

Calculations

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Forecast Analysis - Overview

The concept of forecasting the future based on past trends has proven to be a sound approach. This is especially true of items with many months of demand history and a high volume of activity. When stock items have only sporadic history, are new items, or have external influences which affect demand patterns there will be a need for more than just statistical analysis. Although many inventories are comprised of items which are used on a regular basis, every inventory has, at least, some unusual items. Each of these items will have a unique pattern of usage.

Forecasting is done at the individual item level and is repeated on a monthly basis as new demand history is accumulated. This approach allows an evolving patterns to be discerned and projected into a new forecast as soon as the trend becomes recognizable. Forecasting is the focus of this section.

In order to properly forecast stock items for any inventory, there are four statistical steps to be completed. However, management preparation must be completed prior to any statistical steps and user review must be completed after all statistical steps. It is important to establish strategic values to be incorporated into the forecast process such as Service Level values, Lead Time values, Sensitivity Factor settings for key items and, if desired, Forecast Families for some items. These variables can affect the quality of forecast which will be statistically calculated. It is also important to review and adjust forecasts after each statistical analysis is completed. This serves as a final check of how reasonable the forecast might be - especially for items with sporadic history patterns, new items or promotional items with externally influenced demand patterns.

The four statistical steps include:

1. **DATA FITTING:** This is the application of all models available for analysis of existing demand patterns. Each model simulates a forecast for the most recently completed year based on stock usage patterns from the year prior to that. Resulting forecast errors are derived by comparing actual stock usage of last year to the simulated forecast. Error checking is done next.
2. **ERROR QUALIFICATION:** All simulated forecasts are also subjected to further testing in order to screen any Bias or Volatile models. This will prevent inherent problems found later in the replenishment process such as chronic "over planning" due to high Bias forecasts. This also helps prevent wide fluctuations in production (or ordering) plans by screening Volatile forecast patterns.
3. **MODEL SELECTION:** The remaining models are then reviewed to select the lowest forecast error. This is, in essence, the best statistical fit. Since forecast error is used later in the determination of Safety Stock (Safety Stock compensates for forecast error in the replenishment cycle), it is calculated as a relative percentage of the Lead Time forecast. It is then converted to forecast error units for use in Safety Stock determination.
4. **FORECAST CALCULATION:** This is the actual application of the forecast model to the prior year history pattern to determine the forecast for the upcoming year. This forecast will be used in subsequent replenishment planning unless adjusted or modified manually. The concept of Lead Time forecasting is employed here. Even though a daily, weekly, monthly and annual forecast will be derived, these forecasts are based on the model choice which minimizes Forecast Error over Lead Time - the most accurate forecast during the most critical period for replenishment planning.

Many forecasting techniques are available and can be chosen by Family. Each individual Family is designed to incorporate similar techniques and produce similar forecasts. This may be extremely important since some items have sporadic stock usage while others may be reactive and still others may be seasonal. The default will be the selection of all models from all Families. Also, an additional Family is available for custom specification of single exponential smoothing (i.e. custom "alpha" specification) and is always included if specified.

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These forecasting *Families* are:

- **Moving Average** (3 month / 6 month / 12 month)
 - **Trend Average** (3 month / 6 month / 12 month)
 - **Seasonal** (This year=Last year (TYLY) / 3 month trend / 6 month trend / 12 month trend)
 - **Single Exponential Smoothing** ("alpha" = .08/.25/.50)
 - **Linear Regression**
 - **Custom Exponential Smoothing** ("alpha" = User value)
-

Additionally, a *Forecast Sensitivity Factor* is available to make the forecast simulation process emphasize more (or less) heavily the most recent past in the forecast error calculation. This can make some forecast model techniques a somewhat better fit depending upon knowledge of how representative the most recent past may be.

Forecast Analysis - Data Fitting

Clear trends in demand usage may not be readily apparent since individual transactions are recorded daily. Normally, fresh monthly history is provided via the download process (LOADDOWN.DAT). In a Stock Status function, the mechanism for recording these transactions is a *Demand Usage* data base. Each stock item may have transactions on a daily basis. These transactions can be sales, shipments, returns or transfers. In any event, they relate to the depletion of available stock and, in some cases, demands against stock which is not available (*Back Orders*). These individual transactions form the basis of historical patterns for forecasting.

The first statistical step of data fitting begins with the past twenty four (24) months of this activity summarized by month. Individual transactions should already be summarized by month (and year) as specified. The result is twenty four (24) summarized totals rather than the many individual transactions. In the event that stock items have been returned, a negative entry may exist which will be deducted from the appropriate monthly total. In some cases there may be more returns than sales, hence, a negative monthly value. This is acceptable in the Stock Management System and will be considered as a "null" month for forecasting purposes. **NOTE: In no case will negative values be forecast for any month.**

For purposes of data fitting, these twenty four (24) monthly values are designed to provide smoother forecasting and less "nervousness" which may result from forecasting every week. Weekly fluctuations in activity will be higher than monthly fluctuations. Daily fluctuations will be even higher.

The Stock Management System uses these monthly values - then breaks them down to "average" daily values by dividing the month by the number of days it contains. These daily values are then summarized into weekly values by adding together every seven (7) days of "average" daily values. This means that some weeks actually cross two months - no matter since there are now three hundred sixty five (365) daily values to choose from. These weekly values are then used to assemble *Lead Time* history values (i.e., a seven week *Lead Time* would actually be the first forty nine (49) days - seven (7) weeks times seven (7) days per week). Data fitting actually uses these *Lead Time* values for forecasting and comparison to actual. These comparison numbers, in turn, determine the *Forecast Error*. Detailed examples on the following pages explain this in more depth.

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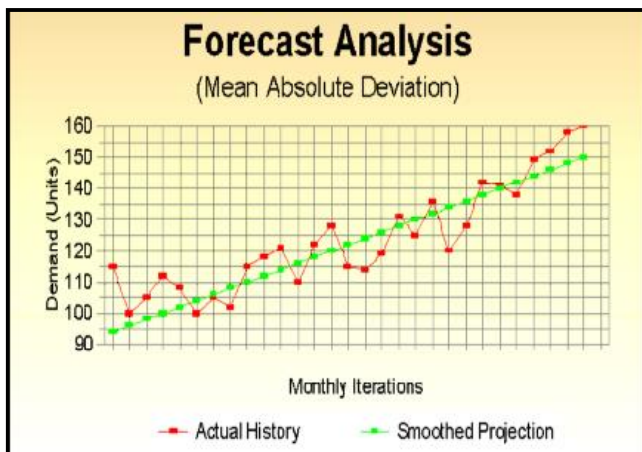
It is important to understand the reason for ultimately using Lead Time values for data fitting. This Lead Time is the most critical time in replenishment planning since it is the expected time available to restock. The capability to restock on time is unreliable on a shorter time frame. The Stock Management System focuses on this time frame to make the forecasts as accurate as possible for replenishment planning purposes.

With daily transactions summarized, a resulting pattern in demand usage will become apparent. What may show on the Forecast Analysis screen or the Forecast Analysis Report will be monthly values. This should approximate the trend as expressed in Lead Time increments. However, various Lead Times will cause differing trends to be discerned.

For example a twenty six (26) week Lead Time may compare a six month value to the corresponding six month value in the next year to record a Forecast Error. This may provide a more stable value for the time frame even though the individual months within this frame are high and/or low. Perhaps a Moving Average model may be chosen. The same demand history for an item with a two (2) week Lead Time would compare two (2) week values to the corresponding two (2) week values in the next year. This may find more high and low values and determine that a Seasonal model better tracks history. Of course, the precise effect depends on the specific Lead Time and the exact nature of the demand history. The important concept to remember here is that the trend in terms of Lead Time values is discerned and tracked in the Stock Management System.

There will be trends for stable items which have many months of history and a high or stable volume. These are stock items which are more easily forecasted. They tend to have lower Forecast Errors and, in turn, require less Safety Stock. These are the predictable items which may not require much manual review (unless deemed to be costly or critical items). This may be reflected by a model choice which shows a slight upward (or downward) level of forecast for each month. This may also be reflected by the same model choice which may show such a slight trend that the individual months appear almost "flat". This should not be confused with a Moving Average model which, of course, will produce a "flat" forecast. The difference may be slight, but discernible.

Some items may not have any trend that can be expressed in a "straight line" type of forecast. These are seasonal items. Their demand pattern tends to have some months with higher sales volume - and these months are approximately the same months for both years of history. If the values are similar from year to year, the model choice will be "this year equals last year". In many cases there may be a hidden trend which means the second year may be distributed in the same fashion, but on a slightly higher (or lower) scale. This will result in a "this year equals last year" arrangement with the values scaled up (or down).



In the event that new stock items are introduced which may not have any demand history (or very few months), the forecasting analysis process cannot necessarily produce a reliable forecast. Depending on the individual monthly values, any model may be chosen. If any expected values are planned for sales of these types of items, they should be entered into the Forecast Analysis screen in order to provide an adjusted forecast that may have more reliability. Statistical reliability is not high for these newer items.

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If an item replaces a previous item, the Supersession function may be used. This function simply checks a user populated table to find the new item/old item relationship. It then uses the old item history to forecast the new item. This can be very effective for a substantial number of items and should be used whenever possible.

The data fitting process actually takes the demand history as accumulated for each item and applies the history from two years prior (YEAR1) to each forecast model. This will result in a forecast for the next year (YEAR2) which would represent the values that would have been forecast for this year just ended. Since the year just ended (YEAR2) is recorded as well, a comparison is made as to the "fit" of the forecast to the actual values. This process is done with absolute differences since a forecast may vary from the actual value regardless of the direction of the variance. A graphic representation of a Linear Forecast compared to "actual" history is shown to the left.

Statistical errors are determined over the Lead Time interval specified for each item, rather than in monthly intervals. This means that errors are calculated for as many Lead Time intervals as can be determined - then "smoothed". Lead Time comparison would be as shown in the following example:

Item #123 has a 6 week Lead Time.

Month	Forecast	Actual	Lead time Forecast	Lead time (Actual)	Lead time Difference
Jan (31)	100	120	178	210	-32
Feb (28)	200	230	290	338	-48
Mar (31)	200	240	310	342	-32
Apr (30)	300	280	454	427	+27
May (31)	400	380	559	563	- 4
Jun (30)	400	500	585	701	+116
Jul (31)	480	520	598	711	+113
Aug (31)	560	540	780	767	+13
Sep (30)	600	620	863	890	-27
Oct (31)	680	700	951	971	-20
Nov (30)	740	820	1,083	1,047	+36
Dec (31)	800	820	N/A	N/A	

The values for Lead Time Forecast are derived from daily values - then summarized for the Lead Time horizon. For example the JANUARY value is as follows:

Six (6) week Lead Time = 6 weeks x 7 days per week = 42 days

42 days = 31 days (JAN) + 11 days (FEB)

January "average" daily usage = 100 units / 31 days = 3.22 units per day

February "average" daily usage = 200 units / 28 days = 7.14 units per day

Lead Time Forecast = 31 JAN days (3.22 units/day) + 11 FEB days (7.14 units/day)

Lead Time Forecast = 99.82 units + 78.54 units

Lead Time Forecast = 178.36 units (truncate to 178 units)

Similarly, the Actual Lead Time history for January is as follows:

Actual Lead Time = 31 days (3.87 units/day) + 11 FEB days (8.21 units/day)

Actual Lead Time = 119.97 units + 90.31 units

Actual Lead Time = 210.28 units (truncate to 210 units)

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To reduce the "nervous" nature of one sample, SMS takes as many samples as possible over the yearly forecasting period. The number of samples that are taken are known as "degrees of freedom" and will be useful in the Error Qualification process for statistical testing. The more samples taken, the more reliable the forecasting process will be (not necessarily the model being used).

In the example shown eleven (11) samples have been taken. These samples are taken for one Lead Time interval starting at the beginning of a new month - for as many months out which will still have a LEAD TIME horizon to total.

These samples are "smoothed" to derive a representative forecast error. The smoothing factor is called Forecast Sensitivity Factor and is used to blend the monthly values. The resulting value is a smoothed version of the "absolute" differences, or Forecast Errors. This may commonly be referred to as the "mean absolute deviation". In referring to the existing example, this value is calculated with the default Forecast Sensitivity Factor as shown in the following example:

Default Forecast Sensitivity Factor = 6 weeks Lead Time / 52 week in year = .11
[In this case "alpha" = .11 ----- while "beta" = 1.00 - "alpha" = .89]

Iteration #1	Factor = 32 units
	<u>Factor = [beta x old value] + [alpha x new value]</u>
Iteration #2	Factor = [(.89) x 32 units] + [(.11) x 48 units] = 33.76 units
Iteration #3	Factor = [(.89) x 33 units] + [(.11) x 32 units] = 32.89 units
Iteration #4	Factor = [(.89) x 32 units] + [(.11) x 27 units] = 31.45 units
Iteration #5	Factor = [(.89) x 31 units] + [(.11) x 4 units] = 28.03 units
Iteration #6	Factor = [(.89) x 28 units] + [(.11) x 116 units] = 37.68 units
Iteration #7	Factor = [(.89) x 37 units] + [(.11) x 113 units] = 45.36 units
Iteration #8	Factor = [(.89) x 45 units] + [(.11) x 13 units] = 41.48 units
Iteration #9	Factor = [(.89) x 41 units] + [(.11) x 27 units] = 39.46 units
Iteration #10	Factor = [(.89) x 39 units] + [(.11) x 20 units] = 36.91 units
Iteration #11	Factor = [(.89) x 39 units] + [(.11) x 36 units] = 36.00 units

In this example, a "smoothed" forecast error has been calculated to be 36 units. This value is stored in a table of values as the "mean absolute deviation" of using this model to forecast. This process is repeated for all models specified (default is all families and all models). The result is table of deviations calculated for various models from the same demand history data. The Stock Management System uses this approach to discern which model has achieved the best statistical fit and, hence, the lowest forecasting error.

NOTE: The FORECAST ERROR value will be converted to a percentage of the "mean Lead Time forecast" for later use in identifying what amount to expect when the chosen model is applied from YEAR2 to the coming year. This is reviewed later in the discussion on FORECAST CALCULATION.

Another feature of SMS forecasting techniques includes a default for calculating forecast error. If an item has very little demand history or has exceptionally long lead times, the forecasting process defaults to monthly intervals to calculate forecast error. It substitutes monthly values for Lead Time values and %smooths+12 monthly values to determine errors. This method is then used in a Standard Error calculation which takes the square root of 1/12th the sum of the values squared. This is a common - and reliable - method for determining forecast errors and applies well for active items.

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Forecast Analysis - Error Qualification

The process of deriving a variety of forecast alternatives and identifying the best choice involves another step to ensure forecast reliability. This step qualifies the forecast for possible statistical problems with each of those alternatives. The Stock Management System includes two additional tests to ascertain the viability of the models chosen. These include Bias testing and Volatile testing.

The test for Bias forecasting involves analysis of the "mean absolute deviation" to verify that it is within the proper limits of standard deviation testing. In this test, the "average deviation" is computed and compared to the "mean absolute deviation". The ratio of "average" to "mean" is then verified on a table of probabilities which provides statistical limits depending on the number of "degrees of freedom" (samples) taken. In the previous example, there were eleven (11) "degrees of freedom" or eleven (11) samples of Lead Time Forecast Errors. This range of statistical limits approximates a "two tailed" test of probability that the "average" value of the error and the true value or "mean absolute deviation" are reasonably close. This measures systematic error and verifies that the procedure (i.e., model used) is reliable. The probability values for this "two tailed" test are as follows:

"Two Tailed" Test

- 1 Degree of Freedom = 63.657
- 2 Degrees of Freedom = 9.925
- 3 Degrees of Freedom = 5.841
- 4 Degrees of Freedom = 4.604
- 5 Degrees of Freedom = 4.032
- 6 Degrees of Freedom = 3.707
- 7 Degrees of Freedom = 3.499
- 8 Degrees of Freedom = 3.355
- 9 Degrees of Freedom = 3.250
- 10 Degrees of Freedom = 3.169
- 11 Degrees of Freedom = 3.106

"Volatility" Test

- 1 Degree of Freedom = 0.004
- 2 Degrees of Freedom = 0.103
- 3 Degrees of Freedom = 0.352
- 4 Degrees of Freedom = 0.711
- 5 Degrees of Freedom = 1.145
- 6 Degrees of Freedom = 1.635
- 7 Degrees of Freedom = 2.167
- 8 Degrees of Freedom = 2.733
- 9 Degrees of Freedom = 3.325
- 10 Degrees of Freedom = 3.940
- 11 Degrees of Freedom = 4.575

The other test for Volatile forecasting involves comparison of the individual differences to the "mean absolute deviation". This test will determine whether any of these individual points are not within the probabilities necessary for the forecast technique to be reasonable.

Further error qualification is also checked by the Stock Management System. This is an additional test for "spiked data" which could be a given history value outside the expected range of valid values. Although legitimate, this value could skew the Forecast Analysis and cause unrealistic (although statistically valid) forecasts. If an item has passed the Bias and Volatility tests, it is subjected to the "spiked data" test and flagged in the data base with a code "S". Items with this code are not eliminated, but are flagged and may use smoothed value in place of the "spike".

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Forecast Analysis - Model Selection

The final selection of forecasting model is a combination of error minimization and error qualification. SMS will check all forecast models that have been used for simulation to determine if any are Bias or Volatile forecasts. If any are found to have either condition, they are eliminated from further consideration. The lowest Forecast Error is then chosen from the remaining choices. This will usually be the model technique that is chosen.

In the event that all model techniques available for simulation are either Bias or Volatile, the Stock Management System will then allow all such models to be considered further. In this case, the lowest Forecast Error from these models is chosen. The model technique will be used but with a "flag" shown on the Forecast Analysis Report and in the Forecast Control data base screen. When no other choice exists, the system will choose a Bias or Volatile forecast.

The user can specify forecasting Family for any and all items through use of the Forecast Analysis screen variable. The tendency toward Bias or Volatile forecast choices occurs more frequently when this feature is exercised. This means that the Stock Management System has fewer models to choose from and must "make do" with the choices available. Use of this feature also may tend to increase Forecast Error since the "best fit" may really be a model not included for simulation. It is recommended that all models be made available for simulation whenever possible.

Forecast Analysis - Forecast Calculation

After the forecasting technique is chosen statistically, the use of that technique must be completed for the coming year. This is the actual application of the model chosen to the prior year demand history pattern to forecast the next twelve (12) months. This approach does not involve Lead Time forecast intervals to make this calculation. True monthly forecast numbers are derived for these projections.

These forecasts are converted to daily and weekly forecast values after the monthly forecasts have been calculated and reviewed. These daily and weekly values are the basis of projecting replenishment plan scheduling throughout the balance of SMS.

The daily forecasts also serve another important purpose. The determination of Safety Stock is based on these daily calculations. In addition to the Forecast Error calculated during the simulation phase of these calculations, this Forecast Error was determined as a percent of Lead Time forecast (i.e., the ratio of error to forecast for Lead Time). This Forecast Error % is also used to identify the percentage of Forecast Error to be expected in the new forecast for the future. This becomes simply the Forecast Error % multiplied by the new Lead Time forecast. It is at this point that the daily forecast values are summarized as discussed in the Forecast Simulation section. For example, if the Forecast Error % was determined to be 25% and the Lead Time forecast was determined to be 2,000 units - the new Forecast Error would be 500 units (25% x 2,000 units). This new value is used in the Safety Stock calculation discussed on the following pages (Safety Stock).

Again, the statistical forecasting process is not the final step to achieving reliable forecasts. The careful review of these statistical forecasts is necessary to incorporate extrinsic factors into the forecast that may be known to the user but not reflected in the demand history. The Stock Management System provides the statistical tools to forecast and the systematic tools to flag potentially unreliable forecasts for further review. The user should understand the importance of such review.

Safety Stock - Overview

As described previously, Safety Stock is designed to compensate for Forecast Error. However, this represents a very real cost when evaluating the level of stock to be maintained. The determination of the Safety Stock is not an arbitrary process. If management arbitrarily reduces stock, then chronic shortages may develop for some key items. This can result in lost sales due to stock-out conditions. Safety Stock often varies more than Economic Order Quantities and, as such, may have a greater impact on replenishment scheduling. In a manufacturing environment, production schedules could change as a result of changes to Safety Stock. In a distribution or retail environment, vendor ability to fill orders on time can be affected. The variables and controls that affect Safety Stock should be kept as stable as possible so that Safety Stock itself is as stable as possible. These variables include:

- Specified Service Level
- Forecast Error %
- Economic Ordering Quantity

Although Forecast Error % is a function of statistical forecasting, adjustment to the forecast can alter the number of units specified as forecast error used in the Safety Stock determination. Service Level and Economic Order Quantity are directly controllable and should not be changed unnecessarily. If the Service Level approaches 99%, the impact on Safety Stock can be substantially increased units (and costs).

The Economic Order Quantity is another matter. Safety Stock is calculated in conjunction with the Order Quantity. The two are inversely related - more Order Quantity means less Safety Stock. This section explains the calculation for Safety Stock including the statistical tables used in its derivation. Also discussed in this section are the effects of various controls used to help make this critical value reflect operations as much as possible.

As Safety Stock is calculated, the cost it represents is also calculated for inclusion in the Order Quantity analysis. This calculation of Safety Stock is repeated for every iteration in the Order Quantity analysis. In this fashion, the two figures are relative to one another and will tend to compensate for each other.

The Carrying Cost (Safety Stock) is inversely related to the quantity ordered. This means that it will tend to decrease with larger ordering alternatives. Safety Stock is recalculated in conjunction with each simulated alternative and will tend to move to a small or zero value as Ordering Quantity increases. Thus, the Carrying Cost of this Safety Stock will also tend to decrease in the same fashion.

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Safety Stock - Calculation

The actual calculation of Safety Stock is based on a Normal Distribution of probability. There are two steps in determining the Safety Stock value. The first step is to determine the ability of ordering options to compensate for the probability of being out of stock. This is a probability number which, in turn, indicates how many factors of Forecast Error should be calculated to ensure coverage during the Lead Time forecasting horizon. The table of probabilities is shown (on the following page). The calculations are illustrated as follows:

Normal Probability Distribution			
Safety Stock Factors			
Factor	Multiple	Factor	Multiple
.0001	4.0	.0228	2.0
.0002	3.9	.0287	1.9
.0003	3.8	.0360	1.8
.0004	3.7	.0446	1.7
.0005	3.6	.0548	1.6
.0006	3.5	.0668	1.5
.0007	3.4	.0807	1.4
.0008	3.3	.0968	1.3
.0009	3.2	.1150	1.2
.0010	3.1	.1357	1.1
.0013	3.0	.1568	1.0
.0019	2.9	.1840	0.9
.0026	2.8	.2119	0.8
.0035	2.7	.2420	0.7
.0047	2.6	.2743	0.6
.0062	2.5	.3085	0.5
.0082	2.4	.3446	0.4
.0107	2.3	.3821	0.3

Specified Service Level = 95%
 Order Quantity (EOQ) = 192
 Forecast Error % = 20%
 Forecast (Lead Time) = 250 Units

First, we determine the ability of the EOQ to compensate for %stock-out+probability.

- Forecast Error for this example is 50 units
 (20% error X 250 units forecast) for Lead Time
- Factor = (1-Service Level) X (Order Quantity/Fcst Error)
- Factor = (.05) X (192 / 50)
- Factor = 192

The number of multiples of Forecast Error quantity needed can be found in the table below. This table indicates a multiple of .9 times, which is used to calculate the Safety Stock value.

Safety Stock = %Multiple+ X Forecast Error
 Safety Stock = .9 X 50
 Safety Stock = **45 Units** (for Lead Time forecast of 250)

Both service level and forecast error can have an impact on the final Safety Stock calculation. It is also possible that these two factors could partially offset each other. The absolute magnitude of the forecast can mean a more stable forecast if the numbers are large. Indirectly, the Lead Time can also impact the safety stock number as well if the Lead Time is longer. It is more difficult to forecast smaller numbers over a longer time horizon. Careful review of Lead Time and Service Level are extremely important.

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Safety Stock - Min/Max/Weeks/Adjustment

MINIMUMS

Under some conditions, the Safety Stock quantity may be determined to be a value which is extremely low. Although this may make sense statistically, the user may not be comfortable for other reasons. Perhaps a vendor has not been reliable in his delivery of stock. Perhaps manufacturing problems have meant low production of items. Perhaps there is some outside factor which must be considered. The Safety Stock quantity control is used to accommodate these kinds of factors.

Minimum Safety Stock is used as an individual item control. **It is entered through the user's Stock Status system.** This entry is retained until changed by the user and should be reviewed regularly.

The Safety Stock quantity is calculated as shown previously. After that calculation is completed, the derived value is checked against the Minimum Safety Stock specified. If less, the Actual Safety Stock is revised to reflect the minimum and will be shown (and used) as a value that agrees with this minimum. If the Actual Safety Stock is greater, it will be shown (and used) as originally calculated.

If used in conjunction with other ordering controls, the Minimum Safety Stock has precedence over all other controls. For example, if an adjustment to the Safety Stock was set at 100 units and the minimum was set at 200 units (by mistake in either case), the minimum would take precedence and the Safety Stock would be no lower than 200 units. This would also be the case for incorrectly entered maximum quantities which would have been set lower than minimum quantities. Care should be exercised when using multiple controls at the same time, since the combined impact can be great.

MAXIMUMS

In some instances, the Safety Stock quantity may be determined to be a value which is extremely high. Although this may also make sense statistically, it may not be practical for other reasons. Perhaps management is trying to reduce stock investment. Perhaps there is a limit on warehouse space. The Maximum Safety Stock control is used to accommodate these kinds of factors.

Maximum Safety Stock is used as an individual item control. **It is entered through the user's Stock Status System.** This entry is retained until changed by the user and should be reviewed regularly.

The Actual Safety Stock is calculated as shown on the previous page. After that calculation is completed, the derived value is checked against the Maximum Safety Stock specified. If more, the Actual Safety Stock is revised to reflect the maximum and will be shown (and used) as a value that agrees with this maximum. If the Actual Safety Stock is less, it will be shown (and used) as originally calculated. This is superseded by the Minimum Safety Stock control in the event of incorrectly entered values.

WEEKS SUPPLY

As a more passive control, the user may wish to enter a continually updated range for the Safety Stock quantity. This can be accomplished by use of the Weeks Supply control. Due to continuous changes in market conditions and forecasts, it is often more advantageous to order a certain number of weeks supply of an item. During the course of many weeks or months, this value will change. The current value changes as the forecast changes. The Weeks Supply control specifies a continually changing Safety Stock which is in tune with the current forecast - yet ensures coverage for the specified number of weeks.

The Weeks Supply field is used as an individual item control. It is entered through the Replenishment Screen. This entry will be retained until deleted by the user and should be reviewed for validity on a regular basis.

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The Actual Safety Stock is calculated as shown on the previous page. After that calculation is completed, the derived value is checked against the Minimum and Maximum Safety Stock quantities specified. If the Weeks Supply specification is within these limits, the Actual Safety Stock is accordingly updated (and used) as a value that agrees with this number of weeks.

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Direct control of the Safety Stock quantity is available through use of the Adjusted Safety Stock control feature. This feature enables the user to directly replace the value of the Safety Stock as calculated by the Stock Management System. This feature is designed to accommodate unusual circumstances which would usually be temporary in nature. For this reason, it is suggested that these entries be reviewed thoroughly for validity. They will remain in effect until removed by the user and could cause undesired values to be used in the ordering process.

Adjusted Safety Stock is used as an individual item control and is entered through the Replenishment Screen. This entry is retained until deleted by the user and should be reviewed for regularly.

The Actual Safety Stock is calculated as shown previously. After that calculation is completed, the derived value is checked against the Minimum and Maximum Safety Stock quantities specified. If the adjustment is within these limits, the Actual Safety Stock quantity is accordingly updated (and used) as a value that agrees with this adjustment. This can be superseded by the Minimum and Maximum Safety Stock quantities to ensure valid ranges of adjustment.

Safety Stock - Slow Moving Items

Managing inventory in support of maintenance operations brings challenges not typically found in retail or wholesale inventories. SMS has incorporated a sound and reasonable approach to slow moving items. This approach makes it simple to identify these items and apply the appropriate tool and inventory policy for managing them.

The most often used variable for managing slow moving items is Safety Stock. Very often applying statistical forecasting to the inherent demand patterns of slow moving items will yield low or zero forecasts. Managers are consequently forced to use extensive manual procedures to manage this inventory. The SMS automatically manages this element for the inventory manager.

The Stock Management System will dynamically interpret all available data and policy elements to categorize an item as slow moving (and target safety stock as spare inventory) or as an active item with the appropriate statistical forecasting method. SMS first scans for the presence of in-use (or installed) inventory data and expected failure rate. It then calculates an observed failure rate using demand history and compares it with an expected failure rate. The greater of the two values is selected for use. That value is then adjusted for lead time. Shorter lead times = lower safety stock.

Lacking in-use inventory data, the Stock Management System then reviews demand history. Items with less than twelve (12) units demand per year are assigned a slow moving status. The minimum safety stock for these items is calculated based on target service level policy for the item. The yielded value is also adjusted for Lead Time. Zero failure rate and zero usage items will carry a minimum safety stock of one unit.

The entire process is fully integrated into the active items process without user intervention. In addition, this process is optional at run time by simply answering yes (or no) to a system prompt. This approach was developed with extensive input from managers operating in maintenance environments. It is designed to simplify the process for integrating this inventory into the total management process and refine a manager's approach over time.

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Safety Stock Calculation (with "in-use" data):

- Determine slow moving status (in-use data > 0 turns on this calculation)
- Calculate observed failure rate
 - sum last two years total demand
 - divide this sum by two (average annual demand)
 - divide average annual demand by in-use data
 - divide the last 12 months demand by in-use data
 - set observed rate at greater of the above two values
- Use manufacturer expected failure rate (if available from file)
- Set minimum safety stock
 - multiply in-use data by greater of observed failure rate or manufacturer expected failure rate
- Adjust minimum safety stock for lead time as follows:
 - if lead-time = 1 week set safety stock = (safety stock) X 25%
 - if lead-time = 2 weeks set safety stock = (safety stock) X 50%
 - if lead-time = 3 weeks set safety stock = (safety stock) X 75%
 - if lead-time >= 4 weeks set safety stock = (safety stock) X 100%
- Set zero failure rate items minimum safety stock to one (1) unit

Safety Stock Calculation (without "in-use" data):

- Determine slow moving status
- calculate average annual demand based on last 2 years demand
- if result <= 12 units (turn on slow moving logic)
- Calculate minimum safety stock based on service level - apply percentage to average annual demand
 - if service level = 99% percentage factor = 92%
 - if service level = 98% percentage factor = 84%
 - if service level = 97% percentage factor = 76%
 - if service level = 96% percentage factor = 68%
 - if service level = 95% percentage factor = 60%
 - if service level = 94% percentage factor = 52%
 - if service level = 93% percentage factor = 44%
 - if service level = 92% percentage factor = 36%
 - if service level = 91% percentage factor = 28%
 - If service level = 90% percentage factor = 20%
 - if service level = 89% percentage factor = 12%
 - if service level = 88% percentage factor = 4%
- Adjust minimum safety stock for lead time as follows:
 - if lead-time = 1 week set safety stock = (safety stock) X 25%
 - if lead-time = 2 weeks set safety stock = (safety stock) X 50%
 - if lead-time = 3 weeks set safety stock = (safety stock) X 75%
 - if lead-time = 4 weeks set safety stock = (safety stock) X 100%
 - if lead-time > 4 weeks set safety stock = (safety stock) X 100%
- Set zero usage items minimum safety stock
 - target service >= 96% (set minimum safety stock = 1 unit)

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Safety Stock - Lumpy Demand Items

Managing inventories for distribution operations stresses availability of stock based on market trends. In some cases, demand patterns are not %high volume+. Conversely, they are not %low-moving+as may be found in maintenance inventories. They have demand patterns known as %lumpy Demand+

%lumpy Demand+within the Stock Management System is defined as 12 (or less) months of activity, regardless of the number of units sold. This targets items which could be %high volume+- thus too large for %low-moving+logic. These items also have intermittent sales - thus too random to forecast.

The Stock Management System will dynamically interpret available data and policy elements to categorize item as %lumpy Demand+(null forecast, but some safety stock as spare inventory) or as an active item with the appropriate statistical forecasting method. The Stock Management System scans for number of months with sales activity. If less than 12 units are sold, the system initializes %lumpy Demand+logic. If not (i.e. more than 12 months of activity) statistical forecasting methods are used to determine safety stock.

When using %lumpy Demand+, the system sums the most recent six (6) months of sales activity. This value is used for the Stock Management System percentage factor table to determine how much to keep on as a safety stock. This value is further adjusted based on cost - with more expensive items having a lower safety stock value.

The entire process is fully integrated into the active items process without user intervention. In addition, this process is optional at run time by simply answering yes (or no) to a system prompt. This approach was developed with extensive input from managers operating in distribution environments. It is designed to simplify the process for integrating this inventory into the total management process and refine a manager's approach over time.

Safety Stock - Lumpy Demand Items

- Determine Lumpy Demand statistics (< 12 month activity)
- Calculate minimum safety stock based on service level - apply % to average annual demand
 - if service level = 99% percentage factor = 92%
 - if service level = 98% percentage factor = 84%
 - if service level = 97% percentage factor = 76%
 - if service level = 96% percentage factor = 68%
 - if service level = 95% percentage factor = 60%
 - if service level = 94% percentage factor = 52%
 - if service level = 93% percentage factor = 44%
 - if service level = 92% percentage factor = 36%
 - if service level = 91% percentage factor = 28%
 - if service level = 90% percentage factor = 20%
 - if service level = 89% percentage factor = 12%
 - if service level = 88% percentage factor = 4%
- Adjust minimum safety stock for cost as follows
 - if cost < \$ 10 Set safety stock = (100 % safety stock)
 - if cost \$10 - \$100 Set safety stock = (safety stock x 75%)
 - if cost \$100 - \$500 Set safety stock = (safety stock x 50%)
 - if cost \$500 - \$1000 Set safety stock = (safety stock x 25%)
 - if cost > \$1000 ... and SS > 1 Set Safety Stock to 1 piece

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EOQ – Overview

After a statistical forecast has been derived and adjusted, attention should be focused on planning for future demand. The Stock Management System has forecasted how much is expected to be used during the next Lead Time horizon. How should the necessary quantities be procured? What is the ~~least~~ least cost alternative to procurement? Should large quantities be ordered less frequently? Should small quantities be ordered more frequently? These questions are addressed by calculating the Economic Order Quantity.

The Economic Order Quantity is a statistically derived value. It represents the lowest cost associated with ordering for the next year. The optimal value balances the high cost of carrying unnecessary stock (large orders - less often) with the high cost of placing orders (small orders - more often).

There are various costs which affect the determination of this quantity. Each is associated with the process of replenishing stock and will vary with alternative stocking levels (lot sizes). These include:

- Procurement Cost
- Receiving/Set-up Costs
- Carrying Cost (Average Stock Level)
- Carrying Cost (Safety Stock)

The Procurement Cost represents the expenditure to obtain the stock item, whether through outside purchase or inside production. In the event that quantity discounts may exist (or production scale efficiencies), this cost will likely diminish for larger alternatives. If no discount exists, it will remain constant for all alternatives.

The Receiving/Set-up Costs are directly associated with placing an order and receiving the ordered stock. This cost is usually determined by summarizing all related ordering costs (i.e., staff time, computer usage costs, administrative overhead, machine set-up, etc.) and allocating them over the number of orders placed during the year. Thus, this becomes a "per order" cost factor - regardless of the quantity contained in each order. Since larger quantities would mean ordering fewer times per year, this component cost will tend to decrease with larger ordering alternatives.

The Safety Stock cost is inversely related to the quantity ordered. This means that it will diminish with larger ordering alternatives. Safety Stock is recalculated in conjunction with each simulated alternative and will approach a small or zero value as ordering quantity increases. Thus, the Carrying Cost of this Safety Stock also tends to decrease in the same fashion.

The Carrying Cost (of the average order quantity) will be the lone cost component which does not decrease. This is a direct relationship of carrying each ordering alternative in stock. The higher the quantity - the greater the cost will be.

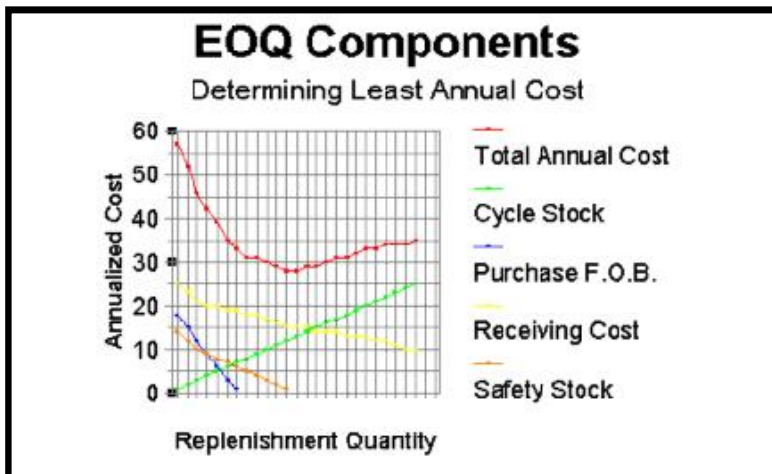
The determination of the Economic Order Quantity is done by simulating alternative ordering quantities (starting with the Minimum and increasing by the Increment) and calculating the component costs for each alternative. The alternative which has the lowest total cost becomes the chosen value.

Calculations

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EOQ - Calculation

The calculation of the Economic Order Quantity EOQ is an iterative process with each component cost calculated for each iteration, then summarized. These costs will usually decrease to a point where Carrying Cost (of the average order quantity) begins to rise without being offset by diminishing component costs. The last value before this rise in total cost is then determined to be the EOQ.



The following iterative calculation illustrates this process:

- Annual Forecast = 1000 units
- Item Cost = \$12.50 / unit
- Receiving Cost = \$50.00
- Carrying Cost = 20%
- Safety Stock = 0 units

The ~~low~~ least cost+alternative value is 192 units. This would be subjected to further limitations of Minimum Quantities and Incremental Quantities. Calculations are shown below.

WKS	Alt Qty	Annual Procure	Annual Receiving	Average Stock	Annual Safety	Total Annual
5	96	\$12,500	\$520	\$120	\$0	\$13,140
10	192	\$12,500	\$260	\$240	\$0	\$13,000
15	288	\$12,500	\$173	\$360	\$0	\$13,033
20	384	\$12,500	\$130	\$480	\$0	\$13,110
25	480	\$12,500	\$104	\$600	\$0	\$13,204

Specific Economic Order Quantity calculations include:

$$\frac{\text{Annual Procure}}{\$12,500} = \frac{\text{Annual Forecast}}{1000 \text{ units}} \times \text{Item Cost} \quad X \quad \$12.50$$

$$\frac{\text{Annual Receive}}{\$260} = \frac{(\text{Annual Fcst} / \text{Alt Qty})}{1000 \text{ units} / 192} \times \text{Receive Cost} \quad X \quad \$50$$

$$\frac{\text{Average Stock}}{\$240} = \frac{\frac{1}{2} \text{ Alt Qty}}{(\frac{1}{2} \times 192)} \times \text{Item Cost} \quad X \quad \$12.50 \quad X \quad \text{Carry Cost} \quad X \quad 20\%$$

$$\frac{\text{Annual Safety}}{\$0} = \frac{\text{Safety Stock}}{0} \times \text{Item Cost} \quad X \quad \$12.50 \quad X \quad \text{Carry Cost} \quad X \quad 20\%$$

In the example illustrated, the iterative process has been abbreviated to show that the alternative quantity of 192 units has the lowest total annual cost. This also happens to be the point where the Receiving Cost begins to approach the cost of average stock (the amount available "on average" between the beginning and the end of Lead Time). Beyond this level Receiving Cost becomes lower. In the actual iteration process, Annual Safety cost is also considered. This value becomes lower as the alternative quantity becomes higher. The Economic Order Quantity is always calculated to be the quantity which minimizes total annual cost.

Stock Management System

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EOQ - Effects of Min/Max/Inc/Weeks/Adjustment

MINIMUMS.....

Under some conditions, the Economic Order Quantity can be determined to be an extremely low value. Although this may make sense financially, it may not be practical for other reasons. Perhaps a vendor will not sell less than a box of one hundred (100). Manufacturing policy may prohibit less than one hundred (100) units per production run. Perhaps there is some outside factor to be considered. The Minimum Order Quantity control will accommodate these factors.

The Minimum Order Quantity is used as an individual item control. **It is entered through the user's Stock Status system and will be retained until changed by the user – requires regular review.**

The Economic Order Quantity is calculated on the previous page. After this calculation is complete, this value is checked against the Minimum Order Quantity. If less, the Economic Order Quantity is revised to reflect the minimum and will be shown (and used) as a value that agrees with this minimum. If the Economic Order Quantity is greater, it will be shown (and used) as originally calculated.

If used in conjunction with other ordering controls, the Minimum Order Quantity has precedence over all other controls. For example, if an adjustment to the order quantity was set at 100 units and the minimum was set at 200 units (by mistake in either case), the minimum would take precedence and the order quantity would be no lower than 200 units. This would also be the case for incorrectly entered maximum quantities which would have been set lower than minimum quantities. Care should be taken when using multiple controls at the same time, since all impact the final EOQ.

INCREMENTS.....

In many cases ordering quantities are also subject to lot sizing+constraints. This is due to pre-packaging by vendors or production schedules in manufacturing processes. It is integrated into the order calculation through use of the Incremental Order Quantity control. **This is entered through the user's Stock Status system.** This entry is retained until deleted and requires regular review.

The Economic Order Quantity is calculated as shown above. After it is calculated, the derived value is checked against the Minimum Order Quantity specified. It is then checked against the Incremental Order Quantity entry to verify that the resulting value is a multiple of this increment. If not, the Economic Order Quantity is revised to reflect the increment (and minimum) and will be shown (and used) as a value that agrees with this increment.

MAXIMUMS.....

In some instances, the Economic Order Quantity may be determined to be a value which is extremely high. Although this may make sense financially, it may not be practical for other reasons. Perhaps a vendor has a limit of supply. Perhaps manufacturing capacity prohibits more production than a small portion of what can be sold. Perhaps there is a limit on warehouse storage space. The Maximum Order Quantity control is used to accommodate these kinds of factors.

The Maximum Order Quantity is used as an individual item control. **It is entered through the user's Stock Status system.** This entry is retained until changed by the user and requires regular review.

The Economic Order Quantity is calculated as shown on the previous page. After that calculation is completed, the derived value is checked against the Maximum Order Quantity specified. If higher than the maximum, the Economic Order Quantity is revised to reflect the maximum and will be shown (and used) as a value that agrees with this maximum. If the Economic Order Quantity is less, it will be shown (and used) as originally calculated. This can be superseded by the Minimum Order Quantity control in the event of incorrectly entered values.

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WEEKS SUPPLY.....

As a more passive control, the user may wish to enter a continually updated range for the order quantity. This can be accomplished by use of the Weeks Supply control. Due to continuous changes in market conditions and forecasts, it may be advantageous to always order a certain number of weeks supply of an item. Over time, this value will change as the forecast changes. The Weeks Supply control specifies a fluctuating order quantity which is in tune with the current forecast, ensuring coverage for a specified number of weeks.

The Weeks Supply field is used as an individual item control. It is entered through the Replenishment Screen. This entry is retained until deleted by the user and should be reviewed for validity on a regular basis.

The Economic Order Quantity is calculated as shown on page 15. After that calculation is completed, the derived value is checked against the Minimums, Maximums and Incremental Order Quantities specified. If the Weeks Supply specification is within these limits, the Economic Order Quantity is accordingly updated (and used) as a value that agrees with this number of weeks.

ADJUSTMENT.....

Direct control of the order quantity is available through use of the Adjusted Order Quantity control feature. This feature enables the user to directly replace the value of the order quantity as calculated by the Stock Management System. This feature is designed to accommodate unusual circumstances which would typically be temporary in nature. For this reason, it is suggested that these entries be reviewed thoroughly for validity. They will remain in effect until removed by the user and could cause undesired values used in the ordering process.

The Adjusted Order Quantity is used as an individual item control. It is entered through the Master View. This entry will be retained until deleted by the user and should be reviewed for validity on a regular basis.

The Economic Order Quantity is calculated as shown on page 15. After that calculation is completed, the derived value is checked against the Minimums, Maximums and Incremental Order Quantities specified. If the adjustment is within these limits, the Economic Order Quantity is accordingly updated (and used) as a value that agrees with this adjustment. This can be superseded by the Minimum, Maximum and Incremental Order Quantities to ensure valid ranges of adjustment.

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Replenishment - Overview

This analysis combines all previously specified and calculated factors into a time-phased plan for replenishing stock. It will compare forecasted stock usage against available stock throughout the coming year. The result of this comparison will be a schedule of orders to replenish stock consistent with previously determined Forecast, Economic Ordering Quantity and Safety Stock. Existing replenishment orders are also considered since these will affect future requirements. Specific factors affecting this ordering schedule are:

- **ON HAND** Stock
- **BACK ORDERED** Stock
- Scheduled **REPLENISHMENT ORDERS**
- **Forecasted Stock Usage**
- **SAFETY STOCK**

Replenishment strategy is categorized by stocking position at the end of Lead Time. These designations are called Ordering Codes and indicate the type of replenishment action to be taken. These Ordering Codes are:

- 4 = Backorder (no incoming replenishments)
- 3 = Backorder (replenishments already placed)
- 2 = Projected Out-of-Stock
- 1 = Normal Reorder
- 0 = Balanced inventory (no action)
- +1 = Overstocked (More than one EOQ)
- +2 = Overstocked and Still Ordering
- +3 = One year's supply in excess
- +4 = Obsolete (inactive for two years)

The resulting order schedules produced will indicate "expedite" and "de-expedite" conditions and, when possible, allow one Lead Time period to receive stock only for the amount needed. If Ordering Codes are negative (-1, -2, -3 or -4) additional orders will be initiated. If Ordering Codes are not negative (0, +1, +2, +3 or +4) no additional orders will be initiated. These calculations provide the foundation for planning and control and can be integrated into existing Stock Status Systems for daily use as well as management reporting and review.

The Stock Management System provides a Pending Orders function which identifies individual items which require Additional Orders in order to balance the projected stock schedule. This function produces a Pending Orders Report and creates a Pending Orders data base - both of which contain ordering information for these items. In the case of Ordering Codes (-3) and (-2) there will likely be a need to expedite the order and receipt of stock. This is because these codes indicate either an existing %stock-out+or potential %stock-out+before the Lead Time horizon. In these cases, the total order shown will include both expedited and normally scheduled orders which are exactly one Lead Time away. For reference, the portion of this total order that should be expedited is also shown next to the total order field. The user can assess the validity of this Pending Order information to determine whether these amounts are proper (or even really needed).

Access to these Pending Orders can be accommodated through use of the Replenishment Screen. This allows the user to add, change or delete individual entries as specific review analysis suggests.

NOTE: These are the ADDITIONAL ORDERS suggested by the Stock Management System which are necessary to balance inventory. These will correct out-of-stock conditions only.

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Once the analysis and review of these *Pending Orders* has been completed, the user can update the Stock Status System by selecting the *Upload* process. This will automatically pass these approved orders back and will be a transparent process resulting in weekly orders being properly placed.

Replenishment - Calculation

The *Stock Position* for each item is determined on a weekly basis for the coming year. Although this looks fifty-two (52) weeks into the future, the critical horizon for replenishment planning purposes is the *Lead Time* horizon. This is the time frame necessary to receive stock either from vendor orders or production orders. This *Lead Time* horizon is the basis for the Stock Management System to determine the type of ordering activity required. This is tagged by an *Ordering Code* which specifies a stock condition and how severe it is.

The calculation of this *Stock Position* is as follows:

To begin Position(0) = On-Hand . Back Order

Week #1 Position(1) = Position(0) - Forecast(1) + Replenishment(2)

Week #2 Position(2) = Position(1) - Forecast(2) + Replenishment(2)

Week #3 Position(3) = Position(2) - Forecast(3) + Replenishment(3)

Week #N Position(N) = Position(N-1) - Forecast(N) + Replenishment(N)

In the Stock Management System, *Safety Stock* is deducted from the *Stock Position* at the end of *Lead Time*. This means that the value for the week of *Lead Time* includes deduction of *Safety Stock*:

Week #LT Position(LT) = Position(LT-1) - Forecast(LT) + Replenishment(LT) . Safety Stock

The value of POSITION(LT) determines ordering activity since this indicates whether an appropriate level of stock exists at this *Lead Time* horizon. Various components of the *Stock Position* equation are controllable to some degree prior to this analysis. If inappropriate controls, limits and/or overrides are put in place, the *Stock Position* will be greatly impacted and unnecessary stock will be suggested (or no stock when it is badly needed).

Consider the following example:

Component	Today	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
On hand	0						
Forecast		50	50	50	50	50	50
Replenish		175					
Safety				- 50			
Position	0	125	75	- 25	- 75	- 125	- 175
Lead time					*****		
Adds				200			
Order	200						

- Safety Stock deducted at the end of Lead Time
- Orders placed one Lead Time ahead of Adds
- Orders placed in multiples of %EOQ+

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In this example, no Back Order exists. The starting Stock Position is the value today (On Hand = 0). This is not presently out-of-stock. However, weekly forecasted demand of 50 units means depletions of stock by this amount each week. During the first week, the Stock Position would have been negative - but a scheduled Replenishment Order is due in during this first week. This means that the Stock Position is 125 units.

In the second week, no Replenishment Orders are scheduled. This means that the depletion of 50 units forecasted demand will bring the Stock Position down to 75 units. This is still adequate stock available for sale.

However, in the third week the situation changes. This is the Lead Time horizon. Another depletion of 50 units of forecasted demand brings the Stock Position down to 25 units - and the deduction of Safety Stock at the end of Lead Time brings this value down further to -25 units. This triggers an Additional Order for more stock. This order is in multiples of Economic Order Quantity (and increments if specified). A negative Stock Position is encountered and, in order to be received during the week of Lead Time, must be placed immediately (though not expedited).

Replenishment - Determining "ADDS"

When the Stock Position becomes negative, the need for Additional Orders is triggered. As shown on the page, this happens immediately when the negative condition emerges. At this point the specification of the order quantity becomes critical.

Any shortage should be covered in entirety. This means that an order quantity is applied to this shortage to attempt to cover the difference. If this is not enough, another order quantity is added to the total order. This process is reiterated until enough multiples of order quantity are included in the suggested Additional Order Quantity to offset the shortage and return the Stock Position to a positive condition (assuming the suggested value is actually ordered).

Looking out into the future, it is possible that the first suggested Additional Order Quantity will not be enough to last throughout the remainder of the year. In most instances this is the case. The Stock Management System continues to trigger Additional Orders every time the Stock Position goes into a negative condition (i.e., as each new order is depleted over time).

In a Back Ordered situation where stock is unavailable and customer demand is still coming in, the Stock Management System will trigger Additional Orders immediately. This means that the first week calls for a replenishment to be scheduled. Of course, this is not usually possible to fill. Nevertheless, an order is triggered and also placed in the expedite field as well.

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Replenishment - Order Code Definition

There are seven Ordering Codes in the Stock Management System. These range from (-4) for extreme under-stock conditions to (+4) for extreme overstock conditions. For a balanced item (i.e., scheduled to replenish stock just before a stock-out) an Ordering Code (0) is displayed.

(-4) <u>BACK ORDERED</u>	More <u>Back Orders</u> than <u>On Hand</u> – no incoming replenishments
(-3) <u>BACK ORDERED</u>	More <u>Back Orders</u> than <u>On Hand</u> – incoming replenishments are placed
(-2) <u>OUT-OF-STOCK</u>	Not presently in a negative stock position – but will be before <u>Lead Time</u>
(-1) <u>NORMAL ORDER</u>	Within the <u>Safety Stock</u> range at <u>Lead Time</u> - but not before <u>Lead Time</u>
(0) <u>BALANCED ITEM</u>	Positive stock balance at <u>Lead Time</u> – and less than one <u>EOQ</u>
(+1) <u>OVERSTOCKED</u>	More than one <u>EOQ</u> available at <u>Lead Time</u> – no incoming orders
(+2) <u>OVER+ORDERS</u>	More than one <u>EOQ</u> available at <u>Lead Time</u> – unnecessary orders placed
(+3) <u>SURPLUS STOCK</u>	More than a year's supply of inventory at <u>Lead Time</u> – has active sales
(+4) <u>OBSOLETE</u>	Positive <u>On Hand</u> balance – has been inactive for the past two years

Replenishment - Past Due Orders

The week Replenishment Orders are scheduled to arrive is a function of when they are placed, unless the Lead Time horizon can be altered through expedite activity. The expected date of receipt may not always be achieved. This can be because of delivery problems or production scheduling difficulties. In these instances, the Replenishment Order is said to be Past Due. This means that it should have already been received prior to the current analysis date. Replenishment Orders of this kind are still considered scheduled orders and are included as additions to the Stock Position equation. These are part of the amount indicated for scheduled receipt in the current week on the Replenishment Schedule Report. A Past Due field also exists on this report which indicates the portion (if any) of the current week scheduled order that is Past Due.

Replenishment - Expedite Conditions

The need to expedite Replenishment Orders arises despite extreme care in planning for future demand. This may be due to changing market conditions, sudden adjustments to Stock Position components or, simply, the ability of the vendor or production line to deliver. Even when identified, these conditions cannot always be resolved. You may be able to transfer stock from another location - or substitute stock from other vendors. In any event, these conditions should be addressed and avoided immediately. What causes expediting?

- Sudden adjustment to Safety Stock causing stock to be deducted from Position in Lead Time week
- Sudden adjustment to forecasted demand could cause a larger depletion than previously planned
- Transfer of stock from an item to resolve an expedite condition elsewhere - leaving the first item short
- Erroneous cancellation of a previously scheduled order needed to keep the Stock Position positive
- Sudden change to the Lead Time specification causing a different ordering horizon
- Failure to place new orders as suggested by SMS when identified in each replenishment analysis

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Replenishment - MRP Logic

In a manufacturing environment, replenishment planning must deal with more than finished goods. It must plan for assembly of finished goods. This means incorporating Material Requirements Planning (MRP) logic to identify needs for components or sub-assemblies to make up these finished goods.

The Stock Management System incorporates a Bill-of-Materials (BOM) function to determine a replenishment plan for these components. This BOM function can go to as many sub-levels as most businesses will require. If a finished good has five components these are known as one level deep. If each of these parts has five components, these are known as two levels deep. The Stock Management System is capable of going 99 levels deep. To date, no client company has approached this level of detail.

To function properly, this BOM logic must have a table of parent-child relationships detailing how many of a specific component are needed for each parent. If multiple levels are needed then a child-sub-child relationship must be specified. This table is commonly referred to as a BOM table and should have all such relationships included in it. The format of this table is shown on B-16. The ratio is usually one child per parent, but could be 2-1, 3-1, etc. Also, one parent could use $\frac{1}{2}$ of a child (such as might be found in chemical mixtures) and could be 0.5 as a relationship.

To activate this logic, Stock Management has a menu switch which is on the Replenishment menu with Processing and can be seen in the Processing section. Simply answering yes or no activates this logic. Stock Management searches for the BOM file and begins additional MRP processing. Stock Management uses the most currently updated file that has been loaded. To update the BOM file, the update Bill-of-Material option should be selected within the Maintenance menu (4-6). SMS is structured in this way because the BOM structure may not change every week.

Replenishment - DRP Logic

In a distribution environment, replenishment planning must deal with procurement for a supplier for multiple locations. In many cases, delivery is made to one location even though many locations may stock the same item. If planning was done individually, each site may have small volumes which result in sporadic orders. By combining each site's requirements into one amount, a more stable - and often larger - order can be delivered. Many companies operate with multiple store rooms and warehouses. They usually don't manufacture. They procure and distribute. This approach is known as Distribution Requirements Planning (DRP). One site may be a master warehouse with several sites being replenished from this master warehouse rather than from the supplier. In some DRP environments there may be several master warehouses which, in turn, have their own satellites.

Stock Management incorporates DRP logic with unlimited levels of master warehouses, satellite warehouses, and sub-satellite warehouses. No tables are needed. However a source must be specified to tell each part where it is replenished from. This is a field in the LOADOWN.DAT file which is created from the host stock status system each week. A description of this field is shown in the Database Schemas (B-3). The field is field #126. Its format is shown on B-7.

To activate this logic, Stock Management has a menu switch which is on the Replenishment menu with Processing and can be seen in the Processing section. Simply answering yes or no activates this logic. Stock Management will begin additional DRP processing. It will search for the Source field and roll-up requirements accordingly. Stock Management can also be set to minimize Safety Stock and EOQ at the satellite warehouses, if desired. This helps minimize unnecessary stock at each site. DRP logic is frequently used in conjunction with Lumpy Demand (discussed on page 13).