

Simple approach to failure modes using a maintenance organisation and management software

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With the high scientific and technological development present today, the investment in asset management has been increasing significantly, which means Maintenance has an increasing role in Companies: in equipment availability, reliability, in operation risk reduction and, very important, in the quality of products and services. Therefore, maintenance strategies today are of particular importance in industry.

There is no such thing as a perfect maintenance strategy – breakdowns/failures will always occur, which means maintenance teams need to respond to these situations in the most effective way possible. In other words, despite the constant evolution of the maintenance function, be it in terms of training of maintenance technicians, tools to support maintenance management or even in terms of the equipment itself, failures will still occur in assets.

And this is exactly where **the importance of Failure Analysis (FMEA)** comes in.

The process of failure analysis is critical in the day-to-day of maintenance teams, it is the only way to find out and assess the causes of recurring failures in the organisation's equipment and, therefore, work to reverse these situations, which will obviously result in more asset availability and reliability within the organisation. The tools involved in the process of failure analysis identify the cause of the problem and directly suggest a response action.

Usually, the response of the maintenance teams in the different failures that emerge in the organisation, involves the substitution of fault components, without an analysis of the cause of the failure. Analysing the failure is a big shift in this paradigm. By engaging itself and others in bringing together, mapping and analysing failures modes, the maintenance team will 'capture' new concepts and intuitively apply them to every failure reported.

*"Carrying out failure analysis with a multidisciplinary group, which includes Maintenance and Operations, results in a change of the concept "yeah, the machine broke down!"; the operators will request the maintenance services in a different manner, indicating the components that have actually broke down" (J. Braidotti presented a seminar called "Failure is not an option" at the 26<sup>th</sup> Maintenance Congress, 2011)*

Failures in assets are, indeed, inevitable. So, maintenance teams can and should learn with these failures. As Mr. Jose Saraiva Cabral so well stated in his book<sup>1</sup>, *"When reporting an equipment failure, if you systematize a significant set of symptoms, components and causes, you will be able to perform analysis on the recurrence and the correlations of these situations and draw lessons from them."*

<sup>1</sup>*"Maintenance Management of Equipment, Facilities and Buildings", Jose Saraiva Cabral, 2013;*

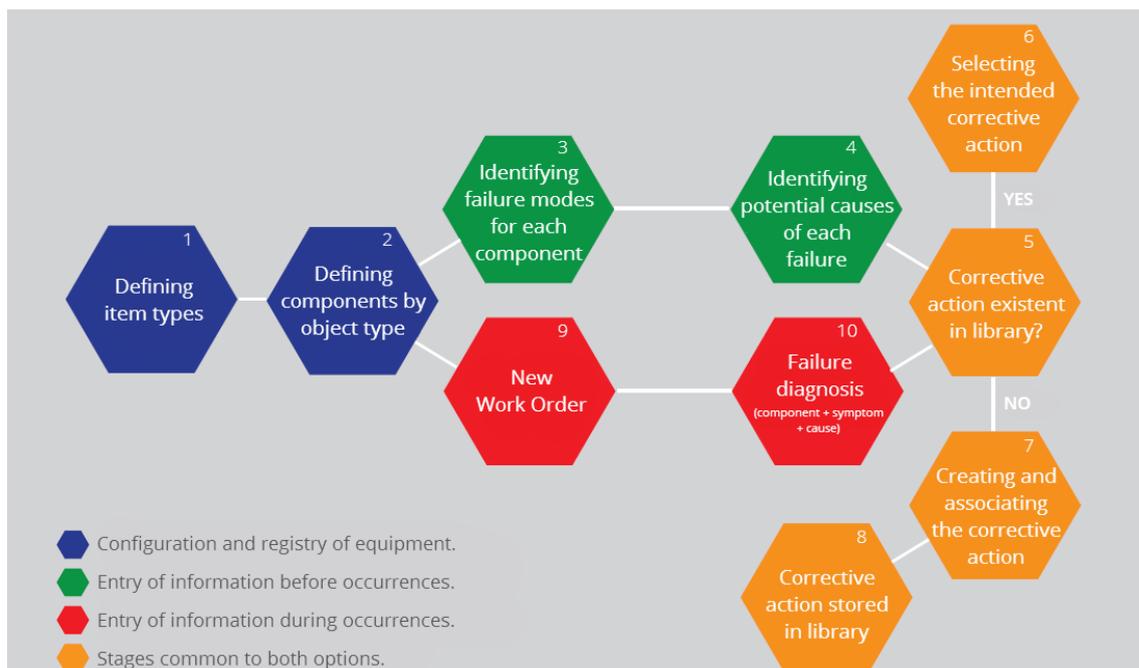
The methodology “Failure Modes & Effect Analysis” or *FMEA* is lined up with this practice described by *Saraiva Cabral*. This approach allows the maintenance manager to hierarchize in a simple way the possible failures for each type of equipment and its components in the organization, to list the possible causes for each failure mode and to set the possible corrective actions. With a maintenance software (or CMMS), this information is generated automatically based on the equipment’s maintenance history (or it can be recorded manually by the user), but the important thing is that, through this approach, the maintenance manager and/or the maintenance team can identify and evaluate the most persistent failures and, based on their causes and on the software’s intelligence, become immediately informed of what corrective actions to apply for each situation.

Here are a few advantages from analyzing failure modes:

- ✓ Create a technical knowledge base for the Company’s assets and making it available to all the maintenance staff
- ✓ Quicker responses to breakdowns
- ✓ It *may* lead to changes (improvements) in the preventive maintenance plans – both in the periodicity and/or the check list of tasks itself
- ✓ Identifies the system’s critical areas or processes
- ✓ And, of course, many other positive impacts like cost reduction, client satisfaction, increase of equipment uptime, less waste (in time, in spares and even in product output)

To implement a simple approach to “Failure Modes & Effect Analysis / FMEA”, it is necessary to carry out several Steps. No matter what the procedure implemented by the user (either creating information automatically through the maintenance history or just recording it manually), it is imperative that, first of all, the necessary technical information about the existing items in the organisation is gathered. The process of implementation is structured in Figure 1.

**Figure 1** – Flowchart of the resource “Failure Modes & Effect Analysis / FMEA”



Configuration and registry of equipment (Blue): the two Steps identified in blue, are related to the equipment recording in the software. Before recording any equipment, the user needs to define the item types and after to list the item's components.

After completing these two Steps, the user proceeds to equipment recording and determines how the resource is managed – automatically or manually.

Entry of information before occurrences (Green): to enter information before occurrences (recording of information in "manual" mode), the Steps identified in green must be followed. To enter this information gradually and automatically (during occurrences), the Steps highlighted in red must be chosen. Selecting one option does not invalidate the other, the user can place the information at his own pace and even conjugate both situations as he is developing the resource.

The Steps marked in orange in the flowchart of Figure 1 are common to both options.

Each Step shown in Figure 1 has one number (Step 1, ..., Step 10) and is described below

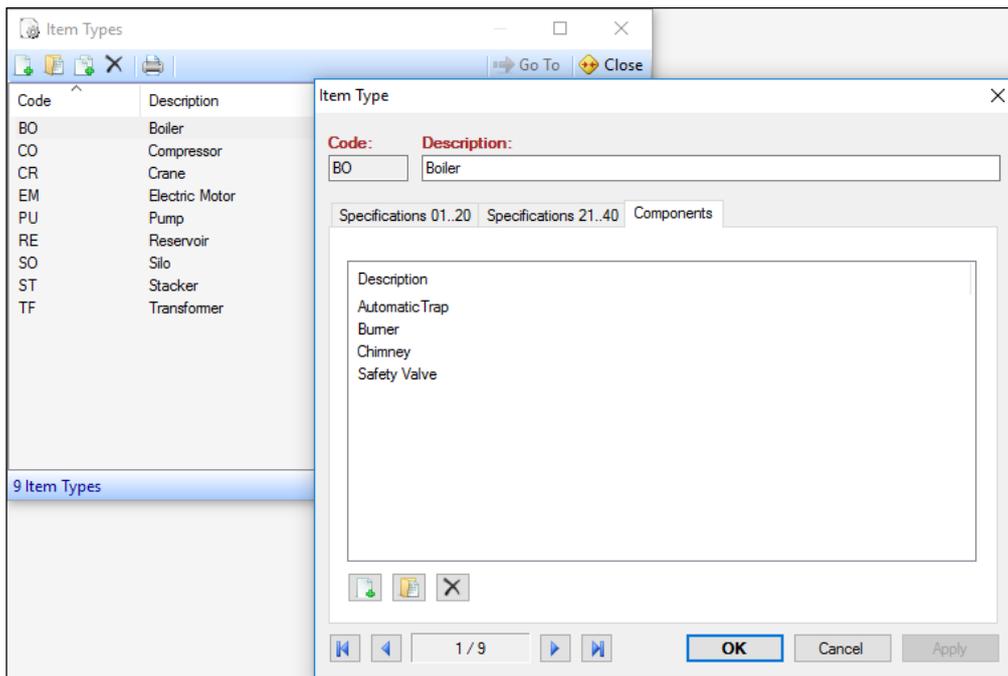
**Step 1 – Defining item types:** In an initial phase, the user should group in a direct and systemised way the items by "Type" (Figure 2), with a specific code associated in the software. By grouping items by "Type" the user can then define, among other information, the components of each item type.

Example: if agreed the code is "BO" for all Boilers, it is possible to use this structure to create a structured code ("BO-\_\_\_\_") and the technical datasheet that will be used for all Boilers. All Boilers will then have a code starting with "BO-\_\_\_\_" and have the same technical datasheet (MAKERS, MODEL, YEAR OF MANUFACTURER, SERIAL NR. ...)

**Step 2 – Defining components by item types:** The components make up the equipment. Each item type has several components that can potentially fail, and this information needs to be recorded in the software.

Example: Chimney, automatic trap, burner, safety valve, etc.

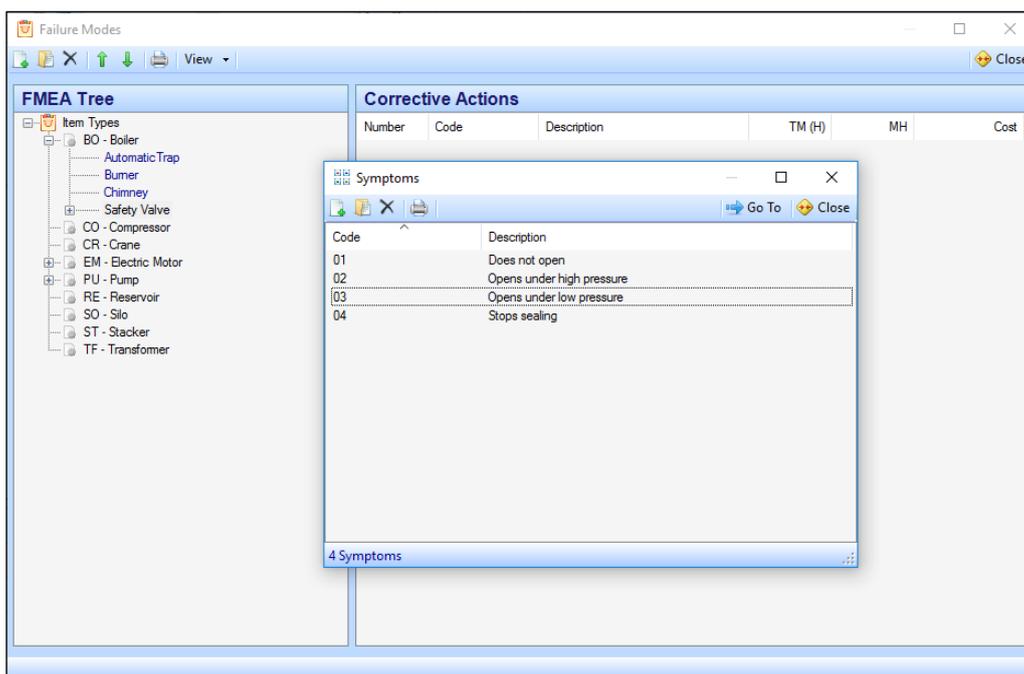
**Figure 2** – Examples of created item types (behind). Components defined for each item type (front)



**Step 3 – Identifying failure modes for each component:** The failure modes (symptoms), translate how a failure appears and which justifies a maintenance action. In this stage, responses are given for questions such as: “How can a specific component fail?” The potential failure modes are expressed in physical terms, more specifically: under fatigue, vibration, wear, leakage, fracture, etc.

Nevertheless, and depending on the way each user is working, the user can list more precisely the failure modes for each component (Figure 3).

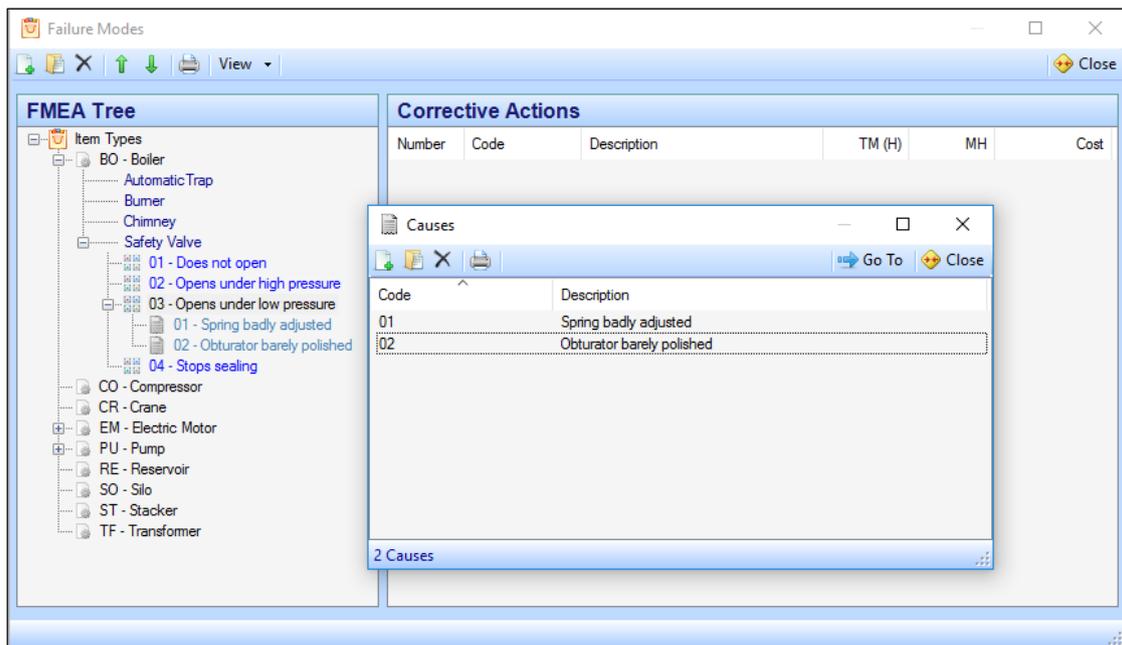
**Figure 3** – Failure modes (Symptoms) of the equipment, type Boiler and component safety valve.



**Step 4 – Identifying potential causes for each failure:** The potential causes of failure are defined as the motive that triggered the corresponding failure mode. Each failure mode may be subject to several potential causes and all these likely causes should be listed, so that it allows the user to identify the cause that is preventing the component from properly performing the functions for which it was designed.

Example: Wear, poor operation, inappropriate maintenance, etc.

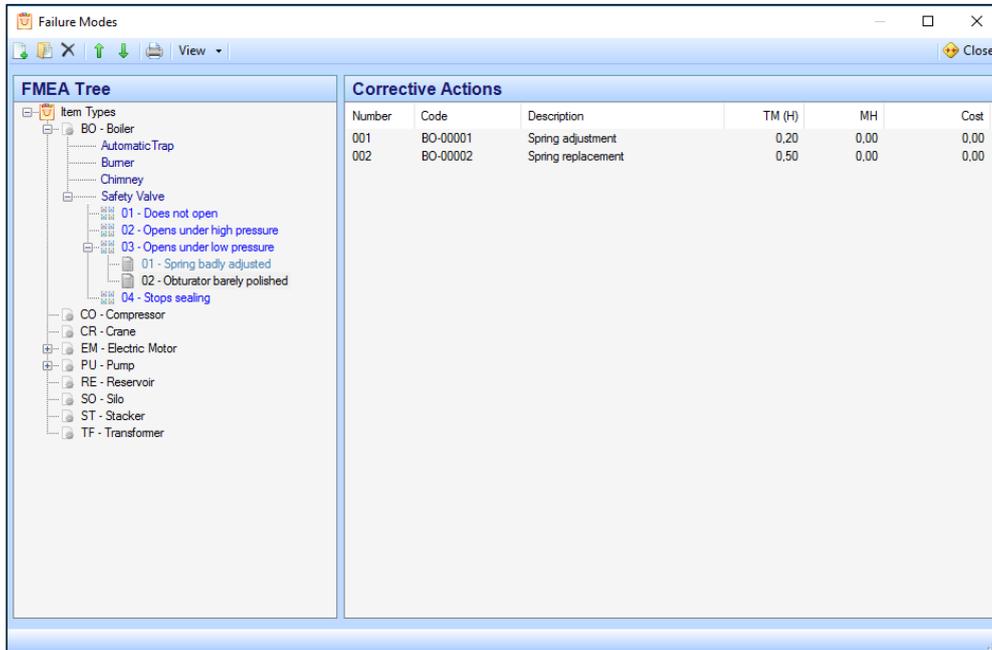
**Figure 4 – Potential failure causes of the equipment, type Boiler, component safety valve and failure mode “Opens at a lower pressure”**



**Step 5 – Corrective action available in the library:** A corrective action is the action established in response to the detected failure. The actions and the descriptions of tasks to carry out can be gathered in a typical feature of CMMS systems, the Work Description Library. This is a valuable feature for any CMMS user. Before creating a corrective action in the system, the user should verify in the library if an appropriate work description for the occurrence already exists.

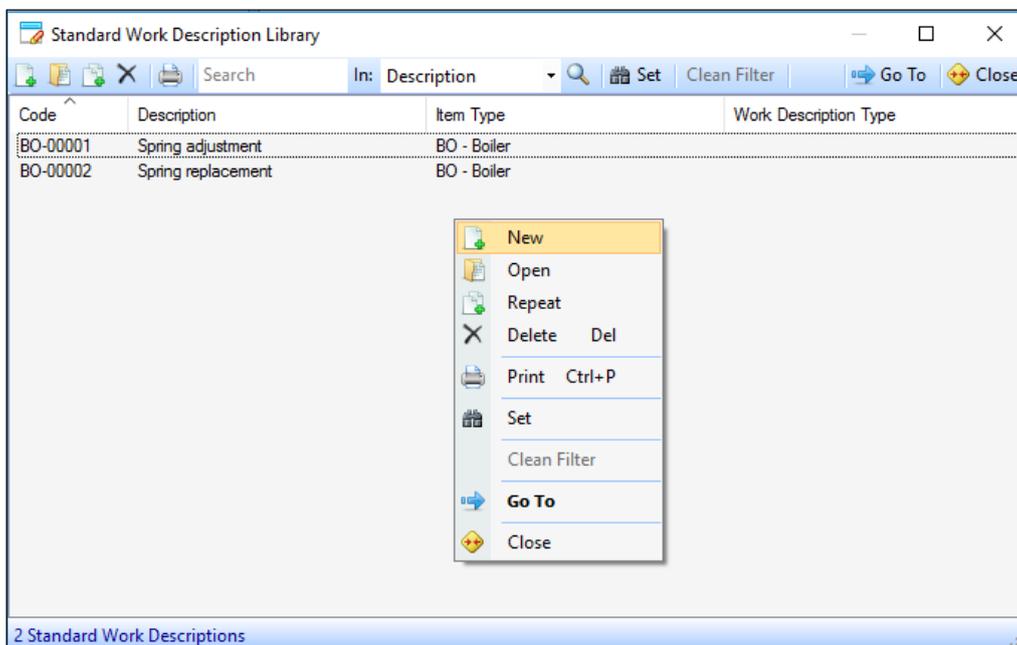
**Step 6 – Selecting the intended corrective action:** In case a corrective action (or actions) to repair the failure is available in the library, the user simply has to select the desired action to finalize the process of systematising the failure. More than one corrective action can be selected and prioritized for each specific failure (Figure 5).

**Figure 5 – Failure Modes & Effect Analysis / FMEA defined for the example case and respective corrective actions**



**Step 7 – Creating and associating a corrective action:** If the corrective action to repair the failure is not available in the library, it is necessary to create it in the system (Figure 6).

**Figure 6 – “Work description library” Window**



**Step 8 – Corrective action stored in the library:** After the creation of the necessary action in Step 7, this one is automatically stored in the software library.

**Step 9 – New Work Order:** To create maintenance history, the user must record all interventions by creating a new work order for them, whether they are or are not corrective.

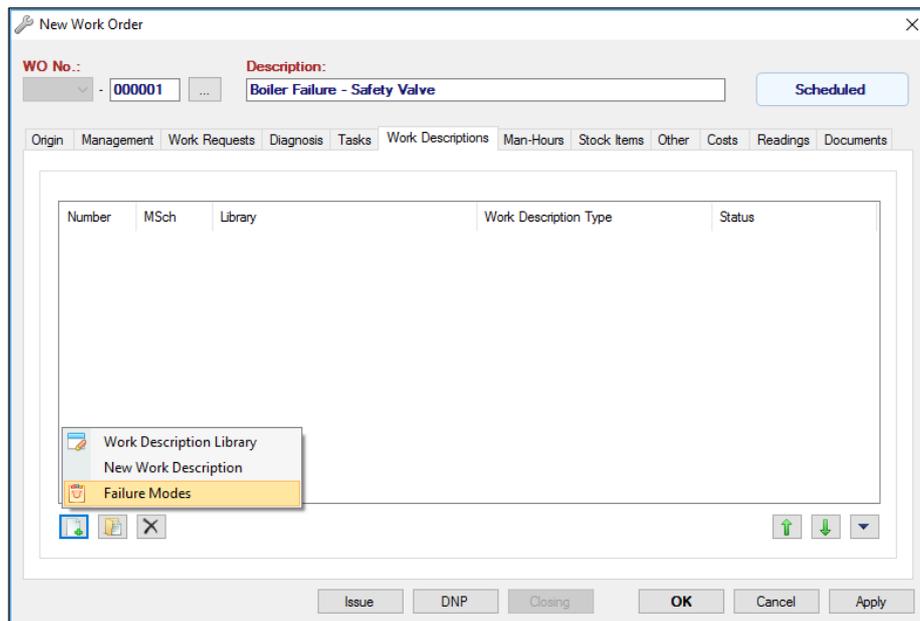
Now, if the user plans to feed the feature “Failure Modes & Effect Analysis / FMEA” during the occurrence, it is necessary to carry out the complete failure diagnosis (component + symptom + cause) on the report of the work order.

**10. Failure diagnosis:** In the tab “Diagnosis” of the failure of the Work Order, (Figure 7), the user should adequately specify the failure, performing its diagnosis. First, the user specifies the failure mode. The component and the cause of the failure, frequently, can only be diagnosed after the intervention. So, before ending the Work Order, the user has to complete the failure diagnosis, so that the Failure Modes & Effect Analysis / FMEA is automatically supplied/fed.

**Figure 7** – Illustration of the diagnosis tab in the “New Work Order” window

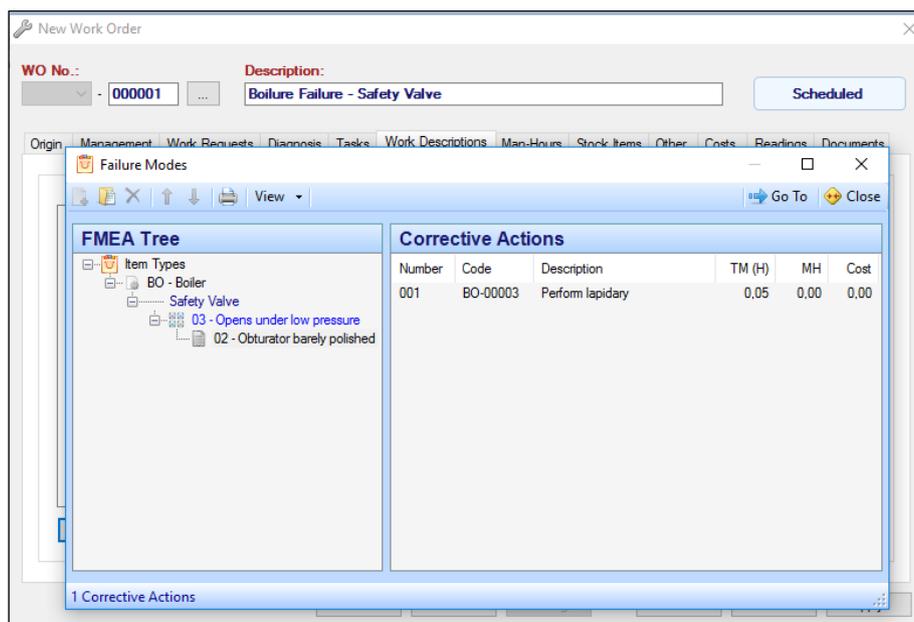
After completing the failure diagnosis, the user is required to repeat the procedures described from Step 5. Through “Work Descriptions” tab of the Work Order, the user has 3 (three) distinct options to select or develop the proper corrective action (Figure 8):

**Figure 8** – Illustration of the work descriptions tab in the “New Work Order” window, and the 3 options: “Work description library”, “New work description” and “Failure Modes”.



- Option 1: if the work description is already created in the library, the user simply has to select the one he desires.
- Option 2: if the corrective action does not exist in the library, the user has to create one, selecting the option “New work description”
- Option 3: in case a work description is already structured in the “Failure Modes & Effect Analysis / FMEA”, the user selects this option and the software suggests which work description(s) to apply for the diagnosis made (Figure 9).

**Figure 9** – “Failure Modes & Effect Analysis / FMEA” window: suggestion of the corrective action to apply for the previously made diagnosis



## **Conclusion**

Failures are inevitable. All the information that enables you and your team to act as quickly as possible on a malfunction (minimising production losses) is most valuable. Creating this knowledge about the asset is equally important when it becomes available/accessible for all technicians.

Systematizing the failures (FMEA Analysis), in the initial stages, might seem like a difficult and time consuming work, but it is not. The possibility of this information being automatically generated based on the maintenance history allows the maintenance manager to feed the resource progressively, with no need to waste too much time in the initial phase to record large amounts of information.

## **Bibliography**

- (1) Carvalho, A, Cabral, J., "Metodologia de Sistematização Técnica para a Gestão de Ativos", 2014;
- (2) Braidotti, J., "A falha não é uma opção", 26º Congresso de Manutenção, 2011;
- (3) Cabral, J., "Gestão da Manutenção de Equipamentos, Instalações e Edifícios", LIDEL, 2013.