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Maintenance & Equipment Reliability

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Holcim “FMEA Software” Manual

Holcim Group Support Ltd
Cement Manufacturing Services

'Failure Mode and Effect Analysis' Software

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Next

"FMEA Software" - User Manual

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Table of Contents

1. INTRODUCTION

One of the major elements of a successful Maintenance Management System and processes is to manage the Risk of our equipment to perform the designed function.
Developing, based on a pre-defined Risk Matrix, the FMEA is the key to define the preventive Maintenance Strategy and to determine spare parts needs.
This software aims at allowing plants to create their FMEA in a very simple way, not focusing anymore on “How to create it?”, but allowing plants managers and maintenance managers to emphasize on “How to reduce the determined Risk?”
Another advantage of this software is to create an FMEA and PMR Database which will be managed by HGRS-MER based on their experience and the feedback from Users. So far, knowledge sharing on this subject doesn’t exist between plants, because there is no tool to achieve it.
Being global, however, doesn’t mean that there is no room for regional particularities: every plant will have its own database which can include its own Failure Modes and PMR, and an option will allow user to translate the database in their own language.

Symbols Used in the Manual:

☺ Indicates a recommended action, which is not compulsory but can help benefit from the full extend of the software.

☹ Indicates an action which is not recommended, because it is unnecessary or is not the optimum way to use the software.

 Indicates an action which should not be done; otherwise the software might not work properly.

2. RISK DEFINITION

Risk can be defined as the probability of occurrence of an incident, multiplied with the severity of this specific incident:

R = P * S

with **R**: Risk
P: Probability
S: Severity

As it will be shown later this can be visualized in a so called "risk matrix", one of the axis representing the level of probability and one the level of severity.
The probability factor can be expressed in terms of frequency, using the probability indicators starting from "A" down to "F". A probability rating of "A" means that an unforeseen incident is likely to happen very frequently, thus “every three months”. The lowest probability is "F" (“once every 20 years”), which means that it is almost impossible that this incident will occur. The probability indicator can basically be adapted from case to case, but experience has shown that for the cement business the following classification is convenient:

- **A**: Occurs every three months
- **B**: Occurs once per six months
- **C**: Occurs once per year
- **D**: Occurs once per two to three years
- **E**: Occurs once per five years
- **F**: Occurs once per 20 years

The severity of an incident can be expressed in terms of production loss and excessive maintenance cost. A "catastrophic" incident has a severity rating of I, a "negligible" incident a rating of IV. For the severity in terms of production loss no standard setting can be applied, since this depends on the specific plant layout or even the plant area.
By monitoring the production loss, the customer point of view is being taken. It has to be determined how long an equipment can be shut down in a specific area until the customer has to be called in order to tell him that cement can no longer be delivered. This reserve time of course very much depends on the reserves in form of silos and bins that are found throughout the process. If an equipment in the quarry is considered it might take up to two weeks or even more before the customer has to be called to tell him that no cement can be delivered anymore. This of course is due to the fact that by looking from the quarry usually reserves in form of pre-blinding beds, homogenization and clinker silos and of course cement silos are found throughout the process. If now an equipment in the cement mill area is considered, the reserve held before our customers need can no more be satisfied of course is

much smaller, since the only remaining silo is the cement silo. In an outsold market this can mean, that only a reserve of 12 hours or even less is held - taking an average value for the whole year.
That's why each time a major reserve in the process is found a new (separate) risk level has to be defined and therefore a cut has to be made.
As already mentioned before the second parameter to be monitored on the severity axis are the maintenance costs. For setting the level of a "catastrophic" incident the following standard procedure can be applied:

1. Take the upper specific maintenance cost guide value and multiply it with the cement capacity based on clinker production. This value represents the plant yearly maintenance budget
2. Take 15% of the value calculated under point 1. This is the setting for a "catastrophic" incident, which means that if more then 15% of the yearly maintenance budget is spent in one single unforeseen incident it is considered as "catastrophic".
3. For the remaining severity classes from "II" to "IV" (negligible) the value of catastrophic is divided into equal steps down to zero

As mentioned above the so called "risk matrix" can be sued as a visualization of the risk (figure 5).

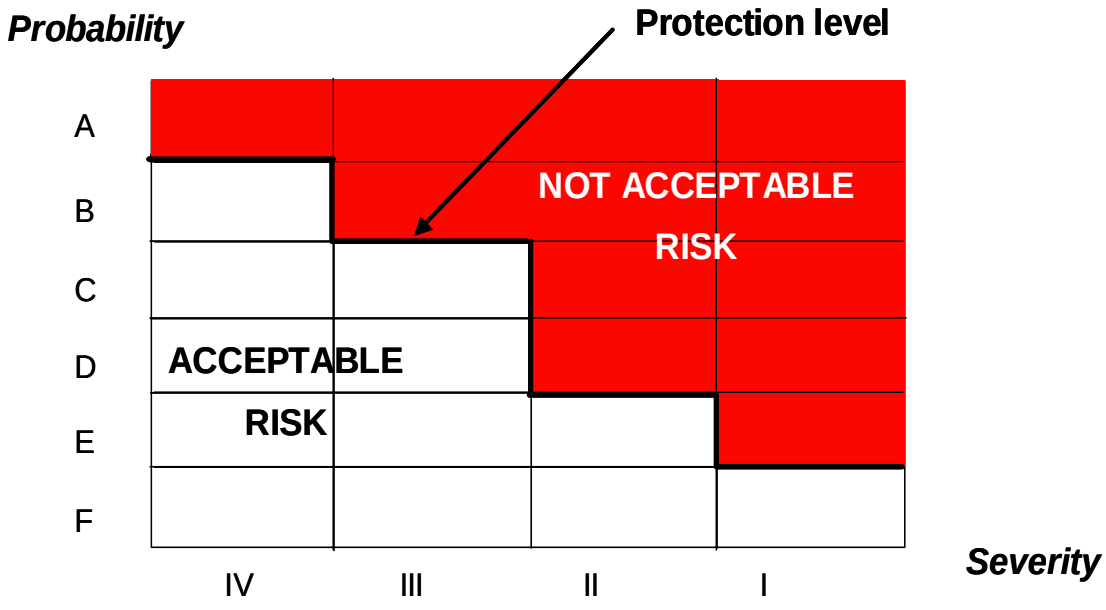


Figure 5 Risk matrix

The risk matrix as shown in figure 5 is built using the probability and the severity ratings as described above.
The line, which separates the red from the white area, is the "protection level". The protection level has to be set field by field by the plant management by balancing the severity of an incident versus its probability of occurrence. The plant manager e.g. would ask himself whether he is willing to accept an incident that occurs very frequently (probability "A") but has a very low severity (severity rating "IV"). As

shown in the example of figure 5 this can't be accepted, thus the field is red. The following field which represents an incident that occurs less often (probability "B") and as the first field has a severity of "negligible" is white, thus acceptable. This means that the protection level is drawn between these two fields. Now the plant manager can switch over to the next column and apply the same approach until he finally reaches the column with a severity of "catastrophic".
As shown in figure 6 four different areas can be distinguished in a risk matrix.

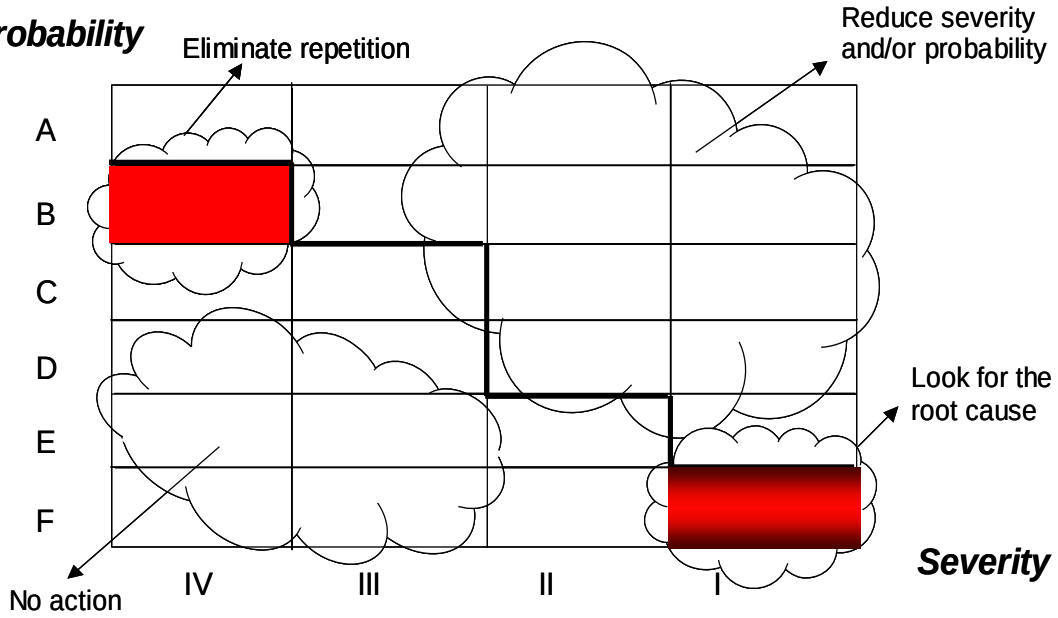


Figure 6 Different areas of a risk matrix

The white area is the one inside the protection level, where no actions need to be considered. On the opposite side - upper right – there is the area with an unacceptable level of risk. For this area either actions to reduce the probability and / or the severity of an incident need to be defined. The description of how exactly this can be done, will be given once the FMEA has been discussed. The two remaining fields of special interest are the field on the upper left side with a low severity of the incident but a rather high probability. On this type of incident measures to reduce the probability need to be defined, since although the incident is not sever at all, it constantly attracts people's attention and by this keeps them busy. The last field of interest is in the lower right corner of the matrix. This incident is very improbable to happen but if it should, the severity would be very bad. For this type of incident it has to be assured that the root cause is detected.

Once the plant specific risk matrixes are defined, the first step in the process of systematic spare parts need detection is concluded. It is very important to mention that a risk matrix is not a static thing. Changes of the market situation or major changes in the process, as e.g. the installation of a new raw mill with a higher capacity or the upgrading of a complete kiln line can have a big influence on the plant specific risk matrix. It is therefore highly recommended to yearly review the matrixes and adapt them if needed.

3. FAILURE MODE AND EFFECT ANALYSIS

3.1 Basics on the methodology

As mentioned above the second step in the process of systematic spare parts need detection is the development of the equipment specific FMEA.
FMEA is a review technique that focuses on defining failure modes of an equipment and actions to reduce the risk of a failure. A major advantage is that by using FMEA these actions and the review process are systematically documented.

When developing an FMEA at least the elements as listed below have to be taken into consideration. Note that each of these elements is being listed in a separate column of the standard Holcim FMEA template. Besides the elements as listed below additional information can be recorded, that however in a first step is not key for understanding the idea of what FMEA is all about:

- **Sub-equipment**: In order to make the whole approach as systematic and structured as possible, each equipment for which an FMEA is being developed is divided into sub-equipment. This guarantees that all failure modes (see next sub-point) of a single sub-equipment are listed in one block.
- **Failure mode**: This column defines which part of an equipment fails, so e.g. a bearing, the gear box or the motor of a belt conveyor or any other equipment that is being considered.
- **Cause**: This is where the cause of the hypothetical failure is being documented in order to later on define any specific measure to be taken as precisely as possible. In case of a bearing failure the cause can e.g. be “lack of lubrication” or “improper installation”.
- **Effect**: This column is used to document the effect of each failure mode in a bigger scale. This means that e.g. if due to a bearing failure in the gearbox the feed-belt of the raw mill fails, also the raw mill itself has to be shut down.
- **Initial risk**: once all the above mentioned information has been recorded for an equipment, the initial risk for each failure can be defined by determining its probability of occurrence as well as the severity. It is important to understand that for defining the initial risk all failures are viewed under the consideration that no action is being considered. In order to support the risk definition the equipment history (➔ probability of occurrence) as well as lead times as documented in the SAP system have to be taken into consideration. After having defined the severity and the probability a crosscheck with the according risk matrix will show whether the specific failure mode is inside or outside the protection level

Once the information as described above has been documented the second phase of the FMEA can be started, which is the definition of measures. For each of the listed failure modes that ends up being outside the protection level – thus in a zone of unacceptable risk – a measure to reduce the risk has to be defined.

Once again it has to be highlighted that when developing an FMEA it is very important to make sure that it does not just become a theoretical paper exercise. Therefore one has to go back to the user manual, the drawings and the part list as provided by the supplier for this specific equipment. As it can be seen, the FMEA basically already includes step three of the process, which is the step of "definition of measures".

Last but not least step three is reached, where the measures that should be taken are defined. The measures to be taken will either focus on reducing probability and / or severity for any failure mode located outside the protection level.
The standard Holcim FMEA template is structured in a way that focus in a first step is being put on the improvement of preventive maintenance. This can e.g. consist of implementing an additional PMR or reviewing the frequency of execution of an already existing one. Once the specific measure is defined the risk level has to be reassessed evaluation the impact of the suggested measure on either probability or severity.
If this first measure should not be sufficient to bring the risk into an acceptable zone, then focus in a second step shall be put on the definition of a contingency plan. Having a contingency plan in the case of an electrical motor can e.g. mean that if the electrical motor of a critical equipment should break down it is replaced by the motor of a less critical equipment until the new motor is delivered on site. This means that the uncritical equipment is stopped to keep running the critical one. This of course requires that the exchangeability of the motors is checked in advance and that the necessary mechanical adaptations (platform, shaft, coupling etc.) are made before anything happens. Once a motor or any other equipment has failed it is definitively too late to start establishing a contingency plan! Once the contingency plan is defined, again the risk is being re-evaluated.
It's only in the third and last step – if still required at all from a risk level point of view - that spare parts shall be considered. In case of long lead time to spares holding a spare part on stock can significantly reduce severity, especially if replacing the part, once it's held on site doesn't take long.

In terms of reducing the probability of a failure, focus needs to be set on the running conditions of the equipment. Assuring a clean working environment, proper alignment, adequate lubrication etc. will help reducing the probability of a failure.

After having accomplished the FMEA for several equipment it might be difficult to take the final decision on which spare part should be bought and which not, since usually the budget is not big enough to buy them all. In this case it is a good practice to focus on the probability/price relation. The more probable a failure is to happen and the cheaper the spare part is, the more it is of course recommended to

keep the spare part on stock. On the other hand it is not very advisable to keep an expensive part, which is very unlikely to be used - unless it is a critical spare part (see list of critical spares as part of the Plant Master Plan).
As a further support in decision taking the diagram as shown in figure 7 might be used.
This diagram shows a systematic way of balancing the different influencing factors, including the economic aspects.

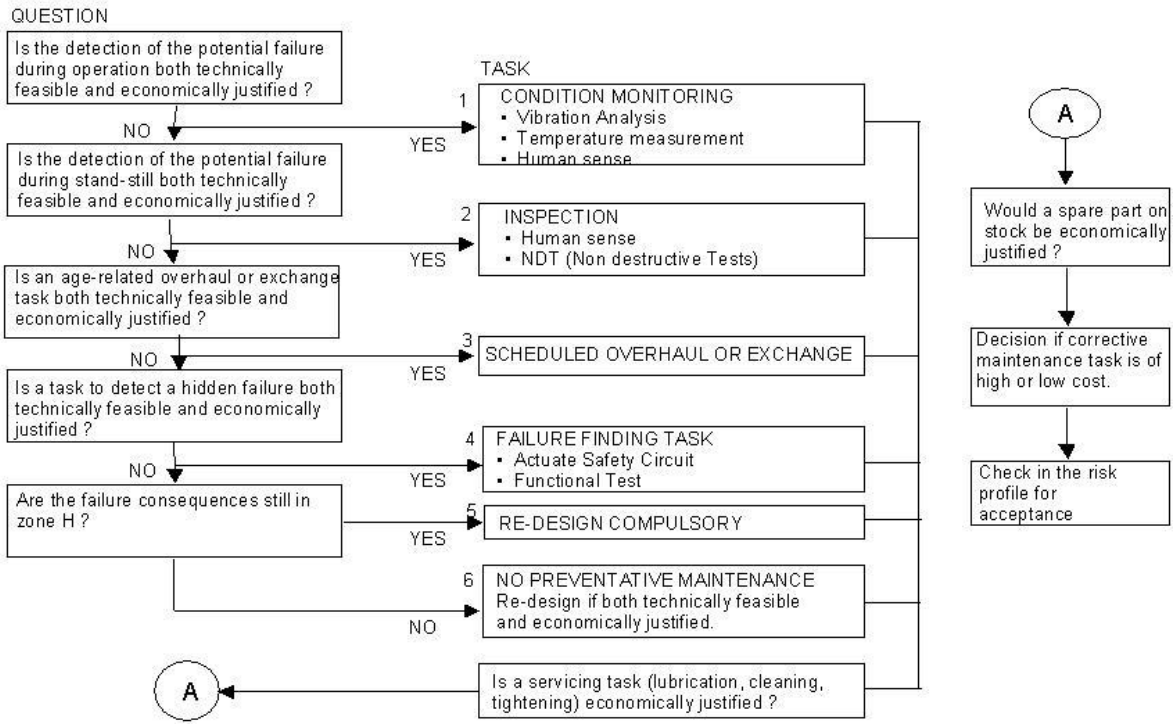


Figure 7 Decision diagram

3.2 Adaptation to the Holcim Software

When developing the software, a special care has been taken about the accuracy of every column for the people on the plant. Starting from a “standard” FMEA, it has been decided to delete some columns, and to add some others, so that this tool can give a thorough overview of the reduction of Risk after the implementation of Preventive Maintenance Routines, Contingency Plans or Spare Parts. This is the reason why those 3 kinds of actions have been separated, and an evaluation of Risk is made for each one of them. The order of these actions have also been set, in so far as in the cement industry it has been shown that Preventive Maintenance is the solution to prefer, before Contingency Plan. The last action to consider is storing the Spare Part, because it is expensive, in terms of storage capacity, expenses but also, and this part is often forgotten, in terms of cost to maintain the parts in good condition while waiting for it to be used on site.

4. BENEFITS OF THE SOFTWARE

This software has been developed in order to make it easier for people on-site to do a FMEA, and to find the right action to have the most reliable equipment at a reasonable cost.

The software has several functions which can be brand-new, or offer some improvements compared to the “manual” FMEA that used to be done in plants:

Creation of an FMEA: interactivity, guided path, and real-time update of the different elements
Central and Local Database of PMR: Knowledge Sharing between plants, standardized names (makes sorting or searching a lot more easier), recommended PMRs and frequency from HGRS/MER (including all Condition Monitoring Matrix and Key-PMR)
Indicators: shows the possibility of improvement of an area, and the maintenance profile which is used (proportion of action in each of the 3 kinds of actions)
Equipment Sheet: shows the different actions that have been decided for each equipment, sorted by frequency
Action Plan: Allows the Maintenance Manager to do the follow-up on actions that need to be implemented, for the whole Area

In the future, interaction between FMEAs created with this tool, and other Holcim Software can be expected in order to avoid multiple entries (eg: Interaction with the Work Load Balancing Tool).
Feedback from plants will also be very useful for next software updates. The update process will allow FMEA already created to benefit from the updates in the software and the database.

5. USING THE SOFTWARE

5.1 Keywords

Here are some keywords that will be used throughout this manual:

- Software (or FMEA File): Excel File which allows the User to create the FMEA for one Area. There is as many Software Files as there are Area in the plant (the file can be copied without any problem to create a new FMEA). Please always use the latest revision of the software (see the "Home page" on the software for Revision information).
- Local Database (or Database): Excel File containing all the Failure Modes and PMR which have been defined by HGRS or the User. It is strongly recommended to have ONLY ONE Database file on your computer, or, even better, a common file shared on the network drive of the plant: This way, all the new Failure Modes or PMR that the User adds can be used in FMEA for other Area of the plant. This file has to be send to HGRS on a regular basis, in order to feed the Global Database for other plants
- Master Database (or Global Database) : Excel File send by HGRS containing all the HGRS-approved PMR and Failure Modes. When the file is received, one should refer to the "Upgrading your Local Database…" later on in this manual.
- /!\ Updating the Database will not erase the PMR that have been created, and which might not have been validated by HGRS. This process is safe and no information will be lost. However, as usual when dealing with electronic documents, regular backups should be done.
- Parameters Files: those are text files (extension .ini) which store some information for network use, or between two sessions of work on the same file. It is recommended not to modify or delete those files.

5.2 Getting ready to use the Software

The FMEA Software is composed of 2 files. It is compulsory to place them in the **same folder.**

☺ Using the software from a network drive is recommended and allows every one in the plant to share the same PMR and Failure Mode Database!

☺ To be informed of new releases, go to “Help” and select “subscribe to newsletter”. An email will be automatically sent to HGRS.

To create a FMEA for a new Area of the plant, one needs to open a COPY of the software, and thus always keep an empty version, to start another area.

Don’t make personal copies of the Database! **There should be only one Database on your hard drive or network drive**, used by every FMEA File!

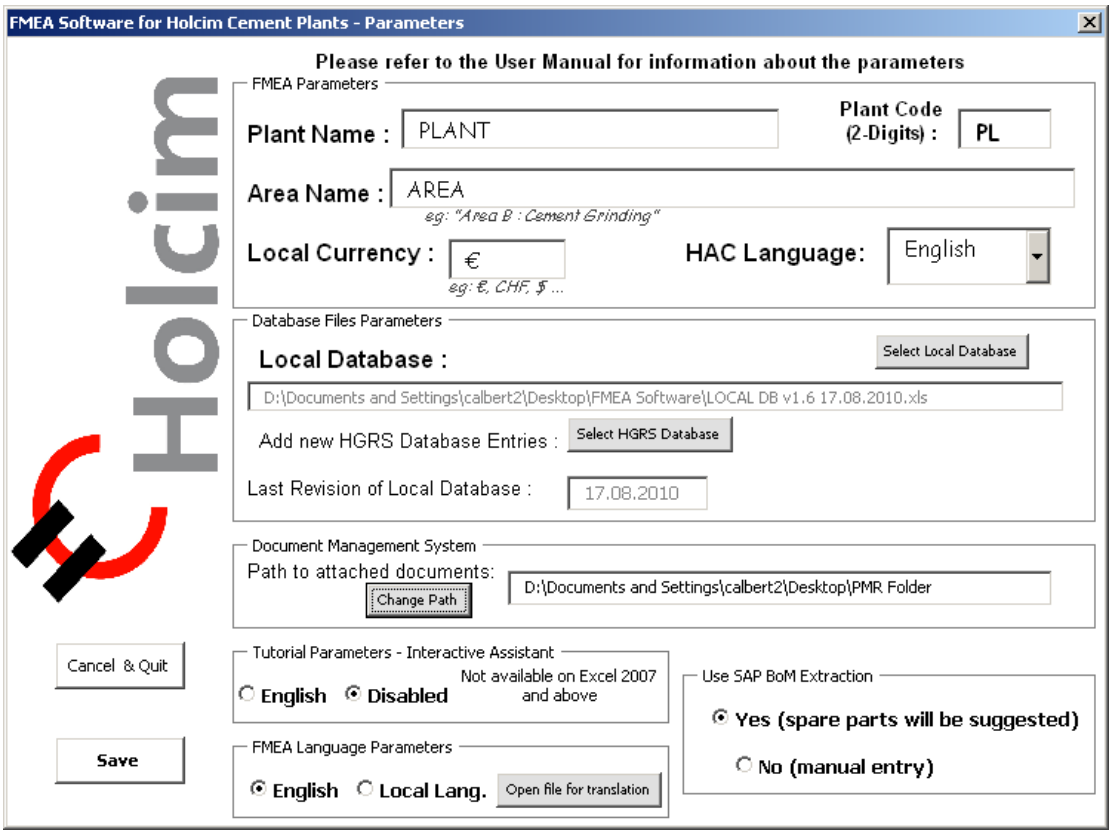
NEVER OPEN THE DATABASE FILE when using the software!! It will be opened by the software when needed. Adding PMR directly in the Database is not permitted

We strongly recommend using English language as much as possible, to avoid having to translate the whole database and allow external personal to understand the FMEA file.

5.3 Creating a New FMEA

Once the files are downloaded, it is possible to start creating the FMEA

First, open a copy of the Software: the “Home Page” is displayed (screenshot on this manual cover). It should automatically detect that the file is opened for the first time, and the Parameters window is shown. If not, click on the “Parameters” button, on the second page:



- Plant Name: Insert the Name of your Plant. This parameter will be inserted on every sheet of the FMEA.
- Plant Code: Use the official plant code, in 2 digits (eg: SG for Siggenthal …etc). This parameter is used for Database update.
- Area Name: Give a name to the Area which is considered in this FMEA. Please note that an Area is defined by a set of equipment for which the Risk level is the same. We recommend choosing letters (eg. “Area B: Cement Grindign”), in order to avoid mix-up with the functional areas of the plants.
- Local Currency: insert here the symbol/code of the currency which will be used in the FMEA. This symbol will be automatically inserted where needed.

When currency is changed, consider changing the risk matrix criterias accordingly.

- HAC Language: Choose the language used for the HAC Codes in your plant. In case this information isn't known, here is a good way to find out the language used:

Consider the plant Rotary Kiln HAC, and compare with the HAC in the 5 possible languages:

KL ➔ English; **FR** ➔ Français; **DQ** ➔ Deutsch; **HR** ➔ Español; **FO** ➔ Italiano.

- Local Database / "Change" Button: click on it and select your Database File. By default the message box will open on the folder where the software is.

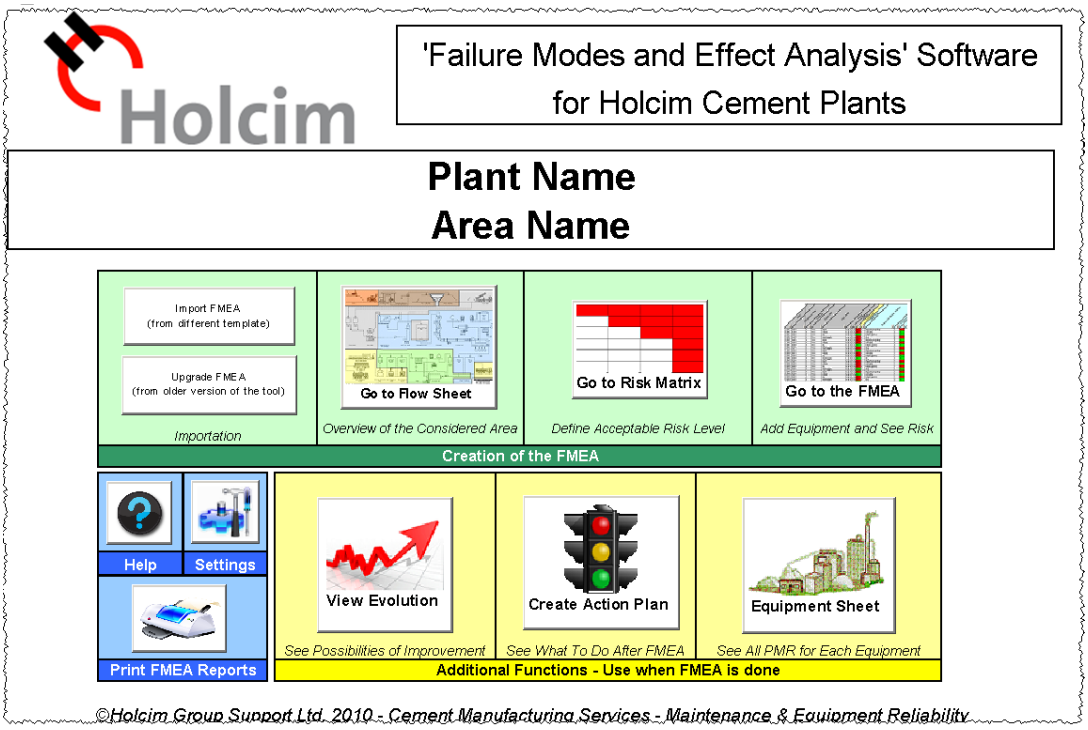
Enable (or not) the "tutorial" assistant, select the database language, select if an SAP extraction of the Bill of Material should be considered. When this is done, click on " Save ".

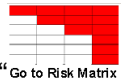
NB: HGRs provide the database only in English. Selecting "Local Language" requires that the plant proceeds to the translation by themselves (see Chapter 6.3)

5.4 Defining the Risk Matrix

Now that the FMEA File is customized, it is possible to start the FMEA by defining the Risk Matrix. From the "Home Page", click on " Next ".

The "Table of Contents" page is displayed:

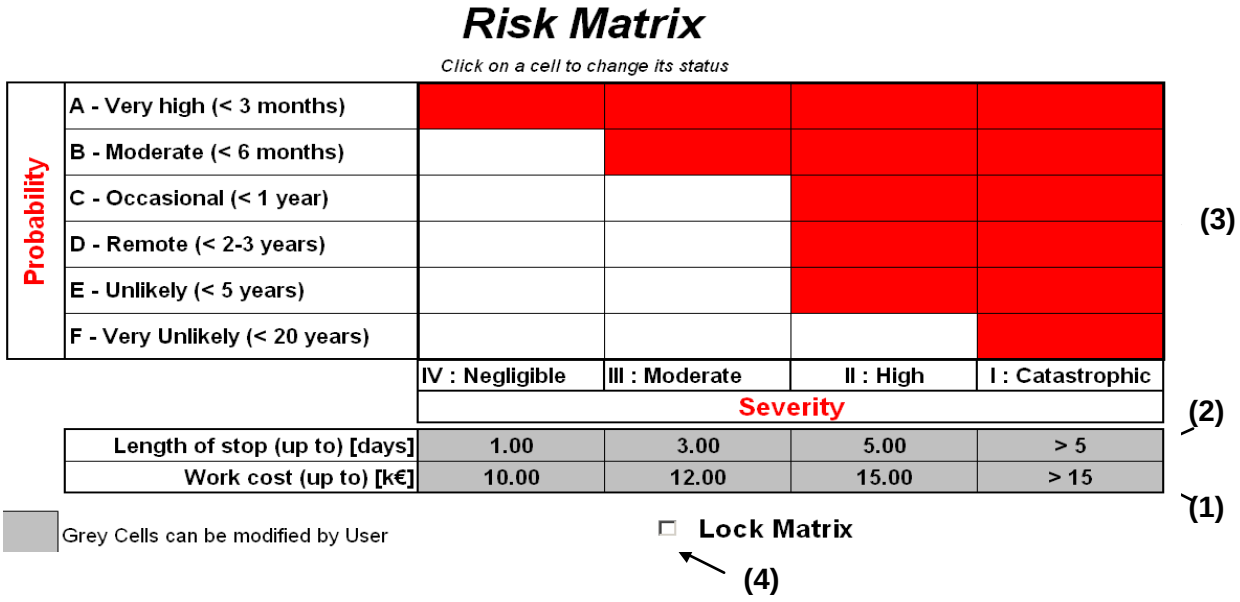


here, choose " 

"

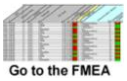
First of all, it is possible to adjust the severity settings **(1)**, according to your local currency; and/or adjust the "Stop time severity" **(2)**, according to the considered area. These adjustments are made by simply clicking on one of the dark grey cell, and filling-in the User Form that will appear.

Once the criteria are set, it is time to define the Protection Level of the Plant Area. To do this, click on the white and red cells in order to switch their color, and put it on the "Risk Zone" **(3)**. Clicking a second time will turn it back to white.



☺ Once the Risk Matrix is set, it is recommended to tick the "Lock Matrix" button **(4)**, so that it becomes impossible to click on the Matrix by mistake. Just un-tick it to modify the matrix again!

5.5 Adding an Equipment

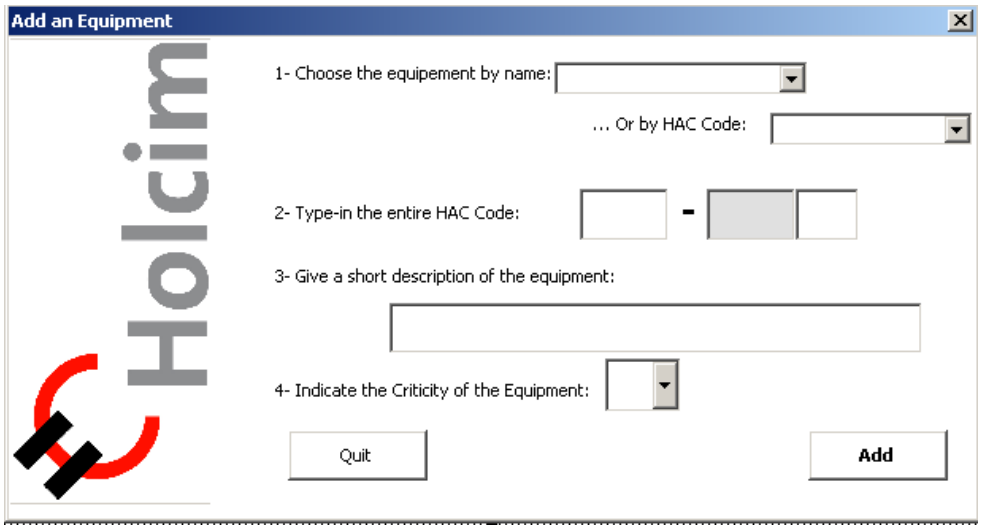
Now that the Parameters and Risk Matrix are set, everything is ready to add an Equipment in the FMEA. From the Risk Matrix page, go back to the Home Page, then click on " 

".

When the FMEA page is opened, a toolbar is shown, which allows to navigate in the software:

On the top-left-hand corner of the page is a button which allows to hide/show the toolbar (eg: to display the FMEA on a beamer, or make a print screen …etc).
To add a new equipment, click on " 

" in the toolbar. A new page will be displayed:



Give the following information:

- HAC Code : It is possible to either, choose directly the HAC Code, or see the list of equipment
- Entire HAC Code: type in full HAC Code of the equipment

- Description: Enter the name of the equipment so that it is easier to know which equipment it is. Note that the generic “Equipment name” (first text field in the window) will NOT be imported in the FMEA.
- Criticality, according to MAC Definition.
- Click on “Add”.
- After a short time, the software will show a list of sub-equipments available for this equipment. Click on the sub-equipment that to consider. Here you can overwrite the criticality of one or several sub-equipment, if needed (eg: auxiliary drive …). The toolbar offers the option to select all / unselect all by a simple click on one of the buttons:

Any Change made on this page will be taken into account for this equipment, but not saved to the database. To change/add something permanently, refer to Chapter 6.1..

- On the new toolbar, click on “Next Step ” once the choices have been made
- A similar page is displayed, with Failure Mode associated to previously selected sub-equipment. Select the Failure Modes to import, and click on “Next Step” a second time.
- The software will then go back to the FMEA page, and all chosen Failure Modes will have been added to the FMEA. The Next Step is to define the Initial Situation for each Failure Mode, or add another equipment!

5.6 Defining Initial Situation & Risk

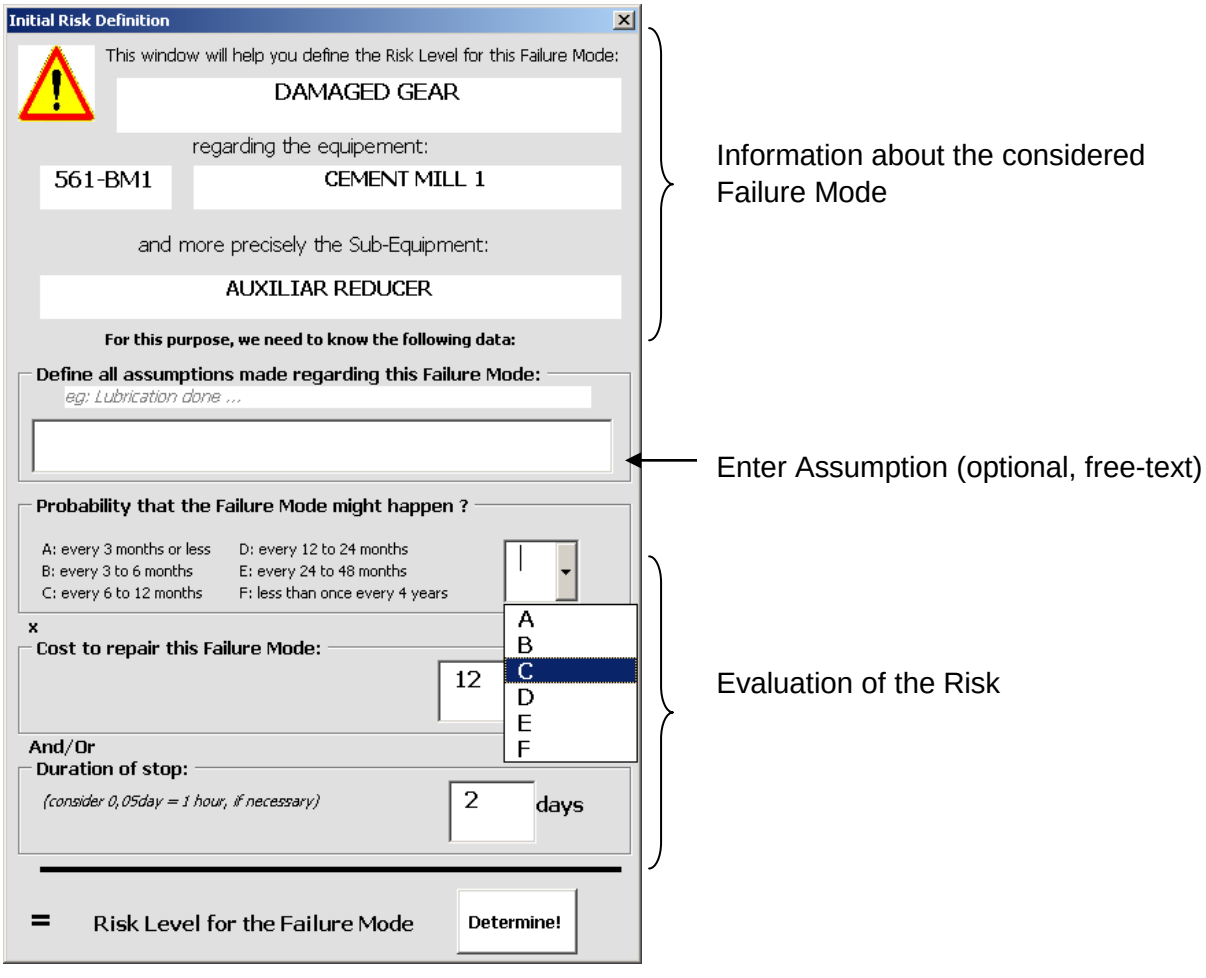
Now that the FMEA contains some Failure Modes, one can define the Initial Situation, and evaluate the Risk of each Failure Mode.

☺ By default, the Initial Risk of each Failure Mode is set to A-I, which is generally in the Red Area (worst case possible). In order not to work on unnecessary PMR, it is recommended to do this initial evaluation prior to searching for PMR. For easy-reading, the Risk cells which have not been evaluated yet are in grey.

For every Failure Mode is written the HAC Code, the description given, the sub-equipment and Failure Mode. One now have to manually write down:

- Consequence of this Failure Mode (free text zone)
- Effect of this Failure Mode (free text zone)

Now, it is possible to define the Initial Risk. To do this, the best way is to use the "Risk Wizard". Simply click on the "Initial Risk" cell of the considered line (the cell should be colored). A new window will appear and ask for required information:



NEVER try to MODIFY manually the RISK CELL content. It is automatically updated according to the information from the Risk Wizard and/or the columns of Probability and Severity, and any change would be automatically erased.

When information are filled-in for a Failure Mode, the Risk cell is automatically taking the suitable colour: Red means the Failure Mode has a Risk level which is not acceptable (according to the Risk Matrix), and green means its Risk level corresponds to a white area in the matrix. One might also notice that when a failure mode has a red Risk Cell, the PMR cell is also in red –as long as no PMR is defined- to catch your attention on the necessity to define Preventive Maintenance Routines to lower the Risk.

5.7 Add Preventive Maintenance Routine & Evaluate New Risk

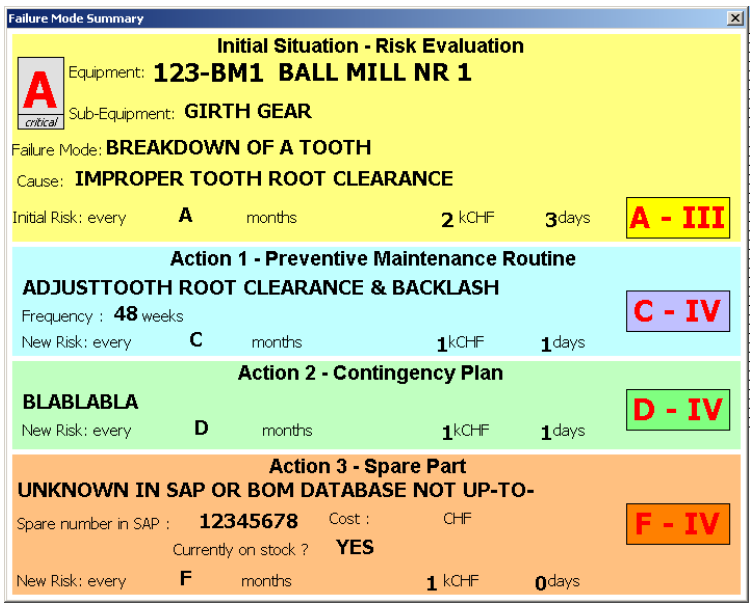
Once every Failure Modes have been evaluated, click on "See suggested PMR" on the toolbar. After a short time, the software shows every PMR in the database which can be implemented to reduce Risk (*only for the red "Initial Risk"*)

Choose the PMR to import, the same way the Failure Modes have been chosen before. Note that it is possible to select several PMR for the same Failure Modes. Click on "Next Step"

	HAC	Equipment D	Sub-Equipment	Failure Mode	Cause	PMR Type	Suggested PMR
X	561-BM1	CEMENT MILL 1	AUXILIAR REDUCER	DAMAGED GEAR	IMPROPER LUBRICATION	OA	DO A OIL ANALYSIS OF THE AUXILIAR REDUCER
	561-BM1	CEMENT MILL 1	AUXILIAR REDUCER	DIVERSE (CONTAINS ALL WA	DIVERSE (CONTAINS ALL WALK-B	WI	DO A WALK-BY (MAINT) OF THE AUXILIAR REDUCER
X	561-BM1	CEMENT MILL 1	BEARINGS	DAMAGED GEAR	IMPROPER LUBRICATION	OA	DO A OIL ANALYSIS OF THE MILL BEARINGS
	561-BM1	CEMENT MILL 1	COUPLING	CRACKS ON THE COUPLING	FATIGUE	NDT	VISUAL TEST FOR CRACKS OF THE COUPLING
X	561-BM1	CEMENT MILL 1	COUPLING	DIVERSE (CONTAINS ALL WA	DIVERSE (CONTAINS ALL WALK-B	WI	DO A WALK-BY (MAINT) OF THE COUPLING
X	561-BM1	CEMENT MILL 1	COUPLING	OVERHEATING	MISALIGNMENT	THERMO	DO A THERMOGRAPHY OF THE COUPLING
X	561-BM1	CEMENT MILL 1	DIAPHRAGM	BREAKAGE	WEAR	WM	MESURE WEAR OF THE MILL DIAPHRAGM
X	561-BM1	CEMENT MILL 1	DIAPHRAGM	BREAKDOWN OF THE DIAPH	FATIGUE	NDT	VISUAL TEST FOR CRACKS ON THE MILL DIAPHRAGM
X	561-BM1	CEMENT MILL 1	DIAPHRAGM	LOW VENTILATION	CLOGGING OF THE DIAPHRAGM	PMR	CLEAN & MEASURE SLOT WIDTH

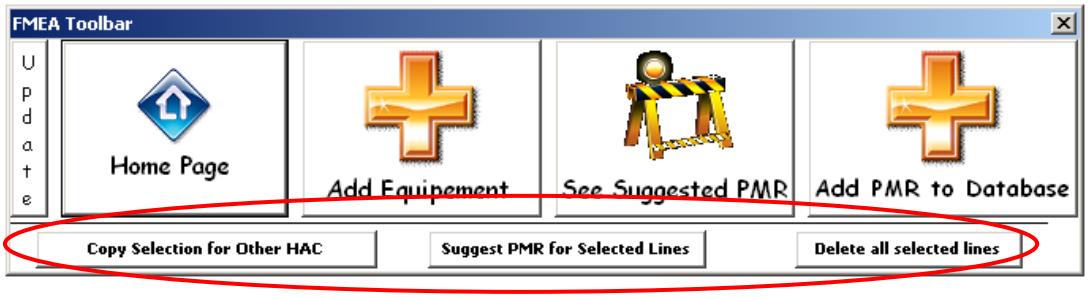
Now that PMR are added into the FMEA, it is possible to evaluate the new Risk by clicking on the "New Risk 1" cell of the considered line, to call the Risk Wizard.
The "New Risk 1" column is updated automatically, with the same color-code as in the "Initial Risk" column.
If needed, the frequency of the PMR can be manually changed, such as comment in the comment line. All the changes made in a FMEA will NOT be reported to the database. For permanent changes/adds in the database, refer to Chapter 5.9.

☺ In order to have a good overview of a complete line of the FMEA, double click on a failure mode to display a summary window, as shown below:



5.8 Importing New Failure Modes from Database

After an Update of the database (local update or update from HGRS Master Database), or if one wants to see Sub-Equipments/Failure Modes/PMR that were not selected the first time, it is possible to proceed to a revision of the Database.
For this, select all the lines that you want to review. The toolbar should expand and offer 3 new Buttons:



Now, click on "Suggest PMR for Selected Lines Only", and you will see all the PMR corresponding to the Failure Modes that are selected.
Note that if you select a PMR which already exists for the same HAC and Failure Mode, this PMR will not be imported, to avoid doubles.

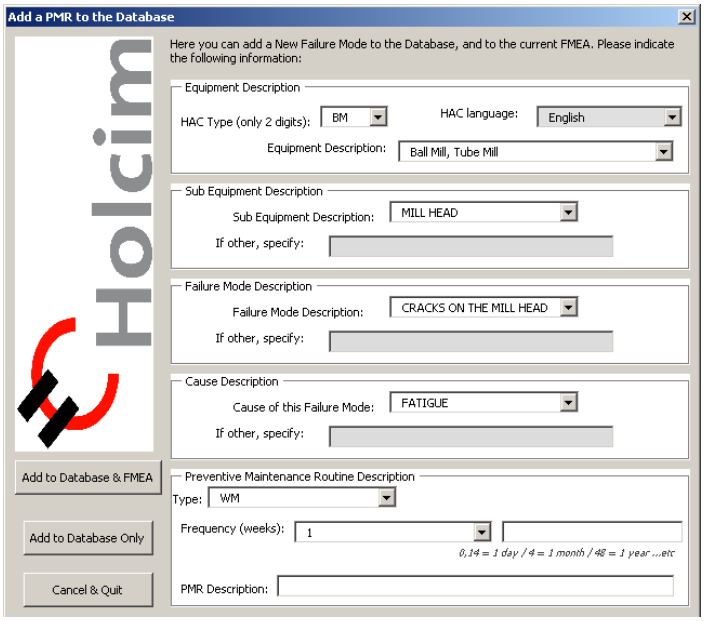
5.9 Adding a New Failure Mode to the Database

If some failure modes or PMR are missing in the Database, it is possible to add new ones so they will be suggested from now on.

To do so, from the FMEA click on the toolbar button " 

"

Then, enter the required information:



When filled-in, click on “Add to Database only” or “Add to Database & FMEA”. In the second case, the software will ask to which HAC Code should it be related to.

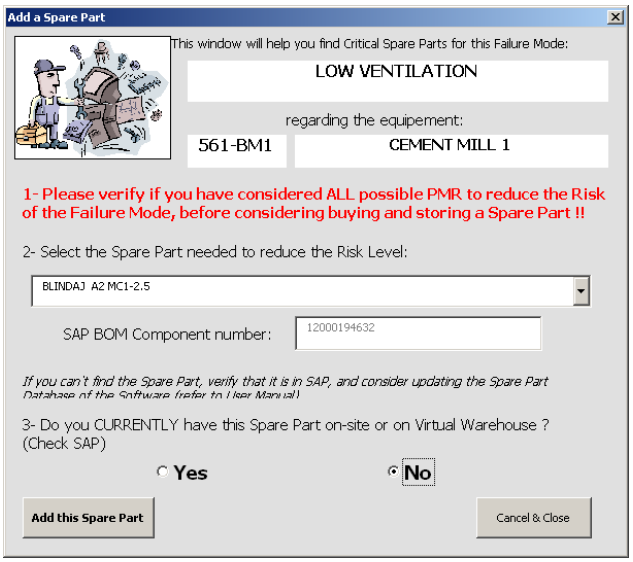
5.10 Adding Contingency Plan & Spare Parts

Now that the New Risk has been evaluated (considering Preventive Maintenance Routines), it is possible that a Failure Mode is still in the Risk Area (Risk Cell in red). To lower the Risk again, one can add Contingency Plan and/or Spare Part.
For those actions, one can enter the description in the FMEA, and proceed to risk evaluation the same way as for Initial Risk, or New Risk 1.

Contingency Plans are free-text zones, in so far as they are specific to each plant. For the Spare Part, it is possible to use a SAP Extraction of the Bill of Material, which is copied-pasted in the Database file (tab “SAP BOM”). See the exemple in the Database, and do the extraction accordingly.

☹ Note that in order to manage the Risk in the best possible way, always keep in mind that **Preventive Maintenance Routine should be considered before Contingency Plan. Spare Parts should be the last to come to mind**. The part of these 3 types of actions can be seen on the Evolution page (see Chapter 7 of this Manual)

When clicking on a Spare Part Cell, a window will be displayed, asking for the Spare information. It is possible to select a Spare Part from the Bill of Material which has been copied into the database, if the Spare Part option has been selected in the Parameters. If so, the SAP number of the Spare part will be automatically added to the FMEA. If the correct Spare Part is not available in SAP, manual entry is possible. The Action Plan will then remind that the Spare Part needs to be created into SAP.



Note that for plants which have an inaccurate BOM, or if the BOM is currently reviewed and changing very often, it is possible, in the “Parameters” window, to deactivate this function. If so, all Spare Parts will have to be entered manually in the software.

To Update the BOM, close the software and launch the local database. On the home page, choose “See Plant BOM”. There, paste the extraction from SAP. Respect the order of the columns (Componant / BOM Component / Quantity ST) The first column, in red, should not be deleted and will be automatically updated by Excel. The 2nd line is an example, which can safely be overwritten.

6. KNOWLEDGE SHARING

6.1 How Can I Share My Knowledge?

One of the benefits of this FMEA Software is to allow knowledge sharing between Holcim Cement plants. As it is not possible for all plants to share a common database from network, it is recommended that plants send their database to HGRS/MER when they think that they have added some PMR / Failure Modes that can be useful for others. The email to be used can be found from the help section in the home page.
Based on the databases which have been send, and on new recommendations, HGRS/MER Team will create a new Master Database, and post a new version on the Holcim Portal.

6.2 Upgrading Your Own Database from Global Database

New release of the database will be available on the Holcim Portal for downloading. If the online file is newer than the local database, download it. Then, launch the software and open the “Parameters” window.

Both Database files should be closed before doing the operation!

In the window, click on “ Select HGRS Database “, then select the HGRS Database (the one which has been downloaded from the Portal). After a short time, a page will show the changes between the local version and the HGRS version :

A	B	C	D	G	H	I	K	O	P	R
Keep Old Line	Choose New	HFID	HAC Code (English)	OLD LINE				NEW LINE		
				Equipment	Sub Equipment	Failure Mode	PMR	Sub	Failure Mode	PMR
		BE.2.3.2	BE	BUCKET ELEVATOR	CHAIN	CRACKS	DYE-PENETRATION TEST FOR CRACKS OF THE CHAIN			LINE WILL BE DELETED !
		CP.1.1.1	CP	COMPRESSOR - GENERAL	COMPRESSED AIR NETWORK	DIVERSE (CONTAINS ALL WALK-BY INSPECTIONS)	DO A WALK-BY (MAINT) OF THE COMPRESSED AIR			LINE WILL BE DELETED !
	x	GC.2.1.1	GC	GYRATORY CRUSHER	MOTOR	BROKEN MOTOR	DO A EMD OFF LINE OF THE MOTOR			LINE WILL BE DELETED !
		BLABLA	BLA	LINE WILL NOT BE CREATED !				essai	encore essai	faire blablabl
		TEST.BL 121.5.2	BL	BLOVER - ROOTS, ROTARY	BLOWERS	DIVERSE (CONTAINS ALL WALK-BY INSPECTIONS)	DO A WALK-BY (MAINT) OF THE BLOVER	BLOVERSs	DIVERSE (CONTAINS ALL WALK-BY	DO A WALK-BY (MAINT) OF
x		LOCAL. CS.1.2.1	CS	CYCLONE AIR SEPARATOR	BODY	DIVERSE (CONTAINS ALL WALK-BY INSPECTIONS)	DO A WALK-BY (MAINT) OF THE BODY	BODYs	DIVERSE (CONTAINS ALL WALK-BY INSPECTIONS)	DO A WALK-BY (MAINT) O
x		LOCAL.K L.7.1.1	KL	KILN, ROTARY KILN	INSPECTION DOOR	CRACKS	VISUAL TEST FOR CRACKS OF THE INSPECTION DOOR	INSPECTION DOOR	CRACKSs	VISUAL TEST FOR CRACKS OF DOOR

Database Update
Cancel
Update!

On this page, it is possible, by clicking on one of the first 2 columns, to choose whether the old line should be kept, or updated. When everything has been chosen, click on “Update”
By default, if no choice has been made for a line, the old information will be kept!

6.3 Translating the Database into Local Language

If you want to translate the database in local language, proceed as follow:

- Close all FMEA datasheet that might be opened
- Open the local Database file
- Every information is repeted in 2 consecutive column: English and Local. Translate the information in the “local” column. When no translation is needed or found, leave the English content in the cell
- When finished, Save and CLOSE the file before opening a FMEA file.
- To use the local language on the software, open an FMEA File, choose “Parameters” on the Home Page, and tick “Local Language”.

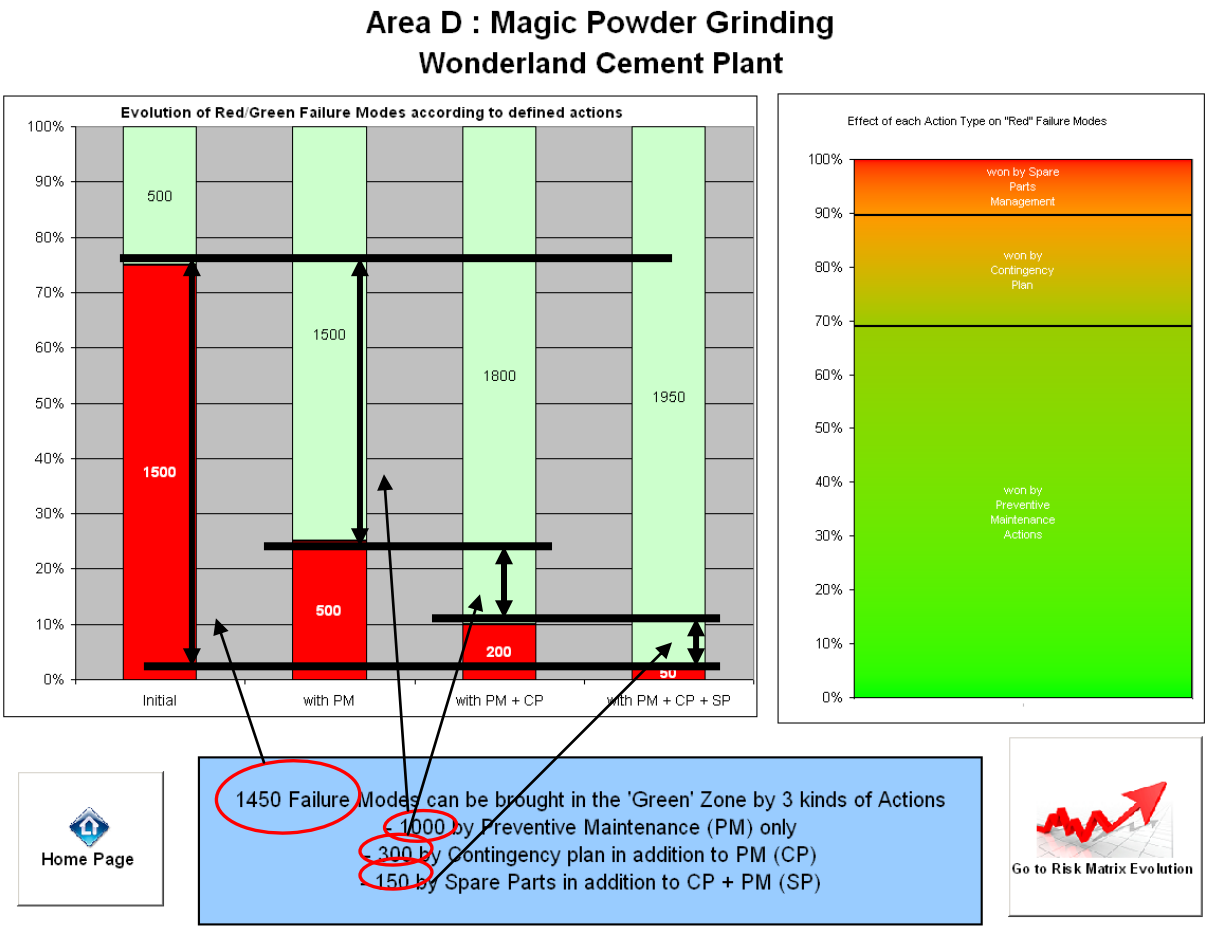
☺ Updating the database will not erase/modify your translations. However, it is strongly recommended to copy your local file in an “Archive” folder in case of a bug during the updating process.
Note that if a line in the database is updated, the local language for this line only will be deleted and put back to English. You will need to translate again this updated information.
Alphabet other than latin are supported, as long as it is accepted by Excel and all plant computers.

WHEN TRANSLATING THE DATABASE, DO NOT MODIFY ANYTHING ELSE THAN THE “LOCAL LANGUAGE” COLUMNS

7. INDICATORS

7.1 Creation of Indicators

Once the FMEA is all set, and Actions have been defined to reduce Risk of the Failure Modes, it is possible to display some information in order to monitor the possible improvement.
To do so, go back to the Risk Matrix, and click on "**View Evolution**". After a short calculation, the software will display the "Evolution Chart" page:



On this page are displayed the evolution of the Risk with the 3 kinds of actions, compared to the initial situation. The result here is binary (Red or Green), which allows to quickly analyze the trend of the FMEA analysis.

Click on " " to see a more thorough analysis of the possible improvements:

Area B: Magic Powder Grinding
Wonderland Cement Plant

Initial Situation

Probability	IV : Negligible	III : Moderate	II : High	I : Catastrophic
A - Very high	2	1	2	6
B - Moderate	2	3	3	3
C - Occasional	3	2	2	3
D - Remote	0	0	0	0
E - Unlikely	0	0	0	0
F - Impossible	0	0	0	0

Severity

1- With Preventive Maintenance

Probability	IV : Negligible	III : Moderate	II : High	I : Catastrophic
A - Very high	13	0	0	0
B - Moderate	1	0	0	0
C - Occasional	1	0	0	0
D - Remote	0	1	0	0
E - Unlikely	0	0	0	0
F - Impossible	6	5	5	0

Severity

2- with PM + Contingency Plan

Probability	IV : Negligible	III : Moderate	II : High	I : Catastrophic
A - Very high	1	0	2	2
B - Moderate	1	0	0	0
C - Occasional	1	0	0	0
D - Remote	0	1	0	0
E - Unlikely	0	0	0	0
F - Impossible	13	4	6	1

Severity

3- with PM + CP + Spare Parts Management

Probability	IV : Negligible	III : Moderate	II : High	I : Catastrophic
A - Very high	2	0	0	0
B - Moderate	1	0	0	0
C - Occasional	1	0	0	0
D - Remote	1	0	0	0
E - Unlikely	0	0	0	0
F - Impossible	27	0	0	0

Severity

On this page are displayed the filled-in Risk Matrixes for each steps of the FMEA process (Initial Situation, Prev. Maintenance Routines, Contingency Plan + PMR, Spare Parts Management + CP + PMR).

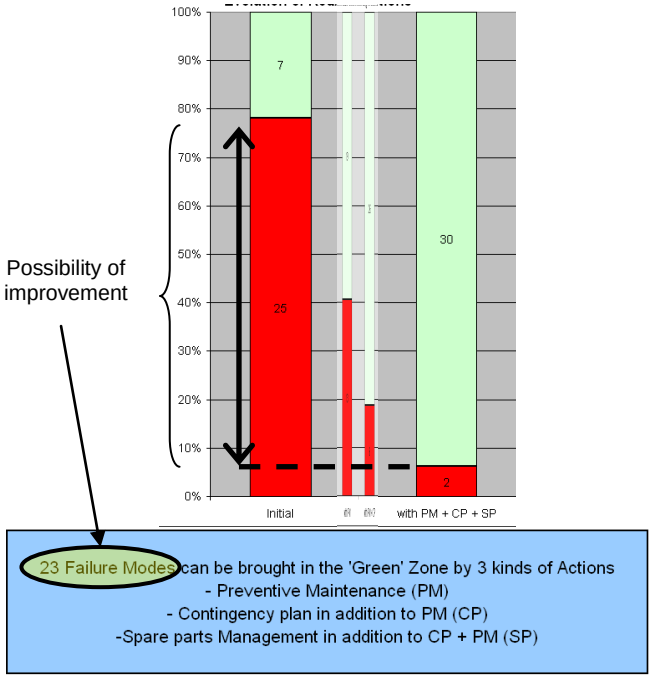
7.2 How Should I Interpret the Indicators?

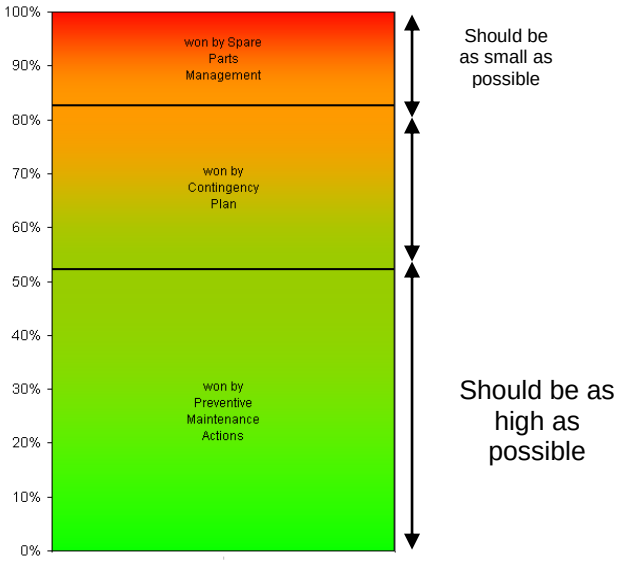
On the Indicator Chart, it is possible to draw conclusions, with a simple glance, about:

- The Initial Situation of the plant: by looking at the 1st bar of the chart, it is possible to see the total number of Failure Modes which have been created, and the number of them which are in the Risk Area. The higher the red part is, the more it can be expected that the maintenance crew will have to execute corrective maintenance (which means high pressure from management, higher costs, high variation of workload, with no predefined

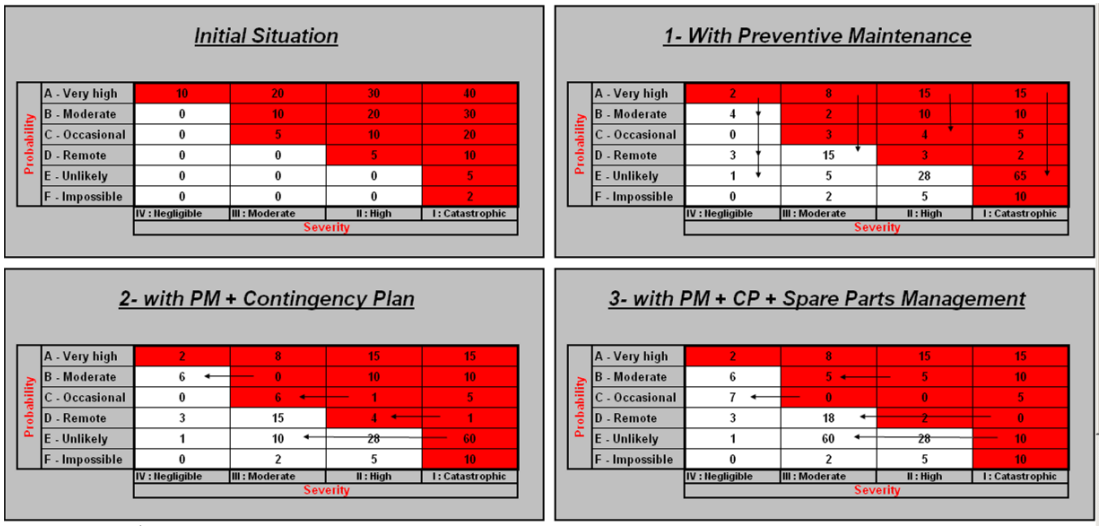
planning …etc). The aim of this software is, in fact, to help plant management to improve this.

- The possibility of improvement: It is the difference between the red bar on the left, and the red bar on the right. The aim is to have the smallest bar possible on the right (ideally, there should be no red at all after all actions are implemented!)
- The chart on the right shows the part of each type of action. As it has been explained before, the simplest and cheapest actions are the Preventive Maintenance Routines, so they should ideally represent the highest percentage possible. A color code allows an easy reading: “Greener is better!”





On the second page, it is possible to have a more thorough overview of the possible evolution of the maintenance in the Area:



Here, it is possible to see the trend in the evolution of the Risk Matrix for each Type of Action. This sheet allows to see the improvements made, and what can still be improved, such as reducing the Probability (which means setting up new PMR, usually), or the Severity (Contingency Plan or Spare Part to reduce Lead-Time).

8. GOING FURTHER

8.1 Action plan

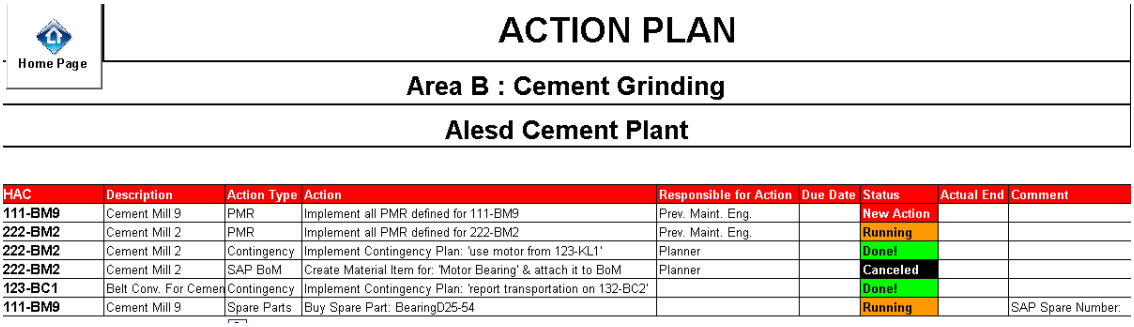
Once the FMEA is created, it is possible to generate automatically an Action Plan, which will summarize all actions that should be completed in order to reduce risk as calculated in the FMEA.

To generate the Action Plan, from the "Contents" page, click on " 

".

Here are all information taken into account in the Action Plan:

- For each HAC, one line to remind about the implementation of all PMR for this HAC (for the detailed list, see "equipment sheets")
- For each contingency plan, a line reminds about the necessity to verify that the plan can be implemented in the shortest time possible.
- For each spare part, a line reminds that one needs to check that it is on stock
- For each spare part without an SAP number, a line reminds to create this part into the Bill of Materials in SAP.



HAC	Description	Action Type	Action	Responsible for Action	Due Date	Status	Actual End	Comment
111-BM9	Cement Mill 9	PMR	Implement all PMR defined for 111-BM9	Prev. Maint. Eng.		New Action		
222-BM2	Cement Mill 2	PMR	Implement all PMR defined for 222-BM2	Prev. Maint. Eng.		Running		
222-BM2	Cement Mill 2	Contingency	Implement Contingency Plan: 'use motor from 123-KL1'	Planner		Done!		
222-BM2	Cement Mill 2	SAP BoM	Create Material Item for: 'Motor Bearing' & attach it to BoM	Planner		Canceled		
123-BC1	Belt Conv. For Cemen	Contingency	Implement Contingency Plan: 'report transportation on 132-BC2'			Done!		
111-BM9	Cement Mill 9	Spare Parts	Buy Spare Part: BearingD25-54			Running		SAP Spare Number:

It is possible to fill the Action Plan manually (responsible, due date …etc). The status, however, is changed by a simple click in the colored cell. The sequence is "New Action" – "Running" – "Completed" – "Canceled".
When a Status is changed in the Action Plan, the change is immediately taken into account in the FMEA, to calculate the current risk for each line.

In the FMEA, never modify the status cell. This would be automatically erased when the Action Plan is displayed. Status changes are to be made only in the Action Plan

8.2 Equipment Sheet

Once the FMEA is created, one can generate a file of “Equipment Sheets”. This Excel file contains as many Worksheets as there are HAC in the FMEA. On each of this sheets, are all the defined PMR, sorted by frequency.
The file will not be modified by the software after its generation, and each time one click on the “Equipment Sheet” button, a new file is generated. Once the FMEA is finished for an equipment, it is recommended to generate the file and save it.

It is possible to add, modify or delete content. However, do NOT add or delete entire columns in between columns A and F.

PLANT

AREA

561-BM1 - BALL MILL NR 1

D:\Documents and Settings\calbert2\Desktop\PMR Folder

Sub-Equipment	Description of the PMR	Task List Group & Counter (SAP)	Comment	File
Every 1 weeks				
MOTOR	VIBRATION ANALYSIS OF THE MOTOR			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
REDUCER	VIBRATION ANALYSIS OF THE REDUCER			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
Every 2 weeks				
AUXILIAR REDUCER	DO A WALK-BY (MAINT) OF THE AUXILIAR REDUCER			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
COUPLING	DO A WALK-BY (MAINT) OF THE COUPLING			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
GIRTH GEAR	VISUAL CHECK ON SPLIT OPENING			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
PINION	MEASURE TEMPERATURE PROFILE OF THE PINION			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
REDUCER	MEASURE TEMPERATURE PROFILE OF THE GIRTH GEAR			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
Every 4 weeks				
DIAPHRAGM	MESURE WEAR OF THE MILL DIAPHRAGM			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
DIAPHRAGM	VISUAL TEST FOR CRACKS ON THE MILL DIAPHRAGM			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
LINERS	MESURE WEAR OF THE MILL LINERS			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
LINERS	VISUAL TEST FOR CRACKS OF THE MILL LINERS			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
Every 12 weeks				
AUXILIAR REDUCER	DO A OIL ANALYSIS OF THE AUXILIAR REDUCER			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
BEARINGS	DO A OIL ANALYSIS OF THE MILL BEARINGS			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
COUPLING	DO A THERMOGRAPHY OF THE COUPLING			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
MOTOR	DO A OIL ANALYSIS OF THE MOTOR			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
MOTOR	DO A THERMOGRAPHY OF THE MOTOR			xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
REDUCER	DO A OIL ANALYSIS OF THE MAIN REDUCER		545MP1 1R1 -> 2M	xxxxxxxxxxxxxxxxxxxxxxxxxxxx.doc
Every 24 weeks				
COUPLING	VISUAL TEST FOR CRACKS OF THE COUPLING			
MILL HEAD	VISUAL TEST FOR CRACKS OF THE MILL HEAD			
MILL SHELL	VISUAL TEST FOR CRACKS OF THE MILL SHELL			
MOTOR	DO A EMD OFF LINE OF THE MOTOR			
PINION SHAFT	VISUAL TEST FOR CRACKS OF THE PINION SHAFT			
TRUNNION BEARING	MILL TRUNNION BEARING PLAY AND CONDITION		CLEARANCE MEASUREMENT BETWEEN TRUNNION AND BEARING	
Every 48 weeks				
GIRTH GEAR	DO A VISUAL INSPECTION ON THE HOUSING			

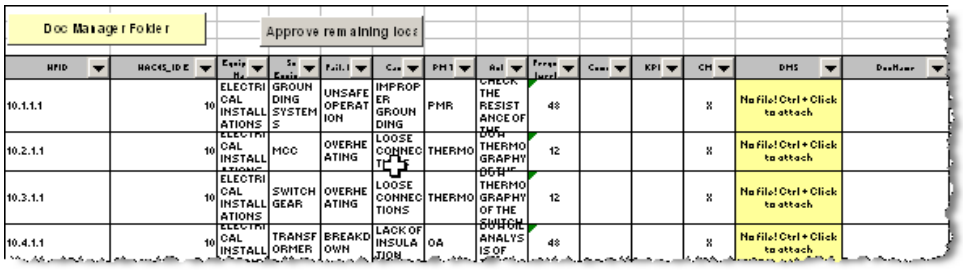
8.3 Document Management System

In version 1.6 and above, the software is provided with a Document Management feature. This means that files of any type can be attached to each PMR in the Database. This link will be kept and re-used in the FMEA and the Equipment Sheets.
The aim of this system is to provide a database of explanatory notes about each PMR, or a set of PMR on an Equipment.
HGRS will provide a set of documents, but any plant can attach additional files.

Reading an attached file:
To read an attached file, click on the file name (Column Y: "Attached File" in the FMEA, Column F: "File" in the Equipment Sheet, Column AF "DMS" in the Database), so the file is automatically opened with the default software.
Note that all the attached files MUST be kept in a single folder. The path to this folder can be changed at any time:

- from the database, by clicking on the yellow button (see screenshot);
- from the FMEA, in the "Parameters" window
- from an equipment sheet, by changing it manually in cell F4

The path defined on the Database will be automatically used by any FMEA linked to this Database. The path defined in an FMEA will be automatically used in all the Equipment Sheets that are generated afterwards.



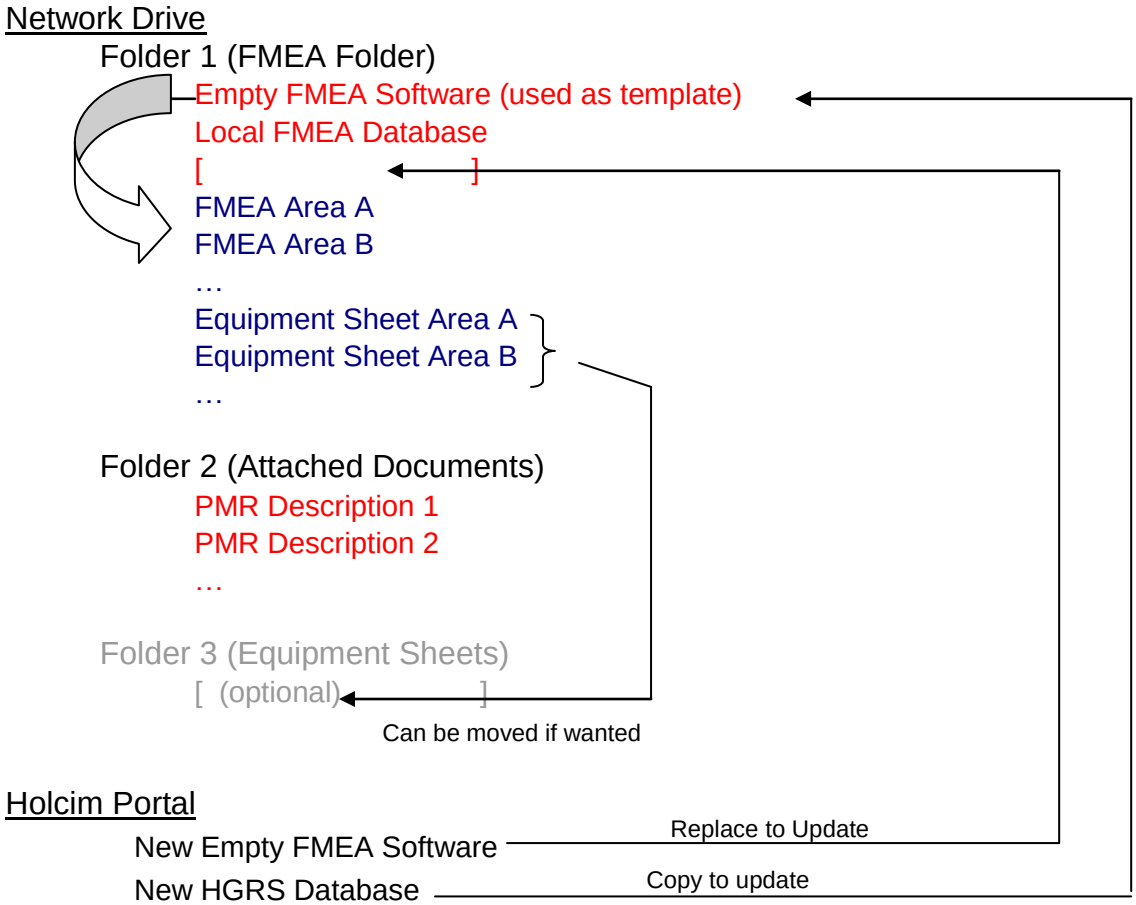
Database: click on the yellow cells

Linking a file:

- From the database: press "Ctrl" and click on the "DMS" column (yellow on the screenshot above), in the appropriate line, then select the file.
- From the FMEA: press "Ctrl" and click on the "Attached file" column and select the file.
- From an Equipment Sheet: press "Ctrl" and click on the "File" column, then select the file.

☺ A change made in the database will be taken into account in all NEW lines of FMEA, and changes in FMEA will be taken into account in newly generated Equipment Sheets only.

9. HOW TO MANAGE ALL THOSE FILES: SYNTHETIC OVERVIEW



Files in Red: placed by user

Files in blue: generated by the software

Copy the file to create a new Area

10. REVISION LOG

Rev.	Date	Object of revision	By
00	30.01.2010	Initial version of the document	ABC
01	18.08.2010	Revision according to Software v1.6 Update	ABC
02	00.01.2011	Minor changes	ABC
03	18.04.2011	FMEA theory updated according to maint. Manual	ABC