Otherwise, create repetitive schedules using Schedule Maintenance (18.22.2.1).

See “Simulating Schedules in the Workbench” on page 275.

Updating a Repetitive Schedule from a Line Schedule

Once you are satisfied with a line schedule in the workbench, use Repetitive Schedule Update (18.22.1.18) to generate the repetitive schedule or update an existing one.

Fig. 10.8
Repetitive Schedule Update (18.22.1.18)



You can delete the line schedule as you update, or retain it. Typically, you retain the line schedule, since you can continuously maintain it by adding new MRP orders. However, you can use this function to delete an unneeded simulation by setting Update Repetitive to No and Delete Line Schedule to Yes.

Example A four-week repetitive schedule for an item on a production line needs an additional week added every week. Use the workbench to schedule the new week, and Repetitive Schedule Update to update the schedule.

After updating repetitive schedules, run MRP to synchronize planned orders with the schedule changes.

Schedule Maintenance

Use Schedule Maintenance (18.22.2.1) to enter or maintain daily schedules for each production line at a site. If the production line has multiple shifts, the schedule represents the total for all shifts. If there are no production lines at the site, you can enter a schedule for the whole site.

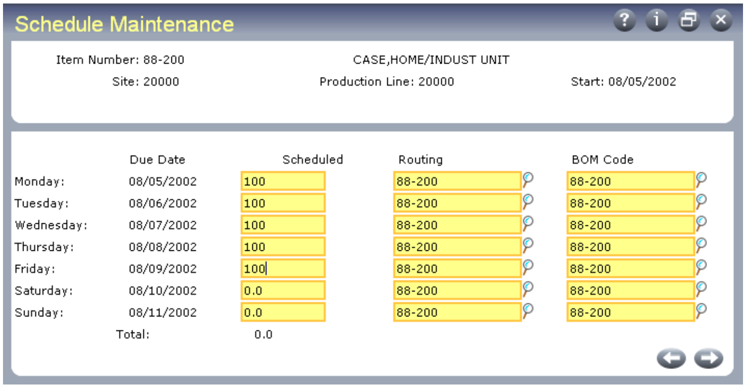


Fig. 10.9 Schedule Maintenance (18.22.2.1)

The bill of material (BOM) and routing for an item on a repetitive schedule default from Item Master Maintenance (1.4.1) or Item-Site Planning Maintenance (1.4.17). You can specify valid alternates, but you cannot combine different BOMs and routings on one order.

Reviewing Repetitive Schedules

Use Production Line Schedule Inquiry (18.22.2.13) to review the production schedule for a selected production line and day.

Use Production Line Schedule Report (18.22.2.15) to review the production schedule for a range of production lines and dates.

Exploding Repetitive Schedules

Once you establish a schedule, you must explode it using Schedule Explosion (18.22.2.4). The explosion creates the material and work center operation requirements necessary to support the schedule.

Until exploded, changes to the schedule are not reflected in component demand or work center load. MRP reports for the components or CRP reports for the affected work centers do not reflect the current repetitive schedule until it is exploded.

The schedule explodes automatically when MRP plans the item and site or when you run Schedule Explosion. An exploded schedule creates scheduled work orders for each day of production. Review these work orders in the Work Orders module. They have a type of S (scheduled).

Run Repetitive Picklist Calculation (18.22.3.1) to see if shortages at work centers need to be corrected.

Using Repetitive Picklists

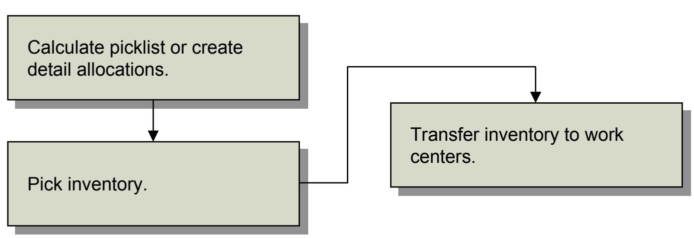
In most repetitive operations, issues are managed solely by backflushing. However, in many operations, you also need to manage the movement of inventory to the point where it is used. In environments where inventory is stored on the production line, the repetitive picklist lets you easily replenish the line's work centers.

Use repetitive picklists to move inventory from stocking locations to a work center. To use this method, you must define work centers as inventory locations.

Each repetitive schedule creates inventory requirements at the work centers in its routing. When you run Repetitive Picklist Calculation (18.22.3.1), the system:

- Determines the available inventory and requirements at each work center for the specified range of parent items
- Determines where shortages exist
- Allocates inventory to meet shortages
- Creates a picklist for each work center shortage

Fig. 10.10
Picklist Processing Flow



The system creates a picklist if there is a shortage and inventory is available to be picked. When you print the picklist, the inventory is picked. Use Repetitive Picklist Transfer (18.22.3.6) to transfer the inventory from its current inventory location to the work center. This move is a location transfer, not an issue to WIP, so there are no GL transactions until the inventory is backflushed.

Example Item A is installed in four different end items at work center OPS. The work center has 900 of Item A on location. For the next week, the repetitive schedules for these items have a total requirement of 1,000. The repetitive picklist calculation will show a shortage of 100 of Item A at OPS and detail allocates 100 at the inventory location. When the picklist is printed, the 100 will be shown as picked, and 100 will be moved to location OPS when the transfer is run. The inventory will not be issued until labor is reported for each operation.

Note To use picklists, you must set up a location with the same ID as the work center.

Calculate the Picklist

Calculate the picklist and create detail allocations using Repetitive Picklist Calculation (18.22.3.1). The calculation considers component requirements from the exploded repetitive schedules that match the sites, items, work centers, and production dates specified.

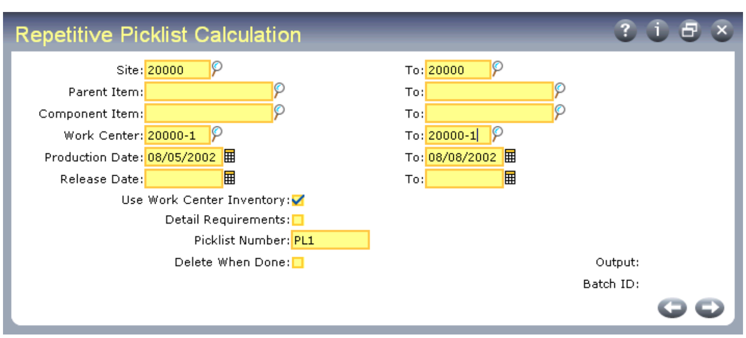


Fig. 10.11 Repetitive Picklist Calculation (18.22.3.1)

For a new schedule creating requirements at a work center with no shortages, Repetitive Picklist Calculation uses the following equation.

Shortage at Work Center = New Requirements – Net Available

Where net available equals:

Actual OH – Qty Alloc – Qty Req by Other Scheds + Untransferred Picked

The Net Available is the material available for these requirements at the work center, consisting of the material already there (Actual OH) and the material to be transferred (Untransferred Picked) minus the existing requirements. The existing requirements consist of the Qty Req by Other Scheds and the quantity allocated at that work center to work orders or sales orders (Qty Alloc).

As the equation shows, the picklist supplies material for the work center, not individual schedules. You can ensure that picklists supply individual schedules by running the picklist calculation immediately after exploding each new schedule. The picklist calculation already considers all existing picklists, so the new picklist will only meet the new requirements.

Choosing Options

Repetitive Picklist Calculation offers several options to control the picklist calculation.

Use Work Center Inventory. When Yes, the system counts inventory in a work center as inventory.

Detail Requirements. When Yes, the system prints all repetitive schedules generating requirements for a component, including the quantity required, parent item, due and start dates, machine, and operation.

Delete When Done. When Yes, the picklist is automatically deleted after the calculation. Use this option to review shortages without actually allocating inventory. The Next Picklist field in Repetitive Control (18.22.24) is not incremented.

Troubleshooting Problems

If problems occur with the picklist calculation, remember the following:

- A location must be created with the same name as the work center.
- The calculation does not create a picklist if there is no inventory to detail allocate. You cannot allocate negative quantities. The system does not warn you if inventory is insufficient to meet the requirements—it just does not create a picklist.
- The system does not create a picklist if there is sufficient inventory at the work center.
- Detail allocations are not associated with specific orders, so no order IDs are shown in the allocated inventory inquiry.
- The schedule treats all existing picklists as supply. To recalculate total requirements at a work center, delete all untransferred picklists. A picklist remains open until deleted or inventory is transferred, even if the schedule changes.
- The picklist calculation blows through phantoms. There is no phantom use-up logic.
- The picklist does not calculate requirements by shift.
- Since the calculation is based on requirements from an exploded repetitive schedule, it is not affected by changes in structures or routings.
- You can further control the quantities on a picklist using the item-site planning parameters Order Maximum and Order.

Print the Picklist

Print the picklist in Repetitive Picklist Print (18.22.3.5). Printing changes the status of the detail-allocated inventory to picked. The picking logic is the same logic used elsewhere in the system, set in Inventory Control (3.24). You can reprint the picklist without affecting inventory status.

See *User Guide Volume 6: Master Data* for information on picking logic.

Use Repetitive Picklist Undo (18.22.3.8) to cancel a picklist and reprint it later. It changes the inventory status back to detail allocated.

When a picklist exists, it is considered supply by later picklist calculations. If you want to start over, you must delete the outstanding picklists with Repetitive Picklist Delete (18.22.3.9). Deleting reverses all effects of running any picklist function. If the inventory is picked or allocated, it is returned to unallocated status.

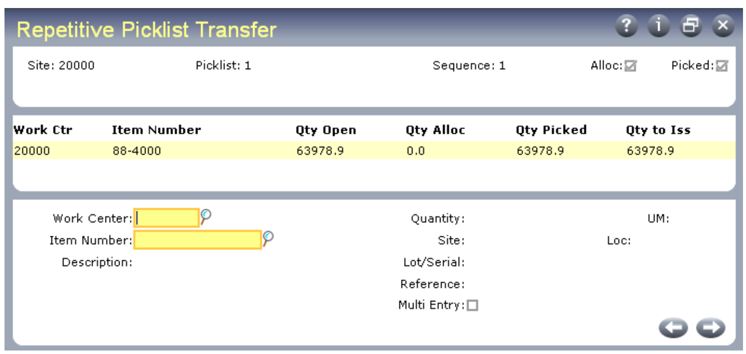
Transfer the Inventory

Tip
Inventory is transferred, not issued.

Use Repetitive Picklist Transfer (18.22.3.6) to transfer inventory from the stocking location to the work center. The new location must exist and must have the same name as the work center. After transferring the inventory, the system deletes the picklist.

Specify the date of the transfer in a pop-up frame after selecting Go from the header. The default is the system date.

Fig. 10.12
Repetitive Picklist Transfer (18.22.3.6)



Use the Sequence code to transfer only part of the total if space at the work center is limited.

Example If a work center holds 1,000 of an item, but the total requirements are 5,000, one picklist is created allocating 5,000, while the material is picked and transferred in sequences of 1,000 (sequence 1 for 1,000, sequence 2 for 1,000, and so on).

Set the maximum order quantity for an item in the Order Multiple field (Ord Mult) in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

To transfer specified quantities other than the order maximum, set the amount in Order Mult.

Example If the stocking unit of an item is liters but the item is delivered to the work center in 500-liter barrels, set an order multiple of 500 to ensure the item is transferred 500 liters at a time.

You can transfer inventory even if a picklist has not been created or printed. Use the Alloc and Picked fields to set the default for your transfers. You can also directly specify inventory to issue.

After issuing inventory, the system records an ISS-TR transaction and a RCT-TR transaction in transaction history.

Managing Cumulative Orders

The system keeps a running total for each combination of items, sites, production lines, product structures, and routings using a cumulative order. The cumulative order tracks work-in-process (WIP) costs and quantities for repetitive production. A cumulative order is created for a profile that defines the site, item number, production line, routing code, BOM/formula code for the order, and start and end effective dates.

Cumulative orders can be created three ways:

- Automatically by the system when you execute a repetitive transaction (18.22.13 –18.22.21)
- One at a time with Cumulative Order Maintenance (18.22.6)
- In a batch with Cumulative Order Create (18.22.11)

When a cumulative order is created, a cost rollup establishes the cumulative order cost. Cumulative orders have an assigned ID number, but no order number.

Repetitive transactions create a cumulative order when they cannot find one with the same profile (site, item, production line, routing, BOM or formula code) where the effective date range includes the effective date of the repetitive transaction. The system sets effective dates on new cumulative orders using the parameters defined in Repetitive Control.

When standard costing is used at the site on the cumulative order, recording repetitive transactions generates rate variances and creates GL entries for them. Usage and method variances are accumulated and posted when you run one of the following:

- Post Accumulated Usage Variances (18.22.9) generates GL entries for usage and method change variances accumulated since this function was last run.
- Cumulative Order Close (18.22.10) closes cumulative orders and creates GL entries for usage and method variances accumulated since Post Accumulated Usage Variances was last run. You can transfer WIP balances to another cumulative order or post them to Method Change Variance.

Post Accumulated Usage Variances and Cumulative Order Close can be run in report-only mode if needed.

All rate and usage variances are measured against the cumulative order cost. GL scrap entries are not created until you run either Post Accumulated Usage Variances or Cumulative Order Close.

Use Cumulative Order Browse (18.22.7) or Cumulative Order Report (18.22.8) to review cumulative order information including start and end effective dates and status.

Cumulative Order Create

Use Cumulative Order Create (18.22.11) to create new cumulative orders in advance in a batch-oriented setting. This prevents the system from having to create them during repetitive transactions, and ensures a better response time for items with many components.

See “End Eff Default Method” on page 266.

To use this function, orders must already exist in the system. The new order is based on the old, with a different effective date. For each cumulative order selected, the system checks to see if a cumulative order exists with an effective date range that includes the day after the entered End Effective date. A new cumulative order is created if none exists. The Start and End Effective dates of the new cumulative order are set based on the End Eff Default Method in Repetitive Control.

A cumulative order is created for a profile that defines the site, item number, production line, routing code, and BOM/formula code for the order, and start and end effective dates. Two orders that have the same profile cannot have overlapping effective dates. When a cumulative order is created:

- The work order ID is automatically assigned.
- The work order number is blank.
- The work order type is C.
- The work order status is R.

Cumulative Order Close

Use Cumulative Order Close (18.22.10) to select and close open cumulative orders according to various criteria. You can optionally create successive cumulative orders and transfer WIP queue balances to them. Cumulative orders must have an end effective date on or before the End Effective value you enter. Orders with a blank end effective date will not be selected.

Note To close orders with blank end effective dates, first enter an end effective date using Cumulative Order Maintenance (18.22.6).

Closing a cumulative order performs the same processing as the Post Accumulated Usage Variances transaction. Variances are calculated, posted, and reported. When Transfer WIP is Yes, WIP queue balances are transferred from the closed cumulative orders to new cumulative orders.

To close a cumulative order before its end effective date, use Cumulative Order Maintenance to set the end effective date to yesterday’s date. The system creates a new cumulative order for the balance of the period if the End Eff Default Method is set to 1 or 2 in Repetitive Control (18.22.24).

Transferring WIP

To transfer WIP values and quantities from closed orders to new cumulative orders, set Transfer WIP to Yes in Cumulative Order Close. The system searches for a cumulative order with the same profile (site, item number, production line, routing, and product structure code) and a start effective date equal to the day after the end effective date specified in the selection criteria.

Table 10.1
Transferring WIP

If	Then
An open cumulative order exists,	it receives the WIP quantities of the cumulative order being closed.
A closed cumulative order exists,	WIP quantities do not transfer.
There is no cumulative order,	the system creates a new one to which WIP is transferred.

Processing Steps

Cumulative Order Close does the following for each operation in the cumulative orders selected for processing:

1. Posts the value of the WIP queue inventory to the appropriate cost account.
   - When Transfer WIP is Yes, this is the WIP Transfer account specified in Repetitive Control.
   - When Transfer WIP is No, this is the Method Change Variance account.
2. Records the posting event by creating an operation history record of type Close.
3. Changes the cumulative order status to Closed.

Transferring WIP

When Transfer WIP is Yes, the system transfers WIP queue quantities from each cumulative order operation that meets the following conditions:

- The WIP quantity is not zero.
- It has a corresponding operation record in the receiving cumulative order.

The system follows these steps to transfer WIP queue balances from closed cumulative orders to new orders:

1 For each operation with a WIP quantity to transfer, the system searches for an operation in the receiving order with the same operation code. If it finds one, it proceeds with the transfer. Otherwise, it ignores that operation and does not transfer the WIP.

   Note For the system to transfer WIP to the first operation in the receiving order, the corresponding operation in the transferring order must also be the first operation, in addition to having the same operation code. Unless both these conditions are met, the system ignores the operation and does not transfer WIP.

2 The system transfers the WIP queue quantities from the old cumulative order operations to the output queues in the receiving order operations.

3 The system records the transfer by creating an operation history record of type Transfer.

4 The system generates the appropriate GL transactions to transfer the WIP value to the new cumulative order.

5 When the cost of the WIP queue inventory for an old cumulative order operation differs from the cost at the receiving operation, the system posts the difference to Method Variance.

After these calculations are complete, a residual value may remain in WIP. This is because when the system debits WIP during repetitive reporting transactions, fractional values may remain in WIP due to rounding differences. These residual values accumulate in WIP until the cumulative order is closed. Cumulative Order Close posts the residual WIP value from each closed cumulative order to Method Variance.

You can run Cumulative Order Close in report-only mode as needed.

Cumulative Order Maintenance

Use Cumulative Order Maintenance (18.22.6) to create new cumulative orders manually or maintain the start and end effective dates on an existing order. You cannot change effective dates so that they overlap those on another cumulative order for the same profile. You can also delete closed cumulative orders.

Executing Repetitive Transactions

As work is performed, labor and movement of WIP units are reported. You can report these activities using various types of transactions, including downtime, scrap, rework, move, and rejects. There are nine transaction types and several purchase order functions for subcontract activities.

Repetitive transactions affect other areas of the system. As quantities are moved through repetitive operations, inventory transactions are recorded and posted as backflushing occurs. Labor and burden costs are recorded by manual entry or as a result of backflushing.

Transactions generate cost variances and create GL entries. Most transactions generate quantity and cost posting to the cumulative order and associated operation and bill of material (BOM) records.

Transactions affect any one of the three quantity queues associated with routing operations:

- The input queue, which holds quantities from the previous operation
- The output queue, which holds quantities from the current operation that have not been moved to the next operation
- The reject queue, which holds quantities rejected by the current or a subsequent operation

Common Transaction Data

All repetitive transactions use common information entered in the first frame. Figure 10.13 shows the first frame of Backflush Transaction (18.22.13).

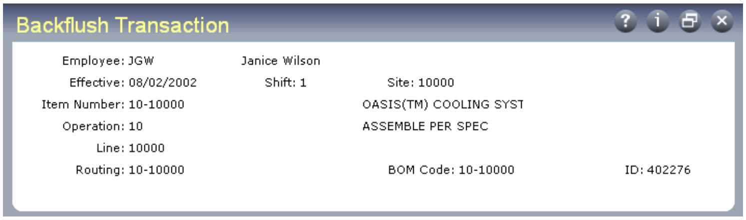


Fig. 10.13 Transaction Programs—Common Information

The Employee field is mandatory. Enter a valid employee set up either in Employee Maintenance (2.7.1) or Actual Pay Rate Maintenance (14.13.21). A valid effective date, site, item number, and operation are required. Shift is optional.

If the item number is associated with a production line, you must enter a valid production line in the Line field. Enter Routing and BOM only if you are not using the default. ID is a system-generated cumulative order ID and cannot be modified.

The system uses the values entered in the Effective, Site, Item Number, Operation, (Production) Line, BOM, and Routing fields to locate the appropriate cumulative order.

The selected cumulative order has start and end effective dates that include the transaction effective date. Table 10.2 describes the way a cumulative order is selected, based on the effective date entered.

Table 10.2 How a Cumulative Order is Selected

If	Then
A cumulative order has a blank start effective date, indicating that its effective interval is from the end effective date into the indefinite past,	it will always be selected if the transaction effective date is on or before the end effective date.
A cumulative order has a blank end effective date,	its effective interval is from its start effective date into the indefinite future, and will always be selected if the transaction effective date is on or after the start effective date.
A cumulative order has blank start and end effective dates,	the cumulative order will always be selected.

If	Then
No cumulative order is found matching the above criteria,	one is immediately created. The start and end effective dates are set according to the parameters defined in Repetitive Control.
The dates in the new order overlap with the dates in some other cumulative order,	the dates in the new order are adjusted forward or backward to prevent overlap.

See "Phantoms" on page 15.

The cumulative order creation process retrieves the routing in effect as of the transaction effective date and copies it to the cumulative order. For each operation in the routing, this process retrieves the product structure in effect as of the transaction effective date and copies it to the cumulative order operation. Any phantoms are blown through.

A cost rollup is then performed in the new cumulative order, and the calculated operation costs are recorded by operation in the cumulative order routing. These costs are used for WIP valuation reporting and calculating variances.

The costs are independent of the item cost and routing cost. The Cumulative Order Cost Report (18.22.4.10) displays the operation costs stored in the cumulative order.

Warning Messages

All transaction programs issue warning messages when one of the following occurs:

- The operation being accessed is a non-milestone operation.
- A transaction would cause a WIP queue for an operation to become negative.

All transaction programs write operation history records to record the transaction events.

Rate Variances

All transactions consuming resources immediately calculate and post rate variances. These are generated when the standard costs in effect for components or labor at the time of the transaction differ from the resource costs recorded on the cumulative order.

The component costs recorded in a cumulative order are based on the GL standards in effect when the order was created. Labor, burden, and subcontract costs in the cumulative order are based on the routing and work center data in effect when the order was created.

For component material, rate variance is calculated as the difference between the GL standard cost currently in effect and the GL standard cost captured in the cumulative order. This type of variance is rare and typically occurs when the GL standard cost of the component material changes during the life of the cumulative order.

Labor and burden rate variance is calculated in a similar way. When a cumulative order is created, standard labor and burden rates are captured from the routing and work center data in effect. When labor is reported at a cumulative order operation work center, rate variance is calculated as the difference between the actual employee pay rate and the standard rate recorded on the cumulative order.

Subcontract rate variance is the difference between the PO price per unit and the subcontract cost per unit as captured in the cumulative order. This is posted when subcontract items are received from a shipper or PO.

Rate variances are posted only if GL standard costing is in effect for the finished item. They are not posted if GL average costing is in effect.

Method Change Variances

Method change variance (MCV), when calculated, is posted by the following transactions:

- Cumulative Order Close (18.22.10)
- Backflush Transaction (18.22.13)
- Run Labor Transaction (18.22.14)
- Setup Labor Transaction (18.22.15)
- Rework Transaction (18.22.17)
- Move Transaction (18.22.19)

MCV is calculated as the difference between the final operation cost recorded in the cumulative order and the GL standard cost of the finished material, extended by the quantity being reported. In the backflush and move transactions, MCV can be posted when moving from the output queue of the last operation to finished material inventory.

In the transactions where labor is reported, MCV is also generated when reporting at a work center other than the cumulative order operation work center. MCV is calculated as the difference between the standard labor and burden rates of the work center being reported and the standard labor and burden rates of the cumulative order operation work center, extended by the number of hours reported. This prevents unexpected rate variances from being applied to work centers.

See "Cumulative Order Close" on page 289.

In Cumulative Order Close, MCV can be posted when transferring WIP quantities to new cumulative orders. MCV is calculated as the difference between the operation cost in the former cumulative order operation and the operation cost of the new cumulative order operation, extended by the quantity transferred.

Method change variances are posted only if GL standard costing is in effect for the finished item. They are not posted if GL average costing is in effect.

Repetitive Transaction Programs

The following sections describe the use and application of various transaction programs on the Advanced Repetitive menu.

Backflush Transaction

Tip
Backflush Transaction can be used at both milestone and non-milestone operations.

Backflush Transaction (18.22.13) is the primary tool for reporting production line activity and the only transaction that automatically backflushes component inventory. You can report the number of gross units processed, scrapped units, rejected units, and labor hours. If the transaction is reported at the last operation, you can receive completed items into inventory.

You can backflush components of the current operation and any preceding non-milestone operations. You can also backflush standard labor and burden if the routing record of the reporting operation, or any preceding non-milestone operation, has Auto Labor Report set to Yes.

When you report that you have completed and moved items at the final operation, the quantity is posted as complete at the operation, and is also posted to the repetitive schedule and the related work order. If there are multiple schedules for an item, the system determines the earliest open schedule date and posts the completed quantities from that point forward.

If the system cannot find enough open balances, the operation is posted with the transaction quantity. However, the repetitive schedule and work order record are posted with the open quantity available.

You can modify repetitive schedule completions using Cumulative Completed Maintenance (18.22.2.6). You can view the repetitive schedule completions using either Schedule Inquiry (18.22.2.2) or Operation Schedule Report (18.22.2.5). You can view work order completions using Work Order Browse (16.2).

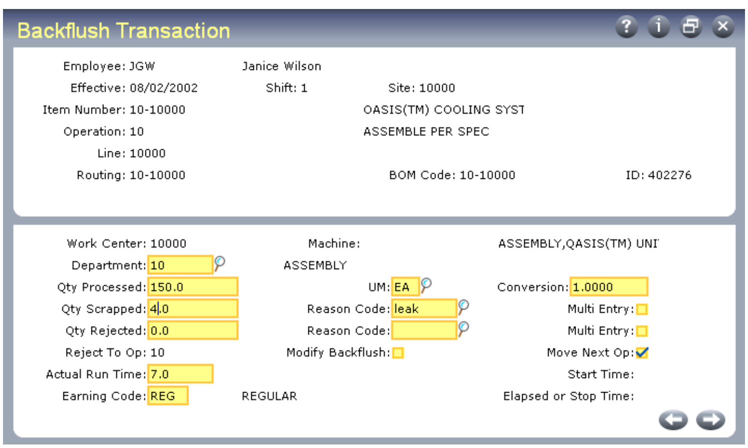


Fig. 10.14 Backflush Transaction (18.22.13)

The following are fields in the second frame of Backflush Transaction (18.22.13). Work Center, Machine, and Department default from the routing operation and can be overridden.

Tip
This value includes any quantity entered in the Qty Scrapped and Qty Rejected fields.

Qty Processed. Shows the quantity processed through the operation. Entering a value in this field has two effects.

- The input queue quantity is reduced by the amount entered.
- The output queue quantity is increased by the amount entered.

Components for the operation are backflushed by the quantities per unit extended by the quantity processed.

Qty Scrapped, Reason Code, Multi Entry. Report scrap quantity along with the processed quantity. Enter up to 10 scrap quantities and reason codes in a separate pop-up.

Qty Rejected, Reason Code, Multi Entry, Reject To Op. Report reject quantity along with the processed quantity. Enter up to 10 scrap quantities and reason codes in a separate pop-up. Reject To Op must reference either the current operation or the one that precedes it. The default is the current operation.

Modify Backflush. If Yes, the Component Issue frame displays so you can modify the default list of sites, locations, lot and serial numbers, and quantities used for component backflush and finished material receipt.

The component backflush logic considers the product structure in effect on the transaction effective date. If components are added, changed, or removed from the current product structure during the life of a cumulative order and backflush transactions occur, the differences cause material usage variances. Product structure and routing changes can be phased into cumulative orders by setting the cumulative order effective dates to match the product structure and routing effective dates.

Move Next Op. If Yes, the Receipt Data frame displays when reporting against the last operation. The Move Next Op field indicates whether the quantity processed—minus rejected and scrapped quantities—is moved to the input queue of the next operation. If the operation being reported is the last operation, the move increases finished goods inventory. This value defaults from the routing operation.

Note You cannot add an operation to the routing for an open cumulative order. You must close the cumulative order, make the routing changes, roll up the cost, then open a new cumulative order.

Run and Setup Labor Transactions

Use these programs to easily report run and setup labor only for non-milestone or milestone operations:

- Use Run Labor Transaction (18.22.14) to report regular labor chargeable against WIP.
- Use Setup Labor Transaction (18.22.15) to enter separate setup times, also charged against WIP.
- Use Down Time Transaction (18.22.20) and Non-Productive Labor Feedback (18.22.22) to report indirect labor. These transactions are not subject to applied burden.

Reject Transaction

Reject Transaction (18.22.16) has two uses:

- To reject previously backflushed units from an operation's output queue to the same operation's reject queue or to the reject queue of any preceding operation
- To reject units from an operation's input queue and record the reject at the previous operation

Enter up to 10 different reject codes at a time. You cannot report hours, and no backflushing takes place.

Use Backflush Transaction (18.22.13) for most reject reporting. This transaction backflushes the rejected units and records all costs at the operation. When you use this transaction to report rejects at a milestone operation, the quantity must be in the input queue of the current operation or in the input or output queues of prior non-milestone operations.

Note If you are rejecting with backflush at a non-milestone operation, the quantity to be rejected must be in the input queue of that non-milestone operation.

Rework Transaction

When you first report rejected quantities, use the Reject To Op field in Backflush Transaction (18.22.13) or the To Operation field in Reject Transaction (18.22.16) to send the quantity to the operation where rework occurs. In WIP Status Inquiry (18.22.12), the rejected quantities appear as negative numbers in the output queue of the operation where the reject occurred, and as a positive number in the reject queue of the receiving operation.

Reworked units are backflushed at the operation rejecting them. After reworking items, use Rework Transaction (18.22.17) to move the reworked items back into the production line. Use the To Operation and To Queue fields to select the operation and queue, typically one of the following:

Tip
This method requires an additional Move Transaction (18.22.19).

- The rejecting operation's output queue
- The input queue of the operation following the rejecting operation

You can enter rework hours and issue additional components. However, no automatic backflushing takes place. Enter up to 10 reject quantities and reason codes at a time.

Scrap Transaction

Use Backflush Transaction (18.22.13) for most of your scrap reporting. It backflushes the scrapped units and records all costs at the operation.

Tip
This transaction is often used to scrap previously rejected units.

Use Scrap Transaction (18.22.18) to scrap or remove quantities from any queue of an operation without backflushing. Enter up to 10 scrap quantities and reason codes at a time.

When scrapping from an operation's input queue, the scrap quantity is first moved back to the prior operation's output queue and then posted as scrap at that operation. This ensures a proper balance in the queues and cumulative quantities (as seen in the WIP Status Report and Browse).

You cannot report hours, and no backflushing takes place with this transaction.

WIP Adjust Transaction

Tip
Labor hours cannot be entered, and no backflushing takes place.

You can reconcile actual WIP quantities with those recorded in your database by using the WIP Status Inquiry (18.22.12) or WIP Status Report (18.22.4.11). When quantities do not match, use WIP Adjust

Transaction (18.22.21) to adjust quantities at an operation's input, output, or reject queues. The current queue balances display when you run the program.

- When you adjust the output or reject queues, you change their balances at the current operation.
- When you adjust the input queue, the net change is made to the prior operation's output queue as well as to the current operation's input queue.

Each adjustment creates operation history records and generates GL transactions. A queue increase debits WIP and credits the Inventory Discrepancy account. Negative adjustments credit WIP and debit the Inventory Discrepancy account. You can designate a GL account, sub-account, and cost center for the transaction. The default is the Inventory Discrepancy account from Product Line Maintenance (1.2.1) or Inventory Account Maintenance (1.2.13).

Open schedule quantities are also updated by this transaction. Increases in the balances of the final operation's output queue increase scheduled completions and vice versa.

Move Transaction

Move Transaction (18.22.19) transfers quantities from an operation's output queue to the following operation's input queue. For the final operation, items are moved to finished material inventory. In this case, the Modify Receipt field lets you modify the default list of sites, locations, lot and serial numbers, and quantities.

You cannot report labor hours. This transaction normally has limited use, since an operation can be set to have the backflush transaction and rework transaction perform this task automatically.

Reporting Downtime and Non-productive Labor

Use Down Time Transaction (18.22.20) and Non-productive Labor Feedback (18.22.22) for reporting. These transactions do not charge costs against WIP. Both debit Cost of Production and credit Labor.

Down Time Transaction references the cumulative order, operation, item, production line, and site. Non-productive Labor Feedback allows you to enter a GL project code and record comments.

You can enter reason codes for both transactions, with type Downtime for Down Time Transaction and type Down for Non-productive Labor Feedback.

Post Accumulated Usage Variances

See "Managing Cumulative Orders" on page 287.

Post Accumulated Usage Variances (18.22.9) calculates and posts accumulated usage variances in cumulative orders, according to the criteria entered. You can post usage variances on demand without having to close the cumulative order.

For each open cumulative order selected, usage variances are calculated by operation for component material, WIP material, labor, burden, and subcontract. The variances calculated are for the entire life of the cumulative order. The amounts to post are reduced by any amounts previously posted. Additionally, floor stock expense is posted.

Component Material Usage Variances

Component material usage variance is calculated as the difference between the actual and expected quantities issued, extended by the cumulative order operation component cost. The expected issue quantity is the cumulative order operation standard quantity required per unit multiplied by the quantity processed at the operation. When you issue component materials that are not in the cumulative order BOM for that operation, they are considered nonstandard and treated entirely as usage variance.

WIP Material Scrap Usage Variances

WIP material scrap usage variance is calculated as the difference between the actual and expected scrap quantities, extended by the cumulative order operation cost. The expected scrap quantity is the quantity processed less the cumulative order expected yield for that operation. For example, if the yield factor at an operation is 75%, and 100 units were processed at the operation, the expected scrap quantity would be 100 less 75%, or 25. The variance amount is posted to the Scrap account from the end-item product line.

You can scrap a quantity without producing a scrap posting. Consider the above example where yield is 75% and the expected scrap quantity is 25. If the actual quantity scrapped is 25, then no variance results. If there is no labor or component usage variance elsewhere, WIP is charged with exactly the amount of resources expected to produce 75. This is reflected in the fact that the operation cost includes an expected scrap amount.

If scrap is always posted regardless of yield, then Include Yield in Repetitive Control should be No. This sets the cumulative order yields to 100%.

See "Include Yield" on page 267.

Usage variances are posted only if GL standard costing is in effect for the finished item. Usage variances are not posted if GL average costing is in effect.

Labor and Burden Usage Variances

Labor and burden usage variances are calculated as the difference between actual and expected labor hours, extended by the cumulative order operation labor or burden rate. The expected labor hours equal the cumulative order operation standard labor hours per unit multiplied by the quantity processed at the operation.

Usage Variance Transaction Records

The system records each usage variance posting by creating an operation history record with one of the following types:

MUV-CMP (material usage variance—component)

MUV-WIP (material usage variance—work in process)

FLOORSTK (floor stock expense)

RLUV (run labor usage variance)

RBUV (run labor burden usage variance)

SLUV (setup labor usage variance)

SBUV (setup labor burden usage variance)

SUV (subcontract usage variance)

You can run this program in a non-update mode. In this case, the report is generated, but no database updates occur.

Generating Repetitive Reports

Table 10.3 lists reports on the Reports Menu, with a brief description of their purpose.

Table 10.3
Repetitive Reports

Report	Description
WIP Status Inquiry (18.22.12)	Displays quantities in the input, output, and reject queues for an operation.
WIP Status Report (18.22.4.11)	Generates a report of WIP queue quantities for all operations in selected cumulative orders. The report also shows the cumulative activities affecting each of the queue quantities, such as cumulative completed, scrapped, adjusted, rejected, reworked and moved to next operation.
Operation Transaction Inquiry (18.22.4.1)	Displays repetitive operation history records.
Scrap Analysis Report (18.22.4.3)	Displays percentages scrapped by reason code over an interval of time compared to the quantity completed in that interval.
Reject Analysis Report (18.22.4.4)	Displays percentages rejected by reason code over an interval of time compared to the quantity completed in that interval.
Rework Analysis Report (18.22.4.5)	Displays percentages reworked by reason code over an interval of time compared to the quantity completed in that interval.
WIP Adjustments Analysis Reports (18.22.4.6)	Displays WIP adjustments over an interval of time.
Cumulative Order Cost Report (18.22.4.10)	Displays all data related to costing captured in the cumulative order when it is created. It reports by operation the product structure and component costs, labor hours per operation, labor cost per hour, burden factors, yield factor, subcontract cost, and the group of costs.

Report	Description
WIP Valuation Report (18.22.4.13)	Reports the value of the WIP queues at the operation costs contained in the selected cumulative orders. Either the cumulative order operation standard costs, the cumulative order average costs, or the current GL standard operation costs can be used for valuation. You have the option to display cost elements.
Scrap and WIP Adjustments Valuation Reports (18.22.4.14 and 18.22.4.15)	Reports the value of material scrapped/ adjusted within an interval of time. The data can be sorted by either site and item or by descending value. Either the cumulative order operation standard costs, the cumulative order average costs, or the current GL standard operation costs can be used for valuation. You have the option to display cost elements.

Managing Subcontracting

Use Advanced Repetitive with other programs to manage subcontract operations.

- You can use supplier-scheduled orders to support repetitive purchasing of subcontract services.
- You can use subcontract shippers to create shipment paperwork and register the physical shipment of materials to the subcontractor.
- You can receive an advance ship notice (ASN) in electronic data interchange (EDI) format using EDI ECommerce to register the receipt of processed materials.

All of the processing that occurs prior to the subcontract operation uses standard Advanced Repetitive functions. The last operation reported just prior to the subcontract operation (milestone or non-milestone) must have Move Next Op set to No. This leaves the WIP in that operation's output queue. Items are then ready to be processed through the subcontract operation.

See "Subcontract Routings" on page 274.

Setting Up Scheduled Orders

You can handle the purchasing side of a subcontract operation through a supplier schedule. Create supplier-scheduled purchase orders using Scheduled Order Maintenance (5.5.1.13).

Tip
For purchase cost, enter the subcontract cost per item.

Set the ship-to site to the repetitive schedule site and create a line for the subcontract item with a line type of S (Subcontract). In the Work Order ID field, enter the cumulative order ID associated with the subcontract items. You can create cumulative orders manually in Cumulative Order Maintenance (18.22.6) or automatically in Backflush Transaction (18.22.13).

Set the item number on the scheduled order line to one of the following:

- The end-item number from the repetitive schedule
- The WIP item specified in the routing operation

Use WIP items to represent services being purchased; for example, HEAT-TREAT-SERVICE. Using WIP items helps ensure consistent pricing for subcontract services. Set up WIP items in the item master before entering them on supplier schedules.

After you create the scheduled order, update the end-item routing with the scheduled order and line numbers if you have not already done so.

Values on the supplier-scheduled order are used by PO Receipts, Supplier Schedule Update from MRP, and PO Shipper Receipt.

When you execute Schedule Update from MRP (5.5.3.1), the subcontract lines on the scheduled PO are processed. The system considers work order routing records (for released work orders) and routing records (for planned work orders) and collects operation demand data used to create an updated supplier schedule.

Shipping Subcontract Items

For more information on shippers and containers, see *User Guide Volume 2A: Distribution*.

You can use the functions on the Subcontract Shipping Menu (18.22.5) to record shipments to subcontractors. These programs create shippers in the same way as the container and shipper maintenance programs associated with sales orders and customer schedules. The major difference is in the Contents (Items) frame. Work Order ID, Operation, and Item replace Item, PO, Order, and Line. The Work Order ID and Operation fields identify a subcontract operation record on a cumulative order. The Item field identifies any component items used at the operation. If Item is blank, it represents the WIP material input at that operation.

Sub Container Maintenance

Use Sub Container Maintenance (18.22.5.4) to create containers for shipping the items to the subcontract supplier. The logic for creating subcontract containers is similar to the logic in customer and supplier schedules. The items placed into the container include the WIP item and any other components required at the subcontract operation.

You can delete containers one at a time in Sub Container Maintenance. To remove all unused container records by range of site and container number, use Container Delete/Archive (7.7.23).

See *User Guide Volume 2A: Distribution*.

Container maintenance is optional and is used only if you need to containerize your data.

Sub Shipper Maintenance

Use Sub Shipper Maintenance (18.22.5.5) to create shippers for shipping the items to the subcontract supplier. The shipper consists of either container items or WIP items and the components used at this operation that are also being shipped to the supplier. If WIP items are not being used, leave the item number blank to indicate that the item being shipped is the parent assembly.

Sub Shipper/Container Inquiry

Use Sub Shipper/Container Inquiry (18.22.5.6) to view shipper information. This program is virtually the same as the shipper and container inquiries in Customer Schedules, except that Work Order ID, Operation, and Item replace Item, PO, Order, and Line.

Sub Shipper Print

Sub Shipper Print (18.22.5.9) is similar to SO Shipper Print in Customer Schedules. For WIP Material, the WIP Item number entered in Routing Maintenance locates an item master item record. The description and weight fields for this item are used to print the shipper. The system also displays item and routing descriptions. Any component items entered on the shipper are also printed. The system prints the shipper number on the shipper.

If there is no WIP item number entered on the routing, the system displays the finished material item number.

Sub Shipper Issue

Confirm the shipper using Sub Shipper Issue (18.22.5.11). For the quantities identified in the subcontract shipper, the equivalent of a move transaction is performed from the output queue of the operation preceding the subcontract operation. If the preceding operation is a non-milestone, then non-milestone backflushing takes place for that operation and any other preceding non-milestone until the quantity requirement is either satisfied or another milestone operation is encountered.

For component material requirements of the subcontract operation, the system performs the equivalent of an inventory location transfer. Inventory is transferred from the site and location entered in the shipper to the cumulative order site and operation work center location, if there is a corresponding record in the location master. Otherwise, the inventory is transferred to the item default location.

Component materials are backflushed when you receive shipments back from the subcontractor using Purchase Order Receipts (5.13.1) or PO Shipper Receipt (5.13.20). If containerization is used, an unplanned issue of the container inventory is performed for container items.

Sub Shipper Delete/Archive

Use Sub Shipper Delete/Archive (18.22.5.23) to delete and/or archive subcontract shippers.

Receiving Completed Subcontract Items

Receive shipments from subcontractors using the functions on the Receipts Processing Menu (5.5.5) or Purchase Order Receipts (5.13.1). Any components associated with the subcontract operation are automatically backflushed.

For scheduled orders, create a shipper in PO Shipper Maintenance (5.5.5.5). Reference the item that is on the supplier schedule. Confirm the shipper using PO Shipper Receipt (5.5.5.11). This moves the WIP to the input queue of the next operation (if Move Next Op is Yes in the cumulative order routing), backflushes the components associated with that operation, and closes out the subcontract operation for that quantity. The appropriate GL transactions, transaction history records, and operation history records are generated.

Alternately, receive the purchase order using Purchase Order Receipts (5.13.1). This creates the same GL transactions and backflushes the components. With this approach, the purchase order does not need to be a scheduled order. You can create it using Purchase Order Maintenance (5.7) and use a line type of S (Subcontract) for each subcontract line.

Be aware of some restrictions when using these programs:

- The system attempts to backflush all possible components. However, lot- or serial-controlled items must be backflushed separately using Backflush Transaction.
- You cannot modify the component backflush list as you can in Backflush Transaction.
- If the subcontract operation is the last operation in a routing, the items are not transferred from the output queue to Finished Material inventory. Use Move Transaction for that task.
- These programs do not post subcontract usage variance. That is posted by Post Accumulated Usage Variances.

The system automatically locates the active cumulative order if the cumulative order recorded on the purchase order is expired. To locate the active cumulative order, it uses the item, site, operation, line, routing, and product structure code of the cumulative order in the PO detail record, along with the effective date of the transaction.

Therefore, receiving personnel do not have to enter the cumulative order ID and operation, as long as there is only one line, routing, and product structure code for the site and item being received against.

Chapter 11

Repetitive

The Repetitive module supports high-volume manufacturing where lead times are one day or less, WIP is complete at the end of each day, WIP costs are tracked and batches do not overlap, or WIP costs are insignificant or fairly constant.

This chapter outlines the differences between Repetitive and Advanced Repetitive functions. Refer to Chapter 10, “Advanced Repetitive,” for a full discussion of repetitive functionality in MFG/PRO.

Introduction

See "Distinctive Features of Advanced Repetitive" on page 263.

The Repetitive module provides many of the basic features of Advanced Repetitive, but differs in some significant respects:

- You can only post usage variances when you close a cumulative order.
- You do not have the same control over the assignment of start and end effective dates.
- You do not have as many options for reporting and tracking WIP throughout the life of the cumulative order. In addition, you cannot transfer WIP from an order that is being closed to a new order.
- You cannot report detailed information about scrap, reject, and rework quantities or enter multiple reason codes.
- Repetitive does not have the integrated support for managing subcontracting operations—from shipping to receiving.
- You can only report against milestone operations.
- Repetitive uses a consume forward or backward logic when completions exceed scheduled quantities. Advanced Repetitive always uses the earliest open schedule.
- Advanced Repetitive has additional utility programs that let you modify the quantity completed on a repetitive schedule and delete schedules as needed.

For details, see *User Guide Volume 11: PRO/PLUS*

Note The PRO/PLUS WIP Lot Trace (WLT) module affects some features of the Advanced Repetitive and Repetitive modules. If you are using the optional PRO/PLUS module, WIP Lot Trace is available as menu option 3.22.13. When activated, additional frames display in some programs. The discussion in this chapter assumes that WLT features are not active.

Setting Up Repetitive

Setup activities for Repetitive are almost exactly the same as for Advanced Repetitive. You need the same kind of base data such as items, sites, locations, employees, product structures, and routings.

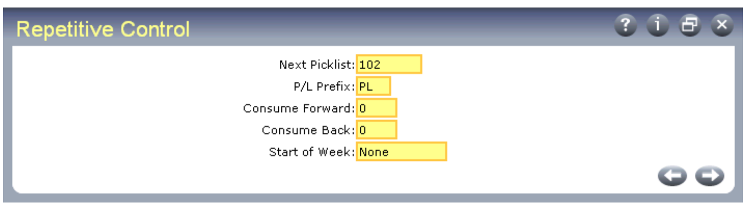
The programs used to set up production lines, allocation percentages, shifts, and changeover times are identical in both modules.

See "Setting Up Production Lines" on page 268.

Defining Control Program Settings

Settings in Repetitive Control (18.24) differ from those in Advanced Repetitive.

Fig. 11.1
Repetitive Control (18.24)



Next Picklist and P/L Prefix. Same as Repetitive Control (18.22.24) in Advanced Repetitive.

Consume Forward and Consume Back. These fields, in coordination with Start of Week, determine how the system handles item completions that exceed the quantity scheduled for a given day.

For more information, see "Reporting Completions" on page 316.

When Consume Back or Consume Forward is nonzero and you record more completions than scheduled, the system consumes open quantities on past schedules, then future schedules, based on the number of calendar days specified in these fields. Schedules with due dates before the day specified in the Start of Week field are not considered.

This process stops when all available schedule quantities are consumed or all excess completions have been recorded against a schedule.

For schedules with due dates in the past, the Consume Back value also determines which open quantities planning functions such as Material Requirements Planning (MRP) consider as sources of supply.

Start of Week. Enter the day of the week for the system to use in coordination with the Consume Back value:

- When searching for exploded schedules with past due dates on which to record excess item completions
- To determine which open quantities on past schedules to consider as sources of supply in planning functions such as MRP

Valid values are Sunday–Saturday, Today, and None.

To ensure that all completions are recorded only against scheduled orders for the current week, you can define control program settings as follows:

- Set Start of Week to the first day of your company's business week (typically Monday).
- Set Consume Back to 7.
- Set Consume Forward to 0 (zero).

Simulating Schedules in the Workbench

See "Simulating Schedules in the Workbench" on page 275.

Line Schedule Workbench (18.1.10) is exactly the same as the workbench (18.22.1.10) in Advanced Repetitive.

Creating and Exploding Repetitive Schedules

See "Creating Repetitive Schedules" on page 279.

These functions are almost identical in the two modules. Internally, the system processes additional information for Advanced Repetitive schedules, but the interface and input values are the same.

Using Repetitive Picklists

See "Using Repetitive Picklists" on page 282.

Picklist Menu (18.3) functions are identical in both the Repetitive and Advanced Repetitive modules.

Managing Cumulative Orders

Cumulative orders track repetitive activities in much the same way as in Advanced Repetitive. Cumulative orders can be added manually using Cumulative Order Maintenance (18.6). However, this function's primary purpose is to change the status of an existing cumulative order to Closed so that Cumulative Order Accounting Close (18.9) can be used. Cumulative orders should remain open for the periods used by accounting to monitor WIP costs. Procedures should be in place to ensure they are closed at the end of each fiscal month or period.

See "Managing Cumulative Orders" on page 287.

Executing Repetitive Transactions

Repetitive transactions provide feedback for repetitive operations. Like those in the Shop Floor Control module, they require use of an employee code. However, Repetitive Labor Transaction differs significantly from shop floor control transactions because it triggers inventory transactions to backflush components and receive completed units.

See Chapter 7, "Shop Floor Control," on page 137.

Operation Reporting

The reporting of setup hours, labor hours, downtime, reject quantities, rework quantities, and scrap quantities works much the same in Repetitive as in the Shop Floor Control module but with the following differences:

- The reason codes for nonproductive labor should use DOWNTIME instead of DOWN.
- Operation scrap can be reported in Repetitive but not in Shop Floor Control. Like the reporting of reject and rework quantities, scrap quantities have no impact on the general ledger and do not affect costing.
- Reports for reporting reject quantities are available in Repetitive.
- The Repetitive module includes some reports specific to that module.

Repetitive Completions

When a routing has many operations, there may be a few that are used to report completions, called milestone operations.

Milestone Operations

In Routing Maintenance (14.13.1), you can define any operation—including standard operations—to be a milestone. At a milestone operation, that operation and all previous non-milestone operations are backflushed when repetitive labor is reported. The last operation is always treated as a milestone.

The following rules govern reporting:

- You cannot report labor against a non-milestone operation.
- You can report setup, downtime, reject, and scrap against a non-milestone operation. However, this reporting does not affect WIP.
- If you report scrap or reject at a non-milestone operation, it will backflush at that operation.

If you do not report setup at non-milestone operations and report labor at milestone operations, the standard setup will be backflushed. If you report setup at the milestone operation, then no setup will be backflushed.

Reporting Completions

Completed units are received into inventory when quantities are reported as complete for the last operation for an item, using Repetitive Labor Transaction (18.14). Components can be backflushed when completed units are received if the components are linked to the last operation.

Note For each change in the quantity complete at a milestone operation, the quantity complete at all of the previous non-milestone operations is changed to reflect the fact that the later operation was completed.

If completions are recorded on nonscheduled dates, the reporting of quantities on these dates causes entries to be automatically added to the repetitive schedule.

If you report completions for today's date using Repetitive Labor Transaction, the report has the following effects:

- Inventory is incremented by the completion amount. A backflush occurs. Component inventory is shown as issued to the repetitive order. The requirements for components at all previous non-milestone operations are decremented. Floor stock items are accounted for.
- If there is a scheduled amount for today, the quantity completed is incremented and the quantity open decremented until the scheduled quantity is reached. These quantities can be reviewed in Operation Schedule Report (18.2.5).
- If there are previous non-milestone operations, the quantity completed at each previous operation is also incremented, up to the amount required to make the scheduled amount of the finished item.
- If the quantity open at the last operation is still nonzero, indicating the quantity completed is less than the quantity scheduled, the quantity open is treated as supply by MRP, and shown as the current amount of the planned order in MRP Detail Inquiry (23.16).

See Chapter 14, "Material Requirements Planning," on page 371.

The Consume Forward, Consume Back, and Start of Week settings in Repetitive Control (18.24) determine how the system handles item completions that exceed the quantity scheduled on a given day. For example, you may complete some items ahead of schedule or scrap fewer items than expected. When this occurs, the system follows these steps to record the excess completions against other exploded schedules:

See "Defining Control Program Settings" on page 313.

1. The system searches for a scheduled order routing with a start and due date range that includes the effective date of the repetitive labor transaction. If the system finds scheduled order routings that meet this criterion, it applies the excess completions to their corresponding schedules, starting with the schedule that has a due date closest to the reporting transaction effective date.
2. If excess quantities still remain after the previous step has executed, the system subtracts the number of days specified in the Consume Back field from the reporting transaction effective date. It then searches for exploded schedules with due dates that are between this day and the effective date. Schedules with due dates that are before the day specified in the Start of Week field are not considered.

Starting with the schedule that has the earliest due date, the system consumes open scheduled quantities until all available quantities are consumed or all excess completions have been recorded against a schedule.

Note When Start of Week is set to Today, the system does not consider the Consume Back value when searching for open schedule quantities to consume. Only the Consume Forward setting is used.

3 If excess quantities still remain after the system has consumed open quantities on past schedules, the system adds the number of days in the Consume Forward field to the reporting transaction effective date. It then searches for exploded schedules with due dates that are between this day and the effective date.

   Starting with the schedule that has a due date closest to the transaction effective date, the system consumes open scheduled quantities until all available quantities are consumed or all excess completions have been recorded against a schedule.

When Consume Back and Consume Forward are both 0 (zero), the system simply transfers excess completed quantities to inventory and does not report them against a repetitive schedule. This also occurs when the system runs out of open schedule quantities to consume.

Completed planned orders are not considered by MRP.

Repetitive Scrap Transaction

An item scrapped in the first operation may have a lower cost than one scrapped on receipt. It will not have the accumulated labor, burden, and additional material costs that accrue during subsequent operations.

Repetitive Scrap Transaction (18.18) reports scrap at the item's accumulated cost through the operation where it is scrapped. The system uses the standard cost created by the most recent use of Operation Cost Calculation (14.13.17). However, if no operation costs exist for the item/routing/cost set, Repetitive Scrap Transaction automatically rolls up and totals the material, labor, burden, and subcontract costs by operation. It also does this for scrap reported for alternate BOMs/routings not included in Operation Cost Calculation.

The item cost by operation can be reviewed using the Operation Cost Browse, (14.13.18) or the Operation Cost Report (14.13.19). After the scrap transaction is recorded, the scrap cost can be verified using the Repetitive Operations Accounting Report (18.4.10). Repetitive Scrap Transaction debits scrap and credits WIP for the operation cost multiplied by the quantity scrapped.

Chapter 12

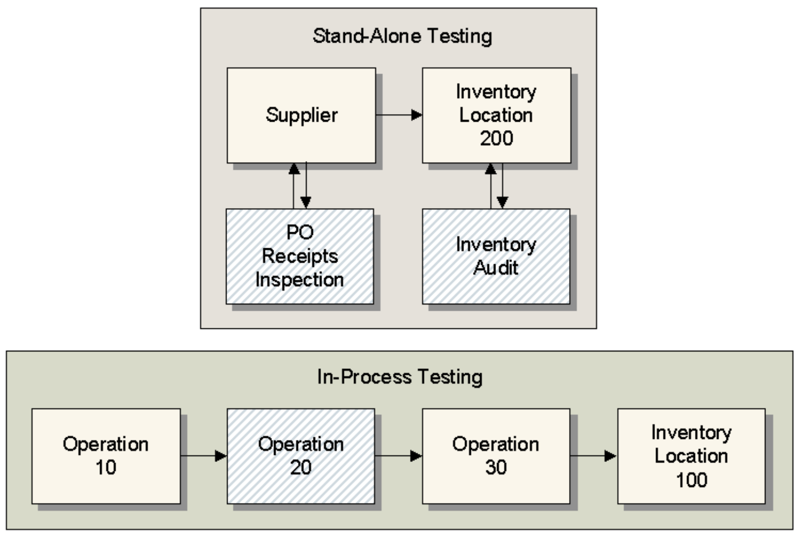
Quality Management

Quality Management supports testing of incoming material, finished products, and inventory; inspection of first articles, processes, and items in-process; and destructive testing.

Introduction

The Quality Management module (19) enables you to test incoming material, finished products, and inventory; inspect first articles, processes, or items in-process; and perform destructive testing. For all but in-process inspection, you manage quality with quality orders: documents that specify what is tested, how, and when. You can define specifications, test procedures, and inventory sampling, and record the results of testing.

Fig. 12.1
Inspection Methods



Testing is generally done in one of two ways:

- As a stand-alone task—at purchase receipt or at an inspection station. For this method, you create a quality order to control quantities and dates. The order provides authority to move inventory, perform work, and route items to various locations after the work is completed.
- As an operation within a work order or repetitive schedule routing. In this case, material is moved to a location where the quality tests are performed. Reporting occurs in the Shop Floor Control or Repetitive modules. For work orders without shop floor control reporting, use Test Results Maintenance (19.13) to record results.

Material that is spoiled, damaged, or made obsolete by an engineering change can be quarantined by changing its inventory status code in Inventory Detail Maintenance (3.1.1) to restrict inventory transactions.

Setting Up Quality Management

Before using Quality Management, set up appropriate control program values. Before you can report quality test results, you must define a quality document, called a *specification*. Test specifications control the testing process, describing each test step, the characteristic to be measured, the measurement tolerance, and the sequence for conducting tests.

If you have tests that apply to more than one item, you can define master specifications. These serve as templates for defining specifications for individual items.

If multiple steps are required for a stand-alone quality test, define them as a procedure in Procedure Maintenance (19.2.1).

You may also want to establish a sampling pattern. These define how items will be selected for testing if all items are not to be tested. The two options are lot intervals and number of days before expiration.

Setting Up Control Programs

Enter appropriate values in Quality Management Control (19.24). Most of the settings affect quality orders.

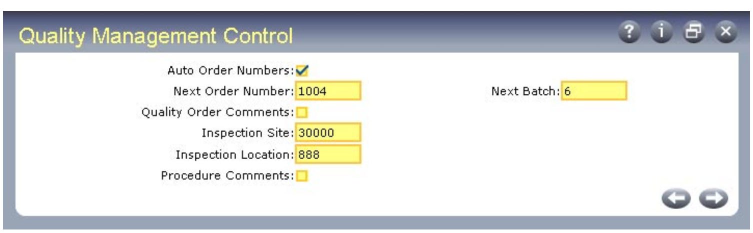


Fig. 12.2 Quality Management Control (19.24)

If you want quality orders to be numbered automatically, set Auto Order Numbers to Yes. The system then uses the Next Order Number and Next Batch when new orders are created.

Specify the default inspection site and location for new quality orders. Items being inspected are transferred from their current site and location to the inspection site and location specified on the order.

Defining Specifications

When a set of tests apply to more than one item, set up the specification in Master Specification Maintenance (19.1.1). A master specification is a list of index numbers, characteristics, specifications, and units of measure, and additional information entered as transaction comments.

You can include tolerances, or acceptable deviations from standard value. These specifications are used by quality orders and in-process inspection operations.

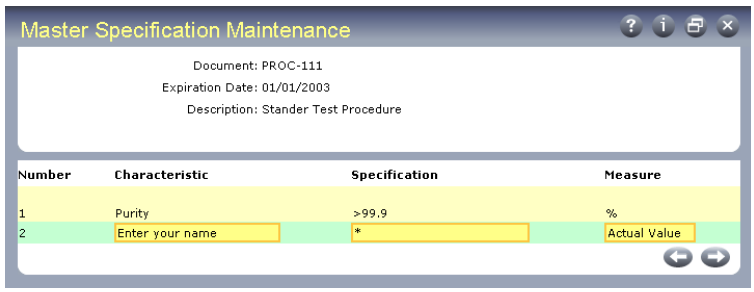


Fig. 12.3 Master Specification Maintenance (19.1.1)

The index numbers associated with characteristics and specifications must be unique but need not correspond to an actual test or inspection sequence.

Specification Values

A specification can take any of the following forms:

- A character string. This is a list of elements separated by commas. For example, if acceptable colors for an item are gray and black, the specification is gray, black.
- A numeric value with a tolerance. This is stated as a range, with minimum and maximum values separated by the pipe (|) character. For example, if the idle speed of an engine is 1000 +/– 150 rpm, the specification is 850 | 1150.

  You can also designate a range within a range. In the previous example, a range of +/– 50 rpm, together with a tolerance of +/– 150, is designated by the string 850 | 950 | 1050 | 1150. The system looks only at minimum and maximum values, but this format allows you to see the optimal range within a tolerance.

Tip
To generate the pipe character, press Shift-\.

- A comparative symbol (<, >, <=, or >=) and a numeric value. This type of specification provides a value against which a measurement is seen as less than, more than, less than or equal to, or more than or equal to. For example, if the acceptable weight for an item is less than 25 grams, the specification is entered as <25.
- An asterisk (*), indicating a wildcard value. This allows any value to be recorded and accepted, a useful feature for collecting data for failure analysis.

Tip
You can record the name of a tester by calling the first test *Name* and defining its specification as the wildcard. The first required test result is then the tester's name.

Defining Item Specifications

Use Item Specification Maintenance (19.1.13) to attach a set of specifications to a routing or quality control operation. You can use a master specification as a template. You can change and add to the information that comes from a master specification.

An item specification can list several characteristics and specifications, but only for a single item and a single operation. Also, a quality control operation is linked to only one item specification. Each specification can include any number of steps, indicated by the Number field.

If several item specifications are required to inspect an item, they must be spread out over several operations, one operation for each specification.

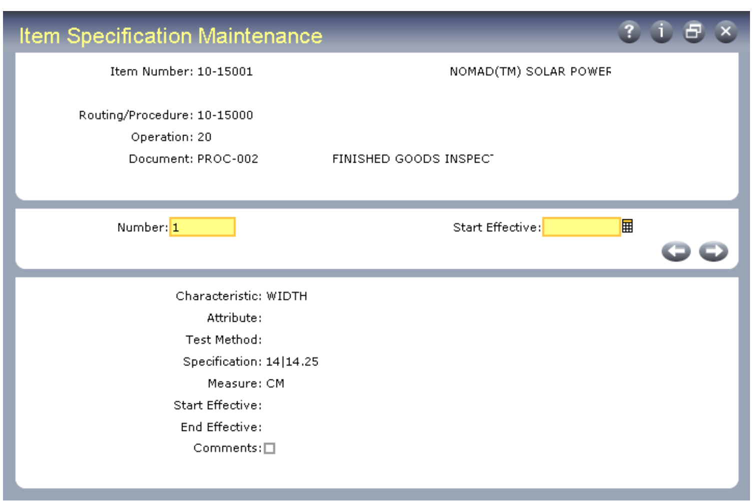


Fig. 12.4
Item Specification Maintenance (19.1.13)

If an item does not have a routing or procedure, you can still link it to a specification by leaving Routing/Procedure blank and Operation as zero (the default).

Use specifications to record information about sample size. For instance, you can set up an item specification with three test steps:

- One for sample size
- One for quantity accepted
- One for quantity rejected

See *User Guide Volume 6: Master Data* for information about the PCC module.

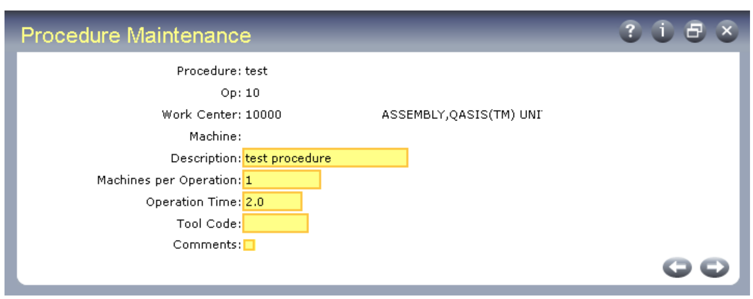
Item specifications can be maintained in the Product Change Control module. The effective date is used to phase in changes managed with product change orders.

Setting Up Procedures

See "Executing Stand-Alone Tests" on page 327.

A quality procedure consists of one or more operations—generally, inspection or testing operations—linked to a work center. Define quality procedures in Procedure Maintenance (19.2.1). Quality procedures are used by quality orders in the same way routings are used by work orders.

Fig. 12.5 Procedure Maintenance (19.2.1)



Tip
There is no integration between quality procedures and capacity requirements plan (CRP).

Operation lead time indicates the time, stated in decimal hours, this test operation normally takes. Operation time is independent of the number of units being tested. Make sure you enter it consistently as either time per unit or time per test batch.

You can link each operation of a procedure to one or more items in the Procedure Supplies pop-up frame. These items are consumed during testing or inspection, and are issued from inventory. They are not issued to WIP, but are treated as floor stock and expensed to cost of production when quality orders are processed.

Defining Sampling Patterns

Define sampling patterns for items in inventory in Sampling Pattern Maintenance (19.3.1). Patterns can be defined so that an audit selects inventory based on expiration dates or lot interval.

See "Inventory Audits" on page 332 for more details.

Days to Expire. Use this method for items with a limited shelf life, as defined in Item Master Maintenance (1.4.1). Enter a number of days to set an expiration date pattern.

For example, set Days to Expire to 7, then run Sample by Expire Days Inquiry (19.3.13) to see items that expire within seven days.

Lot Interval. Use this method for sampling items that are stored at more than one site or location *and* that are stored with lot/serial or lot reference numbers. Enter a value *n* to pick every *n*th lot from inventory.

For example, if there are 16 unique inventory records for an item and Lot Interval is 2, Sample by Lot Interval Inquiry (19.3.14) selects every second record, for a total of eight records.

Inventory selection based on a sampling is not automatically entered into a quality order. You must run Sample by Expire Days Inquiry or Sample by Lot Interval Inquiry to see which items are to be sampled.

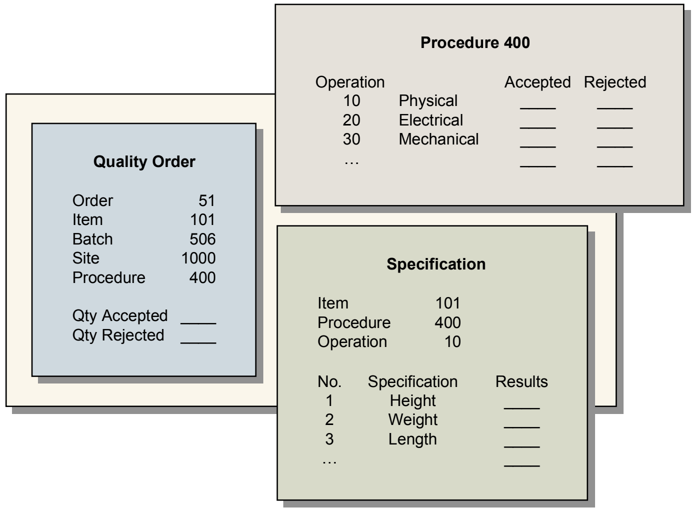
Executing Stand-Alone Tests

Use quality orders to conduct stand-alone inspections of incoming material or material already in inventory. A quality order authorizes a test or inspection and specifies how much to test, where, when, and how. After testing, enter results in Quality Order Results Entry (19.11).

The immediate effect of a quality order is to transfer material from its current inventory location to an inspection location at the same site. This is where the procedure designated on the quality order is run, and test results recorded. Quality orders link:

- The quantity of an item
- A set of testing procedures, and
- A set of test specifications for those procedures

Fig. 12.6
Quality Orders



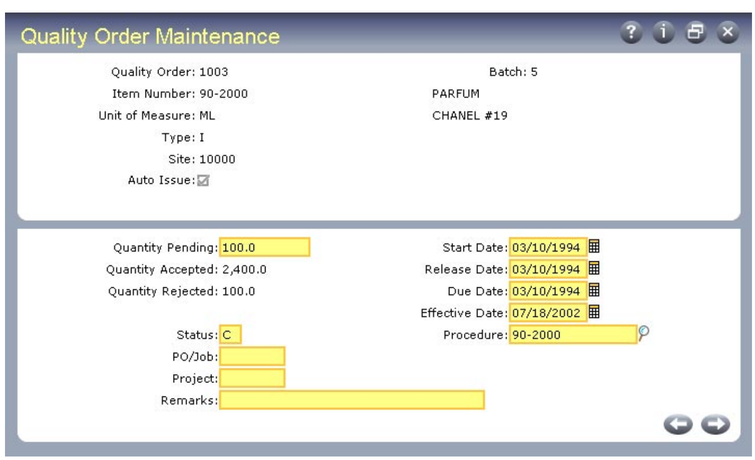
Tip
You must set Inspect to No in Item Planning Maintenance (1.4.7).

You can use quality orders to manage inspection of incoming materials. When material arrives at a receiving location, create a quality order to transfer the material to an inspection location. After inspection, the accepted material is transferred to inventory. Rejected material is issued from the inspection location and expensed using the product line Scrap account.

Creating Quality Orders

Create quality orders in Quality Order Maintenance (19.7).

Fig. 12.7
Quality Order Maintenance (19.7)



Type. Specify the type of testing to be done.

I (Inspection): The quantity to inspect is transferred to the inspection location specified in Quality Management Control. Any quantity rejected is issued from this location and expensed to the Scrap account. Quantity accepted is transferred back to regular inventory.

D (Destructive): The quantity to inspect is transferred to the inspection location, but both accepted and rejected quantities are issued and expensed to cost of production.

Site. This site defaults from the inspection site defined in Quality Management Control.

Auto Issue. Enter Yes to have supplies required for an inspection automatically issued. The quantity issued is the Quantity Per for the supply item, multiplied by the change in the quantity pending inspection. Enter No to have supplies issued during Quality Order Results Entry (19.11).

Tip
Supplies are specified in the associated procedure.

Quantity Pending. This is the quantity to be transferred to inspection. If the quantity pending is changed on a quality order, the difference is calculated and transferred, either to inspection or to inventory.

Quantity Accepted, Quantity Rejected. These quantities default from Quality Order Results Entry.

Effective Date. Enter the date the system should use for GL transactions. The system verifies that the date is in an open GL period.

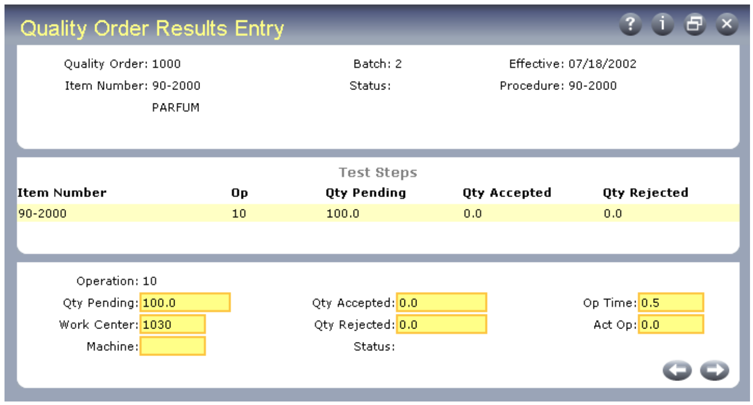
Status. The status of a quality order. Values are either blank, Open, or Closed. An order remains open until quantity pending is zero.

Procedure. A quality order can reference a procedure the same way a work order can reference a routing.

Entering Quality Order Results

Enter results of a test or inspection in Quality Order Results Entry (19.11). This program also moves material out of inspection and issues supplies required by inspection.

Fig. 12.8
Quality Order Results Entry (19.11)



You can record results for an order, for each operation on an order, or for each specification for an operation. For an order, you can record total quantity accepted and rejected. For an operation, you can record quantity accepted and rejected, actual time required for testing, and comments. For each specification, you can enter results and comments.

You can also change the quantity pending for an operation. You might do this if the quantity rejected at a previous operation results in units being scrapped, and thereby made unavailable for inspection at the current operation.

Deleting Quality Orders

If no results are entered for an order, you can change the quantity pending to zero and delete the order in Quality Order Maintenance. If dispositions or results have been entered, you can close the order and delete it with Quality Order Delete/Archive (19.23).

Conducting Process Inspections

When inspection occurs in process, work orders and repetitive schedules control the movement of material. Quality orders are not needed.

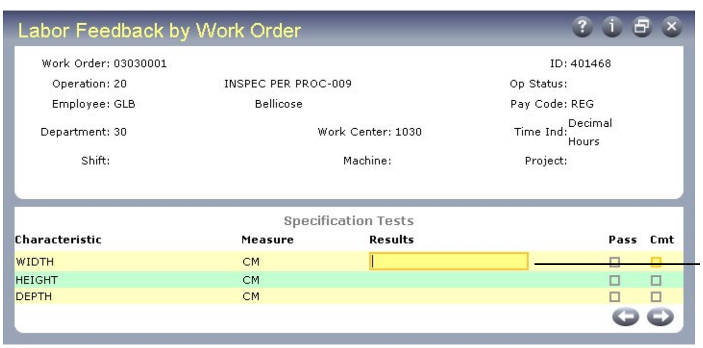
Process inspections are typically performed on a factory floor. You can do this by defining inspection operations in an item's routing in Routing Maintenance (14.13.1). These operations are linked to test specifications in the same way that test steps in quality orders are linked.

Reporting test results can be part of regular labor reporting. For work orders with routings, enter inspection results in:

- The labor feedback transactions in Shop Floor Control (17)
- For a repetitive schedule, in Repetitive Labor Transaction (18.14)
- For an advanced repetitive schedule, in Backflush Transaction (18.22.13)

For scheduled work orders or work orders without routings, enter test results manually in Test Results Maintenance (19.13). Results entered here are processed in the same way as in Quality Order Results Entry.

Figure 12.9 illustrates how test results are reported as part of labor feedback.



Enter the results while reporting labor for the inspection operation.

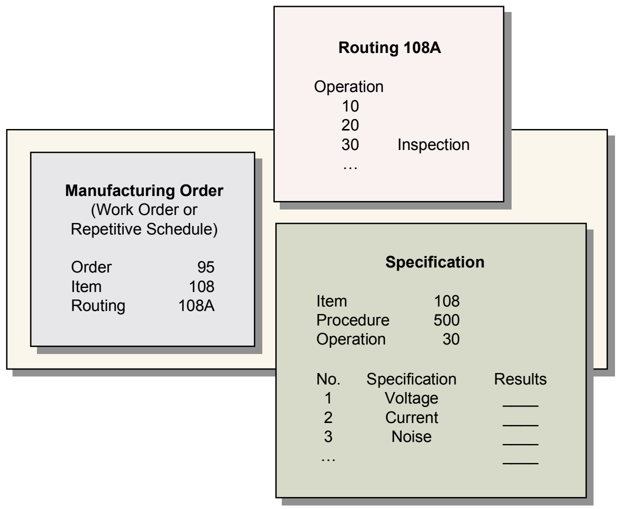
Fig. 12.9 Reporting Test Results in Labor Feedback by Work Order (17.1)

After you enter the quantities accepted and rejected for an operation, the system prompts you to record results and comments. The system compares your entry with the specification for the result. If the result is out of tolerance, a warning displays.

As with quality orders, you can enter only one result per specification. Enter additional information as comments. If you have several samples, you may want to enter the best, worst, or typical case for each group.

During inspection, process material remains in WIP. After an inspection is complete, material moves to the next operation. From the last operation the accepted material is received back into inventory and rejected material is scrapped. Figure 12.10 illustrates the process inspection.

Fig. 12.10
Process Inspection



Conducting Other Tests

You can use quality orders to conduct other specialized kinds of tests.

Inventory Audits

Material subject to an inventory audit is like material processed by incoming inspection. Both use quality orders, and material never leaves inventory. The difference is that material is selected from inventory for audit based on criteria such as expiration date or item.

See “Defining Sampling Patterns” on page 327 for more details.

Use inventory sampling patterns to determine which items are to be audited. Sampling is based on expiration dates or lot intervals. You can also use Inventory Detail Report (3.6.5) to identify inventory items based on expiration date, site, location, assay percentage or grade.

It is not always practical to move an entire lot from inventory for testing. As an alternative, you can test a sample and leave the remainder in inventory. To prevent these from being issued or transferred before results are available, change the inventory status to a code that restricts issues or transfers.

The quantity for a quality order must reflect the quantity of an item moved to inspection for testing. This quantity is the same as the lot size if an entire lot is moved to inspection, and it is the lot sample size if only a portion is tested.

First Article Inspection

First article inspections are used to qualify a machine, a tool, or the setup of a machine or tool by determining whether it can produce items within design limits. It is assumed that if a few items can be produced correctly, the machine or tool is set up properly.

First article inspection differs from regular inspection in that it examines a sample by comparing it to most, if not all, of the engineering specifications appropriate for a specific level of processing.

First article inspection and process validation can use either quality orders or in-process inspection. The selection depends on whether or not the units evaluated are obtained from a supplier or from an internal manufacturing process.

Process Validation

Process validation—an extension of first article inspection—is used to qualify a manufacturing process. Rather than use a single sample or unique lot, process validation requires one or more large batches, each of them a typical manufacturing lot. Samples from the beginning, middle, and end of production can be examined to determine the stability of a manufacturing process and its ability to consistently produce quality material.

Quality orders can handle process validations, since they record inventory transactions and allow unplanned issue of testing supplies.

Destructive Testing

On a regular quality order, the quantity subjected to destructive testing should be reported in Quality Order Results Entry (19.11) as rejected, regardless of whether it passed or failed. This causes the quantity to be issued from inspection and expensed to scrap.

The lot quantity subjected to destructive testing can have its own quality order with a type code of D. When results are entered, quantities accepted and rejected are issued from inspection and expensed to cost of production.

For process inspection, there is no special provision for destructive testing. If rejected or scrapped quantities exist at an inspection operation, they remain in WIP. Quantities are taken out of WIP when received or rejected by a work order receipt function or by Repetitive Labor Transaction (18.14) or Backflush Operation (18.22.13). Nonconforming components can be returned from WIP by processing a Work Order Component Issue (16.10) for a negative quantity.

Printing Test Results

Print test results for quality or manufacturing orders with Certificate of Analysis Print (19.20). An option to disregard the test results lets you print a certificate whether or not an order has passed all specifications. Printing certificates for materials that have failed to meet specifications provides a record when dispositioning non-conforming material. The certificate can be attached to the material and used as data entry to take the material out of inventory.

Chapter 13

Forecasting/Master Schedule Planning

This Forecast/Master Schedule Planning module lets you create and maintain shipment forecasts and master production schedules.

Introduction

Using functions in the Forecast/Master Schedule Planning module, you can calculate and record the number of units of a given item you expect to ship each week from a given site.

These forecasts are used to develop the master production schedule and drive material requirements planning (MRP).

Forecasts and master schedules can be created for any item, but are usually created for end items, critical subassemblies, and service parts.

Creating Forecasts

You can create shipment forecasts using one of the following methods:

See page 337.

- Use the forecasting simulation functions to calculate item forecasts using sales history data and the forecast method you specify.

See page 345.

- Use the CIM interface to load externally generated forecasts into forecast detail records in your database.

See page 354.

- Use Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2) to manually enter forecasts.

See page 346.

- Use the Demand Planner API to import forecasts from Demantra's Demand Planner application.

See page 348.

- Use Simulation-to-Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12) to create new forecasts based on existing forecasts.

Forecast Creation Work Flow

1. Create a criteria template.
2. Do one of the following to create a forecast detail record.
   - Run the simulated forecast calculation.
   - Manually enter a forecast generated outside of MFG/PRO.
3. Manually modify forecast detail records as needed.
4. Optionally copy or combine detail forecast records.

5 Generate reports to review the cost, price, and profit margin for monthly forecast quantities.

6 Load the detail forecast records into summary forecasts to become a source of demand for MRP.

7 If required, manually create forecasts or adjust quantities for forecasts generated by forecast simulation functions using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

8 Run MRP.

Forecasting Simulation

Forecasting simulation functions enable you to analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP), creating a closed-loop system.

Forecasting simulation functions generate forecasts based on shipment history. They use statistical methods and extrapolation techniques to evaluate underlying patterns in sales history data and predict future demand.

Forecasting assumes that historical sales patterns are repeated to varying degrees in the future. The accuracy of any forecast depends on the value of the sales information used to create it. The more sales history available, the more accurate the forecast.

Figure 13.1 outlines the flow of information in forecasting simulation functions.

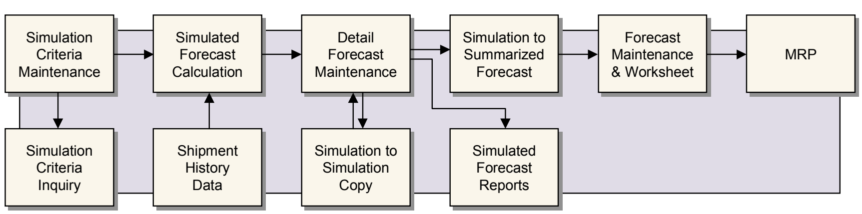


Fig. 13.1
Forecasting Simulation Information Flow

Forecasting Horizon

Forecasts generated using forecasting simulation functions are produced in monthly buckets. They can either be for a given year or for the next 12 months, beginning with the current month. The latter is called a *rolling forecast*.

To produce a forecast for a given year, you must specify a forecast ending year that is earlier than the forecast year. To produce a 12-month rolling forecast beginning in the current month, the ending year must be the same as the forecast year.

Note The system defines the first week of a new calendar year as the first Thursday in January, in accordance with ISO standards.

Setting Up Forecasting Simulation

Forecasting simulation programs analyze shipment history data in the customer-product sales history (cph_hist) table. For shipment history to post to cph_hist, Integrate with SA must be Yes in Sales Order Control (7.1.24).

Creating Criteria Templates

Producing a forecast begins with defining a criteria template. Criteria templates indicate which sales history to analyze and how the system should perform the forecast calculation. You can define criteria templates using Simulation Criteria Maintenance (22.7.1), or use Simulated Forecast Calculation (22.7.5) to define them at the time of forecast calculation.

Once you use a criteria template in a forecast calculation, you cannot modify it using Simulation Criteria Maintenance. However, you can modify previously used criteria templates when performing forecast calculations in Simulated Forecast Calculation.

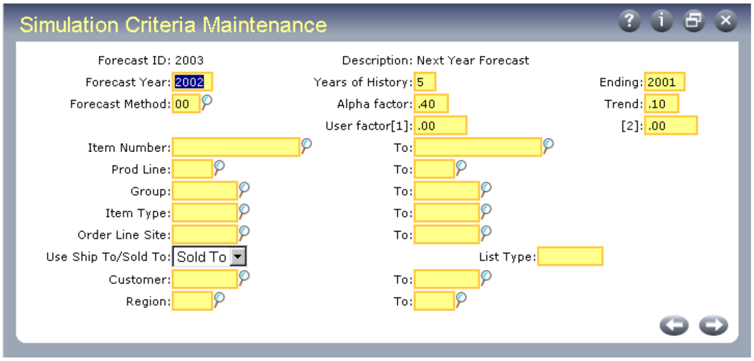


Fig. 13.2
Simulation Criteria Maintenance (22.7.1)

Forecast Year. For a rolling forecast starting this month, this year must be identical to the ending year.

See "Forecasting Horizon" on page 338.

Years of History. Specify the number of years of shipment history to analyze, up to five years. The system reduces this number if there are no sales data for a given year.

Ending. Ending year must be the same as or earlier than the forecast year.

Forecast Method. Specify either a predefined forecast method (01–06) or your own forecast method.

See "Forecast Methods" on page 341.

Alpha factor, Trend, User factor [1] and [2]. Specify weighting factors used by the forecast method.

See "Alpha and Trend Factors" on page 343.

Item Number, Product Line, Group, Item Type. Use these fields to identify a single item or range of items for which to forecast.

Order Line Site. Specify the order line site on sales orders or ship-from site on a customer schedule, used to further define items to forecast.

Use Ship-To/Sold-To. Indicate whether the system selects sales history to analyze based on the customer's ship-to or sold-to address.

Customer, Region, List Type. Use these fields to identify subsets of customers for which the system selects sales data to analyze.

Note When you specify both Ship-To and Region as criteria for selecting sales history data, only permanent ship-to addresses—that is, those defined in Customer Maintenance (2.1.1)—are in the selected region range.

Demand Patterns

Sales history can contain four underlying patterns of demand. Forecasting methods quantify these patterns.

Table 13.1
Demand Patterns

Pattern	Description	Example
Trend	Sales quantities increase or decrease over time.	The growth pattern of a new product.
Seasonal	Sales quantities fluctuate according to some seasonal factor, such as weather or the way a firm handles its operations.	Sales of soft drinks, which increase in the summer months.
Cyclical	This pattern is similar to seasonal, but the length is greater than one year. The pattern does not repeat at constant intervals and is the hardest to predict.	The sale of houses.
Horizontal	Sales quantities do not increase or decrease substantially.	A stable product with consistent demand.

Figure 13.3 shows examples of these demand patterns in graph format.

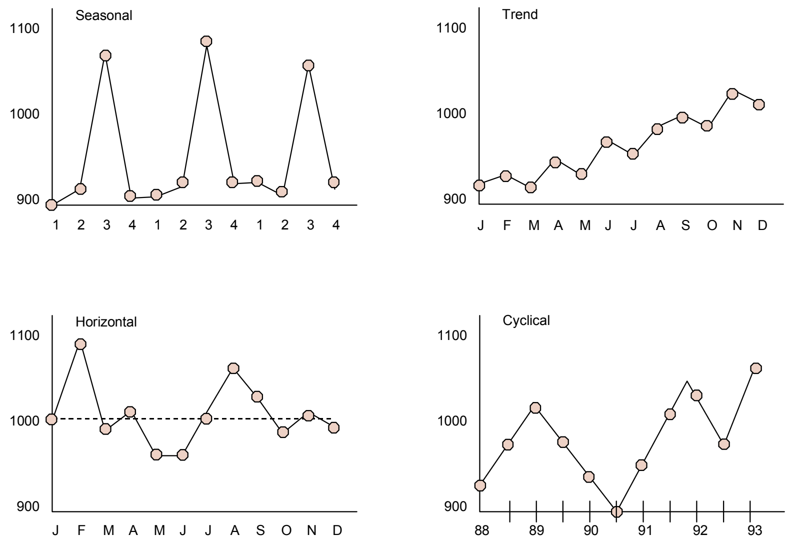


Fig. 13.3
Demand Patterns

Forecast Methods

Forecast methods are identified by two-digit method numbers. Table 13.2 lists the forecast method numbers available.

Table 13.2
Method Numbers

Method Number	Usage
00	Indicates that a forecast detail record was not generated by the system, but was created manually using the copy programs or using CIM interface.
01–06	Predefined forecast methods.
07–50	Reserved for QAD usage.
51–99	Use these numbers to identify your own forecasting methods.

There are six predefined forecast methods, described in Table 13.3. You can create additional methods using User Forecast Method Maintenance (22.7.17).

See page 343.

Table 13.3
Predefined Forecast Methods

Method #	Type	Description
01	Best Fit	Uses all predefined methods—02 through 06—and selects the results with the least mean absolute deviation. This is the default forecast method.
02	Double Moving Average	The simplest of the forecasting techniques. It uses a set of simple moving averages based on historical data and then computes another set of moving averages based on the first set. The moving averages are based on four months of data. This method produces a forecast that lags behind trend effects.
03	Double Exponential Smoothing	The most popular of the forecast techniques. It is similar to Double Moving Average, except that it uses the alpha factor to weigh the most recent sales data more heavily than the older sales data. This method produces a forecast that lags behind trends effects.
04	Winter's Linear Exponential Smoothing	Produces results similar to Double Exponential Smoothing, but incorporates a seasonal/trend adjustment factor. This method can be used to forecast based on sales history containing both trends and seasonal patterns. Uses the trend and alpha factors. Requires two years of history.
05	Classic Decomposition	Recognizes three separate elements of demand patterns in sales history: trend, seasonal, and cyclical factors. See Table 13.1 on page 340 for information about demand patterns. Classic Decomposition is usually the preferred method for forecasting seasonal, high-cost items. It requires at least two years of history.
06	Simple Regression	Also called the least squared method, this method analyzes the relationship between sales and time span to ensure that the forecast quantity is equally likely to be higher or lower than the actual quantity sold. Useful for products with a stable history, or horizontal demand pattern.

Table 13.4 shows each of the predefined forecast methods and indicates the sales patterns they are typically used to quantify, the number of years of shipment history required for calculation, and whether they use alpha and trend factors.

Table 13.4 Overview of Forecast Methods

	01	02	03	04	05	06
Cyclical					Yes	
Trend		Lags	Lags	Yes	Yes	
Seasonal				Yes	Yes	
Horizontal						Yes
Years of History	1	1	1	2	2–3	1
Trend Factor				Yes		
Alpha Factor			Yes	Yes		

Alpha and Trend Factors

Some forecast methods use alpha and trend factors to weight shipment history when calculating forecasts.

When method 03 or 04 is used to calculate forecasts, alpha factors determine the relative importance given to more recent sales history. For new products with rapidly changing sales quantities, you may want to enter an alpha value closer to one to give more weight to recent sales history. However, for products with long and stable sales histories, you might specify a smaller alpha value to produce smoother forecast results.

When method 04 is used to calculate forecasts, trend factors determine the relative weight given to sharp increases or decreases in sales history when calculating forecasts.

Table 13.5 shows the effects of alpha and trend factors on forecasting calculations. Alpha and trend values must be between zero and one.

Table 13.5 Alpha and Trend Factors

Factor	Zero	One
Alpha Factor	Equal weight on all history	Weighs recent history
Trend Factor	Ignores sharp changes in history	Weighs heavily sharp changes in history

Creating Additional Forecast Methods

Forecast methods identify the Progress program the system uses to calculate forecasts. Different programs employ different statistical methods.

You can create specialized forecast methods for the system to use in producing forecast quantities. User Forecast Method Maintenance (22.7.17) lets you add your forecast methods, in the form of Progress programs you supply, to the existing forecast methods.

The criteria template includes two variables that can be set to interact with your own forecast method: User factor1 and User factor2. These are reserved for your forecast methods and do not operate with any of the predefined methods.

For user-defined forecast methods:

- The name of the program must be `ffcalcXX.p` where `XX` is a forecast method number between 51 and 99.
- The Progress program must be written and accessible to MFG/PRO before you can define the method number in User Forecast Method Maintenance.
- Your Progress program must use an array named `calc[1-60]` for the historical data input and an array named `fcast[1-12]` for the calculated output.
- Your Progress program must include the following files at the beginning of the program: `fcalvar.i` and `ffvar.i`.

Compare your forecast method program to the existing programs `ffcalc[02-06].p`, as needed.

Calculating Forecasts

Run forecast calculations using Simulated Forecast Calculation (22.7.5).

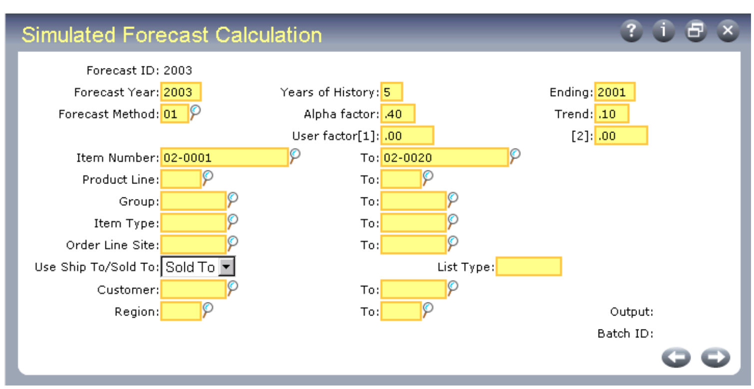


Fig. 13.4
Simulated Forecast Calculation (22.7.5)

Simulated Forecast Calculation analyzes an item's shipment history data and produces a forecast detail record that predicts what quantity of the item will be sold in the future.

This calculation requires a criteria template. You can either specify a criteria template defined in Simulation Criteria Maintenance (22.7.1) in the Forecast ID field or define a new criteria template at this time.

See "Creating Criteria Templates" on page 338.

When insufficient shipment history exists to generate a valid forecast for an item, the detailed forecast record for that item is created for a quantity of zero. Negative results also display as zero quantities.

Tip
At least one sales record is required to produce a nonzero forecast quantity.

Running Simulated Forecast Calculation generates sales predictions for each specified item for a one-year period. If you specify an entire product line, product type, or product group for which to forecast, each individual item is forecasted separately. Also included in the report are the number of items calculated and insufficient items—that is, items that lack enough historical data to generate an accurate forecast.

The calculated forecast quantities are stored in forecast detail records, identified by the forecast ID, year, and item. You can manually modify forecast detail records as needed.

Note You must enter forecast detail records created outside of MFG/PRO manually using Detail Forecast Maintenance (22.7.7) or load them into MFG/PRO using the CIM interface.

See "Manually Creating Forecasts" on page 345.

When you run a forecast calculation, any existing criteria templates or forecast detail records with the same forecast ID are automatically deleted.

Criteria templates used to calculate forecasts can be further modified only when doing another calculation using Simulated Forecast Calculation.

Manually Creating Forecasts

You can use Detail Maintenance Forecast (22.7.7) to manually create forecast detail records.

Note You cannot manually create a rolling forecast.

See *User Guide Volume 9: Manager Functions* for information about the CIM interface.

When loading forecast results using the CIM interface or manually entering forecasts using Detail Forecast Maintenance, you must specify a forecast ID, year, and item number. The system automatically sets the forecast method to 00 and generates a criteria template, which is stored under the same forecast ID as the detail record.

Creating Forecasts with Demand Planner

If you use Demand Planner from Demantra Ltd., you can use the Demand Planner application program interface (API) to export master data and sales order history data from MFG/PRO, import it into Demand Planner, and generate a forecast for export to MFG/PRO.

Use programs on the Demand Planning menu (36.5.9) to set up and exchange data with Demand Planner.

Modifying Forecast Results

Forecast quantities may require modification to be more reflective of future market demand. This is especially true when forecast results are based on historical data that included unprecedented sales—for example, sales due to a sales promotion or a natural disaster. When you believe that future demand will not be similar to sales history, you can adjust existing forecast detail records accordingly.

Note Modify forecast detail records as needed *before* copying forecast quantities to the summary forecasts used by MRP.

You can use Detail Forecast Maintenance (22.7.7) to modify forecast detail records produced by forecast calculations or loaded into the system using the CIM interface.

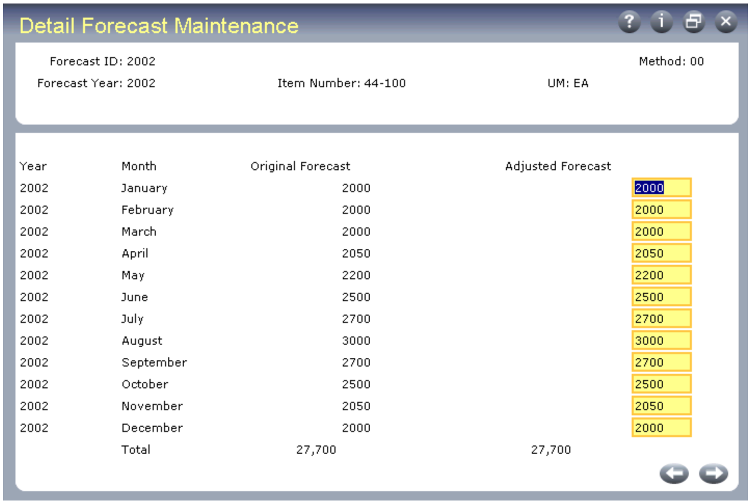


Fig. 13.5
Forecast Detail Maintenance (22.7.7)

Select a forecast detail record to modify by specifying a forecast ID and forecast year. To select a forecast detail record created for a product group, you must also specify an item number.

Forecast detail records display in three columns:

- Month
- Original Forecast
- Adjusted Forecast

The quantities in the Orig. Fcst column are the original forecast quantities, either the result of the system forecast calculation or the original quantity you manually entered or loaded.

You can modify the forecast as needed by changing the quantities in the Adjusted Forecast column.

Warning All changes to forecast detail records are permanent. To reproduce original forecasts, you must rerun the forecast calculation. Before modifying forecast detail records, you should archive the original forecast or copy it to another forecast ID.

Copying and Combining Forecasts

To create new forecasts by copying or combining existing detail records, use Simulation to Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12).

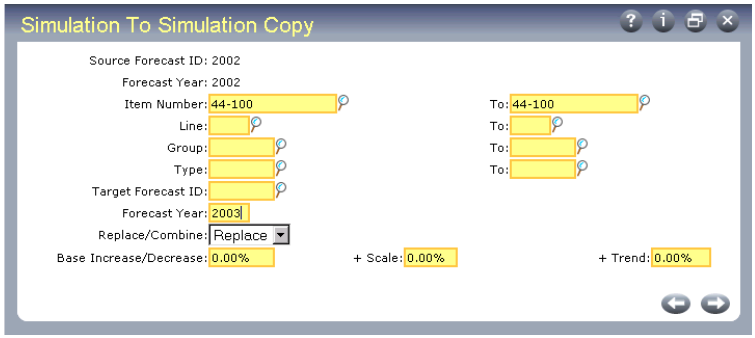


Fig. 13.6 Simulation to Simulation Copy (22.7.11)

These functions let you copy, replace, or combine forecast detail records. With Simulation to Simulation Copy, you can copy forecast records for multiple items in a single transaction, whereas with Single Item to Simulation Copy you can copy only for a single item.

See “Modifying Forecast Results” on page 346.

Note To manually adjust forecast detail records created using these functions, use Detail Forecast Maintenance (22.7.7).

Multipliers

When copying or combining forecast detail records using Simulation to Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12), you can apply multipliers to the resulting forecast quantities. Multipliers, also called multiplicative factors, allow you to increase, decrease, or scale forecast quantities by a specified percentage. Multipliers can be useful when you have prior knowledge of an unscheduled demand, such as a future sales promotion.

There are three types of multipliers:

- Base Increase/Decrease
- Scale
- Trend

In Single Item Simulation Copy, multipliers let you scale the forecast results for a new item as some percentage of an old item. This is useful when you want to match the seasonal demand, but not the quantity, of an old item for a new item.

Simulation to Simulation Copy lets you apply multipliers to a range of items.

Base Increase/Decrease. The percentage by which a forecast quantity is increased or decreased. A negative percentage indicates that the quantity is decreased.

Table 13.6
Base Increase/ Decrease Multiplier

Month	Units	10%	–10%
January	100	110	90
February	150	165	135
March	120	132	108

Scale. The percentage by which a forecast quantity is multiplied, or scaled. This value cannot be negative.

Table 13.7
Scale Multiplier

Month	Units	10%	–10%
January	100	10	n/a
February	150	15	n/a
March	120	12	n/a

Trend. The percentage by which a forecast quantity increases each month. A negative percentage decreases the quantity over time.

Table 13.8
Trend Multiplier

Month	Units	10%	–10%	
January	100	110	90	= 100 +/– (100 * 10%)
February	150	180	120	= 150 +/– (150 * 20%)
March	120	156	84	= 120 +/– (120 * 30%)

You can use more than one multiplier at a time. The effect of multiple factors is cumulative. Base Increase/Decrease is applied first, Scale second, and Trend third.

When you are replacing an existing detail record and apply multipliers to the source quantities, the results overwrite the quantities in the target detail record.

When you are combining records and use a multiplier, the multiplier is applied to the source quantity and the result added to the target quantity. The factor is *not* applied to the combined source and target quantity.

Simulation To Simulation Copy

Use Simulation to Simulation Copy (22.7.11) to copy an existing forecast detail record to another forecast ID or to combine several forecast detail records into a single detail record.

To use this function, you must specify a source forecast ID identifying the forecast detail record to copy to or combine with the target record, and a target forecast ID identifying the forecast detail record to which the source information is copied. A criteria template must exist for the specified source forecast ID.

The target forecast ID you specify does not need to correspond to an existing forecast detail record or criteria template. If a corresponding record does exist for the specified target ID, its forecast method must be 00. If no such record exists, the system creates a target forecast detail record with a method of 00.

If you want to copy detail records for a subset of the items in the source record, you can also specify an item range to be copied.

Note If the item ranges for the target and source records differ, then the target record's range is expanded.

The system combines or copies forecast records only in terms of item units. The Combine/Replace field indicates whether to replace the target forecast quantity with the source quantity or combine the target and source quantities. When you combine forecast quantities, the quantity for an item in the source detail record is added to the quantity for that item in the target detail record. When you replace forecast quantities, the quantity for an item in the source record replaces the quantity for that item in the target detail record.

Note You cannot separate combined forecast records.

See "Multipliers" on page 348 for details.

You can increase, decrease, or scale the resulting detail record, or multiply the detail record by a trend factor.

Using this function to copy or combine forecast detail records automatically deletes the original, or target, forecast record and replaces it with the copied or combined record. The source detail record and criteria template remain unchanged.

Single Item Simulation Copy

Single Item Simulation Copy (22.7.12) enables you to create a forecast for a single item based on the historical sales data for another item. Since there is often little or no sales history for new items, you may want to use the demand history for a similar product to produce forecasts for a new product.

Note If the Target Forecast ID, Item Number, or Forecast Year fields are left blank, the system sets them to the target values.

You must specify an item number to copy from the source detail record. This item must exist in the item master.

Forecast records are copied only in terms of units. The source and target items must have identical units of measure, or a unit of measure conversion must exist.

If the specified target forecast detail record already exists in the system, its forecast method must be 00. If the target does not exist, the system creates a forecast detail record with a method of 00.

When copying forecast records, forecast amounts can be multiplied by a Base Increase/Decrease, Scale, or Trend factor.

See "Multipliers" on page 348.

During a combine or replace, the original target forecast record and criteria template are overwritten. The source record is not altered.

Generating Reports

The system does not generate forecasts in currency values. However, Detail Forecast Report (22.7.9) lets you review forecast quantities along with the production cost and sales price by month. You must specify the cost set, site, price list, and currency in which to display the monetary amounts.

If both the cost and price are in the same currency, the report displays the profit margin, calculated as price minus cost. The number of units, the extended cost value, and the extended price value are also totaled for the entire 12-month reporting period.

Table 13.9 illustrates a sample forecast report, assuming the forecasted item has a unit cost of $15.36 and a unit price of $25.00.

Table 13.9
Sample Forecast Report

Forecast ID	Year	Item No.	Mo.	Units	Ext Cost	Ext Price	Margin
j205095	2002	j2050	Jan	1336	20,520.96	33,400.00	12,879.04
			Feb	1568	24,084.48	39,200.00	15,115.52
			Mar	1839	28,247.04	45,975.00	17,727.96
			Apr	1970	30,259.20	49,250.00	18,990.80
			May	2182	33,515.52	54,625.00	21,109.48
			Jun	1995	30,643.20	49,875.00	19,231.80
			Jul	2003	30,766.08	50,075.00	19,308.92
			Aug	2134	32,778.24	53,350.00	20,571.76
			Sep	1984	30,474.24	49,600.00	19,125.76
			Oct	1781	27,356.16	44,525.00	17,168.84
			Nov	1634	25,098.24	40,850.00	15,751.76
			Dec	1457	22,379.52	36,425.00	14,045.48
			Total	21883	336,122.88	547,075.00	210,952.12

Making Forecast Data Visible to MRP

See Chapter 14, “Material Requirements Planning,” on page 371.

Forecasts generated using forecast simulation functions or loaded into forecasting simulation functions using the CIM interface are stored in forecast detail records, whereas MRP uses summary forecast records to drive its demand calculations.

Use Simulation to Summarized Forecast (22.7.13) to load forecast quantities into the summary forecast records used by MRP. This program uses the forecast detail records to create new summary forecast records, replace old summary records, or combine with existing summary forecasts.

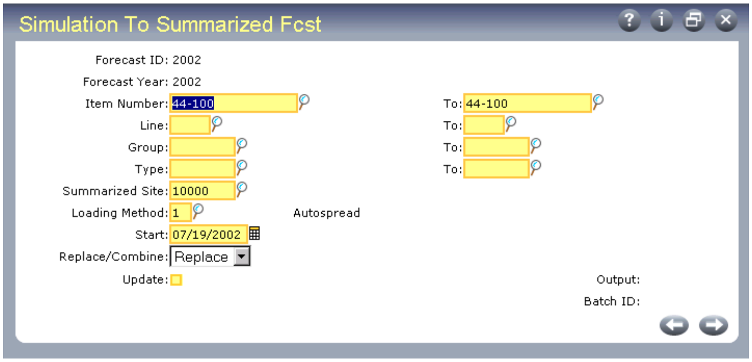


Fig. 13.7 Simulation to Summarized Forecast (22.7.13)

Forecast detail records are identified by forecast ID, year, and item, whereas summary forecast records are identified by item, site, and year.

Since MRP is site-specific, you must specify a summary site to update. This site may be different from the order line site specified on the criteria template. When a forecast is for a group of items, you can generate summary forecast records for one item, a subset of items, or all items in the detail record.

See “Creating Criteria Templates” on page 338.

Forecast detail records are copied to summary forecasts only in terms of units.

Note You can combine multiple detail records into one summary forecast, but this is not recommended, since the combined result is not a valid forecast.

Updates to the summary forecasts are permanent and cannot be undone. You should run Simulation to Summarized Forecast in report mode before performing the update.

You can manually modify summary forecast quantities as needed, using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

See page 354.

Loading Methods

When loading forecast detail records into summary forecasts, you can specify one of three loading methods that the system uses to break the monthly forecast quantities into the weekly quantities used by MRP.

The three loading methods are:

- *Autospread (1).* Monthly forecasts are broken into daily averages and summed into weekly buckets starting on Monday. Unless the day that you are loading forecast is a Monday, the loaded forecast begins on the following Monday. This is the default loading method.
- *Load Last Week (2).* Monthly forecast is loaded into the last Monday of the forecast month.
- *Load First Week (3).* Monthly forecast is loaded into the first Monday of the forecast month.

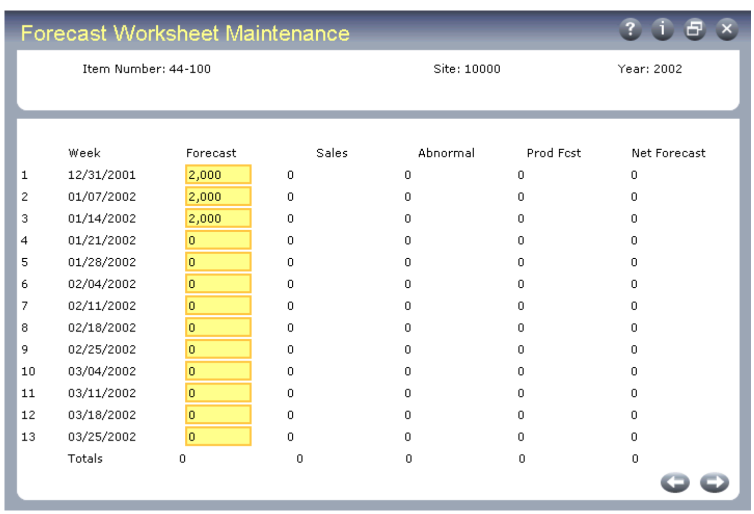
Deleting and Archiving Forecasting Detail Records

Use Detail Forecast Delete/Archive (22.7.23) to delete forecasting detail records or archive them to file as needed. You can also delete and archive criteria templates.

Maintaining Forecasts Outside of Forecast Simulation

If you need to manually enter or modify item shipment forecasts outside of forecasting simulation functions, use Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

Fig. 13.8
Forecast Worksheet Maintenance (22.2)


Forecast Worksheet Maintenance

Item Number: 44-100 Site: 10000 Year: 2002

	Week	Forecast	Sales	Abnormal	Prod Fcst	Net Forecast
1	12/31/2001	2,000	0	0	0	0
2	01/07/2002	2,000	0	0	0	0
3	01/14/2002	2,000	0	0	0	0
4	01/21/2002	0	0	0	0	0
5	01/28/2002	0	0	0	0	0
6	02/04/2002	0	0	0	0	0
7	02/11/2002	0	0	0	0	0
8	02/18/2002	0	0	0	0	0
9	02/25/2002	0	0	0	0	0
10	03/04/2002	0	0	0	0	0
11	03/11/2002	0	0	0	0	0
12	03/18/2002	0	0	0	0	0
13	03/25/2002	0	0	0	0	0
	Totals	0	0	0	0	0

Forecast quantities entered using these functions display in weekly buckets and appear as a demand requirement for the Monday of that week.

To create new item forecasts for a given site and year, enter expected weekly shipment quantities expressed in the item's unit of measure.

You should forecast at least as many weeks as are required to cover the cumulative lead time of the item, which is the maximum time it takes to produce that item if none of its lower-level components are in stock. Forecasting an item based on cumulative lead time ensures sufficient time to respond to changes in the requirements for that item.

Note Shipment forecasts do not represent the quantity of incoming orders, but rather the quantity expected to be shipped during a one-week period.

Forecast Worksheet Maintenance (22.2) includes the following display fields:

Forecast. The shipment forecast for a given week.

Sales. The quantity of an item on confirmed sales orders and required ship schedules to be shipped this week.

Abnormal. Confirmed sales for this week that should not consume forecast.

See page 356.

Production Forecast. A system-calculated forecast quantity used in multilevel master scheduling.

See page 362.

Net Forecast. The total forecast quantity seen as demand by MRP.

See Chapter 14.

Consuming Forecasts

MRP and master production scheduling use shipment forecasts to calculate net forecasts. This is done by consuming the forecast—that is, subtracting sales order demand from the shipment forecast. MRP and master production scheduling then use the calculated net forecasts to determine gross item requirements.

See Chapter 14, “Material Requirements Planning,” on page 371.

Sales Order Demand

Sales order demand is the quantity of an item sold, as recorded on confirmed sales orders or required ship schedules. The system recognizes item quantities ordered as demand when a sales order has been confirmed—that is, Confirmed is Yes in Sales Order Maintenance (7.1.1) or a customer planning or shipping schedule has been changed to a required ship schedule using Required Ship Schedule Update (7.5.5) or Selective Required Ship Schedule Update (7.5.6).

Note Confirmed issue lines on service return material authorizations (RMAs) and material order lines (MOs) in the Customer Services module are treated like sales order lines.

Sales order demand consumes shipment forecasts based on the item number, site, quantity, and due date recorded on the sales order or customer schedule.

Abnormal Sales Demand

Sales order demand is considered abnormal if the quantity or source of demand is not characteristic of quantities anticipated by the current forecast and it should not be used to plan forecasts in the future.

You can designate sales order demand as abnormal by setting the Consume Forecast option to No for that sales order or customer schedule line. Abnormal sales demand is added to the net forecast rather than being subtracted from the shipment forecast.

Net Forecast Calculation

Master production scheduling and MRP use the net forecast and abnormal sales order demand to calculate total demand. The net forecast is calculated as follows:

Net Forecast = Forecast – Sales Order Demand

Note When the shipment forecast is oversold—that is, the quantity sold exceeds the forecast amount, the net forecast will not go below zero.

Forward and Backward Forecast Consumption

Typically, shipment forecasts are more accurate over a month than over a week. You can lessen the effects of inaccurate forecasts using forward and backward consumption.

Confirmed sales order and required ship schedule quantities automatically consume forecast in the week they are due. However, if there is no remaining unconsumed forecast for that week, the system can be set to consume remaining forecast quantities for a number of weeks before or after that week.

You can specify the number of forward and backward weeks over which to consume using the Consume Forward and Consume Back fields in Sales Order Control (7.1.24). The system consumes forecast first by going back, then forward, one period from the original forecast period. Consumption continues alternately backward and forward until the specified number of previous and future periods is exhausted. If there are sales quantities still left over, MRP recognizes them as additional demand.

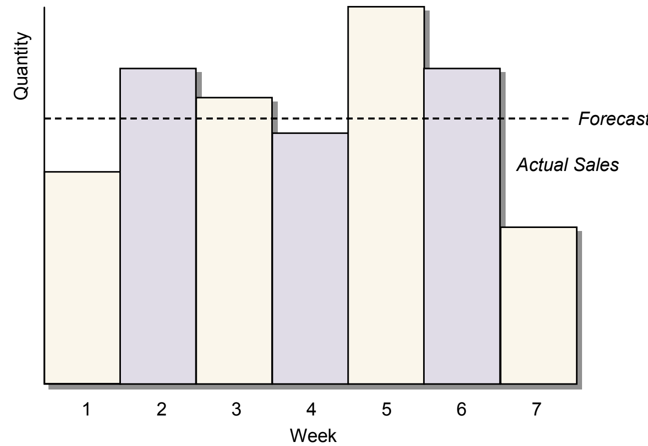
MRP and master schedule planning recognize prior period unconsumed forecast as demand for the number of weeks specified in Consume Back.

If the Consume Back and Consume Forward values change, the system automatically recalculates the net forecast based on the changes.

Figure 13.9 shows an example for which the Consume Forward and Consume Back values in Sales Order Control are both 2 weeks.

- Excess sales in week 2 consume the forecast in week 1.
- Excess sales in week 3 consume the forecast in week 4, then week 1.
- Excess sales in week 5 consume the forecast in week 4, then week 7.
- Excess sales in week 6 consume the forecast in week 7.

Fig. 13.9
Forecast Consumption



MRP and Prior Period Forecasts

When you set up the system to consume forecast in previous periods, MRP recognizes prior period unconsumed forecast as additional demand in the current period. When this occurs, you can:

- Delete the forecast for prior periods.

  This assumes that if the forecast was not fully consumed for a prior period, it was faulty and should not be considered additional demand for the current period. Use this approach to avoid manufacturing excess inventory for items for which demand will not be generated in the near future.

- Make no changes to the prior period forecast.

  This assumes that unsold inventory will be shipped to fulfill future demand exceeding the current, and possibly future, forecast.

- Update the forecast for future periods.

  When prior period forecasts are undersold, you can revise forecasts for future periods to reflect the difference.

Master schedulers typically use a combination of these techniques. For example, past due forecasts may be maintained for four weeks and then deleted, whereas forecasts for future periods may be reviewed and updated once a month.

Creating Master Production Schedules

Master schedulers use detailed forecasts to determine what to produce, when to produce it, and in what quantities. These three things define a statement of production that becomes the master production schedule (MPS).

Master Scheduled Items

Master schedule items are typically end items, critical subassemblies, spares, service items, critical components, or key resources.

To define an item as master scheduled, set Master Schedule to Yes for that item in Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17) for multisite environments.

Approaches to Master Scheduling

There are several possible approaches to creating and managing master production schedules, each allowing a different amount of control by the system:

- Fully automatic
- Fully manual
- Computer-assisted

Fully Automatic Scheduling

The master schedule can be generated entirely by MRP. This means that the system has complete control over master scheduled items, with no distinction between master scheduled and MRP items.

See Chapter 14, "Material Requirements Planning," on page 371.

Note When this approach is used, material plans may change dramatically each time MRP is run. For example, a master schedule order may be expedited one day and canceled the next.

To use the fully automatic approach to master scheduling items, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. Yes.

Order Policy. Any option other than blank.

Fully Manual Scheduling

See Chapter 14, “Material Requirements Planning,” on page 371.

The master schedule can be created and maintained entirely by a master scheduler, who enters firm planned orders using Master Schedule Order Maintenance (22.13) or Work Order Maintenance (16.1). MRP can be set up to generate action messages to assist the master scheduler in creating orders for master scheduled items.

To have MRP review master scheduled items and produce action messages, but not plan orders, for those items, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. No.

Order Policy. Any option other than blank.

Note If an item’s Order Policy is blank, MRP does not generate action messages for that item.

Computer-Assisted Master Scheduling

See Chapter 14, “Material Requirements Planning,” on page 371.

By defining time fences for master scheduled items, you can let MRP control orders outside of a specified time period and allow the master scheduler to control orders within that time period. To use this approach to master scheduling, specify a planning horizon, in calendar days, for each master scheduled item in the Time Fence field in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). When MRP plans orders for these items, it will not schedule order due dates within this time fence.

Note The time fence for an item should generally be equal to the cumulative lead time for that item.

To use the computer-assisted approach for master scheduling, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. No.

Order Policy. Any option other than blank.

Time Fence. The cumulative item lead time.

Selective Materials Plan

Selective Materials Plan (23.3) lets you plan master scheduled items separately from MRP items. If you use the computer-assisted approach to master scheduling, you may want to run Selective Materials Plan as follows.

1. Run Selective Materials Plan for master schedule items only.
2. Adjust the master schedule and rerun Selective Materials Plan as needed.
3. Run Selective Materials Plan for MRP-scheduled items only.

Available-to-Promise

Available-to-promise (ATP) is the uncommitted portion of inventory or planned production available to be promised to new sales orders. The system displays ATP quantities on master schedule reports and inquiries.

ATP can be used to verify whether a sales order can be filled within a specific time frame given other demands and currently scheduled supply orders. By setting ATP Enforcement to Yes in Sales Order Control (7.1.24) and associating an ATP enforcement level with individual items, you can have the system check ATP during order entry and display a warning or error message when ATP is inadequate for the due date.

See *User Guide Volume 2A: Distribution* for information on ATP processing.

The system calculates ATP by time period by deducting real demand from real supply. Real demand includes requirements for work order components, sales orders, and required ship schedules, but excludes forecast and production forecast. Real supply includes quantity on hand, purchase orders, work orders, and repetitive schedules. A net decrease in demand increases ATP, while a net increase in demand decreases ATP.

See page 367.

Note The system regards seasonal build quantities as real demand.

The system performs the following calculation for each date when a Master Scheduled receipt is due or a seasonal build quantity is made available, causing a net increase in supply. It takes into account all sales order and required ship schedule demand and gross requirements up to the next increase in available supply.

Master Scheduled Receipt – Sales Orders and Required Ship Schedules – Gross Item Requirements – Seasonal Build Net Increases + Seasonal Build Net Decreases = ATP

When demand exceeds supply, ATP for that period is zero. The system applies excess demand as real demand in the following order:

- Excess demand is applied against the ATP quantity for previous periods until all excess demand is eliminated or the ATP quantities for previous periods are exhausted.
- If demand exceeds supply after prior-period ATP is consumed, the system consumes future-period ATP until demand is satisfied or all supply is exhausted.
- When both past and future ATP is exhausted, the system displays a negative ATP quantity for first period.

See "Generating Master Schedule Reports" on page 368.

ATP and the master schedule are bucketless because they are calculated using dates rather than fixed periods. However, master schedule report functions let you report ATP quantities in monthly, weekly, daily, or GL calendar period buckets.

Multilevel Master Scheduling

Sometimes, demand for one item is dependent on demand for another item. This is typical in assemble-to-order environments where it is unrealistic to stock all of the possible combinations of end items included in the selection of available models and options.

In these cases, it is impossible to accurately forecast all of these possible combinations for master production scheduling purposes. Instead, you can forecast items at the family-item and planning or option-item levels. Multilevel master scheduling enables you to perform this type of forecasting for planning purposes.

Planning Bills

You can establish the relationship between family-level items and component items by defining planning bills in Product Structure Maintenance (13.5) or Formula Maintenance (15.5). These are identified with a structure type of P (planning).

Usually, the top-level item of a multilevel master schedule product structure, or planning bill, represents the entire group, or family, of products that can be configured from a set of available models and options. Family items are never manufactured or stocked. You must define family items with a Pur/Mfg code of Family (F) in Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17).

Components of the family item in the planning bill can be any type of item: manufactured, configured, or another family item.

A planning bill also contains a forecast percentage. The forecast percentage is the probability that a component of the family-level or parent item will be required, given the requirements for its parent. Components with structure code Planning consume the forecast for their parent.

Example The sale of a specific type of computer, entered in the planning bill with a structure code of Planning, consumes the computer family forecast, but the sale of an extended keyboard, an option, does not.

Option Bills

Structure type O (option) also affects forecasting and master scheduling. Options are typically used with configured products to indicate one of a set of choices.

Option bills are treated in the same way as planning bills by master scheduling. The forecast percentage and quantity per for the option determines the production forecast. However, unlike components in a planning bill, independent demand can often exist for an option.

For example, a Zip drive is an option for a computer model. You enter a forecast percentage indicating how frequently a Zip drive is included when a computer is purchased. Zip drives can also be sold as a separate item.

When you sell a Zip drive separately, it does not consume production forecast. If, however, you have an independent forecast for the zip drive, not derived from upper-level requirements, it will be consumed.

If you know that an option will be sold both by itself and as part of another item, you can plan production by either increasing the forecast percentage associated with the product structure or entering independent forecast in Forecast Maintenance Production Forecasts.

Production Forecasts

When you establish planning bills and forecast and master schedule at the family-item level, the system automatically calculates the derived demand for components of the family or upper-level item. These calculations are based on the ATP quantities for the family-level item and the quantity per and forecast percentage for the components of that family item. The result is called a *production forecast*, since it derives from the master production schedule and the forecast percentage specified in the planning bill.

Production forecasts are only created for components with structure codes P and O. Production forecast amounts display in MPS reports and inquiries and contribute to the total demand that MRP regards as input.

As forecast for the family-level item is consumed, the ATP quantity for that item changes, resulting in revised calculations for the production forecast the next time MRP is run.

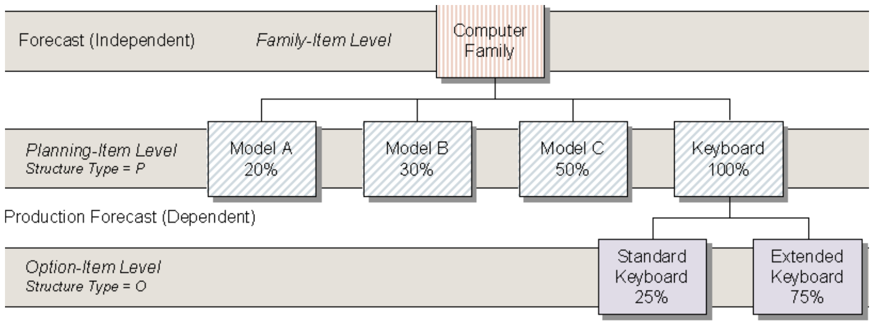


Fig. 13.10 Multilevel Master Scheduling Example

Multilevel Scheduling Techniques

When using multilevel master scheduling, you can plan family-level items using either the fully automatic or the computer-assisted technique. Either way, you must use MRP to plan orders in order to generate production forecasts for the components of these family items.

See "Approaches to Master Scheduling" on page 359.

Set the following values for family-level items in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. Yes.

Order Policy. Any option other than blank.

Time Fence. Optional.

The components of a multilevel master schedule can be planned using either the fully manual or computer-assisted technique.

Maintaining Master Schedule Orders

You can enter master schedule orders as firm planned work orders or create them using repetitive schedules. Under some circumstances, they are also automatically generated when you create flow scheduled orders.

Work Orders

You can enter master schedule orders as firm planned orders using Master Schedule Order Maintenance (22.13) or Work Order Maintenance (16.1). When you set the order status to Firm Planned, MRP explodes the parent

See Chapter 6, "Work Orders," on page 99.

item's product structure when planning the gross requirements for its components. Master schedule orders are managed and released like normal work orders.

Flow Scheduled Orders

See Chapter 8, "Flow Scheduling," on page 151.

When you enter a flow scheduled order using Flow Schedule Maintenance (17.21.3) and do not include a reference to an existing work order, the system automatically creates a type W (Flow) work order for the due date and required quantity entered on the flow scheduled order. The status of the order is set to exploded, and MRP uses it when planning requirements.

Note You cannot update system-maintained type W work orders using Master Schedule Order Maintenance or Work Order Maintenance.

Repetitive Schedules

See Chapter 10, "Advanced Repetitive," on page 261 and Chapter 11, "Repetitive," on page 311.

If you use the Advanced Repetitive or Repetitive module to manage your manufacturing processes rather than the Work Orders module, you can enter your master schedule as a repetitive schedule.

Do this using Schedule Maintenance (18.2.1 or 18.22.2.1). Then, explode the repetitive schedule to create scheduled orders by running Net Change MRP (23.1), Regenerative MRP (23.2), and Schedule Explosion (18.2.4 or 18.22.2.4). Exploding the repetitive schedule creates new scheduled orders and revises existing orders to support the repetitive schedule.

Note You can modify the master production schedule by modifying the repetitive schedule and then re-exploding it.

Scheduled orders are work orders with a type code of Scheduled and a status of Exploded. They have their own bills of material.

To produce the master scheduled items, you can use the programs in the Advanced Repetitive or Repetitive module or convert the scheduled orders to regular work orders, if required.

Note When a scheduled order is converted to a regular work order, it is no longer part of the repetitive schedule.

Verifying Capacity for Master Schedules

You can verify master schedule orders against user-defined resources, as for product lines, using the Resource Plan module. The resource plan functions convert ordered end-item quantities into resource units to calculate resource consumption.

See *User Guide Volume 5: Supply Chain Management* for more information.

You can also verify capacity for master schedule orders by department, work center, or machine using the Capacity Requirements Planning (CRP) functions.

See Chapter 15.

Master Scheduling for Seasonality

For products with seasonal demand cycles, you may need to build up inventory in advance of periods of peak demand. You can do this using work orders or repetitive schedules, or you can use seasonal build requirements to build up inventory to a predetermined level prior to its expected demand.

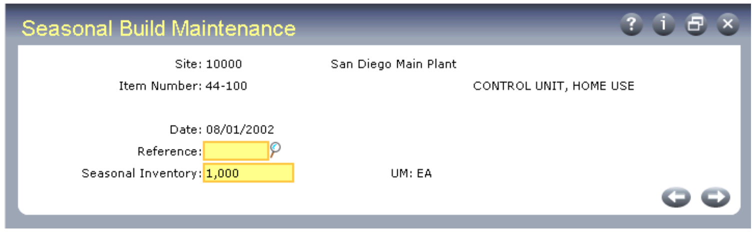
Seasonal build requirements let master schedulers specify a target inventory level for seasonal demand items that is not included when calculating ATP quantities, but can still be allocated and shipped on sales orders and customer schedules. Seasonal build quantities appear separately on master schedule reports that display ATP quantities.

Example 600 snowmobiles are scheduled to be completed in July due to a seasonal build requirement. A rush order for 200 snowmobiles arrives from Australia for shipment in July. The current production of snowmobiles would not be promised to that order, since it would be excluded from the ATP calculation.

MRP plans for the target inventory levels set by seasonal build requirements. Specifying seasonal build requirements causes MRP to plan orders to satisfy those requirements and prevents it from issuing action messages to cancel or delay orders for seasonal build items when their demand is not yet apparent.

Use Seasonal Build Maintenance (22.9) to create seasonal build forecasts for items by site. You must define an end date by which you need items in inventory and a seasonal inventory quantity needed by that end date.

Fig. 13.11
Seasonal Build Maintenance (22.9)



Example If you need 600 snowmobiles available in inventory by December 1st, you may decide to build them during the previous three months at a rate of 200 per month. You would then enter the following values:

Date	Seasonal Inventory
09/30/02	200
10/31/02	400
11/30/02	600
12/1/02	1

See "Available-to-Promise" on page 361.

Setting the seasonal inventory quantity to 0 (zero) for December 1 indicates that the seasonal build requirement is complete. This means that the item is now included in ATP calculations and is considered a source of supply by MRP.

Generating Master Schedule Reports

The Master Schedule Summary Inquiry and Report (22.18 and 22.19) and Master Schedule Detail Inquiry and Report (22.21 and 22.22) functions display the following information:

See page 362.

Production Forecast. System-calculated forecast used in multilevel master scheduling.

Forecast. Forecast quantity for an item, either loaded into forecast summary records using Simulation to Summarized Forecast (22.7.13) or manually entered using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

See page 356.

Sales Orders. Demand derived from confirmed sales orders and required ship schedules.

Gross Requirements. Manufacturing requirements from a parent work order. On a multilevel bill, gross requirements can include both master-scheduled family items (type P) and components of any type. In a DRP environment, gross requirements may also indicate intersite demand.

See Chapter 14.

Master Scheduled Receipts. Total scheduled receipts for an item from work orders, repetitive schedules, purchase orders, and distribution orders.

Projected QOH. Projected item quantity on hand, calculated by the system. This is a projection by period of an item's on-hand balance plus scheduled receipts minus gross requirements.

Available-to-Promise. The uncommitted portion of inventory or planned production, calculated by deducting real demand from real supply.

See page 361.

Cumulative ATP. A running total based on available-to-promise quantities.

Note To prevent the program from consuming ATP from other periods, set Negative ATP to Yes. This allows the system to display negative ATP in any column of the report.

Seasonal Build. Seasonal build quantity in inventory for that period, not included in the ATP quantity.

See page 367.

The Master Schedule Detail Inquiry and Report functions (22.21 and 22.22) display the same information as the Master Schedule Summary Inquiry and Report, sequenced by due date. They also include source-to-demand pegging details, allowing you to identify the actual work order or sales order generating a particular item requirement.

Chapter 14

Material Requirements Planning

Material Requirements Planning (MRP) is a key manufacturing planning process that uses a site's master schedule and all other sources of demand and supply to:

- Calculate gross item requirements and projected on-hand inventory
- Schedule and plan orders
- Produce action messages

This chapter explains how to use MFG/PRO to create and maintain a material requirements plan.

Introduction

Material requirements planning (MRP) balances supply and demand for purchased and manufactured items. Given a set of demands or requirements, MRP automatically calculates a time-phased schedule of planned supply orders or replenishments to satisfy those demands.

MRP looks at demand for finished items and uses product structure information to calculate demand for component items. For each item, MRP looks at the ordering information, the amount currently on hand, and lead times, and generates planned orders suggesting how many of that item to buy or make and when to do so.

MRP and Sites

MRP's planning activity is performed by site. Each site's material plan is completely independent from inventory, demand, and supply at other sites. You can run MRP for several sites in succession, but it does not plan for these sites as a group.

See *User Guide Volume 5: Supply Chain Management*.

For organizations with multiple sites, MRP can be used in conjunction with distribution requirements planning (DRP), which balances supply and demand among sites.

Sources of Demand and Supply

MRP uses the master production schedule (MPS) to calculate dependent component demand. Dependent demand is directly derived from the demand for other items, and includes demand for components items, raw materials, and subassemblies.

See Chapter 13, "Forecasting/ Master Schedule Planning," for more detail.

Independent demand is demand that cannot be calculated or derived from demand for other products. It is represented through forecasts and sales orders, and includes demand for end products and replacement items. Independent demand generally passes to MRP through the master production schedule.

Sources of Demand

MRP considers the following as sources of demand:

- Forecasts
- Sales orders
- Customer scheduled orders from a required ship schedule
- Intersite orders, generated by DRP
- Component requirements from manufacturing
- Production forecasts
- Safety stock requirements

MRP does not consider unconfirmed sales orders or component requirements from batch firm-planned orders as sources of demand.

Sources of Supply

MRP considers the following as sources of supply:

- Nettable quantity on hand (QOH)
- Purchase orders
- Intersite requests, generated by DRP
- Manufacturing orders (work orders and repetitive schedules)
- System-generated work orders resulting from flow scheduled orders
- Quality orders
- Supplier scheduled orders

MRP does not consider blanket purchase orders or non-nettable inventory as sources of supply.

Setting Up MRP

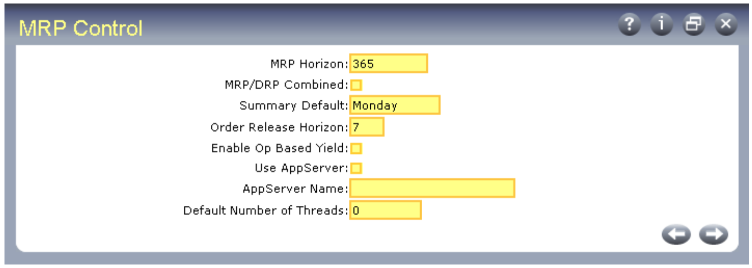
Before running MRP, set up the following data in your system:

- Control program parameters in MRP Control
- Item planning parameters
- Inventory status codes
- Product structures and formulas

MRP Control

Enter appropriate values in MRP Control (23.24).

Fig. 14.1
MRP Control (23.24)



MRP Planning Horizon. Enter the period of time, in calendar days, which MRP should plan. MRP calculations ignore data outside this time period. The horizon should be at least one day longer than the longest item cumulative lead time in the database.

If you change the MRP planning horizon, impacted items are not automatically replanned when you run net change MRP. Ensure that all items are replanned by running MRP in regenerative mode.

See *User Guide Volume 5: Supply Chain Management*.

MRP/DRP Combined. Enter Yes to indicate that MRP planned items can be planned using DRP functions. Enter No if they can only be planned using MRP functions.

Summary Default. Specify the day of the week used by all MRP summary reports and inquiries when displaying item requirements summarized by week.

Order Release Horizon. Enter the number of calendar days before a planned order's release date on which the `Release Due For` action message should appear.

The order release horizon should be based on your normal paperwork lead time and how often you run MRP. For example, if you run MRP weekly, you should set the order release horizon to at least seven days. If you run MRP daily, you can set it to zero.

See "Operation-Based Yield" on page 42.

Enable Op Based Yield. This field determines how the system calculates yield for component items when product structures and routings are exploded in material requirements planning (MRP) programs, work orders, repetitive, advanced repetitive, and configured products.

No: The system uses the Yield % field associated with the parent item in Item Planning Maintenance or Item-Site Planning Maintenance to calculate component requirements.

Yes: The system derives the yield percentage amount for components from operations on the parent item's routing. The Yield % field associated with the item is used for the parent item only, not the components.

Even when Enable Op Based Yield is Yes, operation-based yield is only calculated for parent items with Operation Based Yield set to Yes in either Item Planning Maintenance (1.4.1 or 1.4.7) or Item/Site Planning Maintenance (1.4.17).

Setting this field to Yes typically results in more accurate calculations and prevents overplanning of components. This is especially true in a mature process where yield percentages are highly predictable.

Use AppServer. Specify whether your system uses a Progress application server to enhance MRP performance.

See "Improving MRP/DRP Performance" on page 385.

AppServer Name. When Use AppServer is Yes, enter the name of the application server that is configured to run the MRP programs. The value you enter must already be defined in AppServer Service Maintenance (36.19.1).

Default Number of Threads. When your system uses an AppServer for MRP processing, enter the default number of processing threads, or agents, that the AppServer can create. This can be any integer up to 99.

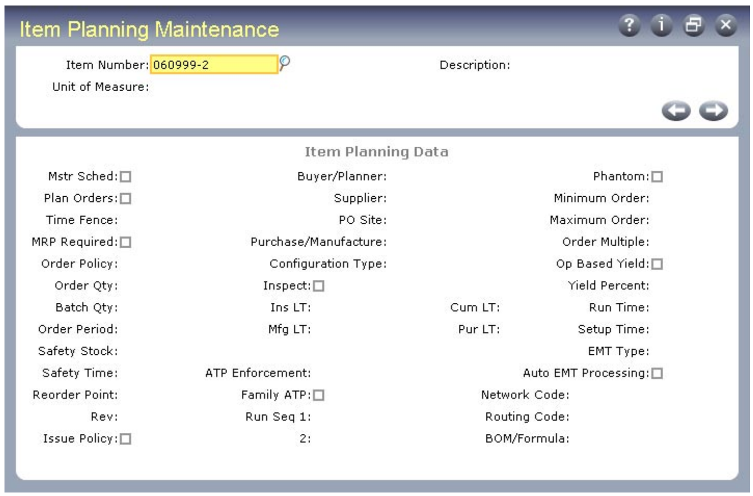
This value defaults to the Number of AppServer Threads field in the MRP programs. You can update it based on the overall load on your system when you run MRP.

As a general rule, set this field to twice the number of processors your computer has. For example, if you have a dual-processor machine, set the field to 4. You can adjust it based on how well your system and MRP perform.

Item Planning Data

MRP uses item planning data to plan items. Define this data in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). If an item is used at multiple sites, you can set up planning data differently for each site using Item-Site Planning Maintenance (1.4.17). Data not defined in Item-Site Planning Maintenance defaults from Item Master Maintenance or Item Planning Maintenance.

Fig. 14.2
Item Planning Maintenance (1.4.7)



Master Schedule

See “Creating Master Production Schedules” on page 359.

For non-master scheduled items planned by MRP, set Master Schedule to No. This lets you plan master scheduled and MRP-planned items separately, if required, using Selective Materials Plan (23.3). Items with Master Schedule set to No are excluded from reports and inquiries in the Forecasting/Master Plan (22) module.

For master scheduled items, set Master Schedule to Yes. Items subject to independent demand, such as end products or service parts, are usually master scheduled.

Plan Orders

When Plan Orders is Yes and a value is specified in the Order Policy field, MRP generates planned purchase and work orders to satisfy net requirements for this item.

If Plan Orders is No and an order policy is specified, MRP plans this item but does not generate planned orders for it. Only action messages, suggesting orders that should be placed, are generated.

Pur/Mfg Code

MRP uses the Pur/Mfg code to distinguish manufactured items from purchased items. A code of Manufactured, Routable, Configurable, Family, Line, Flow, or blank indicates that an item is usually manufactured, while a code of Purchased indicates that it is usually purchased.

MRP generates planned work or line orders for manufactured items and planned purchase orders for purchased items. However, you can create and approve planned work or line orders for purchased items or planned purchase orders for manufactured items. This field indicates only what the normal procedure is, not what it must be.

Run Sequences

Run sequences are used when MRP planned orders are approved for line manufacture using Planned Repetitive Schedule Approve (23.8).

If multiple items are produced on a single production line, efficiency can be improved by producing the items in a certain order. Run sequences let you control the order, or sequence, in which items are scheduled on a production line.

An item’s run sequences are sorted by primary run sequence and then secondary run sequence. A two-digit numeric value should be the first characters of a run sequence. This convention provides enhanced control over the sorting of run sequences.

Example Items 100, 200, and 300 are produced on production line 500. These items are made of plastic and have different colors: items 100 and 200 are green, item 300 is white. To minimize the change-over time between items, they must be scheduled in the following sequence:

- Items 200 and 300 produced before item 100
- Item 300 produced before item 200

To make sure approved orders with the same due date for items 200 and 300 are scheduled before orders for item 100, enter 01Plastic as the primary run sequence for items 200 and 300 and 02Plastic for item 100. To schedule approved orders for item 300 before orders for item 200, enter 01White as the secondary run sequence for item 300 and 02Green for item 200.

When approving planned orders for these items with Planned Repetitive Schedule Approve (23.8), set Sort by Run Sequence to Yes. Table 14.1 illustrates the resulting production schedule for line 500.

Table 14.1
Production Line Sequence Using Run Sequences

Production Sequence	Item Number	Primary Run Sequence	Secondary Run Sequence
1	300	01Plastic	01White
2	200	01Plastic	02Green
3	100	02Plastic	02Green

Order Policy

The order policy determines the number and size of each MRP planned order. If an item's Order Policy is blank, it is ignored by MRP, and planned orders or action messages are not generated for it. Any value entered in the Order Policy field other than those listed in Table 14.2 is processed by MRP as lot-for-lot.

Leave Order Policy blank for items planned manually based on a reorder point.

Table 14.2
Order Policy

Order Policy	Description
Period order quantity (POQ)	MRP calculates demand for this item over the number of calendar days specified as the Order Period and creates one order to satisfy this demand.
Fixed order quantity (FOQ)	MRP generates planned orders for the quantity specified as the Order Quantity. If the quantity required exceeds this quantity, multiple orders are generated.
	If the quantity in the Min Ord field is greater than the specified order quantity, planned orders are generated for this minimum quantity.
Lot-for-lot (LFL)	MRP generates a separate planned order to satisfy each net requirement. If there are many sources of demand, MRP creates many planned orders.
	When LFL policies are used across multiple product levels, running MRP may produce unmanageable numbers of manufacturing orders.
One time only (OTO)	MRP generates a single planned order with a quantity of one unit. As long as one order for this item exists, the system will not create another. OTO can be used for prototype items, or for planning project activities and one-time events.

Order Modifiers

MRP uses order modifiers along with order policies to determine planned order quantities.

Table 14.3
Order Modifiers

Order Modifier	Description
Order Quantity	The quantity for which all MRP planned orders are created for an item with an order policy of FOQ.
Safety Stock	The quantity of this item maintained in inventory as protection against fluctuations in demand or supply. MRP processing considers safety stock a requirement, and schedules planned orders to cover this requirement.
	You should not designate safety stock levels for non-master scheduled items because it may cause MRP to overplan inventory.

Order Modifier	Description
Minimum Order Quantity	The minimum quantity allowed for a planned order. If the net requirement is below this amount, MRP creates an order for this minimum quantity. To ensure that items that have decimal demand values due to yield or scrap calculations are ordered in whole number quantities, set this value to 1, or to any whole number.
Maximum Order Quantity	When a net requirement exceeds this amount, MRP generates the action message `Order Exceeds Maximum` for the order created to fill this requirement.
Order Multiple	When order policy is POQ or LFL, planned orders are created in multiples of this quantity. For example, if the order multiple is 100, planned orders are only created for quantities of 100, 200, 300, and so on.
Yield %	The percentage of an order expected to be in usable condition. If Yield % is less than 100%, MRP plans orders for more than needed. For example, if the net requirement is 100 and the item Yield % is 50%, then the planned order quantity will be 200. You can enter this value manually or use Routing Cost Roll-Up (14.13.13) to calculate yield percent based on the yield percentages at each operation in the item routing. • If operation-based yield is No, MRP uses this yield percentage amount to calculate component requirements. • If operation-based yield is Yes, the yield percentage for components is derived from the parent item's routing data. The item yield percentage is ignored. If an item's yield percentage is less than 100 percent, MRP may generate planned orders for fractional quantities. To prevent this, set Order Minimum or Order Multiple to 1, or any whole number.
Scrap %	The percentage of a component item expected to be scrapped during manufacture of the parent item.This value increases the component requirements for planned orders for that component-parent pair. Specify scrap % values for components in Product Structure Maintenance (13.5). When scrap percentage is greater than zero, MRP may calculate fractional component quantities, even if the component is a discrete item. For example, if one housing is required to build an item and the scrap factor is 5%, the system will calculate a requirement for 105.2631 housings to make 100 units. To prevent MRP from generating planned orders for fractional quantities, set Order Minimum or Order Multiple to 1, or any whole number.

Lead Times

Lead time determines when MRP planned orders are due—manufacturing lead time for manufactured items, and purchasing lead time plus inspection lead time for purchased items.

For both purchased and manufactured items, if the lead time varies, you can define a safety time. MRP then calculates the planned order due date by adding safety time to the lead time.

Table 14.4
Lead Times

Lead Time	Description
Manufacturing Lead Time	The number of working days it takes to manufacture an item, including the time it takes to process paperwork, issue components, inspect the finished product, and receive it into stock. For DRP items, enter DRP transit and order time in this field so that this value is included in the cumulative lead time for this item.
Purchasing Lead Time	The number of calendar days it takes to complete a purchasing cycle for an item, from the date the need for a purchase is recognized to the date the item is received.
Inspection Lead Time	The number of working days it takes to inspect a purchased item after it is received.
Safety Lead Time	The number of working days early that MRP plans to receive orders for an item, to allow for late deliveries.
Cumulative Lead Time	The longest number of calendar days it takes to obtain an item, assuming that neither it nor any of its components are in stock. The system calculates this value, by converting manufacturing, inspection, and safety lead time to calendar days.

Time Fence

The time fence is the number of calendar days inside of which MRP will not generate or adjust any planned orders, even if there are net requirements within that period. MRP still deletes a planned order, even if it is inside the time fence, if no demand is generated for that item.

Time fences are often used with master scheduled items and are usually set to greater than or equal to the manufacturing lead time.

MRP Required

See "Net Change Materials Plan" on page 387.

The MRP Required field is set by the system to indicate whether this item has had changes made against it and will be replanned the next time you run net change MRP. Yes indicates that the item will be replanned; No indicates that it will not.

Inventory Status Codes

Assign a non-nettable inventory status code to inventories that should not be considered quantity on hand by MRP. This might include inventory to be returned to a supplier or designated as scrap or salvage.

Product Structures and Formulas

See Chapter 2 and Chapter 4 for details.

Product structures and formulas provide some of the information used in MRP calculations, including component quantities, lead times, and effective dates. Enter and modify product structure and formula information in Product Structure Maintenance (13.5) and Formula Maintenance (15.5).

Component Quantity

To calculate component requirements for planned orders, MRP multiplies each component's quantity per assembly value by the planned order release quantity.

Component Lead Time

MRP determines a component's due or required date using the scheduled release date of the parent item and the component lead time offset specified in the product structure.

Example When a component's lead time offset is 10 days, its due date will be 10 manufacturing days after the planned release date of the assembly. When it is –5 days, the due date is 5 manufacturing days before the planned release date of the assembly.

If no lead time offset is specified for a component, the component release date will be the same as the release date for the parent item.

Component Effective Dates

MRP uses component effective dates to determine which components are required for a given order due date. Components are active beginning on the start date specified in the product structure and remain active through the stop date, the last day a component will be used.

See "Engineering Effectivity" on page 23 for more information on how MRP handles component effective dates.

Executing MRP

MRP Processing

MRP reports and inquiries can optionally display item requirements summarized by week. The beginning day of the week is specified in the Summary Default field of MRP Control. Calculations are based on this weekly period.

MRP calculates net requirements for items using three variables:

- Gross item requirements are the sum of an item's requirements from forecasts, higher level products, customer orders, service items, and intersite orders. They do not take into account inventory on hand or scheduled receipts.
- Scheduled receipts for that item, including open purchase orders, open work orders with a quantity open and a status of R, and intersite requests for DRP items.
- Quantity on hand from the previous period.

MRP uses these three variables in the following calculation:

Net Requirements = Gross Requirements – Quantity on Hand for the previous period – Scheduled Receipts

MRP schedules planned purchase orders and work orders to fill these net requirements. Planned work orders generated by MRP are exploded into gross requirements for their components. This process continues until there are no more planned work orders to explode.

Note MRP does not explode product structures for purchased and distribution items or components with structure code Document.

Yield Calculations

See "Yield" on page 41.

When MRP plans orders for a parent item, it also determines if orders are required for any of the parent's component items.

MRP generates component requirements using the standard product structure or formula effective for that item-site or site on the date of the requirement. Alternate structures and substitute items are not considered by planning.

Yield is also considered by MRP when it calculates component requirements. These calculations are based either on the parent item yield percentage or the yield associated with each operation in the parent's routing. Operation-based yield is used when both of the following are true:

- Enable Op Based Yield is Yes in MRP Control.
- Op Based Yield is Yes for the parent item in Item Master Maintenance or Item-Site Planning Maintenance.

If the parent item qualifies for operation-based yield calculation, each component could potentially have a different yield percentage.

See "Phantoms" on page 15 for more information on global phantoms.

If a component item is a global phantom, MRP may need to blow through the phantom and plan another order for any required components of the phantom.

The system automatically applies the yield percentage of a global phantom to each of its components. This is true even if the parent item's planned order includes components of local phantoms.

Co-products and Base Processes

See Chapter 5, "Co-products/ By-products," for more details.

MRP plans co-products and base processes differently than other items. Net requirements for co-products are passed down to their respective base process items. MRP then generates planned orders for base process items to meet these requirements. These planned orders are imploded, creating planned orders for each of the co-products and by-products.

Routable Assemblies

For routable assemblies, MRP generates a separate routable work order when an order for the parent item is released. Usually, you should not approve these orders or change their status to firm planned.

Improving MRP/DRP Performance

Because of the number of calculations required in an MRP or DRP run, it can be a time-consuming, resource-intensive process. MRP/DRP is typically executed as a batch process; for example, at night, when the load on the system is usually much lower.

To enhance MRP/DRP performance in an environment that includes Symmetric Multiple Processor (SMP) computers, your system can be configured in two optional ways, which are described in more detail in the DRP discussion:

See the DRP chapter in *User Guide Volume 5: Supply Chain Management* for information.

- Running synchronized, simultaneous MRP/DRP calculations by defining synchronization codes.
- Using a Progress application server (AppServer) to perform multi-threaded processing, which allows MRP/DRP tasks to be spread out among more computing resources.

See *User Guide Volume 9: Manager Functions* for information on AppServers.

These methods can result in a significant improvement in the time required to run MRP—particularly with scenarios such as running regenerative MRP for a large database that includes multiple sites.

MRP Scheduling

When MRP runs, it compares each item's demand with existing supply orders for each period. It automatically reschedules planned orders to reflect changes in the plan and generates an action message for each rescheduled order. Some orders MRP cannot change because they are firm planned or within the time fence specified in the item planning data. For these, it generates action messages suggesting that these orders be rescheduled to balance supply with demand.

When MRP reschedules planned orders for higher-level end items, lower-level components dependent on the rescheduled demand remain associated with the original supply order date. They are not automatically rescheduled based on where action messages say parent orders should be moved. To adjust for this:

1. Run selective MRP for master scheduled items and review and handle action messages.
2. Run selective MRP again at this level to ensure that all action messages have been dealt with.
3. Then, run regenerative or net change MRP for all dependent demand items.

MRP Pegged Requirements

MRP source-to-requirement pegging makes it possible to review each of the sources of demand for gross requirements. Use MRP Detail Inquiry (23.16) or MRP Detail Report (23.17) to:

- Trace the requirement for a particular end item to the forecast or sales order creating the demand.
- Identify the specific parent item creating the need for a component item.

Pegging is made possible by low-level codes, which maintain a numeric value for each item relative to its parent item, including items planned across sites using DRP.

The lowest-level components of product structures in the database are assigned low-level codes of 0 (zero). Items at the next level are assigned a low-level code of –1, and so on.

Example At a particular site, a purchased component has a low-level code of 0. That component is then built into an assembly, which is assigned a low-level code of –1. The assembly item is built into an end item that is assigned a low-level code of –2. The end item is then packaged and assigned a low-level code of –3.

When MRP is run across multiple sites in the same database, it processes lower-level items first, regardless of site. Purchase orders and intersite requests are generated after all site and intersite demand has been calculated.

Because item planning, product structure, MRP, and DRP transactions can alter low-level codes, net change and regenerative MRP automatically update low-level codes before performing calculations. Selective MRP updates low-level codes only if you set Resolve Low Level Codes to Yes. You can also use Low Level Code Update (23.22) to resolve codes as a separate

MRP Detail Inquiry (23.16) and MRP Detail Report (23.17) display each source of demand for an item with the due date, item quantity, parent item number, and type of requirement—whether forecast, production forecast, sales order, customer schedule, work order, or repetitive.

Tip
Run MRP reports and inquiries immediately after MRP, since they are sensitive to changes in inventory, demand, and supply.

MRP Planning Modes

MRP can be run in three operational modes:

- Regenerative MRP plans for all items at selected sites.
- Net change MRP plans only for items that have changed since MRP was last run. It produces the same results as regenerative MRP, but generally requires less time to execute.
- Selective MRP plans only for the items you select.

Net Change Materials Plan

Net Change Materials Plan (23.1) considers only items with MRP Required set to Yes in their item planning data. The system sets this field to Yes automatically when changes occur for an item in any of the following areas:

- Item or item-site planning data
- Product structures
- Sales or purchase orders
- Work orders or repetitive schedules
- Inventory

- Forecasts
- Master production schedule
- Intersite demand

Tip
Typically, Net Change MRP is run daily.

In addition to planning items that have changed, net change MRP recalculates lower-level requirements for items planned.

Both net change and regenerative MRP plan items based on low-level codes. They determine requirements at the top level first, then continue down through the item structure, one level at a time.

Regenerative MRP

Regenerate Materials Plan (23.2) recalculates demand and plans supply for all items in the site. The outputs of net change and regenerative MRP are the same. However, net change MRP generally runs faster than regenerative, since it only plans for items that changed since MRP was last run.

Tip
The first time you run MRP, it should be regenerative.

You should always schedule periodic regenerative MRP runs, even if you primarily use net change MRP, since net change MRP does not consider demand or forecast for items entering the MRP horizon over time.

Selective Materials Plan

Selective Materials Plan (23.3) plans only for items and sites you select. It can be run in net change mode by setting the Required Items Only field to Yes, or in regenerative mode by setting Required Items Only to No.

You can use Selective Materials Plan to plan master schedule items separately from other items, or to plan small groups of items by using buyer/planner, product line, group, type, supplier, or any combination of these, as selection criteria.

See *User Guide Volume 5: Supply Chain Management*.

Set MRP Items to Yes to generate planned orders for items at the specified sites and gross requirements for DRP items. Set DRP items to Yes to generate intersite requests for DRP items.

Selective MRP recalculates demand and plans supply only for selected items, passing down gross requirements to the next non-selected level, but not replanning orders. It does not implode product structures to replan higher-level items before planning selected items, nor does it explode resulting orders to calculate component demand.

Reviewing MRP Output

The primary outputs of MRP are planned orders and action messages. These are generated if MRP sees an imbalance of supply and demand.

- If supply exceeds demand, MRP automatically reschedules or cancels planned orders and generates messages suggesting you de-expedite or cancel open orders.
- If demand exceeds supply, MRP reschedules or creates planned orders and generates messages suggesting you expedite or create orders.

Action Messages

MRP generates action messages for all items with non-blank order policies. Action messages recommend the actions a planner should take to balance supply with demand, such as rescheduling, canceling, or releasing orders.

Review action messages using Action Message Review/Update (23.5). Or use Action Message Report (23.7) to review messages by item, site, buyer/planner, Pur/Mfg code, or action message number.

Table 14.5 lists the messages generated by MRP with a brief explanation. In the explanation, a *supply order* can be a work order, purchase order, repetitive schedule, or intersite request.

Table 14.5 MRP Action Messages

Message	Meaning
Beginning Quantity Less Than Zero	The initial nettable quantity on hand is negative.
Beginning Available Less Than Zero	The quantity on hand less safety stock is negative.

Message	Meaning
Create	A supply order should be created to satisfy a negative projected on-hand balance. This message is only generated if Plan Orders is No or if a new requirement appears within the time fence.
De-Expedite	A scheduled supply order is due before it is needed and should be delayed, or demand rescheduled to an earlier date.
Expedite	A scheduled supply order is due after it is needed and should be rescheduled to an earlier date, or demand rescheduled to a later date.
Cancel	A scheduled supply order is no longer needed and should be deleted.
Release Due For	A supply order should be released. You can release both planned and firm-planned orders. Approving the order changes its status to firm planned. Use the Order Release Horizon field in MRP Control (23.24) to specify the number of days prior to the order release date for this action message to display.
Release Past Due For	A supply order was not released when it was due. It now needs to be released and expedited, or the demand must be rescheduled for a later date.
Quantity Less than Minimum	A supply order was created for a quantity less than the minimum quantity set in the item planning data.
Quantity Exceeds Maximum	A supply order was created for a quantity greater than the maximum quantity set in the item planning data.
Past Due	Scheduled supply order receipt is past the due date.
Time Fence Conflict	Unsatisfied material requirement exists inside the planning time fence for the item. MRP will not create planned orders within the time fence. You should either manually schedule and expedite orders to fill this demand or delay fulfillment of the requirement that created the demand.
Shipment Due	A shipment for an intersite request item is due. Action should be taken at the source site to ensure that the order is received on time.
Shipment Past Due	A shipment for an intersite request item is past due. You should either delay the orders that created the requirement for the item or expedite them when the item does arrive.

Message	Meaning
No Source Of Supply	A valid source network is not available for the date a DRP item is required. Either the item or item-site planning data does not reference a source network, or the source network is not effective on that date.
Planned Order Count Exceeds Maximum	An item/site combination generated the maximum number of planned orders. MRP currently cuts off the creation of orders for an item/site combination at 1000. Calculation for other items continues. This prevents runaway calculations caused by, for example, an incorrect item order quantity.

Planned Orders

MRP generates planned orders to satisfy net requirements for items with Plan Orders set to Yes and non-blank order policies specified in the item planning data. MRP generates planned work orders for manufactured items, planned line orders for items manufactured on production lines, and planned purchase orders for purchased items based on the item Pur/Mfg code.

See "Pur/Mfg Code" on page 377.

The scheduled release date for a planned order is the item due date minus the purchasing or manufacturing lead time. For manufactured items, MRP calculates planned order release dates using the manufacturing lead time. For planned purchase orders, both the inspection lead time and the purchasing lead time are used. If a planned order release date falls on a non-workday, MRP schedules it for the last prior workday.

See "Lead Times" on page 381.

When MRP plans orders, it uses the default shop calendar for the site. If there is no shop calendar, MRP does not plan orders for that site.

Planned purchase, work, and line orders are stored with status Planned. Work orders and line orders are created with work order bills; purchase orders are not. A planned order, regardless of its type, can be approved using any of the planned order approval programs.

Approving Planned Orders

To approve planned purchase, work, and line orders, use Planned Purchase Order Approval (23.11), Planned Work Order Approval (23.10), or Planned Repetitive Schedule Approve (23.8). Once approved, planned orders become either purchase requisitions, firm-planned work orders, or are added to production line schedules.

After a planned order is approved, MRP does not change the quantity or due date on the order the next time it is run. Instead, it generates action messages suggesting changes to the order. You can modify firm-planned order due dates and quantities as needed in Work Order Maintenance (16.1), Purchase Requisition Maintenance (5.1.4), and Line Schedule Workbench (18.1.10 or 18.22.1.10).

Approving Planned Purchase Orders

Approving a planned purchase order deletes the planned order and creates a purchase requisition, which can be filled by a purchase order.

Approving Planned Work Orders

See “Creating Work Orders” on page 104.

Approving a planned work order changes its status to firm planned. MRP does not replan firm-planned orders, but generates action messages as needed. A firm-planned order has a work order bill and a routing with scheduled operations. These are not fixed. Bills are re-exploded by MRP, while routings are re-exploded by CRP. Both are re-exploded when the status is changed to Exploded, Allocated, or Released.

Approving Planned Line Orders

Approving a planned line order adds the order amount to the schedule for that item’s production line. Orders approved for line production using Planned Repetitive Schedule Approve (23.8) are added to a schedule in a sequence according to the following hierarchy:

- Due date
- Primary run sequence
- Secondary run sequence
- Item number

The Sort Schedule by Run Sequence field controls the sequence in which orders are scheduled on a production line.

See "Run Sequences" on page 377.

Yes: Items are sorted and sequenced by due date, primary run sequence, secondary run sequence, and item number.

No: Items are sorted and sequenced by due date and item number.

The production schedule sequence for a given line can be viewed and modified using Line Schedule Workbench. Once a production line's schedule is established, run Repetitive Schedule Update (18.1.18 or 18.22.1.18) to convert the line schedule to a repetitive schedule and remove the planned line orders from MRP.

See "Simulating Schedules in the Workbench" on page 275.

Chapter 15

Capacity Requirements Planning

The Capacity Requirements Planning (CRP) module uses MRP planned orders, other work orders, and repetitive schedules to determine work center load and generate a capacity requirements plan for a department, work center, or machine.

This chapter explains how to use MFG/PRO to generate and maintain a capacity requirements plan.

Introduction

CRP calculates workload for a department, work center, or machine. It does this by exploding the routings and processes for MRP planned and firm planned orders and determining start and due dates for each operation, using the work center and shop calendars and a technique called back scheduling.

Defining Capacities

See "Departments" on page 28 for details.

The resources used to process orders on the shop floor are work centers, departments, and machines. The capacity of a department or work center is the time available for production in that location.

The capacity of a department is the total number of available labor hours per day for all work centers in that department, defined in Department Maintenance (14.1).

See *User Guide Volume 9: Manager Functions* for more information about shop calendars.

The capacity for a work center is the number of machines or personnel available for that work center, defined in Work Center Maintenance (14.5), multiplied by work hours, defined in the shop floor calendar. You can define and maintain shop floor calendars using Calendar Maintenance (36.2.5).

Executing CRP

Generate capacity requirements for manufacturing orders using Recalculate Capacity Plan (24.1).

Note Generally, you should run CRP after running MRP.

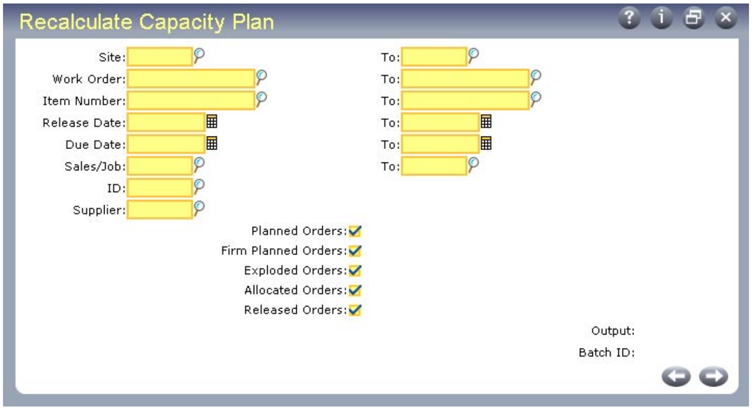


Fig. 15.1 Recalculate Capacity Plan (24.1)

CRP determines capacities based on the available hours or machines for a work center or department. It multiplies working days, defined in the shop calendar, by work center machine capacity to calculate capacity per CRP reporting period.

CRP explodes the routings and processes for the orders you select. It then determines capacity requirements for selected manufacturing orders by scheduling their operations. CRP determines operation start and due dates using the work center and shop calendars and a technique called back scheduling.

Back Scheduling

When CRP back-schedules orders, it takes the due date of an order or repetitive schedule and schedules each of its operations from the last operation in the order routing or process backward to the first one.

CRP assigns each operation a start date and a due date, using the operation lead time components—queue, setup, run, wait, and move—to calculate operation start dates. The start date of an operation is the same as the due date of the previous operation.

Note CRP calculates run times based on the actual order quantity—that is, the order quantity less the quantity completed.

When manufacturing order operations overlap, the system smoothes the scheduled start and due dates to prevent the scheduled due date for one operation from occurring later than the due date for a subsequent operation.

Schedule Discrepancies

See Chapter 14, "Material Requirements Planning," on page 371.

MRP calculates manufacturing order release dates using a manufacturing lead time that is based on an average order quantity defined in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17). If the order quantities used in CRP calculations differ from this average quantity, CRP may schedule the start date for an order's first operation before the release date for that order.

When this occurs, a message displays to alert you of the conflict. You can resolve such conflicts by adjusting the order release or due date and rerunning CRP.

Note Exceptions to the normal work week in the work center and shop calendars—for example, planned overtime—may also cause schedule discrepancies in CRP.

CRP and Order Statuses

CRP is normally executed for Planned and Firm Planned orders. For these orders, CRP explodes the standard item routing and schedules the operations to create work center/machine load.

Tip
Repetitive schedules are treated like Exploded orders.

You can also choose to include orders with other statuses. For Exploded and Allocated orders, the work order routing is scheduled. For Released orders, only open operations are rescheduled.

When you run CRP, all open operations for selected work orders are rescheduled. That means that if you have manually adjusted your operation start and stop dates, they will probably be changed unless you also adjusted the work order release and due date to match.

Generating Load Reports

You can generate load reports by department, work center, or machine using the work center and department load inquiries and reports.

CRP determines load hours for a work center based on setup and run times. Queue, wait, and move times are excluded from load calculations. To include queue times in load calculations, set up separate operations for queue. CRP then considers these operations when calculating load.

CRP determines the load an operation exerts on a work center using the following calculation:

Operation Load = Setup Time + (Run Hours/Unit x Quantity Open)

The quantity open for an operation is the order quantity minus any quantities reported complete.

Note The system assigns the entire load for an operation to its scheduled start date. Even for operations with run times longer than one day, load is not spread between operation start and due dates.

Reviewing Input and Output

You can compare the planned input and output for a work center or machine with actual input and output using Input/Output Inquiry (24.4) and Input/Output Report (24.5). These functions help you evaluate a work center or machine's response to planned loads.

You can display planned and actual input and output in daily, weekly, or monthly periods.

Planned Input. Planned input is load on a work center or machine represented by work order operations scheduled to start in a reporting period. It is determined using the following calculation:

*Standard Setup + (Standard Run * Quantity Ordered)*

Actual Input. Actual input is load that has been moved to the first and subsequent order operations. It is calculated for a reporting period based on move transactions entered using work order release and shop floor control functions. Actual input is determined using the following calculation:

*Standard Run Hours * Quantity Moved*

Planned Output. Planned output is load calculated based on order operations scheduled to be completed in a reporting period. It is determined using the following calculation:

*Standard Setup + (Standard Run * Quantity Ordered)*

Actual Output. Actual output is load calculated for a reporting period based on operation quantity completed transactions for work orders and repetitive schedules. You can report completed quantities for order operations using labor feedback transactions in the Shop Floor Control, Advanced Repetitive, and Repetitive modules, or using Work Order Accounting Close (16.21).

Actual output is determined using the following calculation:

*Actual Setup + (Standard Run * Quantity Completed)*

Planned Queue. The planned queue is the difference between planned input and planned output.

Actual Queue. The actual queue is the difference between actual input and actual output.

Adjusting Capacity and Load

If a work center or machine is over- or under-loaded, you can modify either its capacity or the timing or amount of the load.

Adjusting Capacity

Adjust capacity using one of the following functions:

- Holiday Maintenance (36.2.1)
- Calendar Maintenance (36.2.5)

Add or subtract workday hours as needed for work center or shop calendars.

Adjusting Load

Adjust the timing or amount of load by modifying:

- Work order due dates
- Operation lead time components
- Repetitive schedules

Note If you manually adjust operation start or stop dates, CRP reschedules them the next time it is run.

Index

Numerics

L

M