

Quantity Variation

11.2

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Quantity Variation

This tutorial provides an overview of the different ways the quantity of a BOM Item can be defined and configured in Critical Manufacturing MES. It covers quantities dependent on the main **Material**, fixed quantities, negative quantities for by-products, as well as specific configurations such as quantity tolerances and reference items.

Overview

This tutorial will explain the key concepts related to how BOM Item quantities can be defined and managed, including:

- BOM Item consumption dependent on main **Material** quantity - where the required quantity scales with the quantity of the main **Material**.
- BOM Item consumption with fixed quantity - where the required quantity remains constant, regardless of the main **Material** quantity.
- BOM Item consumption tolerances - allowing flexibility in meeting exact quantity requirements.
- Negative quantity (by-products) - where the BOM defines **Materials** produced as a result of the process.
- BOM reference Items - used for reference or informational purposes without consumption in MES.
- Option to capture - enabling the recording of specific values or details during assembly.

The tutorial concludes with a practical use case that brings these concepts together, demonstrating their application and the necessary configurations to support them.

Dependent Quantity

The dependent quantity configuration is the most common approach for BOM Items. In this scenario, the required quantity of a BOM Item is directly proportional to the quantity of the main **Material** being assembled.

This behavior covers situations where, for example, assembling 1 unit of a main **Material** of a given **Product** requires X units of a specific consumable **Product**.

Main configuration requirements:

- Units of the **Product** to be assembled
- BOM Item **Products** and their substitutes
- Amount of BOM Item units to be consumed

Fixed Quantity

The fixed quantity configuration applies when the required amount of a BOM Item is constant, regardless of the main **Material** quantity being processed.

For example, a quality test kit might be included with the **Product**. Whether 1 or 100 units are assembled or tested, only a single kit is added for the final customer. This applies for Assemble, Disassemble and Replace & Disassemble operations, and is also considered for Material Transfer Requirements and BOM Explosion.

Main configuration requirements:

- Units of the **Product** to be assembled
- BOM Item **Products** and their substitutes
- Amount of BOM Item units to be consumed
- Assembly Type must be Explicit Long Running, Automatic at Track-In or Automatic at Track-Out

Tolerances

Tolerances allow for flexibility in BOM Item consumption, enabling the recorded consumed quantity to differ from the theoretical quantity. This is available for **BOMs** with the Materials scope with manual assembly types, and is in use by default in BOM Weigh and Dispense.

This supports use cases, as for example: an industrial air conditioning unit BOM specifies 1.2 m² of insulation foam based on CAD measurements. In practice, operators may use 1.6-1.8 m² due to manual cutting inaccuracies or overlapping pieces to ensure coverage.

Main configuration requirements:

- Units of the **Product** to be assembled
- Use Tolerances property set to true
- BOM Item products and quantities
 - Lower and upper tolerance values (percentage-based set from 0 to 100) for all BOM Items
 - If the **Product** is discrete, tolerances are not supported or required
- Substitute BOM **Products**, where applicable

Regarding the Disassemble operation, the calculated quantities are the theoretical ones, and tolerances are applied in order to allow the user to disassemble the same quantity that was assembled before. Regarding the Replace, BOM Item tolerances are applied to the quantity available for replacement.

Negative Quantity

Negative quantities support scenarios where the production process also produces by-products that need to be tracked in the system. This applies to **BOMs** with the Materials scope only. Also, Transfer Requirement for material ignore the negative BOM Item and it is not possible to add negative BOM Item for Material deviation in a **Checklist**.

The key difference from normal BOM Items is that consumption happens in reverse: the by-product quantity increases during assembly and decreases during disassembly.

To illustrate an example, consider a juice production, where processing fruit yields peel by-products. These peels may be collected for essential oil extraction or biofuel production.

Main configuration requirements:

- Units of the **Product** to be assembled
- BOM Item **Products**, no substitutes are not allowed for negative BOM Items
- Negative quantity value representing the by-product yield

Reference Items

A reference item is a BOM Item which consumption is not recorded in MES. It is included purely for informational or display purposes within the **BOM**, ensuring that relevant, non-consumable items are visible in the assembly context.

Main configuration requirements:

- Units of the **Product** to be assembled
- BOM Item **Products** and their substitutes
- Flag option `IsReference` set to True for the Reference Items
- Any informational quantity (optional, since it will not be tracked in the system)

Option to Capture

The Option to Capture setting is independent of whether the BOM Item is to be consumed or is just a reference. It enables the collection of specific data during assembly, which is associated with the BOM Item.

This feature is available for **BOMs** with Materials and Parts scope. It does not apply to substitutes, which inherit the capture settings from the main BOM Item.

There are some use cases where this feature might be relevant:

- Capturing lot, batch, or serial numbers for traceability, with or without actual consumption.
- Recording details for external components not tracked as materials in MES, such as cable ties used in machine assembly.
- Enforcing manual entry of specific data during the assembly of certain components.

Main configuration requirements:

- Units of the **Product** to be assembled
- BOM Item **Products** and their substitutes
- Enable the `Information Capture Required` field for the item, and set the `Information Capture` data

Use Case

For this use case, a more specific manufacturing context will be presented, as these concepts are easier to assimilate with a actual production process.

Consider a manufacturing company that assembles Industrial Coffee Machines (**Product**: CMC-5000). Each unit requires a set of components, some of which are consumed proportionally to the quantity of machines, while others are fixed.

The process may also produce by-products, allow tolerances for certain components, include items for reference only, or require optional data capture for traceability.

At the final stages of the production processes, the following steps and requirements must be considered:

Step	BOM Item Functionality	Product	Quantity	Extra Settings	Description
Grinder Assemble	Option to Capture	Coffee Grinder Module	1 per unit	Capture Serial Number	Serial number recorded for warranty and traceability.
Thermal Insulation	Tolerances	Thermal Insulation Foam	1.2 m ² per unit	Lower: 0% ; Upper: 50%	Allows extra usage due to manual cutting imprecision.

Step	BOM Item Functionality	Product	Quantity	Extra Settings	Description
Machine Testing	Negative Quantity	Coffee Grounds Waste	-0.5 kg per unit	—	Produced during testing, collected and sold to composting partner.
Boxing	Reference Item	User Manual	1 per unit	Display only	Included in packaging; not tracked for consumption.
Boxing	Fixed Quantity	Water Quality Test Kit	1 kit (fixed per order)	—	Used once per production order for water flow testing.

For simplicity, the overlaying structure includes a general **Service** provided by a shared **Resource**, which is required by all **Steps**.

In addition, there is a storage **Flow** and a **Step** dedicated to gathering all component Materials.

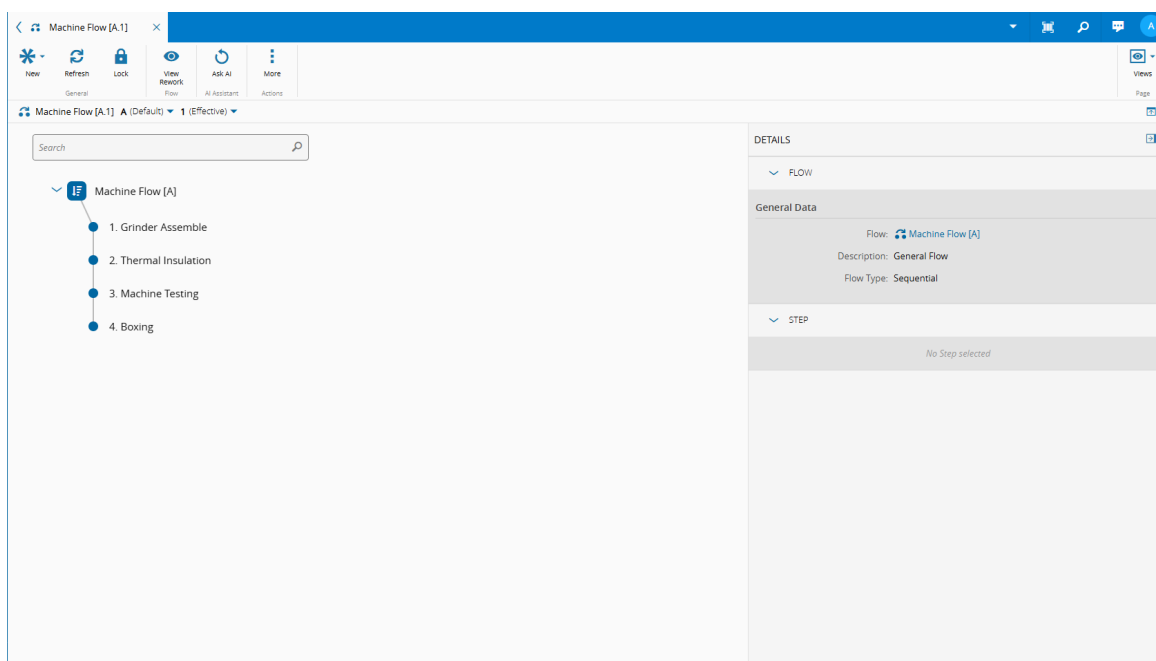
Configuration

Basic configurations like **Calendar**, **Facility**, **Area**, **Resource**, and **Service** are assumed to be pre-defined and are not detailed here.

[Useful Documentation](#)

Steps and Flows

The general configuration of the sequential main production **Flow** and **Step** is detailed in the images below.



Grinder Assemble Step

Grinder Assemble

Refresh Edit Ask AI More

Grinder Assemble (Active)

DETAILS

Step

Name: Grinder Assemble
Description: Grinder Assemble
Type: Standard
Universal State: Active
Data Group:

Information

Processing Type: Process
Display Order: 600
Material Sort Rule Set:
Resource Sort Rule Set:
Lot Traveler:
Material Label:

Material Tracking

Pass-Through: X No
Packing Step: X No
From Packing Level:
To Packing Level:
Sub-Material Track State Depth: 0
Setup Characteristic:
Link Dispatch and Track-In by X No
Default:
Link Track-Out and Move Next X No
by Default:
Track-Out Losses Mode: Main Material
Use Split and Track-Out: X No

Units

Set Units: X No
Primary Units:
Secondary Units:

Settings

Allow Shipping: X No
Allow Material Transfer: X No
Allow Decimal Quantity: X No
Auto Split by Product: X No
Is Plan Counting Step: X No
Marks Product Completion: X No
Enable In-Process Verification: X No

Storage

Queued Storage Service:
Processed Storage Service:

DETAILS

LOGICAL NAMES
AREAS
REASONS
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Thermal Insulation Step

Thermal Insulation

Refresh Edit More

Thermal Insulation (Active)

DETAILS

Step

Name: Thermal Insulation
Description: Thermal Insulation
Type: Standard
Universal State: Active
Data Group:

Information

Processing Type: Process
Display Order: 700
Material Sort Rule Set:
Resource Sort Rule Set:
Lot Traveler:
Material Label:

Material Tracking

Pass-Through: X No
Packing Step: X No
From Packing Level:
To Packing Level:
Sub-Material Track State Depth: 0
Setup Characteristic:
Link Dispatch and Track-In by
Default: ✓ Yes
Link Track-Out and Move Next
by Default: ✓ Yes
Track-Out Losses Mode: Main Material
Use Split and Track-Out: X No

Units

Set Units: X No
Primary Units:
Secondary Units:

Settings

Allow Shipping: X No
Allow Material Transfer: X No
Allow Decimal Quantity: X No
Auto Split by Product: X No
Is Plan Counting Step: X No
Marks Product Completion: X No
Enable In-Process Verification: X No
Enable Step Certification
Process: X No

Storage

Queued Storage Service:
Processed Storage Service:

DETAILS

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Machine Testing Step

Machine Testing

Refresh Edit Ask AI More

Machine Testing (Active)

DETAILS

Step

Name: Machine Testing

Description: Machine Testing

Type: Standard

Universal State: Active

Data Group:

Information

Processing Type: Process

Display Order: 800

Material Sort Rule Set:

Resource Sort Rule Set:

Lot Traveler:

Material Label:

Material Tracking

Pass-Through: X No

Packing Step: X No

From Packing Level:

To Packing Level:

Sub-Material Track State Depth: 0

Setup Characteristic:

Link Dispatch and Track-In by X No

Default:

Link Track-Out and Move Next X No

by Default:

Track-Out Losses Mode: Main Material

Use Split and Track-Out: X No

Units

Set Units: X No

Primary Units:

Secondary Units:

Settings

Allow Shipping: X No

Allow Material Transfer: X No

Allow Decimal Quantity: X No

Auto Split by Product: X No

Is Plan Counting Step: X No

Marks Product Completion: X No

Enable In-Process Verification: X No

Storage

Queued Storage Service:

Processed Storage Service:

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Boxing Step

Boxing

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Boxing (Active)

DETAILS

Step

Name: Boxing

Description: Boxing

Type: Standard

Universal State: Active

Data Group:

Information

Processing Type: Process

Display Order: 900

Material Sort Rule Set:

Resource Sort Rule Set:

Lot Traveler:

Material Label:

Material Tracking

Pass-Through: X No

Packing Step: X No

From Packing Level:

To Packing Level:

Sub-Material Track State Depth: 0

Setup Characteristic:

Link Dispatch and Track-In by X No

Default:

Link Track-Out and Move Next X No

by Default:

Track-Out Losses Mode: Main Material

Use Split and Track-Out: X No

Units

Set Units: X No

Primary Units:

Secondary Units:

Settings

Allow Shipping: X No

Allow Material Transfer: X No

Allow Decimal Quantity: X No

Auto Split by Product: X No

Is Plan Counting Step: X No

Marks Product Completion: X No

Enable In-Process Verification: X No

Storage

Queued Storage Service:

Processed Storage Service:

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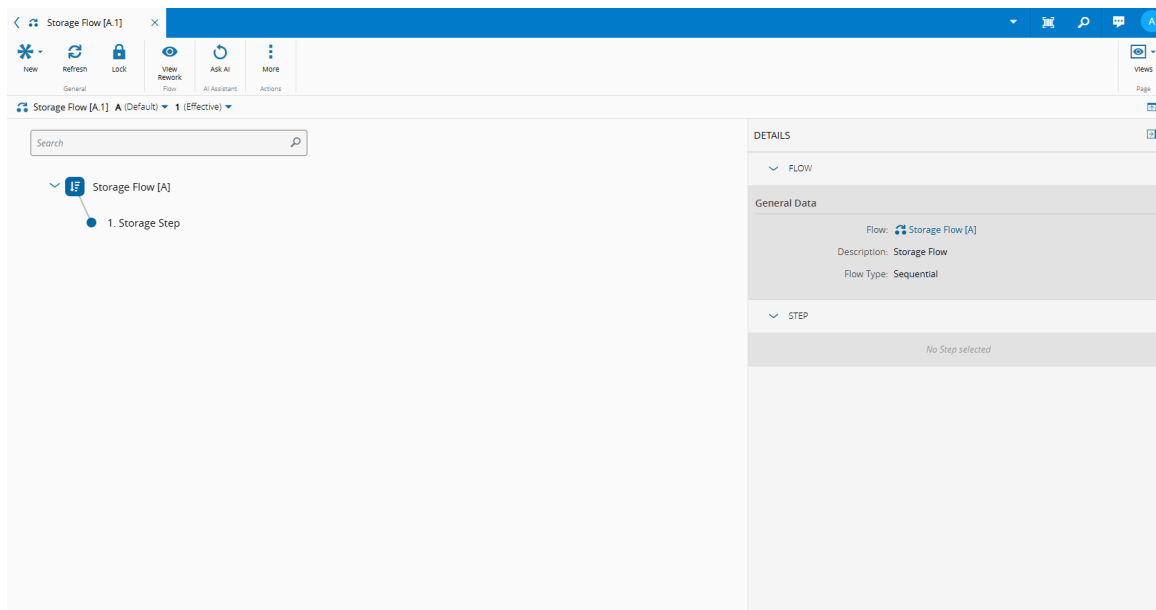
INSPECTIONS

SCHEDULING

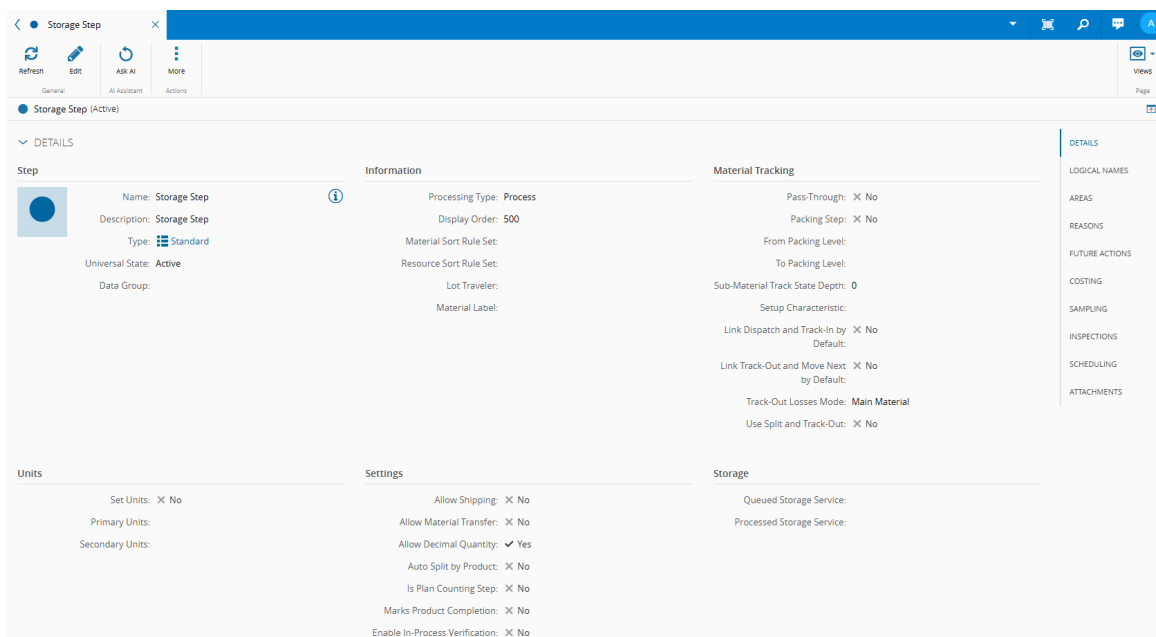
ATTACHMENTS

The general configuration of the sequential storage **Flow** and **Step** is detailed in the images below.

Storage Flow



Storage Step



A few details worth mentioning are the following:

- The property `IsDecimalQuantityAllowed` is set to true for the Storage Step as this **Step** will deal with decimal quantities for **Materials** of the **Product** Thermal Insulation Foam and Coffee Grounds Waste.
- Both Storage and Machine Flows are sequential.

Useful Documentation

- [Create Step](#)
- [How to: Create a Step](#)
- [Create Flow](#)
- [How to: Create a Flow](#)

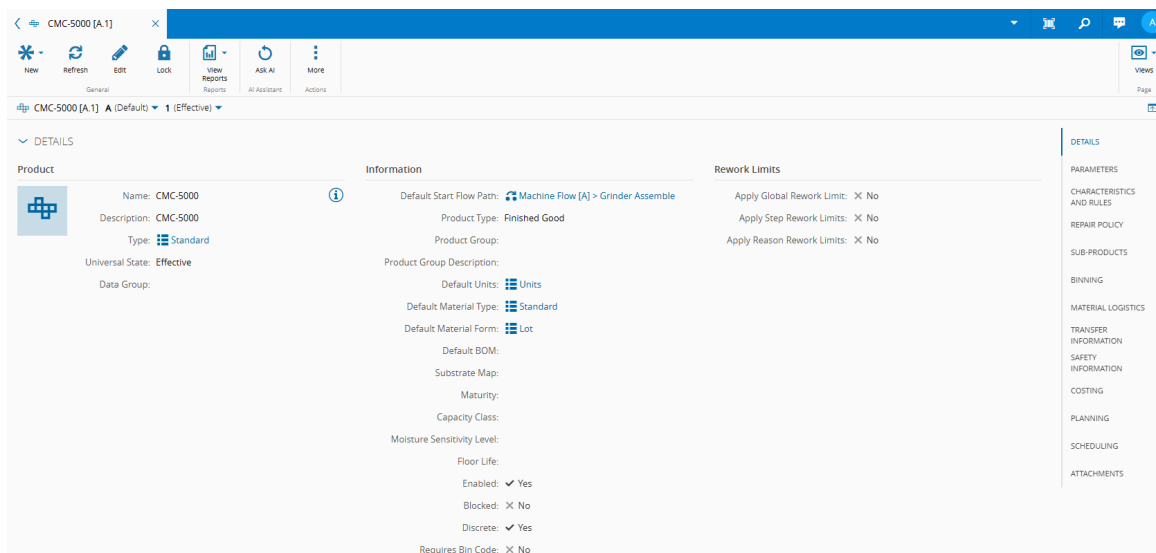
Product

For this scenario, six **Products** are considered:

Product	Product Type	Default Units	Is Discrete
CMC-5000	Finished Good	Units	Yes
Coffee Grinder Module	Raw Material	Units	Yes
Thermal Insulation Foam	Raw Material	m ²	No
Coffee Grounds Waste	Raw Material	Kg	No
User Manual	Raw Material	Units	Yes
Water Quality Test Kit	Raw Material	Units	Yes

The general configuration of the **Products** is detailed in the images below.

CMC-5000



The screenshot shows the 'CMC-5000' product configuration page. The left sidebar contains a 'DETAILS' section with a 'Product' icon. The main content area is divided into three columns: 'Product', 'Information', and 'Rework Limits'. The 'Product' column shows the product name 'CMC-5000', description 'CMC-5000', type 'Standard', and universal state 'Effective'. The 'Information' column shows the default start flow path 'Machine Flow [A] > Grinder Assemble', product type 'Finished Good', product group, and various settings like 'Default Units' (Units), 'Default Material Type' (Standard), 'Default Material Form' (Lot), 'Default BOM', 'Substrate Map', 'Maturity', 'Capacity Class', 'Moisture Sensitivity Level', 'Floor Life', 'Enabled' (Yes), 'Blocked' (No), 'Discrete' (Yes), and 'Requires Bin Code' (No). The 'Rework Limits' column shows 'Apply Global Rework Limit' (No), 'Apply Step Rework Limits' (No), and 'Apply Reason Rework Limits' (No).

Coffee Grinder Module

Coffee Grinder Module
[A.1]

New

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Coffee Grinder Module [A.1] A (Default) 1 (Effective)

DETAILS

Product



Name: Coffee Grinder Module

Description: Coffee Grinder Module

Type: Standard

Universal State: Effective

Data Group:

Information

Default Start Flow Path: Storage Flow [A] > Storage Step

Product Type: Raw Material

Product Group:

Product Group Description:

Default Units: Units

Default Material Type: Standard

Default Material Form: Lot

Default BOM:

Substrate Map:

Maturity:

Capacity Class:

Moisture Sensitivity Level:

Floor Life:

Enabled: Yes

Blocked: No

Discrete: Yes

Requires Bin Code: No

Requires Approval:

Approval Role:

Rework Limits

Apply Global Rework Limits: No

Apply Step Rework Limits: No

Apply Reason Rework Limits: No

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Thermal Insulation Foam

Thermal Insulation Foam
[A.1]

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Thermal Insulation Foam [A.1] A (Default) 1 (Effective)

DETAILS

Product



Name: Thermal Insulation Foam

Description: Thermal Insulation Foam

Type: Standard

Universal State: Effective

Data Group:

Information

Default Start Flow Path: Storage Flow [A] > Storage Step

Product Type: Raw Material

Product Group:

Product Group Description:

Default Units: m²

Default Material Type: Standard

Default Material Form: Lot

Default BOM:

Substrate Map:

Maturity:

Capacity Class:

Moisture Sensitivity Level:

Floor Life:

Enabled: Yes

Blocked: No

Discrete: No

Requires Bin Code: No

Requires Approval:

Approval Role:

Rework Limits

Apply Global Rework Limits: No

Apply Step Rework Limits: No

Apply Reason Rework Limits: No

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Coffee Grounds Waste

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Coffee Grounds Waste [A.1]

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Coffee Grounds Waste [A.1] (Default) 1 (Effective)

DETAILS

Product



Name: Coffee Grounds Waste

Description: Coffee Grounds Waste

Type: Standard

Universal State: Effective

Data Group:

Information

Default Start Flow Path: Storage Flow [A] > Storage Step

Product Type: Raw Material

Product Group:

Product Group Description:

Default Units: Kg

Default Material Type: Standard

Default Material Form: Lot

Default BOM:

Substrate Map:

Maturity:

Capacity Class:

Moisture Sensitivity Level:

Floor Life:

Enabled: Yes

Blocked: No

Discrete: No

Requires Bin Code: No

Requires Approval:

Approval Role:

Rework Limits

Apply Global Rework Limit: No

Apply Step Rework Limits: No

Apply Reason Rework Limits: No

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User Manual

User Manual [A.1]

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User Manual [A.1] (Default) 1 (Effective)

DETAILS

Product



Name: User Manual

Description: User Manual

Type: Standard

Universal State: Effective

Data Group:

Information

Default Start Flow Path:

Product Type: Raw Material

Product Group:

Product Group Description:

Default Units: Units

Default Material Type:

Default Material Form:

Default BOM:

Substrate Map:

Maturity:

Capacity Class:

Moisture Sensitivity Level:

Floor Life:

Enabled: Yes

Blocked: No

Discrete: Yes

Requires Bin Code: No

Requires Approval:

Approval Role:

Rework Limits

Apply Global Rework Limit: No

Apply Step Rework Limits: No

Apply Reason Rework Limits: No

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Water Quality Test Kit

Water Quality Test Kit [A.1]

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Water Quality Test Kit [A.1] (Default) 1 (Effective)

DETAILS

Product



Name: Water Quality Test Kit

Description: Water Quality Test Kit

Type: Standard

Universal State: Effective

Data Group:

Information

Default Start Flow Path: Storage Flow [A] > Storage Step

Product Type: Raw Material

Product Group:

Product Group Description:

Default Units: Units

Default Material Type: Standard

Rework Limits

Apply Global Rework Limit: No

Apply Step Rework Limits: No

Apply Reason Rework Limits: No

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Default Material Form: ☒ Lot
Default BOM:
Substrate Map:
Maturity:
Capacity Class:
Moisture Sensitivity Level:
Floor Life:
Enabled: ☒ Yes
Blocked: ☒ No
Discrete: ☒ Yes
Requires Bin Code: ☒ No
Requires Approval:
Approval Role:

MATERIAL LOGISTICS
TRANSFER INFORMATION
SAFETY INFORMATION
COSTING
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ATTACHMENTS

Useful Documentation

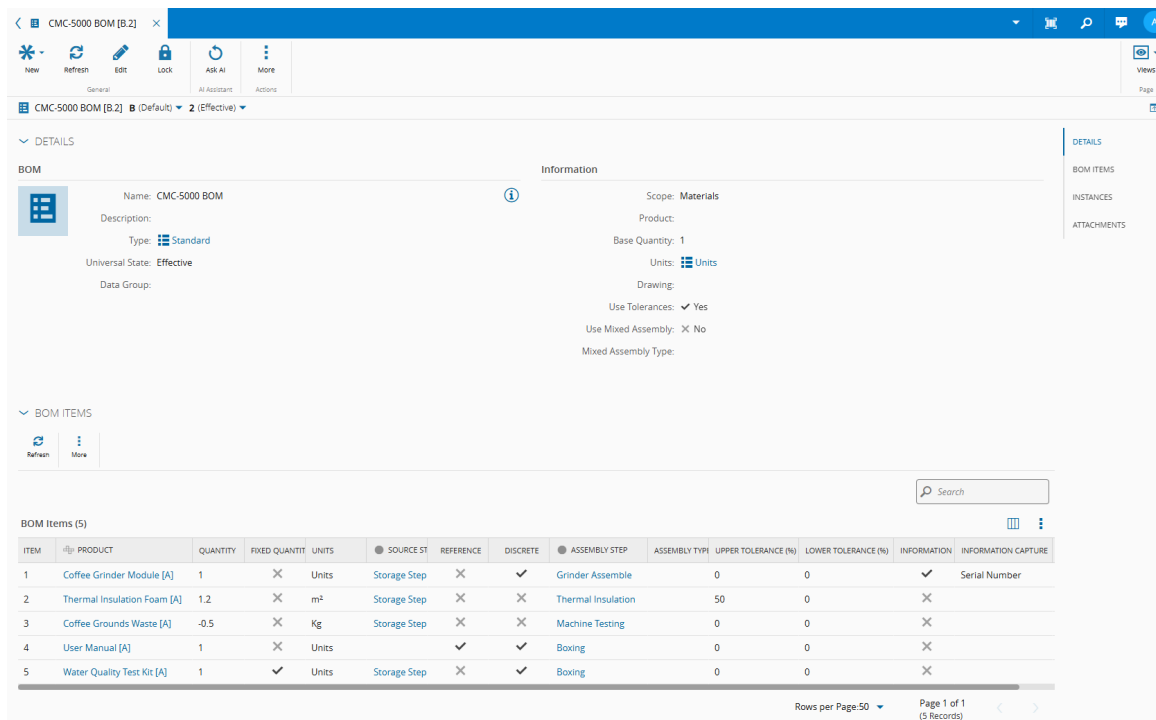
- [Create Product](#)
- [How to: Create a Product](#)

BOM

The **BOM** is configured to be of scope Materials, and to use tolerances. The details to consider for each BOM Item are the following:

Source Product	Quantity	Is Fixed Quantity	Lower Tolerance	Upper Tolerance	Source Step	Assembly Step	Is Ref
Coffee Grinder Module	1 Units	No	0	0	Storage Step	Grinder Assemble	No
Thermal Insulation Foam	1.2 m ²	No	0	50%	Storage Step	Thermal Insulation	No
Coffee Grounds Waste	-0.5 Kg	No	0	0	Storage Step	Machine Testing	No
User Manual	1 Units	No	0	0	Storage Step	Boxing	Yes
Water Quality Test Kit	1 Units	Yes	0	0	Storage Step	Boxing	No

The configuration of the **BOM** and BOM Items can be found in the image below.



CMC-5000 BOM [B.2] (Default) 2 (Effective)

DETAILS

BOM

Name: CMC-5000 BOM

Description:

Type: Standard

Universal State: Effective

Data Group:

Information

Scope: Materials

Product:

Base Quantity: 1

Units: Units

Drawing:

Use Tolerances: Yes

Use Mixed Assembly: No

Mixed Assembly Type:

BOM ITEMS

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Search

BOM Items (5)

ITEM	PRODUCT	QUANTITY	FIXED QUANTITY	UNITS	SOURCE ST	REFERENCE	DISCRETE	ASSEMBLY STEP	ASSEMBLY TYPE	UPPER TOLERANCE (%)	LOWER TOLERANCE (%)	INFORMATION	INFORMATION CAPTURE
1	Coffee Grinder Module [A]	1	X	Units	Storage Step	X	✓	Grinder Assemble		0	0	✓	Serial Number
2	Thermal Insulation Foam [A]	1.2	X	m ²	Storage Step	X	X	Thermal Insulation		50	0	X	
3	Coffee Grounds Waste [A]	-0.5	X	Kg	Storage Step	X	X	Machine Testing		0	0	X	
4	User Manual [A]	1	X	Units		✓	✓	Boxing		0	0	X	
5	Water Quality Test Kit [A]	1	✓	Units	Storage Step	X	✓	Boxing		0	0	X	

Rows per Page: 50 Page 1 of 1 (5 Records)

- The Use Mixed Assembly property is set to false.
- The **BOM** is configured with the Materials scope.
- The Base Quantity property is set to 1.

BOM Context

For each **Step**, when a **Material** of CMC-5000 Product is tracked in, the CMC-5000 BOM will be triggered, and each **Step** has its own assembly type.

The configuration of the BOMContext Smart table is presented in the table below.

Step	Product	BOM	Assembly Type
Grinder Assemble	CMC-5000	CMC-5000 BOM	Explicit
Thermal Insulation	CMC-5000	CMC-5000 BOM	Explicit
Machine Testing	CMC-5000	CMC-5000 BOM	Explicit
Boxing	CMC-5000	CMC-5000 BOM	Explicit Long Running

Useful Documentation

- [How to: Add Value to Smart Table](#)

The master data file supporting this use case is available here: [XML File](#).

Execution

To begin this scenario, a **Material** must exist for each BOM Item that is not marked as a reference (for example, all BOM Items except the User Manual **Product**). These Materials must be available at the Storage Step of the Storage Flow, with sufficient quantity to fulfill the demand of the main **Material**.

In addition, a **Material** with a quantity greater than 0 must exist to simulate the production of a CMC-5000 **Product**. This **Material** should be placed at the Grinder Assemble **Step** of the Machine Flow.

Grinder Assemble **Step**:

1. Dispatch and Track-In the CMC-5000 **Material**.
 - The **BOM** information for the BOM Item Coffee Grinder Module and its required quantity is displayed.
2. Perform Assemble.
 - Select the component **Material**.
 - The system prompts for the Serial Number, as defined in the configuration.
 - Once assembled, it is possible to perform Disassemble or Replace.
3. After the full **Material** quantity is assembled, Track-Out and Move Next.

Thermal Insulation **Step**:

1. Dispatch and Track-In the CMC-5000 Material.
 - The **BOM** information for the BOM Item Thermal Insulation Foam and its required quantity is displayed.
2. Perform Assemble.
 - Select the component **Material**.
 - Since this BOM Item has tolerances, the user may assemble a quantity within the allowed range (up to 50% above the theoretical requirement).
 - Because this step uses the Explicit Assembly type, it is also possible to disassemble quantities within the defined tolerances, as explained above.
3. After the full **Material** quantity is assembled, Track-Out and Move Next.

Machine Testing **Step**:

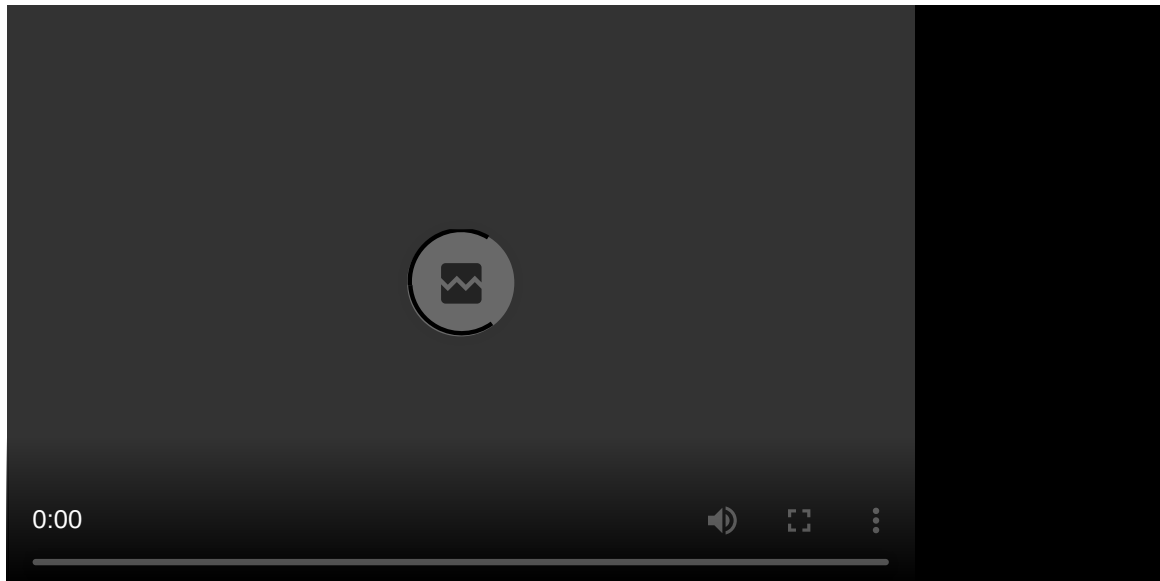
1. Dispatch and Track-In the CMC-5000 **Material**.
 - The BOM information for the BOM Item Coffee Grounds Waste and its expected quantity is displayed.
2. Perform Assemble.
 - Select the component **Material**.
 - As this BOM Item represents a by-product, the quantity of the source **Material** increases when assembled.
 - Once assembled, it is possible to perform Disassemble or Replace.
3. After the full **Material** quantity is assembled, Track-Out and Move Next.

Boxing **Step**:

1. Dispatch and Track-In the CMC-5000 **Material**.
 - The **BOM** information for the BOM Items User Manual and Water Quality Test Kit, along with their required quantities, is displayed.
2. Perform Assemble.
 - For the User Manual, marked as a Reference BOM Item, no source **Material** is required.

- For the Water Quality Test Kit, configured with a fixed quantity of 1, only one kit is consumed/assembled regardless of the main **Material** quantity.
- Once assembled, it is possible to perform Disassemble or Replace.

3. After the full **Material** quantity is assembled, Track-Out.





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