Forecasting (LO-PR)

HELP.LOPR

Release 4.6C

Copyright

© Copyright 2001 SAP AG. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or for any purpose without the express permission of SAP AG. The information contained herein may be changed without prior notice.

Some software products marketed by SAP AG and its distributors contain proprietary software components of other software vendors.

Microsoft®, WINDOWS®, NT®, EXCEL®, Word®, PowerPoint® and SQL Server® are registered trademarks of
Microsoft Corporation.

IBM®, DB2®, OS/2®, DB2/6000®, Parallel Sysplex®, MVS/ESA®, RS/6000®, AIX®, S/390®, AS/400®, OS/390®, and OS/400® are registered trademarks of IBM Corporation.

ORACLE® is a registered trademark of ORACLE Corporation.

INFORMIX®-OnLine for SAP and Informix® Dynamic Server™ are registered trademarks of Informix Software Incorporated.

UNIX®, X/Open®, OSF/1®, and Motif® are registered trademarks of the Open Group.

HTML, DHTML, XML, XHTML are trademarks or registered trademarks of W3C®, World Wide Web Consortium,
Massachusetts Institute of Technology.

JAVA® is a registered trademark of Sun Microsystems, Inc.

JAVASCRIPT® is a registered trademark of Sun Microsystems, Inc., used under license for technology invented and implemented by Netscape.

SAP, SAP Logo, R/2, RIVA, R/3, ABAP, SAP ArchiveLink, SAP Business Workflow, WebFlow, SAP EarlyWatch, BAPI, SAPPHIRE, Management Cockpit, mySAP.com Logo and mySAP.com are trademarks or registered trademarks of SAP AG in Germany and in several other countries all over the world. All other products mentioned are trademarks or registered trademarks of their respective companies.

Icons

Icon	Meaning
	Caution
	Example
	Note
	Recommendation
	Syntax

Contents

Forecasting (LO-PR) 6
The Forecast in SOP 7
Forecast Models 8
Forecast Parameters 10
Model Selection 12
Manual Model Selection 13
Automatic Model Selection 15
Model Initialization 17
Ex-Post Forecast 18
Forecasting Online 19
Analyzing the Time Series and Modifying the Historical Values 21
Changing the Forecast Results 22
Forecast Profiles 23
Creating a Forecast Profile 25
Forecast Versions 26
Copying a Historical Time Series 27
Forecast Formulas 28
Material Forecast 36
Forecast Parameters 37
Forecast Models 38
Model Selection 40
Manual Model Selection 41
Automatic Model Selection 43
Manual Model Selection with Additional System Check 44
Model Initialization 45
Ex-Post Forecast 46
Parameter Optimization 47
Maintaining Forecast Parameters 48
Forecast Parameters: Dependent on the Forecast Model 49
Forecast Parameters: Independent of the Forecast Model 52
Creating Historical Data 54
Creating Forecast Values 55
Carrying out the Forecast with Reference to Another Material 56
Maintaining Parameters Using Profiles 57
Creating a Profile 58
Displaying a Profile 60
Changing a Profile 61
Deleting a Profile 62
Where-Used List for Profiles 63
Carrying Out the Forecast 64
Things to Think About Before Carrying out the Forecast 65
Forecast Options 66
Carrying Out the Individual Forecast 67
Carrying Out the Total Forecast 69
Carrying Out the Total Forecast in Background Mode 71

Calculating the Forecast Values **72**
Calculating the Safety Stock and the Reorder Level **73**
Ex-Post Forecast **74**
Monitoring the Selected Forecast Model **75**
How Does the System Optimize the Smoothing Factors **76**
Forecast Result **77**
Checking the Forecast Result Using a List 78
Checking the Forecast Result in Online Mode 79
Changing the Forecast Results 81
Significance of the Material Forecast for Materials Planning **82**
Reducing Forecast Requirements 83
Effects on Consumption-Based Planning Procedures 84
Splitting the Forecast Requirements 85
Forecast Formulas **86**
Moving Average Model 87
Weighted Moving Average Model 88
Principles of First-Order Exponential Smoothing 89
Constant Model with First-Order Exponential Smoothing 90
Trend and Seasonal Models with First-Order Exponential Smoothing 91
Second-Order Exponential Smoothing 93
Evaluating Forecast Accuracy 94
Safety Stock Calculation 96
Reorder Level Calculation 98

Forecasting (LO-PR)

Forecasting (LO-PR)

The Forecast in SOP

With the forecast, you can estimate the future progression of values in a time series on the basis of past history. You do this either online or in the background.

In standard SOP, you can forecast the sales quantities of a product group or material. The system bases the forecast on the historical consumption of materials. It then aggregates these results to the product group level. Consumption data includes every kind of goods issue, even goods that have been written off as scrap.

In flexible planning, you can forecast any key figure that you want, provided that it has been defined for forecasting in Customizing (in *Set parameters for info structures and key figures*). The system bases the forecast on the actual values of this key figure. In level-by-level planning, you can also base the forecast on historical consumption data. In this case, the information structure must contain the characteristics “material” and “plant,” and you must set the *Consumpn.* indicator in the forecast profile.

In level-by-level planning, you can base the forecast on the consumption quantities of a “reference material.” This is useful if you do not have any historical values for a material; for example, because it is new. You define the reference material in the material master record.

The historical data is automatically aggregated to the current planning level before the forecast is carried out. If you run the forecast online, this is the planning level on which you are working in the planning table. If you run the forecast in the background, this is the planning level you define in the job variant.

If you run the forecast at a high level and the results are disaggregated to the detailed level, the results will be different than if you carry out the forecast at the detailed level.

See also:

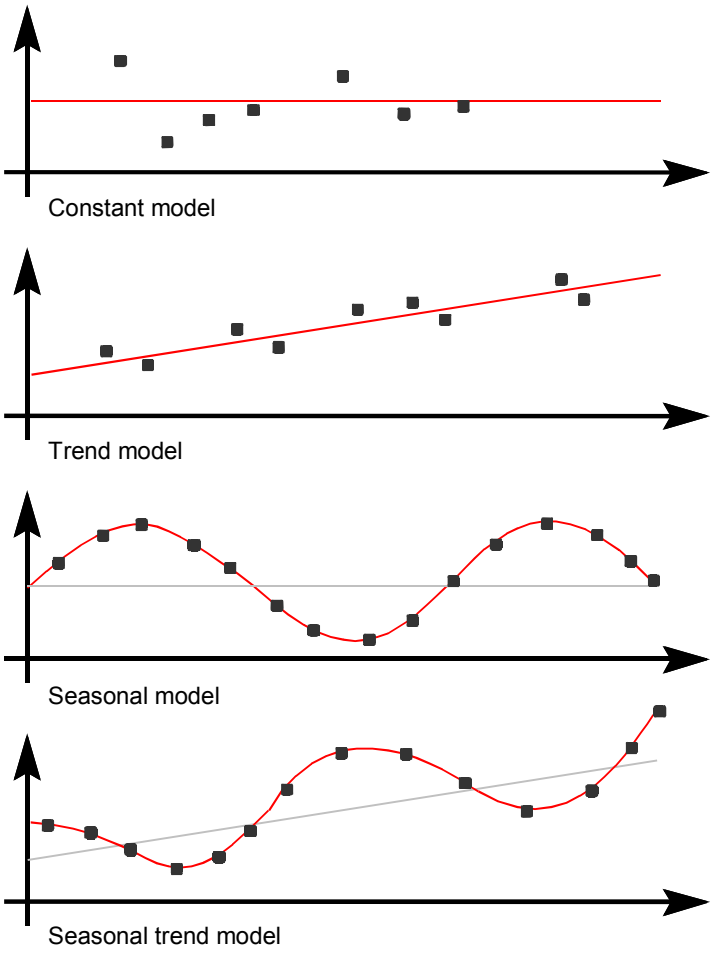
Forecasting Online [Page 19]

Mass Processing in SOP [Ext.]

Forecast Models

When a series of consumption values is analyzed, it normally reveals a pattern or patterns. These patterns can then be matched up with one of the forecast models listed below:

- Constant—consumption values vary very little from a stable mean value
- Trend—consumption values fall or rise constantly over a long period of time with only occasional deviations
- Seasonal—periodically recurring peak or low values differ significantly from a stable mean value
- Seasonal trend—continual increase or decrease in the mean value
- Copy of actual data (no forecast is executed)—copies the historical data updated from the operative application, which you can then edit
- Irregular—no pattern can be detected in a series of historical consumption values



Forecast Parameters

Maintenance of the following parameters is optional or mandatory, depending on how you carry out model selection and which model you choose; that is, the forecast parameters are dependent on the forecast model. Which parameters are required for which model is shown in the table below.

Forecast Parameters Dependent on the Forecast Model

Specified model/model to be tested	Mandatory parameters
Constant models: First-order exponential smoothing model	Alpha factor
First-order exponential smoothing model with optimization of the smoothing factors	-
Moving average model	Number of historical values
Weighted moving average model	Weighting group
Trend models: First-order exponential smoothing model	Alpha and beta factors
Second-order exponential smoothing model	Alpha factor
Second-order exponential smoothing model with optimization of the smoothing factors	
Seasonal model: Winters' method	Alpha and gamma factors Periods per season
Seasonal trend model: First-order exponential smoothing model	Alpha, beta, and gamma factors Periods per season

Weighting group

You only have to maintain this field if you selected the forecast model “weighted moving average”. This key specifies how many historical values are included in the forecast and how these values are weighted in the forecast calculation.

Periods per seasonal cycle

You only have to specify the number of periods per season if you have selected the seasonal model or if you want the system to carry out a seasonal test.

The following factors are used by the system, depending on the model, for exponential smoothing. Thus, for example, only the alpha and the delta factors are required for the constant model, whereas all the smoothing factors are required for the seasonal trend model.

Alpha factor

The system uses the alpha factor to smooth the basic value. If you do not specify an alpha factor, the system will automatically use the alpha factor set in the profile. In the standard SAP profile, this is the factor 0.2.

Beta factor

The system uses the beta factor to smooth the trend value. If you do not specify a beta factor, the system will automatically use the beta factor set in the profile. In the standard SAP profile, this is the factor 0.1.

Gamma factor

The system uses the gamma factor to smooth the seasonal index. If you do not specify a gamma factor, the system will automatically use the gamma factor set in the profile. In the standard SAP profile, this is the factor 0.3.

Delta factor

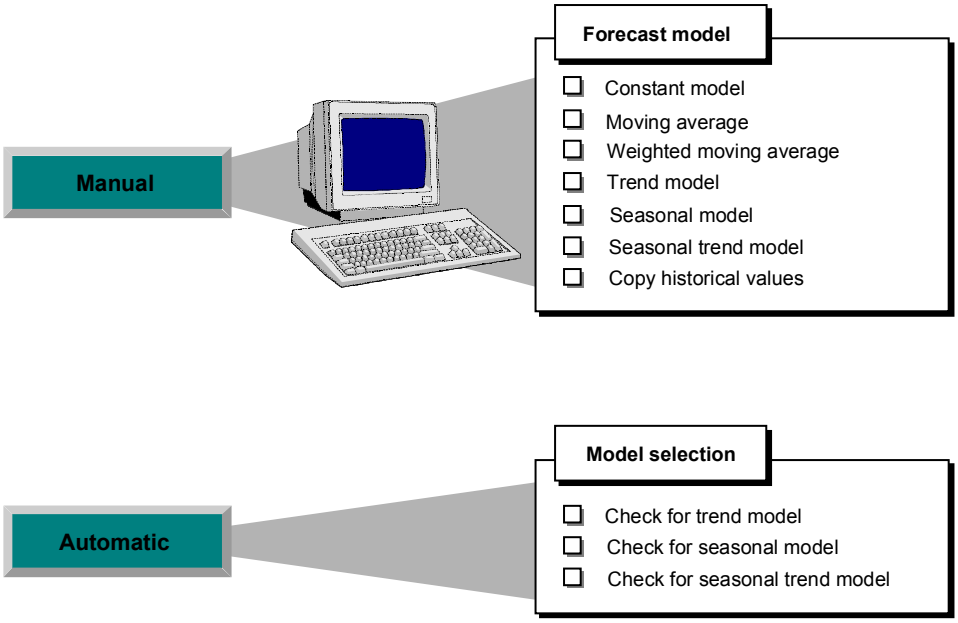
The system uses the delta factor 0.3 in every forecast model to smooth the mean absolute deviation.

Model Selection

Before you run a forecast, you must specify which model the system should use to calculate the forecast values.

There are three possibilities:

- Manual model selection
- Automatic model selection
- Manual model selection with the system also testing for a pattern



Manual Model Selection

If you want to select a model manually, you must first analyze the historical data to determine whether a distinct pattern or trend exists. You then define your forecast model accordingly.

Constant pattern

If your historical data represents a constant consumption flow, you select either the constant model or the constant model with adaptation of the smoothing factors. In both cases, the forecast is carried out using first-order exponential smoothing. When adapting the smoothing parameters, the system calculates different parameter combinations and then selects the optimum parameter combination. The optimum parameter combination is the one which results in the lowest mean absolute deviation.

You have another two possibilities if the historical pattern is constant; either the moving average model or the weighted moving average model.

In the weighted moving average model, you weight individual historical values with the result that the system does not give equal value to historical data when calculating the forecast values. By so doing, you can influence the calculation so that more recent historical values play a more important role in the forecast than less recent ones—as is also the case with exponential smoothing.

Trend pattern

If your historical data represents a trend, you should select either the trend model or a second-order exponential smoothing model. In the trend model, the system calculates the forecast values using first-order exponential smoothing.

In the second-order exponential smoothing models, you can choose a model with or without a model parameter optimization.

Seasonal pattern

If your historical data represents a seasonal pattern, you specify the seasonal model. The system calculates the forecast values for the seasonal model using first-order exponential smoothing.

Seasonal trend pattern

If your historical data represents a seasonal trend pattern, you select a seasonal trend model. The system calculates the forecast values using first-order exponential smoothing.

Irregular pattern

If you cannot detect any of the above trends or patterns, and you still want the system to carry out a forecast, it is usually advisable to select either the moving average model or the weighted moving average model.

Forecast Models for Different Historical Patterns

Pattern	Forecast model

Manual Model Selection

Constant	Constant model Constant model with smoothing factor adaptation Moving average model Weighted moving average model
Trend	Trend model (1st-order exponential smoothing) Trend model (2nd-order exponential smoothing model, with and without parameter optimization)
Seasonal	Seasonal model (Winters' method)
Seasonal trend	Seasonal trend model (1st-order exponential smoothing model)
Irregular	No forecast Moving average model Weighted moving average model

Automatic Model Selection

If you do not want to specify a forecast model manually, you must instruct the system to make an automatic selection. With automatic selection, the system analyzes the historical data and then selects the most suitable model. The following models are possible:

- Constant
- Trend
- Seasonal
- Seasonal trend

If the system cannot detect any regular pattern in the historical data, it automatically selects the constant model.

The system requires a different number of historical values for different tests. For further information, see Model Initialization [Page 17].

Model Selection Procedures

You choose between two procedures for automatic model selection:

Procedure 1

If you want the system to select the forecast model, you can choose between various statistical tests and test combinations which determine the model. The test that is carried out depends on your level of knowledge (see table below).

Trend test

In the trend test, the system subjects the historical values to a regression analysis and checks to see whether there is a significant trend pattern.

Seasonal test

In the seasonal test, the system clears the historical values of any possible trends and then carries out an auto-correlation test.

Pattern	Test
No information	Test for trend and seasonal patterns
No trend	Test for seasonal pattern
No season	Test for trend pattern
Trend	Test for seasonal pattern
Season	Test for trend pattern

If you know that a particular pattern exists or does not exist before the model is selected, you can have the system test the historical time series for a trend pattern or a seasonal pattern.

Automatic Model Selection

If you are unable to make any statement about the historical pattern, the system carries out a trend test and a seasonal test. The forecast model is determined on the basis of which test produces the more significant results (see table below).

Test / Level of Knowledge	Trend	Season
None	X	X
No trend pattern		X
No seasonal pattern	X	
Trend pattern		X
Seasonal pattern	X	

Procedure 2

The system calculates the models to be tested using various combinations for alpha, beta, and gamma. The smoothing factors are also varied between 0.1 and 0.5 in intervals of 0.1. The system then chooses the model which displays the lowest mean absolute deviation (MAD). Procedure 2 is more precise than procedure 1, but takes much longer.

To use procedure 2 in mass processing, set forecast strategy 56 in the forecast profile. If you run the forecast online and set *Automatic model selection* in the Model Selection dialog box, a further dialog box appears in which you can set procedure 2 as one of your forecast parameters.

Model Initialization

Model initialization is the process of determining the necessary model parameters—such as the basic value, the trend value, and the seasonal indices—for the selected forecast model. Initialization takes place each time a planning time series is forecasted.

The following table shows you which model parameters are necessary for each forecast model.

Model	Model parameters
Constant model	Basic value
Trend model	Basic value, trend value
Seasonal model	Basic value, seasonal indices
Seasonal trend model	Basic value, trend value, seasonal indices

As a general rule, the forecast model is initialized automatically. In order to do this, the system requires a certain number of historical values. This number depends on the forecast model, as shown in the following table.

Model	No. of historical values
Constant model	1
Trend model	3
Seasonal model	1 season
Seasonal trend model	1 season + 3
2nd-order exp. smoothing	3
Moving average	1
Weighted moving average	1

The system calculates the basic value on the basis of the average and the trend using the results of the regression analysis. The seasonal indices are given by the actual historical value divided by the basic value adjusted for the trend value.

These calculation methods are used for the constant, trend, seasonal, and seasonal trend models, depending on which parameters are to be determined.

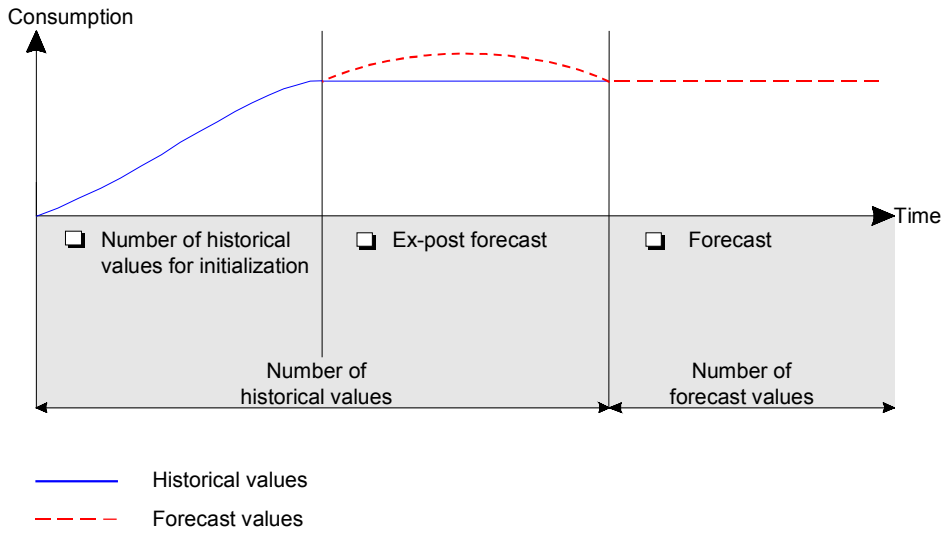
A regression analysis is carried out for the second-order exponential smoothing model.

For the moving average and weighted moving average models, the system calculates an average value.

Ex-Post Forecast

If more historical values are available than are required for the system needs initialize the model, an ex-post forecast is carried out automatically as follows:

- The historical values are divided into two groups: the first group with the older values is used for initialization; the more recent values in the second group are used to carry out an ex-post forecast (see the figure below).
- The basic value, the trend value, the seasonal index, and the mean absolute deviation (MAD) are modified in every ex-post period. These values are used to calculate the forecast results in the future.
- The error total is calculated using the ex-post forecast results. The error total allows you to assess the accuracy of the chosen forecast model.



Forecasting Online

The forecast is one way to obtain planning data in Sales & Operations Planning (SOP). If necessary, you can change the forecast results after you have copied them to the planning table.

1. Place the cursor in the planning table on the key figure (if you are planning the characteristic view) or the characteristic (if you are planning the key figure view) for which you want to carry out a forecast.
2. Select the columns of the periods you want to be forecasted by choosing *Edit* → *Select*.

   See also Selecting Columns in the Planning Table [Ext.].
3. Choose *Edit* → *Forecast.* Or, if you are planning product group or material sales quantities in the standard planning table, choose *Edit* → *Sales plan* → *Forecast* → *Execute*.

   The *Model Selection* dialog box appears.
4. Specify the start and finish dates of the period for which you want to forecast data.
5. Specify the start and finish dates of the historical period on which the forecast is to be based.

   In standard SOP, the forecast is based on consumption data (historical usage data). In flexible planning, the historical values on which the forecast is based are actual data; that is, the forecast is based on the key figure values updated to information structures from the operational applications. In the case of level-by-level planning, you can define the forecast profile such that the forecast is based on consumption data or on the consumption data of a reference material. You maintain the reference material in the material master record.
6. Analyze the time series and, if necessary, correct the historical values (see Analyzing the Time Series and Modifying the Historical Values [Page 21]). Alternatively, you can base the forecast on the corrected historical values of the previous forecast version by setting the *Corr. vals* indicator in the forecast profile.
7. Check to see if the forecast profile displays settings you want to use. If not, choose a different forecast profile with *Forecast profile*.

   Do not try to choose a different forecast profile by using the possible entries button in the field *Profile*.
8. Choose *Perform forecast*.

   The *Forecast Parameters* dialog box appears.
9. Define the forecast parameters for the selected model.
10. Choose *Perform forecast*.

    A dialog box displaying the forecast results appears (see Interpreting the Forecast Results [Ext.]).

If the forecast results are not what you expected, check the settings in your forecast profile.

11. If necessary, change the forecast results (see Changing the Forecast Results [Page 81]).
12. Flag the forecast results for saving in one of two ways:

– Choose *Copy results* if you want to copy the forecast results into the planning table.

– Choose *Save* if you want to save the forecast results in the forecast versions database but do not want to copy the forecast results into the planning table. The prerequisite for saving the results to the forecast database is that you have **not** set the indicator *Do not save to forecast DB* in Customizing (the Customizing activity is *Set parameters of info structures and key figures*).

13. To save the forecast version, you must save the planning version by choosing *Planning* → *Save* in the planning table.

See also:

Forecast Versions [Page 26]

How to Run the Forecast with Mass Processing [Ext.]

Analyzing the Time Series and Modifying the Historical Values

Before you run the forecast, you can check and, if necessary, change the historical values on which the forecast will be based.

1. From the initial forecast dialog box in the planning table, choose *Historical*.

   A dialog box appears listing historical data from the specified period. Historical data is displayed in the *Val.fld* column for each period.

2. Make any necessary corrections to the original values in the *Corr.value* column.

   These are the values that will be used in the forecast.

Time Series Analysis Using Interactive Graphics

The interactive graphics help you to spot patterns and trends at a glance. You can modify your historical data directly in the graphic.

1. Choose *Interact.graphics*.

   A business graphic appears showing the historical values for the specified period.

2. Choose *Edit* → *Modify objects (analog)*.
3. Analyze the time series by comparing the graphic with the models listed in Forecast Parameters [Page 10].
4. Fine-tune the forecast by correcting unusual or extreme values directly in the business graphic: click on the relevant column, hold the mouse button down, and move the mouse until the desired value is obtained.
5. To accept the corrected values for use in the forecast, choose *Copy*.

   A dialog box appears in which you see the revised historical data.

6. Choose *Perform forecast*.

   A dialog box appears in which you define the forecast parameters (see Forecast Parameters [Page 10]).

7. To carry out the forecast, choose *Perform forecast*.

   A dialog box appears displaying the forecast results.

Changing the Forecast Results

You correct the forecast results in the same way as you correct the historical values on which the forecast is based.

One method is to enter a new value in the *Corrected forecast value* column of the *Forecast Results* dialog box.

Alternatively, you can use the interactive graphics:

1. From the *Forecast Results* dialog box, choose *Interact.graphics*.

   A business graphic and a statistics graphic appear. You can modify forecast values in the business graphic. The statistics graphic gives you an overview of the forecast and shows all the forecasted data. Thus, the statistics graphic provides a good basis for evaluating the quality of the forecast.

2. In the business graphic, choose *Edit* → *Modify objects (analog)*.

3. To change a forecast value, click on the relevant column, hold the mouse button down, and move the mouse until the item acquires the desired value.

4. To adopt the corrected value(s) in your forecast results, choose *Copy*.

   A dialog box appears showing the revised forecast results.

5. To copy the forecast results into the planning table, choose *Copy results.* You can make further revisions to your forecast results in the planning table.

Forecast Profiles

Forecast profiles allow you to run the forecast over and over again without redefining the forecast settings. The forecast settings are stored in a forecast profile.

You can use a forecast profile as often as you want to forecast a key figure. Because you define the forecast profile separately from the key figure, you can use the same forecast profile to forecast several key figures, or you can forecast the same key figure several times using different profiles.

You run the forecast based on a forecast profile, either online or in the background.

The forecast profiles in SOP are different than those in the material master. In SOP, you can use one forecast profile to forecast a whole group of materials. In the material master, each material has its own forecast profile.

Forecast Period

The period indicator on which you base the forecast can be different than the storage periodicity. You maintain the forecast period in the *Period ind.* field of the forecast profile.

See also Period Units [Ext.].

Forecast Strategy

Each profile includes a forecast strategy. This specifies the forecast model together with the desired parameters, or the model selection procedure. The following strategies are available:

Forecast Strategy	Forecast Strategy Description
10	Constant model
11	Constant model with first-order exponential smoothing
12	Constant model with automatic alpha adaptation and first-order exponential smoothing
13	Constant model based on the moving average model
14	Constant model based on the weighted moving average model
20	Trend model
21	Trend model with first-order exponential smoothing
22	Trend model with second-order exponential smoothing
23	Trend model with automatic alpha adaptation and second-order exponential smoothing
30	Seasonal model
31	Seasonal model based on the Winters' method
40	Seasonal trend model

Forecast Profiles

41	Seasonal trend model with first-order exponential smoothing
50	Automatic model selection
51	Automatic model selection with test for trend
52	Automatic model selection with test for season
53	Automatic model selection with test for trend and season
54	Automatic model selection assuming a seasonal pattern and with an additional test for a trend pattern
55	Automatic model selection assuming a trend pattern and with an additional test for a seasonal pattern
60	Historical data is copied

For more information on individual parameters in the forecast profile, please see the F1 Help.

See also:

Forecast Models [Page 8]

Forecast Parameters [Page 10]

Manual Model Selection [Page 13]

Automatic Model Selection [Page 15]

Creating a Forecast Profile

To create a forecast profile [Page 23]:

1. Choose *Settings* → *Forecast profile* from one of the main SOP menus.

   The forecast profile configuration overview appears.

2. Choose *Edit* → *New entries*.

   The new entries screen appears.

3. Enter a unique name for your forecast profile and a profile description.

4. Make your settings.

   The forecast strategy is either a forecast model or a model selection procedure. For further information on this and other settings, see Forecast Models [Page 8], Forecast Parameters [Page 10], Manual Model Selection [Page 13], and Automatic Model Selection [Page 15].

5. To save your forecast profile, choose *Table view* → *Save*.

   You can also create forecast profiles in Customizing for Sales & Operations Planning (SOP).

Forecast Versions

By saving many versions of the forecast for one key figure and characteristic values combination, you can compare, for example, forecasts based on different models but using the same historical data, or forecasts with corrected and uncorrected historical time series.

In consistent planning, forecast versions are saved at the detailed level only.

In level-by-level planning, forecast versions are saved at the level on which you create them.

This function is not available with delta planning.

To access the forecast versions of a product group, material, or other characteristic value, choose *Versions* in the model selection dialog box. For each version, you see:

- The date on which the forecast was run.
- The version's history number.

  The version numbers show you the sequence in which forecast versions based on this forecast model were created.
- The version number of the forecast profile, that is, of the forecast parameters.

  Each forecast profile has its own version number. The combination of history number and forecast profile version number uniquely identifies a forecast version.
- The description of the forecast profile.
- The status of the forecast profile.
  - Status 1 designates the last version to be copied to the planning table.
  - Status 2 designates the last version to be saved but not copied to the planning table.
  - A blank designates any older version that was saved or copied to the planning table.

To copy a previously saved forecast version into the planning table, select the version you want to copy in the *Versions* dialog box and then use the *Choose* and *Copy results* pushbuttons.

To delete one or more forecast versions in the background, choose *Planning* → *Mass processing* → *Reorg. forecast*. You can opt to delete one or more forecast versions based on a particular forecast model (that is, a particular combination of forecast parameters). You can also delete individual forecast versions online, by choosing *Versions* and *Delete* in the forecast dialog box.

By setting the indicator *Do not save to forecast DB*, you can switch off the use of forecast versions. You set this indicator by choosing *Set parameters of info structures and key figures* in Customizing. The forecast results are then saved in the information structure but not in the forecast database. Therefore, if you run the forecast and copy the results to the planning table, any previous forecast results are lost. The advantage of setting this indicator is that you achieve performance improvements.

See also:

Forecasting Online [Page 19]

Copying a Historical Time Series

To copy a historical time series from one forecast version to another:

1. From the planning table in flexible planning, choose *Edit* → *Forecast* → *Execute*. Or, in standard SOP, choose *Edit* → *Sales plan* → *Forecast* → *Execute*.

   The model selection box appears.

2. Choose *Versions*.

   The forecast version selection box appears.

3. To identify the forecast version whose historical time series you want to copy, select a version and then press *Display*. Repeat this process until you find the desired time series.

4. To copy this historical time series to a new forecast version, choose *Copy*.

   The forecast version selection box appears again.

5. Choose *Choose*.

   The model selection box appears.

6. To view the historical time series you have just copied, choose *Historical*.

7. Make any necessary corrections to the historical data before continuing with the forecast.

Forecast Formulas

The statistical forecast is based on several types of formula:

- Formulas on which the forecast models are based
- Formulas that are used to evaluate the forecast results
- Formula to calculate the tolerance lane for automatic outlier correction

Formulas for Forecast Models

Moving Average Model

This model is used to exclude irregularities in the time series pattern. The average of the n last time series values is calculated. The average can always be calculated from n values according to formula (1).

Formula for the Moving Average

$$(1) \quad M(t) = \frac{V(t) + V(t-1) + \ldots + V(t-n+1)}{n}$$

$$(2) \quad M(t+1) = M(t) + \frac{V(t+1) - V(t-n+1)}{n}$$

Thus, the new average is calculated from the previous average value and the current value weighted with 1/n, minus the oldest value weighted with 1/n.

This procedure is only suitable for time series that are constant, that is, for time series with no trend-like or season-like patterns. As all historical data is equally weighted with the factor 1/n, it takes precisely n periods for the forecast to adapt to a possible level change.

Weighted Moving Average Model

You achieve better results than those obtained with the moving average model by introducing weighting factors for each historical value. In the weighted moving average model, every historical value is weighted with the factor R. The sum of the weighting factors is 1 (see formulas (3) and (4) below).

Formula for the Weighted Moving Average

$$(3) \quad M(t) = \frac{V(t)}{n} + \frac{V(t-1)}{n} + \ldots + \frac{V(t-n+1)}{n}$$

$$(4) \quad M(t) = R(t) * V(t) + R(t-1) * V(t-1) + \ldots + R(t-n+1) * V(t-1)$$

M = Average
V = Actual value
R = Weighting factor

If the time series to be forecasted contains trend-like variations, you will achieve better results by using the weighted moving average model rather than the moving average model. The weighted moving average model weighs recent data more heavily than older data when determining the average, provided you have selected the weighting factors accordingly. Therefore, the system is able to react more quickly to a change in level.

The accuracy of this model depends largely on your choice of weighting factors. If the time series pattern changes, you must also adapt the weighting factors.

First-Order Exponential Smoothing Model

The principles behind this model are:

- The older the time series values, the less important they become for the calculation of the forecast.
- The present forecast error is taken into account in subsequent forecasts.

Constant Model

The exponential smoothing constant model can be derived from the above two considerations (see formula (5) below). In this case, the formula is used to calculate the basic value. A simple transformation produces the basic formula for exponential smoothing (see formula (6) below).

Formulas for Exponential Smoothing

Determining the Basic Value

$$(5) \quad G(t) = G(t-1) + \alpha\,(V(t) - G(t-1))$$

$$(6) \quad G(t) = \alpha V(t) + (1 - \alpha)\,G(t-1)$$

Determining the Basic Value

G(t)	=	The current basic value for the current period (t)
G(t-1)	=	The previous basic value from the previous period
V(t)	=	Actual demand for the current period (t)
α	=	Smoothing factor for the basic value

To determine the forecast value, all you need is the preceding forecast value, the last historical value, and the “alpha” smoothing factor. This smoothing factor weights the more recent historical values more than the less recent ones, so they have a greater influence on the forecast.

How quickly the forecast reacts to a change in pattern depends on the smoothing factor. If you choose 0 for alpha, the new average will be equal to the old one. In this case, the basic value calculated previously remains; that is, the forecast does not react to current data. If you choose 1 for the alpha value, the new average will equal the last value in the time series.

The most common values for alpha lie, therefore, between **0.1** and **0.5**. For example, an alpha value of **0.5** weights historical values as follows:

1st historical value: 50%

2nd historical value: 25%

3rd historical value: 12.5%

4th historical value: 6.25%

The weightings of historical data can be changed by a single parameter. Therefore, it is relatively easy to respond to changes in the time series.

The constant model of first-order exponential smoothing derived above can be applied to time series that do not have trend-like patterns or seasonal variations.

General Formula for First-Order Exponential Smoothing

Using the basic formula derived above (6), the general formula for first-order exponential smoothing (7) is determined by taking both trend and seasonal variations into account. Here, the basic value, the trend value, and the seasonal index are calculated as shown in formulas (8) - (10).

Formulas for First-Order Exponential Smoothing

Forecast value for the period (t+i)

(7) $P(t+i) = (G(t) + i * T(t)) * S(t-L+i)$

where:

Basic value:

(8) $G(t) = G(t-1) + T(t-1) + \alpha \left[\frac{V(t)}{S(t)} - G(t-1) - T(t-1) \right]$

Trend value:

(9) $T(t) = T(t-1) + \beta \left[G(t) - (G(t-1) - T(t-1)) \right]$

Seasonal index:

(10) $S(t+L) = S(t) + \gamma \left[\frac{V(t)}{G(t)} - S(t) \right]$

For the constant model

$T(t) = 0$, $\beta = 0$, $S(t) = 1.0$, γ = Gamma = 0

For the trend model

$S(t) = 1.0$, γ = Gamma = 0

For the seasonal model

$T_{(t)} = 0$, $\beta = 0$

$P(t+i)$	=	The forecast calculated for the period (t+i) in the current period (t)
i	=	Forecast horizon
G(t)	=	The current basic value for the current period (t)
G(t-1)	=	The previous basic value from the previous period
L	=	Period length (often 12)

Determining the Basic Value

V(t)	=	Actual demand (history) for the current period (t)
T(t)	=	The current trend value calculated for the current period
T(t-1)	=	The previous trend value from the previous period
S(t)	=	The seasonal index for the period (t)
S(t-L)	=	The previous seasonal index for the period (t)

α	=	Smoothing factor for the basic value 'G', $0 < \alpha < 1$
β	=	Smoothing factor for the trend value 'T', $0 < \beta < 1$
γ	=	Smoothing factor for the seasonal indices 'S', $0 < \gamma < 1$

Second-Order Exponential Smoothing Model

If, over several periods, a time series shows a change in the average value which corresponds to the trend model, the forecast values always lag behind the actual values by one or several periods in the first-order exponential smoothing procedure. You can achieve a more efficient adjustment of the forecast to the actual values pattern by using second-order exponential smoothing.

The second-order exponential smoothing model is based on a linear trend and consists of two equations (see formula (11)). The first equation corresponds to that of first-order exponential smoothing except for the bracketed indices. In the second equation, the values calculated in the first equation are used as initial values and are smoothed again.

Formulas for Second-Order Exponential Smoothing

Seasonal index:

(11) $G^{(1)}(t) = \alpha V(t-1) + (1-\alpha) G^{(1)}(t-1)$

$G^{(2)}(t) = \alpha G^{(1)}(t) + (1-\alpha) G^{(2)}(t-1)$

$G^{(1)}$ = Simply smoothed basic

$G^{(2)}$ = Doubly smoothed basic

V = Historical value

α = Smoothing factor

Forecast Evaluation Criteria

Every forecast should provide some kind of basis for a decision. The SAP R/3 System calculates the following parameters for evaluating a forecast's quality:

- Error total
- Mean absolute deviation (MAD)
- Tracking signal
- Theil coefficient

Error Total

(12) $ET = \sum_{t-1}^{n} \left[V(t) - P(t) \right]$

Mean Absolute Deviation for Forecast Initialization

(13) $MAD = \frac{1}{n} \sum_{t-1}^{n} \left| P(t) - V(t) \right|$

n = Number of periods for initialization

Mean Absolute Deviation for Ex-Post Forecast

(14) $MAD(t) = (1 \delta) * MAD(t-1) + \delta * \left| V(t) - P(t) \right|$

Tracking Signal

$$(15) \quad TS = \left| \frac{ET}{MAD} \right|$$

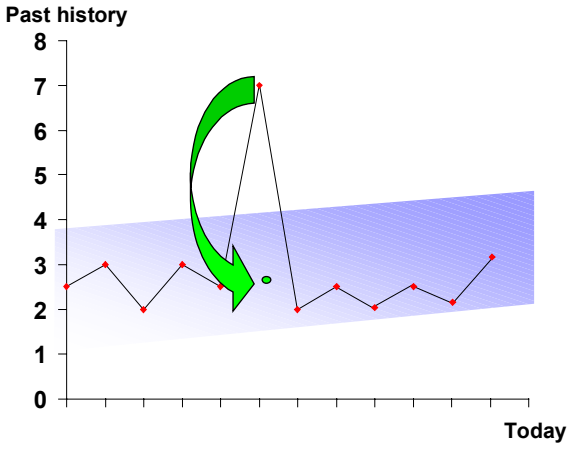
Theil Coefficient

$$(16) \quad U = \frac{\sum_{(t=1)}^{(T)} (P_{(t)} - V_{(t)})^2}{\sum_{(t=1)}^{(T)} (V_{(t)} - V_{(t-1)})^2}$$

P(t)	=	Forecast value
V(t)	=	Actual value
ET	=	Error total
TS	=	Tracking signal

Formula for the Tolerance Lane

To correct outliers automatically in the historical data on which the forecast is based, you select *Outlier control* in the forecast profile. The system then calculates a tolerance lane for the historical time series, based on the sigma factor. Historical data that lies outside the tolerance lane is corrected so that it corresponds to the ex-post value for that point in time. If you run the forecast online, historical data that has been automatically corrected by this function is indicated in column *C* of the *Forecast: Historical Values* dialog box.



The width of the tolerance lane for outlier control is defined by the sigma factor. The smaller the sigma factor, the greater the control. The default sigma factor is 1, which means that 90 % of the data remains uncorrected. If you set the sigma factor yourself, set it at between 0.6 and 2.

Tolerance Lane

(17) **Tolerance lane = ep ± σ * MAD**

where ep = ex-post forecast

Material Forecast

The results of the material forecast are frequently used as a basis for SOP. In MRP, the forecast values calculated during the forecast run result in purchase requisitions or in planned orders and they can also be used for determining safety stock and reorder levels.

Forecast Parameters

Overview [Ext.]

Forecast Models [Page 38]

Model Selection [Page 40]

Manual Model Selection [Page 41]

Automatic Model Selection [Page 43]

Manual Model Selection with Additional System Check [Page 44]

Model Initialization [Page 45]

Ex-Post Forecast [Ext.]

Parameter Optimization [Page 47]

Maintaining Forecast Parameters [Page 48]

Forecast Parameters: Independent of the Forecast Model [Page 52]

Forecast Parameters: Dependent on the Forecast Model [Page 49]

Creating Historical Data [Page 54]

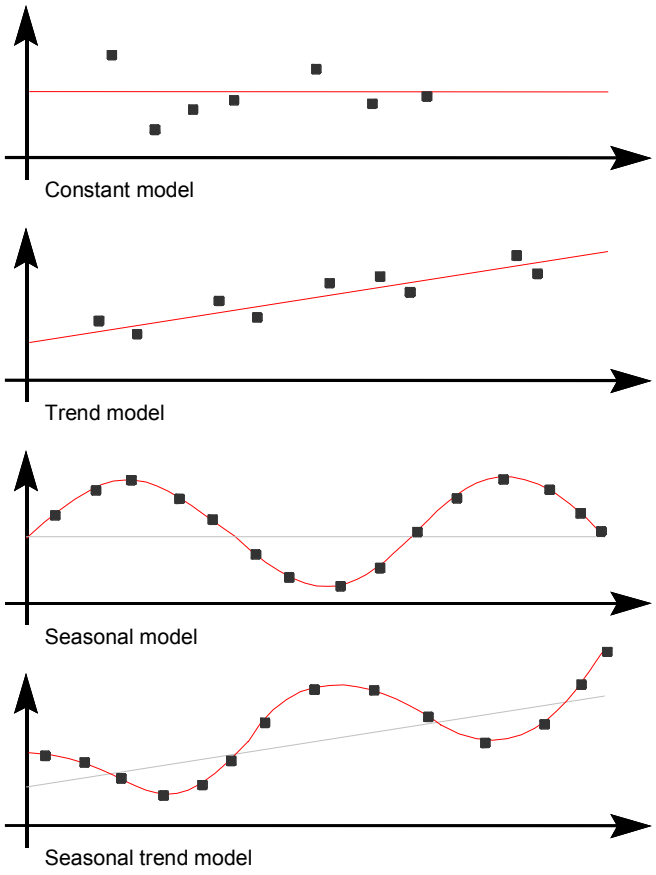
Creating Forecast Values [Page 55]

Carrying out the Forecast with Reference to Another Material [Page 56]

Forecast Models

When a series of consumption values is analysed, certain patterns can usually be detected. From these patterns it is then possible to differentiate between various forecast models:

- Constant
- Trend
- Seasonal
- Seasonal trend



A constant consumption flow applies if consumption values vary very little from a stable mean value.

With a trend model, consumption values fall or rise constantly over a long period of time with only occasional deviations.

If periodically recurring peak or low values which differ significantly from a stable mean value are observed, it is a case of a seasonal consumption flow.

A seasonal trend consumption model is characterized by a continual increase or decrease of the mean value.

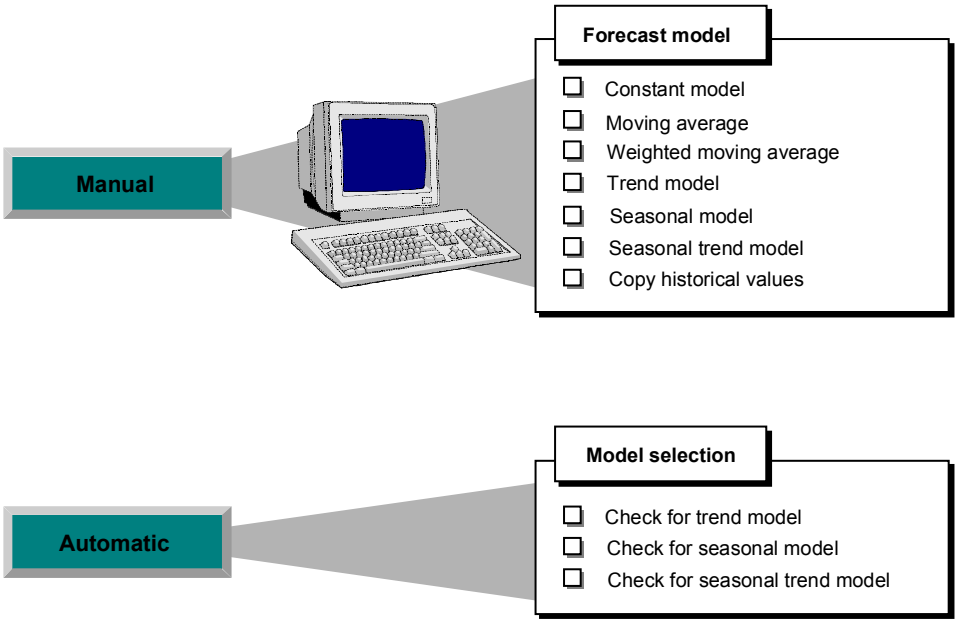
If none of the above patterns can be detected in a series of past consumption values, then we have an irregular consumption flow.

Model Selection

Before the first forecast can be carried out, you must specify which forecast model the system is to use to calculate the forecast values.

There are three basic possibilities:

- Manual Model Selection [Page 41]
- Automatic Model Selection [Page 43]
- Manual Model Selection with Additional System Check [Page 44]



Manual Model Selection

If you want to select a model manually, then you must first of all analyse past consumption data to determine whether a distinct pattern or trend exists according to which you can manually select a model for the system.

Constant requirements pattern

If your past data represents a constant consumption flow, you can then select either the constant model or the constant model with adaption of the smoothing factors. In both cases, the forecast is carried out by first-order exponential smoothing. When adapting the smoothing parameters, the system calculates different parameter combinations and then selects the optimum parameter combination which is the one which results in the lowest mean absolute deviation.

You have another two possibilities if your past consumption pattern is constant; either the moving average model or the weighted moving average model.

In the weighted moving average model, you can weight individual past consumption values, which means that the system will not give equal value to past data when calculating the forecast values. In so doing, you can influence the calculation so that the most recent consumption values play a more important role in the forecast than the previous periods - as is also the case in exponential smoothing.

Trend requirements pattern

If your past consumption data represents a trend, it makes sense to select either the trend model or the second-order exponential smoothing model. In the trend model, the system calculates the forecast values by means of the first-order exponential smoothing procedure.

In the second-order exponential smoothing models, you can choose between a model with or without parameter optimization.

Seasonal requirements pattern

If your past consumption data represents a seasonal pattern, you can specify the seasonal model you want. The system calculates the forecast values for the seasonal model by means of first-order exponential smoothing.

Seasonal trend requirements pattern

If your past consumption data represents a seasonal trend pattern, you can select the seasonal trend model you want. The system calculates the forecast values by means of first-order exponential smoothing.

Irregular requirements pattern

None of the patterns or trends mentioned in the above examples can be recognized in an irregular consumption flow. If the system is to carry out a forecast for an irregular pattern, then it is usually advisable to select either the moving average model or the weighted moving average model.

Forecast Models for Different Requirements Patterns

Requirements pattern	Forecast model
Constant	constant model

Manual Model Selection

	constant model with smoothing factor adaption
	moving average model
	weighted moving average model
Trend	trend model (first-order exponent smoothing)
Irregular	no forecast
	moving average model
	weighted moving average model
Extended forecasting component used:	
Trend	second-order exponential smoothing model (with and without parameter optimization)
Seasonal	seasonal model
Seasonal trend	seasonal trend model

Automatic Model Selection

If you do not want to specify a forecast model manually, you must instruct the system to make an automatic selection. The system then analyzes the historical data for different patterns and selects the appropriate model. The following models are possible:

- Constant model
- Trend model
- Seasonal model
- Seasonal trend model

If the system does not detect any regular pattern in the past consumption data, it automatically selects the constant model.

The system requires a different amount of historical values for the individual tests. For more information on the exact number that it requires, see Model Initialization [Page 45].

Model Selection Procedures

If the system is to make an automatic model selection, you have the choice between two model selection procedures:

Procedure 1

The system carries out statistical tests and checks whether a trend or a seasonal requirements pattern applies.

In the trend test, the system subjects the historical values to a regression analysis and checks to see whether there is a significant trend pattern.

In the seasonal test, the system clears the historical values of any possible trends and carries out an autocorrelation test.

Procedure 2

The system calculates the models to be tested using various combinations for alpha, beta and gamma. The smoothing factors are also varied between 0.2 to 0.8 in intervals of 0.2.

The model which is then chosen is the the model which displays the lowest mean absolute deviation (MAD).

Procedure 2 is more precise than procedure 1 but takes considerably longer.

Manual Model Selection with Additional System Check

In the third case, you can have a combination of manual and automatic model selection: you specify a model and set the system so that it additionally checks historical values for a seasonal pattern or trend.

Possible combinations that you can choose are as follows:

1. You enter a trend model for the forecast model and then let the system check historical data for a seasonal pattern by setting the model selection to seasonal for the test.
2. You enter a seasonal model for the forecast model and then let the system check historical data for a trend by setting the model selection to trend for the test.

A reference is given to the forecast formulae used by the system for the individual models in Forecast Formulae [Page 86].

Model Initialization

Model initialization is the process of specifying the necessary model parameters, such as the basic value, the trend value and the seasonal indices for the selected forecast model. In each case, initialization occurs during the first forecast for a material. It must also be carried out in cases of structural interruption, that is, if the existing forecast becomes invalid.

Which model parameters are necessary for which forecast model is shown in the following Table:

Model Parameters

Model	Model parameters
Constant model	basic value
Trend model	basic value, trend value
Seasonal model	basic value, seasonal indices
Seasonal trend model	basic value, trend value, seasonal indices

The forecast model is usually automatically initialized. In order to do this, the system requires a certain amount of historical values. The number required varies depending on the forecast model as shown in the table below.

Number of Historical Values Required for Model Initialization

Model	No. of historical values
Constant model	1
Trend model	3
Seasonal model	1 season
Seasonal trend model	1 season + 3
2nd-order exp. smoothing	3
Moving average	1
Weighted moving average	1

The system calculates the basic value on the basis of an average value, and the trend using the results of the regression analysis. The seasonal indices result from the quotient of the actual past value and the basic value which has been adjusted for the trend value.

These calculation methods are used for the constant, trend, seasonal and seasonal trend models, depending on which parameters are to be determined.

For the second-order exponential smoothing model, a regression analysis is carried out.

For the moving average and the weighted moving average models, the system calculates an average value.

Ex-Post Forecast

The system carries out an ex-post forecast for the initial forecast if more past values are available than are required/are to be used for initialization. It also carries out the ex-post forecast during parameter optimization, model initialization and for evaluating the accuracy of the forecast.

The system only carries out the ex-post forecast for subsequent forecasts when there is a gap of more than one forecast period between the last forecast date and the current forecast date. For technical reasons, the series of forecast values must be recalculated for every period. Since this requires a lot of time and effort for articles which are forecast daily or weekly, you can now make up for periods which you have "omitted" from the forecast. This means that it is no longer necessary to carry out the forecast for each period as the missing values can be provided by a later forecast. This is then achieved with the help of the ex-post forecast.

Parameter Optimization

For forecast models with exponential smoothing, you can instruct the system to optimize the smoothing factors (see Forecast Parameters: Dependent on the Forecast Model [Page 49]).

If the system is instructed to optimize the smoothing factors, it calculates several parameter combinations and then selects the combination with the lowest mean absolute deviation (MAD). The finer the degree of optimization, the more exact, but also the more time-consuming, the parameter optimization. You can vary the increment (also known as the degree of optimization) from 0.1 (low), 0.2 (medium) and 0.3 (high).

If you have set the system correctly, it will carry out parameter optimization during initialization for the initial forecast as well as for all other forecasts. The most effective combination of the smoothing factors is determined by means of the ex-post forecast.

Please refer to Appendix B in this manual for additional information on the calculation of the MAD as well as the significance of the smoothing factors.

Optimizing the smoothing factor is only possible for models with the exponential smoothing procedure.

Maintaining Forecast Parameters

You maintain forecast parameters in the material master record. In order to do this, proceed as is described below:

1. Starting from the menu screen of the material master record, select *Material* → *Create* general.
2. Enter the material type, allocate it to an industry sector and press ENTER.

   The pop-up window Select View(s) appears on your screen.
3. Select the *Forecasting* view and press ENTER.

   The Organizational Levels/Profiles pop-up window now appears.
4. Because material requirements are forecast at plant level, you must enter the appropriate plant
5. Press ENTER.

   The "Forecasting" data screen now appears.
6. Fill in the data screen and save your entries via *Material* → *Save*.

A more detailed description is given of the individual forecast parameters in the follwoing sections:

Forecast Parameters: Independent of the Forecast Model [Page 52]

Forecast Parameters: Dependent on the Forecast Model [Page 49]

For more information on maintaining the material master record, please refer to *MM Managing Material Master Data*.

Forecast Parameters: Dependent on the Forecast Model

You can/must maintain the following parameters depending on how you carry out model selection and which model you choose. The relationship between parameters and model selection is shown in the following two tables.

Parameters Dependent on Model Selection

Model selection	Parameters
Manual model	forecast model selection
Automatic	model selection, model selection procedure model selection

Parameters Dependent on the Forecast Model

Specified model/ model to be tested	Possible/required parameters
Constant model	parameter optimization
	optimization level
	alpha and delta factors
Constant model with optimization of the smoothing factors	-
Trend model	parameter optimization
	optimization level
	alpha, beta and delta factors
Moving average model	initialization periods
Weighted moving average	weighting group model
Extended forecast component used:	
Seasonal model	parameter optimization
	optimization level
	alpha, beta and delta factors
Seasonal trend model	parameter optimization
	optimization level
	alpha, beta, gamma and
	delta factors
2nd-order exponential smoothing model	parameter optimization
	alpha and delta factors

Forecast Parameters: Dependent on the Forecast Model

2nd-order exponential smoothing model with smoothing factor optimization	alpha and delta factors

Forecast model

You determine via the forecast model which model the system uses as a basis when calculating the forecast values. If you do not know the forecast model, you can have it determined by the system via automatic model selection.

Model selection

This indicator specifies for which model the system is to examine the historical values. You can specify whether the system searches the historical values

- for a constant pattern
- for a pattern corresponding to the trend model type
- for a seasonal pattern or
- for both a trend model pattern and a seasonal pattern.

Please note that depending on the model test, a minimum number of historical values must be available. This field is significant if you do not know the model and you want the system to determine it automatically. Furthermore, you also have the possibility of pre-selecting a trend model, but at the same time instruct the system to search for a seasonal pattern and vice versa.

Selection procedure

This indicator specifies how the system is to carry out the model selection. Here, you can choose between two procedures:

- The first procedure involves the system carrying out a significance test and then selecting the appropriate model.
- The second procedure involves the system determining the mean absolute deviation (MAD) using various parameter combinations for the models to be tested and then selecting the model which displays the lowest MAD. This procedure takes considerably longer than the first procedure.

Parameter optimization

Via this indicator, you can specify that the system is to optimize the necessary smoothing factors for the appropriate model. The system calculates several parameter combinations and selects the one that displays the lowest MAD. Parameter optimization is carried for the initial forecast as well as for the subsequent forecasts.

Periods per seasonal cycle

You must enter the number of periods that constitute a season here if you have selected a seasonal model or if the system is to carry out a seasonal test.

Optimization level

By determining the optimization level, you are specifying the increment with which the system is to carry out parameter optimization. The lower the increment, the more exact but also the more time consuming the optimization process will be.

Weighting group

You only have to maintain this field if you selected the forecast model, "weighted moving average". This key specifies how many historical values are taken into account for the forecast and how these values are weighted in the forecast calculation.

The following factors are used by the system, depending on the model, for exponential smoothing. Thus, for example, only the alpha and the delta factors are required for the constant model whereas all of the smoothing factors are required for the seasonal trend model.

Alpha factor

The system uses the alpha factor for smoothing the basic value. If you do not specify an alpha factor, the system will automatically use the alpha factor 0.2.

Beta factor

The system uses the beta factor for smoothing the trend value. If you do not specify a beta factor, the system will autimatically use the beta factor 0.1.

Gamma factor

The system uses the gamma factor for smoothing the seasonal index. If you do not specify a gamma factor, the system will automatically use the gamma factor 0.3.

Delta factor

The system uses the delta factor for smoothing the mean absolute deviation and the error total. If you do not specify a delta factor, the system will automatically use the delta factor 0.3.

If you set parameter optimization, the system will overwrite the originally set smoothing factors with those which have been newly calculated by the optimization process.

Forecast Parameters: Independent of the Forecast Model

You can/must maintain the following parameters independent of the method you use for model selection and which model you choose.

Period indicator

The period indicator determines the time interval the system is to use to store consumption or forecast values. You can define the period indicator when maintaining the MRP parameters as well as when maintaining the forecast parameters.

Fiscal year variant

You must maintain the fiscal year variant if you want a flexible period length for the material equal to that of the accounting period.

Historical values

You specify how many historical values the system should take into account for the forecast by filling in this field. The default value in this case is the maximum number possible (60). If fewer values are available, then they are used for initialization.

Initialization periods

You specify the number of periods the system is to use for model initialization here. If the number of historical values is greater than the number of initialization periods, then the system will carry out an ex-post forecast for those periods which were not used for initialization. The number of periods that the system requires for initialization depends on the forecast model.

Forecast periods

Via the number of forecast periods, you specify for how many periods the system determines forecast values.

Fixed periods

Via the number of fixed periods, you determine how many periods are fixed in the future and are no longer automatically changed by the next forecast run.

Initialization

This field activates re-initialization during the forecast. This is necessary for the first forecast and also when structural changes (that is, if the forecast model which has been used until now has lost its validity) appear in the time series.

Model initialization can either be carried out automatically (X) or manually (M). In the case of manual initialization (which should be the exception), you must determine the model parameters manually. To do this, select *Details* → *Forecast details* → *Model parameters*. Depending on the forecast model, you can manually maintain such parameters as the basic value and the trend in the pop-up window. If you do not set these parameters here, you will be requested to set them during the forecast. No historical data has to be stored in the system in order to carry out manual initialization.

Tracking limit

During the forecast calculation, the system compares the tracking limit with the quotient of the error total and the mean absolute deviation (MAD). This quotient is known as the tracking signal. If the value calculated by the system lies below that of the tracking limit, then the forecast

remains valid. If not, the system generates an exception message which indicates that a structural interruption has taken place. This means that the forecast model should be revised and possibly re-initialized.

Autom. reset

Causes the system to reset the forecast model automatically if the tracking limit is exceeded. Furthermore, the system carries out a new model selection during the next forecast.

Correction factors

If you fill in this field, historical values and forecast values are weighted with the appropriate period factors which you determined via customizing.

Reference material for consumption

If you define a reference material, the system accesses the historical data of the reference material up to the specified validity date. This makes sense, if no historical data exists yet for the specified material.

Reference plant for consumption

If you enter a reference material for consumption, you must also define a reference plant where the historical data to be used comes from.

Validity date

During the forecast, the system accesses the historical data of the reference material up to the specified validity date. From this date, it uses the material's own historical data.

Multiplier

By entering a multiplier, you can define that only a certain percentage of the consumption quantity of the reference material is used in the forecast.

Creating Historical Data

Historical data is generally updated in the material master record when stock is withdrawn from the warehouse. However, it is also possible to enter historical data manually, which then forms the basis of the initial forecast.

There are two types of historical data (consumption values) in the material master record: **total consumption** and **unplanned consumption** values.

Total consumption is the total of planned and unplanned consumption. For materials planned according to the consumption-based planning procedure, it is always the total consumption that is updated.

Unplanned consumption is only updated for materials that are planned according to MRP,

- if goods are withdrawn from the warehouse without a reservation
- if goods are withdrawn from the warehouse on the basis of a reservation, but if the quantity withdrawn exceeds the reservation

When withdrawing a material that is planned according to the MRP procedure on the basis of a reservation, only the planned consumption is updated. This value is not recorded in the material master record but, instead, it must be calculated by the user by subtracting unplanned consumption from total consumption.

This is how you enter consumption values manually:

1. In the Forecasting or Material Requirements Planning screen that you have already filled in, specify whether the consumption values are managed in days, weeks, or months by filling in the Period indicator field.
2. In the Forecasting screen, check the proposed values in the area Number of periods required, and change or add to them as necessary.
3. Select *Details* → *Consumption*.

   The consumption values entry screen appears.
4. Enter your consumption values, starting from the current period and working backwards.

   You can enter as many values as you want, both for total consumption and for unplanned consumption. Switch between the total consumption and unplanned consumption entry screens with *Edit* → *Unplanned consumption* or *Total consumption*.

   If you want to enter more values than there is room for on the first screen, press F23 to obtain further empty lines.
5. Store the data in the system with *Material* → *Save*.

   You can change the consumption values in any way required by your company using user exit EXIT_SAPMM61W_002.

Creating Forecast Values

Forecast values are generally calculated by the system as part of the forecasting process, and then updated in the material master record. However, it is possible to enter forecast values manually, which then form the basis of the planning run.

This is how you enter forecast values:

1. Once you have specified the required entries on the Forecasting data screen, define whether forecast values are managed in days, weeks, or months by filling in the *Period indicator* field.
2. Select *Details* → *Forecast details* → *Forecast values*.

   The forecast values entry screen appears.
3. Enter your forecast values.

   You can enter as many forecast values as you want. If you want to enter more values than there is room for on the screen, press F23 to obtain further empty lines.
4. Store the data in the system with *Material* → *Save*.

Importing External Forecasts

To import forecast values from a legacy system or another external system into the material master, use program RMPR1001. This program does not take account of MRP areas.

If you import an externally created forecast, you must enter 'N' (*No forecast/external model*) as the forecast model on the forecasting screen of the material master record.

Carrying out the Forecast with Reference to Another Material

If no historical data exists for materials, which the system can access during the forecast, it is possible to use another material for the forecast. To do this, you must define a so-called reference material for consumption as well as a reference plant, a validity date, and a multiplier.

If you have defined a reference material, the system accesses the historical data of the reference material during the forecast up to the specified validity date. From the validity date, the system then uses the material's own historical data.

By entering a multiplier, you can define that only a certain percentage of the consumption quantity of the reference material is used for the forecast.

Maintaining Parameters Using Profiles

Overview [Ext.]

Creating a Profile [Page 58]

Displaying a Profile [Page 60]

Changing a Profile [Page 61]

Deleting a Profile [Page 62]

Where-Used List for Profiles [Page 63]

Creating a Profile

This is how you create a profile in the material master:

1. From the menu screen of the material master record, select *Profile* → *MRP profile* or *Forecast profile* → *Create*.

   The initial Create Profile screen appears.

2. Enter the key you want to assign to the profile.

   If you want to use an existing profile as a reference, enter the name of this profile in the Reference field so that the system can copy its values to the new profile.

3. Select *Goto* → *Selection screen*.

   The selection screen appears. It shows all the fields that can be copied to the MRP or forecasting screen of the material master record.

4. Enter a profile description and select the fields you want the profile to contain.

   You must also decide whether each field will be copied to the material master record as a fixed value or a default value.

5. Select *Goto* → *Data screen*.

   The data screen appears. Only the fields you marked on the selection screen are presented for you to fill in. The fixed and default values are displayed in different colors.

   All fixed values are required fields except where the field can also accept the value `BLANK`.

6. Enter your data and save the profile with *Profile* → *Save*.

   You now return to the initial screen where you can create another profile.

   The data for the MRP profiles are split over two data screens. With *Goto* → *Data screen 1* or *Data screen 2*, you can spring from one data screen to another.

The system runs a number of checks when you create a new profile:

- When you go from the selection screen to the data screen, the system checks whether the selected fields form a reasonable combination and are allowed to appear in the same profile.

  The Fixed lot size and Maximum stock level fields may not be combined in one MRP profile.

- When you save the data on the data screen, the system checks
  - whether the values you you have entered are valid, for example, whether they are defined in the appropriate table
  - whether the values you have entered are compatible with each other

If the Maximum stock level field appears in the profile, you must also specify a Lot size that can give the highest stock level.

If the system detects inconsistencies or errors, it asks you to change the fields selected on the selection screen and/or correct the values.

Displaying a Profile

This is how to display a profile in the material master:

1. From the menu screen of the material master, select *Profile* → *MRP profile* or *Forecast profile* → *Display*.

   The initial Display Profile screen appears.

2. Enter the name of the profile.

3. Select *Goto* → *Selection screen*.

   The selection screen appears. In display mode, only the fields that are defined in the profile are displayed.

4. Select *Goto* → *Data screen*.

   The data screen appears. You see the values that are defined in the profile.

   Press `F3` to return to the initial screen and continue.

Changing a Profile

When you change a profile, the system not only updates the changed values in the profile; it also generates a background job which updates all material master records that have this profile assigned to them. However, this applies only to changes that affect fixed values. A changed document is created automatically for all materials where such changes have occurred.

Material master records are updated by the background job PROFILE. The system generates this job automatically when a profile has been changed and runs overnight. If errors occur due to data incompatibility, the details are recorded in a log. The next day, you can check the log to see which material master records were affected by these errors, and then edit them manually.

This is how you change a profile in the material master:

1. From the menu screen of the material master, Select *Profile* → *MRP profile* or *Forecast profile* → *Change*.

   The initial Change Profile screen appears.

2. Enter the name of the profile and select *Goto* → *Selection screen*.

   The selection screen appears. All the fields already included in the profile have a checkmark beside them.

3. Make the desired changes:

– Select new fixed values or default values.

– Change fixed values to default values or vice versa.

– Reset check marks.

4. Select *Goto* → *Data screen*.

   The data screen appears.

5. Enter the changed values and save the profile with *Profile* → *Save*.

   You now return to the initial screen and can continue.

The same checks are run as when you create a profile (see Creating a Profile).

In addition, the system automatically generates the background job, PROFILE which is used to update the material master records. The background job is automatically started overnight. A background process is only created if you change several profiles on the same day.

If errors appear during the update due to data inconsistencies, then the system records these errors in a log. The next day, you use this log to identify the material master records for which an error was recorded, and you can then manually reprecess them.

If the background process shoud be terminated for any reason, then you have to request the update of the material master record manually by creating a background job for the program RMMM0001. You can use PROFILE again for the name of the background job or the job group; a variant is not required.

Deleting a Profile

The system also generates the background job PROFILE when you delete a profile. The job is started automatically in the evening. It cancels the profile in every material master record with that profile assigned to it; that is, the profile assignment disappears, but the values themselves remain stored in the material master record.

If errors occur while the job is being run, they are recorded in a log. The next day, you can check the log to see which material master records were affected by these errors, and then edit them manually.

This is how you delete a profile in the material master:

1. From the menu screen of the material master, select *Profile* → *MRP profile* or *Forecast profile* → *Delete*.

   The initial Delete Profile screen appears.

2. Enter the name of the profile you want to delete and press ENTER.

   A pop-up window appears.

3. Position the curser on Yes and press ENTER.

You now return to the initial screen and can continue.

Where-Used List for Profiles

Carrying Out the Forecast

Overview [Ext.]

Things to Think About Before Carrying out the Forecast [Page 65]

Forecast Options [Page 66]

Carrying Out the Individual Forecast [Page 67]

Carrying Out the Total Forecast [Page 69]

Carrying Out the Total Forecast in Background Mode [Page 71]

Calculating the Forecast Values [Page 72]

Calculating the Safety Stock and the Reorder Level [Page 73]

Ex-Post Forecast [Page 74]

Monitoring the Selected Forecast Model [Page 75]

How Does the System Optimize the Smoothing Factors [Page 76]

Things to Think About Before Carrying out the Forecast

Before you can carry out the forecast for an article, the following prerequisites must be fulfilled:

- You must have maintained the forecast parameters in the article master.
- You must have determined the period for which the system is to carry out the forecast. You do this by defining the period indicator in the article master. For each article, the forecast can be carried out on either a daily, weekly, or monthly basis, or alternatively, according to accounting period.
- You must already have determined how the system is to select the forecast model. This can either be done manually by the RP controller or automatically by the system. In the case of automatic model selection, you must make sure that the required number of historical values are available; the number required varies depending on the forecast model selected.
- If no historical values were entered when creating the article master, you must carry out manual model initialization.

For a more detailed description of these prerequisites, see Overview [Ext.]

Before carrying out the forecast, you also have the possibility of revising an article's historical values which are normally automatically updated by the system during withdrawal postings. On the one hand, you can achieve this by doing one of the following;

- manually changing the values in the article master by means of the correction values
- correcting the weighting factor for the historical values in customizing - for the weighted moving average model.

On the other hand, you can reduce the number of periods to be taken into consideration by limiting the number of historical values in the article master. This means that not all of the historical values are used for the forecast, and instead, only the number of values that you enter.

If a structural interruption appears in the time series of past values stored in the article master record, and if for the next forecast you only want the system to take those values into account which lie after the interruption, then you do this by entering the appropriate number of past time periods in the Historical values field.

Consumption values not determined by the SAP System can be maintained directly with the following exception.

Consumption values for the period in which the article was created as well as in the previous period. These periods can only be influenced by consumption postings for the respective period.

Forecast Options

There are several possibilities available to you for carrying out the article forecast:

- You can carry out the **individual forecast**. This means that you carry out the forecast for a certain article in a certain site.

  Carrying Out the Individual Forecast [Page 67]

- You can carry out the **total forecast**. This means that you carry out the forecast for all articles of one particular site or for all sites.

  Carrying Out the Total Forecast [Page 69]

- To improve performance, it is advisable to carry out the total forecast in background mode.

  Carrying Out the Total Forecast in Background Mode [Page 71]

  You can also carry out the article forecast from the forecast screen of the customized article master. Depending on the forecast parameters maintained here, you can carry out the forecast in simulative mode in several online steps. The functionality used for this is that of the single-item forecast for an article.

  The forecast values are posted when you save the article master record. This also automatically adjusts the two RP parameters, the *reorder level* and the *safety stock level*.

Carrying Out the Individual Forecast

Carrying out the forecast for a particular article in a particular site is known as the individual forecast. You carry out an individual forecast as is described below:

1. From the menu screen of the forecast, select *Forecast* → *Individual forecast* → *Execute*.

   The initial Forecast screen appears.

2. Enter the article number and the site for which you want to carry out the forecast and press ENTER.

   The Parameter Overview screen now appears. This screen displays the following information:

– the last forecast date

– data, copied from the article master record

– parameter values, which were calculated as a result of the previous forecast

   If no forecast has yet been carried out for this article, the Last forecast field is empty and the message *Until now no forecast values were saved* appears.

   From this screen you can display the historical values by selecting *Goto* → *Historical values* and if a forecast has already been carried out, you can display the forecast values by selecting *Goto* → *Forecast values*.

3. To carry out the forecast for the article, select Proceed.

   A pop-up window now appears where the date of the first day of the period is suggested.

   If you choose to overwrite the forecast date, please note that the date you enter must lie within the current or the following period.

4. Select ENTER.

   The forecast is carried out. The Forecast Values screen then appears and the following message appears:

   Forecast calculation was carried out.

5. Check the individual values.

   You now have the option of manually changing the forecast values calculated by the system by entering new values in the Corrected value column.

   The system then uses these new values as a basis for the future planning run.

6. Return to the Parameter Overview screen, and select, *Details* → *Addtl parameter*.

   A pop-up window appears with the additional parameters.

7. Select Cancel to return to the Parameter Overview screen. Here you can check the exception messages which were created during the forecast with *Details* → *Messages*

8. Return to the Parameter Overview screen and save the forecast values by selecting *Forecast* → *Save*.

Carrying Out the Individual Forecast

If you manually change a forecast value, then you should check the actual consumption value that results for this period later and correct it, if necessary.

Carrying Out the Total Forecast

If you want to carry out the forecast for all the articles in one certain site or in all sites, then you must carry out a total forecast. A description of how to do this is given in the following paragraphs:

1. From the menu screen of the forecast, select *Forecast* → *Total forecast* → *Execute*.

   The initial Forecast screen appears for carrying out the total forecast.

2. Enter the required data:

   Site

   Enter the site for which the total forecast is to be started. If you do not enter a site here, the forecast is carried out for all sites.

   Period indicator

   This indicator specifies the time period for which the forecast values are managed in the system. The options given mean the following:

   M - Monthly

   W - Weekly

   T - Daily

   P - Period according to fiscal year variant

   All those articles which have the same period indicator in the article master record as the indicator you enter here are included in the forecast.

   Forecast execution

   Indicator A means that the forecast will be carried out for the current period and indicator F means that the forecast will be carried out for the following period.

   Save

   Select this field if you want the forecast result to be stored in the system.

   Log record

   If you select this field, a list is displayed after the forecast run of all the articles for which forecast values were created. The list also contains the process and exception messages.

3. To start the forecast run, press ENTER.

   The corresponding texts for the entries now appear and you are requested to check your entries.

4. Press ENTER.

   The following message will appear:

   Total forecast to be started. Please press ENTER.

5. Press ENTER again.

   When the forecast run is complete, you receive a list of all the articles which were included in the forecast if you filled in the *Log record* field. If not, then no list will appear.

Carrying Out the Total Forecast

The total forecast must be carried out periodically. The time intervals available are; monthly, weekly, daily, or per accounting period. If you carry out the forecast on a daily basis, then, for articles that are planned using time-phased planning, the system only includes the articles whose turn it is according to the RP date.

If past consumption values are known at the end of a period, the system will use them as a basis for carrying out the forecast for the next period.

Subsequently, the forecast results can be printed out. The print program prints the forecast results which have automatically been sorted according to company code, site, RP controller and highest error number. For more information on this subject, see Overview [Ext.].

Carrying Out the Total Forecast in Background Mode

To start the total forecast in background mode, from the menu screen of the forecast, select *Forecast → Total forecast → Execute (background).*

The initial screen for Background Request appears.

Here, you can either start the forecast run immediately or you can plan it to start at a later date by means of a selection variant. The forecast is then carried out in background mode. More detailed information on background request procedures can be found in the SAP document *ABAP/4: Generating and Printing Reports*.

A repeat forecast (that is, the forecast is carried out again for a certain period) is not possible for the total forecast either in online or in background mode.

Calculating the Forecast Values

The forecast calculates the forecast values by using various mathematical formulae which evaluate historical data. The accuracy of the forecast basically depends on the extent and quality of the data that is available.

You only enter historical values when you create a new article master record or when the system creates a new article master record via batch input. The system then generates these values using withdrawal postings.

The system recalculates the basic value and the trend value for each forecast by using the smoothing factors and the most recent consumption values. The smoothing factors are the weighting factors used for historical data, with the values from the most recent period playing a more important role in the forecast than the values from previous periods. The greater the smoothing factors you select in the article master, the faster the forecast values are adapted to the actual past consumption values.

For more details on the forecast formulae see Overview [Ext.]

If your system is set so that the forecast values are to be taken into account for a planning run, then a so-called planning file entry is automatically made by creating a forecast requirement independent of the forecast result. In turn, this planning file entry initiates a new planning run for the articles affected.

For articles planned by reorder point planning, however, a requirements planning run is only initiated if the new reorder level, recalculated during the forecast, differs from the old level.

Calculating the Safety Stock and the Reorder Level

If a warehouse that stores article has to be ready for delivery at all times, then there has to be a high level of **safety stock** in this warehouse, as forecasting error cannot always be ruled out. This would also entail a high level of warehousing costs. The level of safety stock depends on the service level you select, on the replenishment lead time and on the accuracy of the forecast.

In order to keep the safety stock and therefore the storage costs as low as possible, the RP controller usually specifies a **service level** for each article. From a mathematical point of view, the service level represents an organization's ability to avoid a shortfall occurring during replenishment lead time.

If you opt for a relatively high service level, then the safety stock level calculated by the system will also be high. If you opt for a low service level, then the safety stock level will also be low.

The **replenishment lead time** refers to the in-house production time for in-house production and the planned delivery time for external procurement. It represents the time between the initiation of a procurement procedure and transferring the article into the warehouse. The replenishment lead time is stored at site level in the article master record by the RP controller. Since the probability of a shortfall is higher in a longer period, the safety stock level must also be set higher for long replenishment lead times.

Finally, the safety stock level also depends on the **accuracy of the forecast**. If the forecast deviates greatly from the actual consumption values, then the safety stock level will also be unusually high.

In addition to the safety stock level, the system recalculates the **reorder level** for articles which are subject to automatic reorder level adjustment. The reorder level is the sum of the safety stock and the forecast requirement within the replenishment lead time or the overall lead time for articles produced in-house.

The system compares "static" availability during article withdrawal; that is current availability, without taking future requirements into consideration, with the reorder level. In other words, it compares the remaining stock with the reorder level. If remaining stock falls below the reorder level, then the system marks the article for the planning run by making an entry in the planning file. During the next planning run, the system automatically generates a purchase requisition or a planned order for the article.

You can find a list of the various formulae for calculating the safety stock level and the reorder level in Overview [Ext.]

Ex-Post Forecast

The system carries out an ex-post forecast for the initial forecast if more past values are available than are required/are to be used for initialization. It also carries out the ex-post forecast during parameter optimization, model initialization and for evaluating the accuracy of the forecast.

The system only carries out the ex-post forecast for subsequent forecasts when there is a gap of more than one forecast period between the last forecast date and the current forecast date. For technical reasons, the series of forecast values must be recalculated for every period. Since this requires a lot of time and effort for articles which are forecast daily or weekly, you can now make up for periods which you have "omitted" from the forecast. This means that it is no longer necessary to carry out the forecast for each period as the missing values can be provided by a later forecast. This is then achieved with the help of the ex-post forecast.

Monitoring the Selected Forecast Model

In the course of time, the characteristics of a consumption series can change. In order to be able to react to this in time, the system calculates a so-called **tracking signal** during every forecast. The tracking signal links the error total (FS) and the mean absolute devialtion (MAD) in the following manner:

Tracking signal = | FS/MAD |

The forecast error is the difference between actual consumption values and the forecast values from the same period whereas the error total is the sum of all the forecast errors in a consumption series.

The error total is used to check the validity of the forecast model in operation.

If a model is still valid, that is, if the consumption series has not changed, then you can assume that the error total is distributed normally and has an average of zero.

If the consumption pattern has changed, however, the error total will no longer be equal to zero. You must standardize the calculated forecast error in order to set boundaries. Therefore, in addition to the error total, the system also calculates the mean absolute deviation (MAD) as a second value. The system then adds the errors (irrespective of the plus or minus sign) and divides them by the number of consumption values. The first-order exponential smoothing procedure is used to calculate the MAD. The smoothing factor used for this is the delta factor.

Using the quotient from the error total and the MAD, the system can now define a warning limit, the tracking signal which it then compares with the tracking limit specified in the article master. When the tracking signal is greater than the tracking limit, the RP controller receives a message stating that the forecast model should be checked.

After a model change or a forecast model initialization, the error total is automatically reset to zero and the MAD to its initial value.

The system automatically sets the tracking limit (the default value is 4.00). You can change it, however, when maintaining the article master record.

How Does the System Optimize the Smoothing Factors

The process of the ex-post forecast described above is used for parameter optimization in order to optimize the smoothing factors. In the article master, you can store whether parameter optimization is to take place during the forecast and if it is to take place, the degree of optimization you want to select.

When a forecast is carried out with parameter optimization, the system will start from an initial value and then gradually increase the increment of the smoothing factors in every simulation run. (This constitutes the first stage of the ex-post forecast.) The increment in this case is specified in the article master record by the optimization level. The system then further analyzes the situation for the parameter combination with the smallest MAD (second stage). The optimum parameter combination is the combination which has the lowest possible MAD.

Forecast Result

Overview [Ext.]

Checking the Forecast Result Using a List [Page 78]

Checking the Forecast Result in Online Mode [Page 79]

Changing the Forecast Result [Ext.]

Checking the Forecast Result Using a List

In order to print out a list of materials from a certain plant which were included in a forecast run and which you want to use for checking the forecast results, follow the procedures described below:

1. Starting from the menu screen of the forecast, select *Forecast* → *Total forecast* → *Print*.

   The initial screen for Material Forecast Printing appears.

2. Enter the plant, for which you want to print out the forecast result, as well as a period indicator if you want to limit the selection to a certain time interval.

   If you also want a printout of the process and exception messages which were created during the forecast, select the Log field.

3. Press ENTER.

   The Print Parameters screen now appears.

4. Specify the print parameters, for example, the printer on which the list is to be printed, and then select the *Print* button.

   For more detailed information on printing procedures, see *Getting Started With the R/3 System*.

   After the system has created the list of all the material forecasts, the screen with the list of results appears and you can see exactly how many material forecasts the printed list contains.

Printing the list in background mode

If the forecast was carried out in background mode, it is also possible to print out the list in background mode. You do this as is described below:

1. Starting from the menu screen of the forecast select *Forecast* → *Total forecast* → *Print (background)*.

   The Background Request screen appears.

2. Using a background request means that you can plan the print for a later date and you can start it for a certain variant.

   You can read more about background request procedures in *ABAP/4: Generating and Printing Reports.*

Checking the Forecast Result in Online Mode

Errors or exceptional situations which appear during the total forecast are recorded in the exception messages and are allocated to a certain error class. If an error occurs in a material forecast, then the system marks the material for which the error occurs for reprocessing.

If you want to check the forecast result in online mode and reprocess the marked materials, proceed as follows:

1. Starting from the menu screen of the forecast, select *Forecast* → Total *forecast* → Reprocess.

   The initial screen for Forecast Reprocessing appears.

2. Enter the plant and the MRP controller number.

   If you want to limit the selection to a certain interval, you must enter the appropriate period indicator.

   Furthermore, you can limit the selection of exception messages to one particular error class by selecting various error classes. The following Table shows which types of exception messages exist and to which error class they are allocated.

Description of error classes

Exception message	Error class
Reorder level and safety stock	1
Model selection and test	2
Initialization	3
Parameter optimization	4
Difficulties during the forecast	5
Forecast not calculated	6
Missing table entries	7
Terminations	8

3. Press ENTER.

   A list of materials now appears displaying those materials for which one or more forecast errors occurred and which correspond to your selection.

4. Position the cursor on one of the materials and select, Choose.

   The Parameter Overview for the selected material now appears.

5. To display the exception message, select *Details* → *Messages*.

   A screen with the corresponding exception message appears. You can now see what caused the error during the forecast.

   Example:

Checking the Forecast Result in Online Mode

The MRP controller did not enter any historical values when creating the material master record. You must now respond to this situation with manual initialization.

a) Change the material master record by setting the initialization indicator to **m**.

b) Then, select the material to be reprocessed from the reprocessing list and branch into the Forecast Parameter screen.

c) Carry out an individual forecast for the material. A pop-up window appears, in which you can maintain the parameters corresponding to the forecast model.

d) Press ENTER.

   The system carries out the forecast and displays the forecast value with the message:

   Forecast calculation was carried out.

e) Check the forecast values and then save the result via *Forecast* → *Save*. The system returns to the overview screen and displays the message:

   The forecast values were saved.

By saving the new forecast result, the system then records that the material in question has been reprocessed and this material will automatically be deleted from the list of materials to be reprocessed.

Changing the Forecast Results

You correct the forecast results in the same way as you correct the historical values on which the forecast is based.

One method is to enter a new value in the *Corrected forecast value* column of the *Forecast Results* dialog box.

Alternatively, you can use the interactive graphics:

6. From the *Forecast Results* dialog box, choose *Interact.graphics*.

   A business graphic and a statistics graphic appear. You can modify forecast values in the business graphic. The statistics graphic gives you an overview of the forecast and shows all the forecasted data. Thus, the statistics graphic provides a good basis for evaluating the quality of the forecast.

7. In the business graphic, choose *Edit* → *Modify objects (analog)*.
8. To change a forecast value, click on the relevant column, hold the mouse button down, and move the mouse until the item acquires the desired value.
9. To adopt the corrected value(s) in your forecast results, choose *Copy*.

   A dialog box appears showing the revised forecast results.

10. To copy the forecast results into the planning table, choose *Copy results.* You can make further revisions to your forecast results in the planning table.

Significance of the Material Forecast for Materials Planning

Overview [Page 36]

Reducing Forecast Requirements [Page 83]

Effects on Consumption-Based Planning Procedures [Page 84]

Splitting the Forecast Requirements [Page 85]

Reducing Forecast Requirements

Forecast requirement values created during the forecast run are displayed on the time axis as issues:

- When calculating the current stock/requirements situation (displayed in the stock/requirements list), the system reduces the current period's forecast requirements by the consumption figures from the same period which have already been posted.
- The same procedure is also used for calculating material requirements, that is, the system successively consumes forecast requirements with withdrawal postings.

In MRP, the reduction of forecast requirements only differs in two aspects:

- the results of the forecast are available for planning as forecast requirements for **unplanned consumption**.
- forecast requirements are reduced by **unplanned consumption** from the same period which has already been posted.

The results of the forecast are transferred to material requirements planning as forecast requirements and are displayed on the time axis. In the following example, the reduction of forecast requirement quantities is shown by consumption.

Reduction of forecast requirement quantities

	Forecast reqmt	Available for plng	Withdr. posting	Reduction	After reduction
Period 1	1000	1000	**400**	400	**600**
Period 2	1000	1000	0	0	1000
Period 1	1000	1000	**1200**	1000	**0**
Period 2	1000	1000	0	**200**	**800**

Goods issue results in a withdrawal posting and reduces the current period's forecast requirement by the amount withdrawn. If the goods issue was higher than the corresponding forecast requirement, the remaining amount is subtracted from the following period's forecast requirement.

In this example, a goods issue of 400 pieces was posted in the first period. As a result, the forecast requirement of 1000 pieces was reduced by 400 pieces. In the first period, 600 pieces are still available for planning.

If consumption (that is, the goods issue) (1200) in the first period is higher than the original forecast requirement (1000) then the forecast requirement for the following period (1000) is reduced by the remaining amount (1200 - 1000 = 200). That means that in the first period, 0 pieces are still available for planning and in the second period, 800 pieces.

Effects on Consumption-Based Planning Procedures

A forecast run has different effects on the different MRP procedures which support the forecast:

- In the automatic reorder point planning procedure, the reorder level and the safety stock are automatically determined during the forecast run.
- In forecast-based planning, the results of the forecast are copied into material requirements planning as forecast requirements and the safety stock level is calculated.

In both of the above cases, the statistical total consumption fields of the material master data is the basis for forecasting. You can find more precise information on this subject in Overview [Ext.].

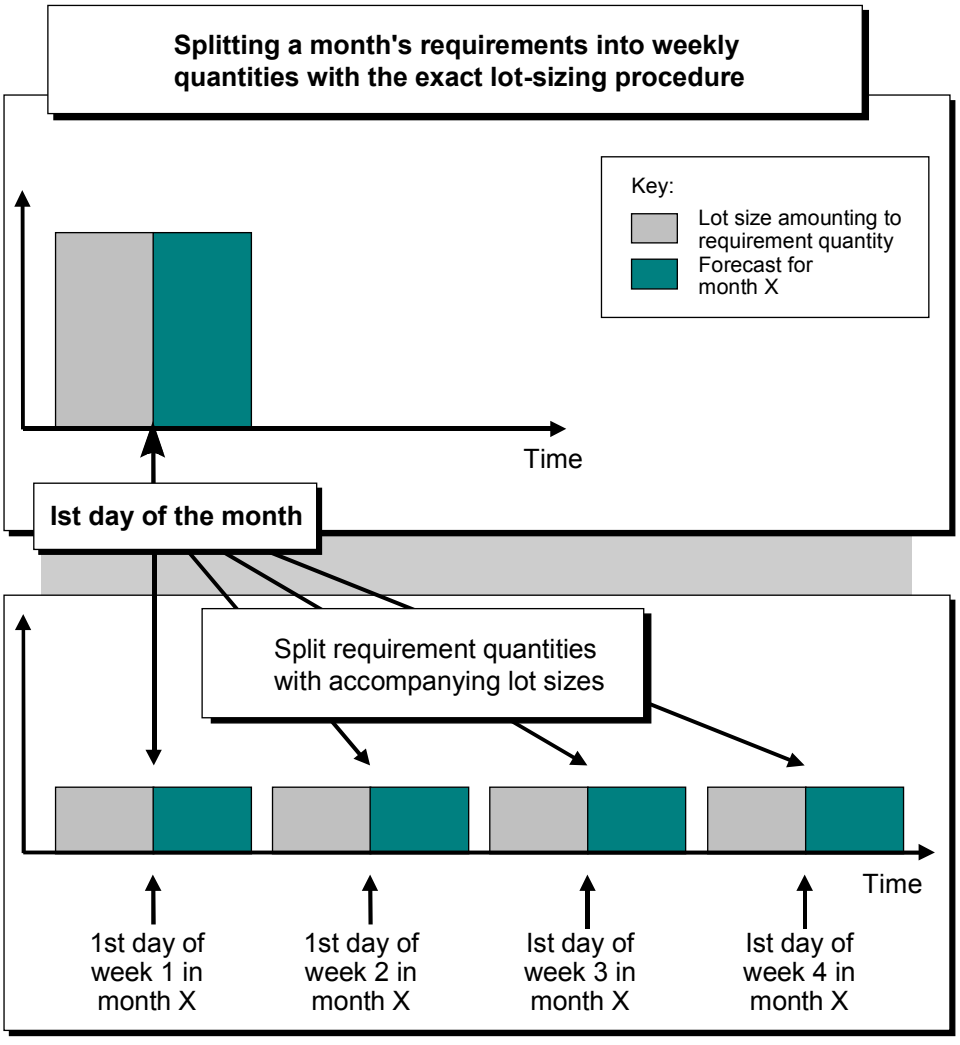
Splitting the Forecast Requirements

For material requirements planning, it is possible to split the period requirements into smaller periods. For example, monthly forecast values can be split into weekly or daily quantities.

You set the splitting indicators in the material master record in the *Splitting indicator* field.

If you have selected a daily split, the system distributes the forecast requirement, which has been reduced by the actual consumption values, over the remaining workdays in the month.

The requirements split is identical for both the consumption-based planning procedure and the MRP procedure.



Forecast Formulas

Overview [Ext.]

Model: Moving Average [Page 87]

Model: Weighted Moving Average [Page 88]

Model: First-Order Exponential Smoothing [Page 89]

Model: Constant [Page 90]

General Formula for First-Order Exponential Smoothing [Page 91]

Model: Second-Order Exponential Smoothing [Page 93]

Formula for Evaluating the Forecast [Page 94]

Formula for Calculating the Safety Stock [Page 96]

Formula for Calculating the Reorder Level [Page 98]

Moving Average Model

The moving average model is used to exclude irregularities in the time series pattern. The model calculates the average of the n last time series values. The average can always be calculated from n values according to formula (1).

$$(1) \quad M(t) = \frac{V(t) + V(t-1) + \ldots + V(t-n+1)}{n}$$

$$(2) \quad M(t+1) = M(t) + \frac{V(t+1) - V(t-n+1)}{n}$$

Therefore, the new average is calculated from the previous average and the current consumption value weighted with 1/n, minus the oldest consumption value weighted with 1/n.

This procedure is suitable for time series which are constant; that is, for time series with no trend-like or season-like patterns. As all historical data is equally weighted with the factor 1/n, it takes precisely n periods for the forecast to adapt to a possible level change.

Weighted Moving Average Model

You achieve better results than those received from the moving average model by introducing weighting factors for each past value. This means that every past value is weighted with the factor R. The sum of the weighting factors is 1 (see formulas (3) and (4) below).

$$(3) \quad M(t) = \frac{V(t)}{n} + \frac{V(t-1)}{n} + \ldots + \frac{V(t-n+1)}{n}$$

$$(4) \quad M(t) = R(t) * V(t) + R(t-1) * V(t-1) + \ldots + R(t-n+1) * V(t-1)$$

M = Average
V = Actual value
R = Weighting factor

If the time series to be forecast contains trend-like variations you will receive better results by using the weighted moving average model rather than the moving average model. The reason for this is that more weight is given to more recent data when determining the average than to older data, that is, if you selected appropriate weighting factors. Therefore, the system will be able to react more quickly to a change in level.

This model, however, depends strongly on your choice of weighting factors. If the time series pattern changes, you must also adapt the weighting factors.

Principles of First-Order Exponential Smoothing

The principles of first-order exponential smoothing are:

- The older the time series values, the less important they become for the calculation of the forecast.
- The present forecast error is taken into account for the following forecasts.

Constant Model with First-Order Exponential Smoothing

The constant model with first-order exponential smoothing is derived as in formula (5). A simple transformation gives the basic formula for exponential smoothing as shown in (6).

(5) $G(t) = G(t-1) + \alpha (V(t) - G(t-1))$

(6) $G(t) = \alpha V(t) + (1 - \alpha) G(t-1)$

$G(t)$	=	The current basic value for the current period (t)
$G(t-1)$	=	The previous basic value from the previous period
$V(t)$	=	Actual demand for the current period (t)
α	=	Smoothing factor for the basic value

To determine the forecast value, you only require the preceding forecast value, the last past consumption value and the alpha smoothing factor. The smoothing factor weights the most recent consumption values more than the less recent ones, so that they have a stronger influence on the forecast.

How quickly the forecast reacts to a change in consumption pattern depends on what value you give the smoothing factor. If you set alpha to be 0, the new average is equal to the old one and the basic value calculated previously remains; that is, the forecast does not react to current consumption data. If you give alpha the value 1, the new average equals the last consumption value.

The most common values for alpha lie between 0.1 and 0.5. An alpha value of 0.5 weights past consumption values as follows:

1st historical value : 50%

2nd historical value : 25%

3rd historical value : 12.5%

4th historical value : 6.25%

and so on.

The weightings of past consumption data can be changed by one single parameter. Therefore, it is relatively easy to respond to changes in the time series.

The constant model of first-order exponential smoothing derived above is applicable to time series that do not have trend-like patterns or seasonal-like variations.

Trend and Seasonal Models with First-Order Exponential Smoothing

From the basic formula derived in (6), the general formula for first-order exponential smoothing (7) takes into account both trend and seasonal variations. The basic value, the trend value and the seasonal index are calculated as shown in formulas (8) - (10).

Forecast value for the period (t+i)

$$(7)\quad P(t+i) = (G(t) + i * T(t)) * S(t-L+i)$$

where:

Basic value:

$$(8)\quad G(t) = G(t-1) + T(t-1) + \alpha \left[\frac{V(t)}{S(t)} - G(t-1) - T(t-1) \right]$$

Trend value:

$$(9)\quad T(t) = T(t-1) + \beta \left[G(t) - (G(t-1) - T(t-1)) \right]$$

Seasonal index:

$$(10)\quad S(t+L) = S(t) + \gamma \left[\frac{V(t)}{G(t)} - S(t) \right]$$

For the constant model

$T(t) = 0$, $\beta = 0$, $S(t) = 1.0$, $\gamma = \text{Gamma} = 0$

For the trend model

$S(t) = 1.0$, $\gamma = \text{Gamma} = 0$

For the seasonal model

$T_{(t)} = 0$, $\beta = 0$

Trend and Seasonal Models with First-Order Exponential Smoothing

P(t+i)	=	The forecast calculated for the period (t+i) in the current period (t)
i	=	Forecast horizon
G(t)	=	The current basic value for the current period (t)
G(t-1)	=	The previous basic value from the previous period
L	=	Period length (often 12)

V(t)	=	Actual demand (history) for the current period (t)
T(t)	=	The current trend value calculated for the current period
T(t-1)	=	The previous trend value from the previous period
S(t)	=	The seasonal index for the period (t)
S(t-L)	=	The previous seasonal index for the period (t)

α	=	Smoothing factor for the basic value 'G', $0 < \alpha < 1$
β	=	Smoothing factor for the trend value 'T', $0 < \beta < 1$
γ	=	Smoothing factor for the seasonal indices 'S', $0 < \gamma < 1$

Second-Order Exponential Smoothing

If, over several periods, a time series shows a change in the average value such that a trend pattern is revealed, first-order exponential smoothing produces forecast values that lag behind the actual values by one or several periods. You can achieve a more efficient adjustment of the forecast to the actual values pattern by using second-order exponential smoothing.

The second-order exponential smoothing model is based on a linear trend and consists of two equations (see formula (11)). The first equation corresponds to that of first-order exponential smoothing except for the indices in brackets. In the second equation, the values calculated in the first equation are used as initial values and are smoothed again.

Seasonal index:

(11) $$G^{(1)}(t) = \alpha\, V(t-1) + (1-\alpha)\, G^{(1)}(t-1)$$

$$G^{(2)}(t) = \alpha\, G^{(1)}(t) + (1-\alpha)\, G^{(2)}(t-1)$$

$G^{(1)}$	=	Simply smoothed basic
$G^{(2)}$	=	Doubly smoothed basic
V	=	Historical value
α	=	Smoothing factor

Evaluating Forecast Accuracy

Every forecast should provide a basis for a decision in some form. So that changes in a time series pattern can be recognized early, the following parameters are calculated in the R/3 System:

- Error total
- Mean absolute deviation (MAD)
- Tracking signal
- Theil coefficient

Error Total

$$(12) \quad ET = \sum_{t-1}^{n} \left[V(t) - P(t) \right]$$

Mean Absolute Deviation for Initialization

$$(13) \quad MAD = \frac{1}{n} \sum_{t-1}^{n} \left| P(t) - V(t) \right|$$

n = Number of periods for initialization

Mean Absolute Deviation for the Ex-Post Forecast

$$(14) \quad MAD(t) = (1 - \delta) * MAD(t-1) + \delta * \left| V(t) - P(t) \right|$$

Tracking Signal

$$(15) \quad TS = \left| \frac{ET}{MAD} \right|$$

Theil coefficient for the Ex-Post Forecast

(16)

$$U = \sqrt{\frac{\sum_{t=1}^{T} \left(P(t) - V(t)\right)^2}{\sum_{t=1}^{T} \left(V(t) - V(t-1)\right)^2}}$$

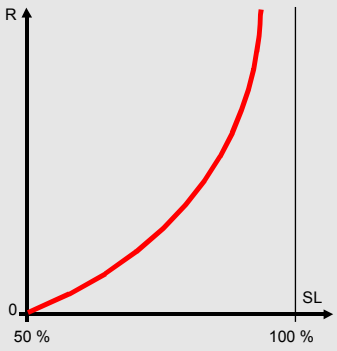
Key

P(t)	=	Forecast value
V(t)	=	Actual value
ET	=	Error total
TS	=	Tracking signal

Safety Stock Calculation

The safety stock depends on the service level that you specified in the MRP II view of the material master record and on the accuracy of the forecast. The more accurate the forecast, the smaller your safety stock can be.

The following figure shows that, without safety stock, customer demand can be satisfied by 50%. It also shows that it is almost impossible to satisfy customer demand 100% of the time. Factor R describes the relationship between forecast accuracy and service level (SL).



SL (%)	Factor R
50	0
55	0.16
60	0.31
65	0.49
70	0.65
75	0.84
80	1.05
85	1.30
90	1.60
95	2.06
98	2.56
99	2.91
99.5	3.20
99.8	4.00

If replenishment lead time is greater than the forecast period by factor W, then the mean absolute deviation (MAD) is recalculated for this period (formula 17). The MAD is a parameter of forecast accuracy. Otherwise, see formula 18.

Safety Stock (SS) Formulas

Formula 17

$$SS = R \times \sqrt{W} \times MAD$$

$$W = \frac{\text{Delivery time (in days)}}{\text{Forecast period (in days)}}$$

Formula 18

$$SS = R \times W \times MAD$$

If the material is produced in-house, the delivery time is: opening period + in-house production time + goods receipt processing time. It is expressed in workdays. The forecast period is taken from the material master record and is also expressed in workdays.

If the material is procured externally, the delivery time is: goods receipt processing time + planned delivery time + goods receipt processing time. It is expressed in calendar days. The forecast period is taken from the material master record and is also expressed in calendar days.

The safety stock calculation may lead to rounding effects.

Minimum Safety Stock

You can specify a minimum safety stock. If the result of the safety stock calculation is lower than this limit, the safety stock is then automatically set to this minimum value. You enter the minimum safety stock in the material master record (the MRP 2 screen).

Reorder Level Calculation

The reorder level is defined as the sum of the safety stock plus the requirement forecast within the replenishment lead time (see formula (17)).

A forecast was carried out on a monthly basis. A month has 30 days in the case of external procurement.

Safety stock		100
Forecast	1st subsequent period	200
	2nd subsequent periode	00
	3rd subsequent period	400
Replenishment lead time	40 days	0/30
		30/30 + 10/30

(an entire monthly requirement + a part of the the following month)

Reorder level = 100 + 30/30 * 200 + 10/30 * 300 = 400