EUROPEAN COMMISSION
DG III INDUSTRY

INDUSTRIAL RTD PROJECT 20874

REMOTE MAINTENANCE for FACILITY EXPLOITATION

DELIVERABLE 1.3

REMAFEX TERMINOLOGY

BODY REFERENCE : WP1/003/Rev.A

TITLE :	REMAFEX TERMINOLOGY
SOURCE :	SEMA GROUP
STATUS :	FINAL DOCUMENT
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VERIFIED BY :	ALL PMT MEMBERS
DISTRIBUTION :	ALL CONSORTIUM PARTICIPANTS, EC DGIII
DATE :	18 MAY 1996
NUMBER OF PAGES :	46
INTERNAL REFERENCE :	C:\EUROP\REMAFEX\1306REMA.DOC

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1. EXECUTIVE SUMMARY (A)

Following an ESPRIT proposal during which the Consortium was more or less difficult to constitute, and some partners appeared to be the "driving force", it is now imperative to establish, **at the very beginning of the project**, a clear contract between all participants and define every participant's scope of work for the entire project duration.

It was done in ESPRIT projects coordinated by Sema Group and it accounted for their success. **As a consequence, the first workpackage of the REMAFEX project (WP1) aims at setting the foundations of the Contract between the REMAFEX Consortium, and comprises 3 deliverables :**

- **REMAFEX PROJECT MANAGEMENT : ORGANISATION AND PROCEDURES**
  This is the first deliverable (D1.1) of the REMAFEX project, and this is the basic document for the REMAFEX project global management.

- **REMAFEX NEW REVISED WORKPLAN**
  This is the second deliverable (D1.2) of the REMAFEX project detailing all tasks to be performed by the REMAFEX Consortium, and constitutes a clear commitment for the REMAFEX Consortium.

- **REMAFEX PROJECT MANAGEMENT : COMMON TERMINOLOGY**
  This is the third deliverable (D1.3) of the REMAFEX project which presents the common maintenance terms and definitions of the maintenance manufacturing activity used while developing the REMAFEX project and useful to a clear understanding.

These 3 deliverables provide a clear definition of all tasks to be performed by the REMAFEX Consortium, and constitute a clear commitment for the REMAFEX Consortium.

The present deliverable D1.3 « REMAFEX Terminology » is a dictionary including all maintenance terms used within the REMAFEX project.

As such, this document will be integrated into the REMAFEX tutorial (the REMAFEX multimedia dissemination tool) and will be improved all along the project, with the maintenance manufacturing expertise gained by the REMAFEX Consortium.

This deliverable is divided into fourth parts :

- **Hydroelectric terms (section 2)** used by the REMAFEX end-users with :

  - general terms,
  - types of turbines,
  - main components of hydroelectric turbines.

- **The standard maintenance terms definition (section 3)** used by all industrial sectors and normalised :

  - fundamental concepts,
  - performance terms,
  - maintenance concepts,
  - failures,
  - faults, errors and mistakes,
  - maintenance related times,
  - ARM related times,
  - fundamental state related times,
  - analysis concepts,
  - availability.

- **The maintenance REMAFEX terms (section 4)** used by all project partners and which are not normalised.

- **The manufacturing domains definition of the global maintenance activity** which constitutes the so-called « maintenance focus area » where the user needs have to be expressed at each level of the system decomposition, the « **maintenance focus area » (section 5).**

2. HYDROELECTRIC INSTALLATIONS : TERMS AND DEFINITIONS (A)

2.1. GENERAL TERMS

- **Power station** [IEC 50(602)]
  An installation whose purpose is to generate electricity and which includes civil engineering works, energy conversion equipment and all the necessary ancillary equipment.

- **Hydroelectric installation** [IEC 50(602)]
  An ordered arrangement of civil engineering structures, machinery and plant designed chiefly to convert the gravitational potential energy of water into electricity.

- **Hydroelectric power station** [IEC 50(602)]
  A power station in which the gravitational energy of water is converted into electricity.

- **Generating set** [IEC 50(602)]
  A group of rotating machines transforming mechanical or thermal energy into electricity.

- **Hydroelectric set** [IEC 50(602)]
  A generating set consisting of a hydraulic turbine mechanically connected to an electrical generator.

- **Reversible hydroelectric set** [IEC 50(602)]
  A rotating set capable of assuming the generating or pumping function.

- **Unit** [IEC 4/112/CDV] **or set**
  A complete set of hydraulic and electrical machines used for generating or pumping or both.

- **Binary unit** [IEC 4/112/CDV]
  A motor-generator combined with a pump-turbine.

- **Ternary unit** [IEC 4/112/CDV]
  A motor-generator combined with a turbine and a storage pump.

- **Turbine** [IEC 4/112/CDV]
  A machine for transforming hydraulic energy into mechanical energy. The term does not include the inlet or outlet valves for the associated generator or regulator.

- **Storage Pump** [IEC 4/112/CDV]
  A machine for transforming mechanical energy into hydraulic energy. The term does not include the inlet or outlet valves for the associated mater.

- **Pump-turbine** [IEC 4/112/CDV]
  A machine designed to operate as both a turbine and a pump.

- **Vertical shaft, horizontal shaft, inclined shaft** [IEC 4/112/CDV]
  The orientation of the machine's rotational axis.

- **Regulated machine** [IEC 4/112/CDV]
  A machine in which the flow is controlled through an adjustable device such as guide vanes, needles and/or runner [impeller] blades while operating.

- **Double regulated machine** [IEC 4/112/CDV]
  A regulated machine with two adjustable devices.

- **Single regulated machine** [IEC 4/112/CDV]
  A regulated machine with one adjustable device.

- **Non-regulated machine** [IEC 4/112/CDV]
  A machine in which no flow controlling device is provided. Flow may be temporarily controlled by the main valve.

2.2. TYPES OF TURBINES

- **Impulse type turbine** [IEC 50(602)]
  A turbine in which a fluid acts chiefly by its kinetic energy.

- **Reaction type turbine** [IEC 50(602)]
  A turbine in which a fluid acts both by its kinetic energy and by its pressure.

- **Pelton turbine** [IEC 50(602)]
  A hydraulic impulse type turbine usually operated from a high head source with small flow rate.

- **Francis turbine** [IEC 50(602)]
  A hydraulic reaction type turbine with fixed runner blades usually operated from a medium flow rate.

- **Kaplan turbine** [IEC 50(602)]
  An axial hydraulic reaction type turbine with adjustable runner blades operated with a high flow rate.

- **Bulb-type unit** [IEC 50(602)]
  A hydroelectric set with its casing containing the generator and turbine immersed in the water flow.

- **Propeller turbine** [IEC 50(602)]
  A Kaplan type turbine with non-adjustable runner blades suitable for non-varying head sources.

2.3. PRINCIPAL COMPONENTS OF HYDRAULIC TURBINES, STORAGE PUMPS, PUMP-TURBINES AND THRUST BEARINGS

- **Bearing oil injection system** [IEC 4/112/CDV]
  Device to supply pressure oil into bearings.

- **Bottom ring** [IEC 4/112/CDV]
  Stationary ring which supports the lower guide vane stems and provides water passage surfaces leading to the runner band of Francis turbine or to the discharge ring of a Kaplan and propeller turbine. It may be connected to the lower shroud of the stay ring (pump diffuser).

- **Bulb** [IEC 4/112/CDV]
  Streamlined watertight housing of a bulb unit containing generator and gear box if any.

- **Cam - guide vane : blade cam** [IEC 4/112/CDV]
  Mechanical or electronic device on a double regulated machine designed to maintain the optimum relationship between runner (impeller) blade angle and guide vane opening.

- **Deflector** [IEC 4/112/CDV]
  Device of an impulse (Pelton) turbine controlled by the regulator at deflect the jet away from the buckets.

- **Deflector servomotor** [IEC 4/112/CDV]
  Servomotor to operate the deflector and keep it in position.

- **Diffuser** [IEC 4/112/CDV]
  Structural component of a hydraulic machine converting velocity energy into pressure energy, see pump diffuser and draft tube.

- **Distributor** [IEC 4/112/CDV]
  Components of a reaction machine which distribute flow from the high pressure side to the runner or to the high pressure side from the impeller. The term distributor includes guide vanes, stay vanes (diffuser vanes) and surrounding parts, such as headcover and bottom ring for radial and Kaplan machines, and guide rings for tubular machines.

- **Draft tube** [IEC 4/112/CDV]
  Formed tube which transforms velocity energy into pressure energy of water leaving the runner.

- **Guide bearing** [IEC 4/112/CDV]
  Device to guide the main shaft and to support radial forces.

- **Guide bearing housing** [IEC 4/112/CDV]
  Outer casing of the guide bearing that supports the shell or shoes.

- **Guide bearing shell** [IEC 4/112/CDV]
  Removable element containing the material that forms the guide bearing surface.

- **Guide bearing shoe** [IEC 4/112/CDV]
  Individually adjustable element of a segmented type guide bearing.

- **Guide vane or wicket gate** [IEC 4/112/CDV]
  Angularly adjustable streamlined element which controls flow to the turbine runner or from the pump impeller.

- **Guide vane regulating apparatus** [IEC 4/112/CDV]
  Assembly used to move the guide vanes. consisting essentially of the guide vane servomotors, regulating ring and guide vane linkage.

- **Guide vane servomotor** [IEC 4/112/CDV]
  Servomotor actuating the guide vanes individually or through regulating ring and linkage device.

- **Headcover** [IEC 4/112/CDV]
  Axisymmetric structural member that separates the water passage and the outside of the machine and supports the main shaft seal and the machine guide bearing. In radial, Kaplan and propeller machines, the headcover also supports the guide vane stems. It may also support the thrust bearing.

- **Housing** [IEC 4/112/CDV]
  Casing which forms the chamber in which the impulse (Pelton) runner operates.

- **Impeller** [IEC 4/112/CDV]
  Rotating element of the pump which converts mechanical energy into hydraulic energy.

- **Injector housing or nozzle assembly** [IEC 4/112/CDV]
  Assembly consisting of injector pipe, nozzle pipe, needle rod, needle and needle servomotor in case of internal servomotor.

- **Intermediate shaft** [IEC 4/112/CDV]
  A removable section of the main shaft.

- **Kaplan runner** [IEC 4/112/CDV]
  Assembly which includes the runner hub, runner blades, runner cone and runner blade operating mechanism. It may include the runner servomotor.

- **Main shaft** [IEC 4/112/CDV]
  Rotating element that transmits torque developed by the runner to the generator rotor or transmits torque developed by the motor to the impeller. In units with a gear the main shaft extends from the runner (impeller) to the gear.

- **Needle** [IEC 4/112/CDV]
  Streamlined moving element which controls nozzle discharge.

- **Needle servomotor** [IEC 4/112/CDV]
  Servomotor to operate the needle and keep it in position. It can be internal or external depending on its position inside or outside of the nozzle pipe.

- **Nozzle** [IEC 4/112/CDV]
  Shaped water passage which produces the jet.

- **Oil pressure unit** [IEC 4/112/CDV]
  Device providing oil under pressure to actuate the servomotor(s) and auxiliary equipment.

- **Pump diffuser** [IEC 4/112/CDV]
  Structural component of a storage pump or pump-turbine having two annular shrouds connected by a number of fixed diffuser vanes in the water passages to provide support and structural continuity and to guide the water as it leaves the impeller and enters the spiral case.

- **Regulating ring** [IEC 4/112/CDV]
  Ring element which transmits force from the servomotor(s) to all guide vanes.

- **Runner** [IEC 4/112/CDV]
  Rotating element of the turbine which converts hydraulic energy into mechanical energy. In pump-turbines the runner converts mechanical energy into hydraulic energy during pump operation.

- **Runner band** [IEC 4/112/CDV]
  Axisymmetric portion of a Francis or diagonal turbine runner to which the outer ends of the runner blades are attached.

- **Runner band seal** [IEC 4/112/CDV]
  Surfaces which constitute close running clearances between the runner band and the foundation or bottom ring. These close clearances restrict flow of water between the high pressure zone and the low pressure zone of the runner.

- **Runner blade** [IEC 4/112/CDV]
  Profiled component of a reaction turbine runner which performs the energy conversion.

- **Runner blade servomotor** [IEC 4/112/CDV]
  Servomotor which operates the blades through links and levers.

- **Runner bucket** [IEC 4/112/CDV]
  Contoured component of an impulse turbine runner which performs the energy conversion.

- **Runner cone** [IEC 4/112/CDV]
  Extension of the runner crown or runner hub.

- **Runner crown** [IEC 4/112/CDV]
  Axisymmetric portion of a Francis or diagonal turbine runner which provides a mechanical attachment to the main shaft and to which the inner ends of the runner blades are attached.

- **Runner crown seal** [IEC 4/112/CDV]
  Surfaces with provide close running clearances between the runner crown and the headcover. These close clearances restrict flow of water into the chamber between the runner crown and the headcover.

- **Runner disk** [IEC 4/112/CDV]
  Portion of an impulse turbine which provides attachment to the main shaft and to which the runner buckets are attached.

- **Runner hub** [IEC 4/112/CDV]
  Central axisymmetric element of an axial turbine runner from which runner blades are supported.

- **Semi-spiral case** [IEC 4/112/CDV]
  Water passage to provide uniform flow distribution to the turbine, having rectilinear sections giving direct flow to the upstream part of the turbine and a downstream part in the form of a spiral case.

- **Servomotor** [IEC 4/112/CDV]
  Device actuated by fluid pressure to move adjustable regulating devices, see "guide vane servomotor", "runner blade servomotor", "needle servomotor" and "deflector servomotor".

- **Shaft seal** [IEC 4/112/CDV]
  Seal used to minimise leakage at the main shaft.

- **Spiral case** [IEC 4/112/CDV]
  Spiral shaped water passage which surrounds the machine to provide uniform flow distribution to the turbine and to collect water from the diffuser of the pump. The spiral case connects either directly or indirectly to the high pressure conduit.

- **Standstill seal** [IEC 4/112/CDV]
  Retractable seal device which when activated prevents leakage at the main shaft when the units is not operating.

- **Stay cone** [IEC 4/112/CDV]
  Components that line the inner and outer surfaces of the water passage and function with the bulb support and/or other stay vanes to transmit loads to the powerhouse structure.

- **Stay ring** [IEC 4/112/CDV]
  Structural member surrounding the guide vanes having two annular shrouds connected by a number of fixed stay vanes in the water passages to provide support and structural continuity and to guide the water as it leaves the spiral case.

- **Stay vane** [IEC 4/112/CDV]
  Streamlined structural member of the stay ring. In case of a bulb unit connecting the inner and outer stay cones, see also bulb support.

- **Thrust bearing** [IEC 4/112/CDV]
  Device so support the axial forces (hydraulic forces and machine loads). It may sometimes be combined with a guide bearing.

- **Wearing ring** [IEC 4/112/CDV]
  Replaceable ring fastened to the runner (impeller) and/or to the corresponding stationary parts constituting the runner (impeller) band seal.

2.4. LIST OF THE USED INTERNATIONAL STANDARDS

Pr EN45543 : Guide for procurement - Turbines - Hydraulic Machines
IEC 545 : International Electrotechnical Commission - Guide for commissioning, operation and maintenance of hydraulic machines.
IECTC4-4/1364 : Hydraulic Turbines.
IEC-50(604) : International Electrotechnical Commission - Generation, transmission and distribution of electricity - Operation
IEC-50(601) : International Electrotechnical Commission - Generation, transmission and distribution of electricity - General
IEC-50(602) : International Electrotechnical Commission - Generation, transmission and distribution of electricity - Generation
IEC-994 : Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps and pumps-turbines).
ISO7919-5 : Part 5 - Machine sets in hydraulic power generating and pumping plants.

3. MAINTENANCE : TERMS AND DEFINITIONS (A)

3.1. FUNDAMENTAL CONCEPTS

- **Entity** [IEC©50(191)]
- **Item**
  Any part, component, device, subsystem, functional unit, equipment or system that can be individually considered.

- **Service** [IEC©50(191)]
  A set of functions offered to a user by an organisation

- **Required function** [IEC©50(191)]
  A function or a combination of functions of an item which is considered necessary to provide a given service.

- **Operation** [IEC©50(191)]
  The combination of all technical and administrative actions intended to enable an item to perform a required function, recognising necessary adaptation to changes in external conditions.
  Note. - By external conditions are understood, for example, service demand and environmental conditions.

- **Life** [pr EN 45 543]
  The continuous time period over which the plant item might be expected to operate with planned maintenance but without replacement of a significant component.

3.2. ITEM RELATED PERFORMANCE (A)

- **Dependability** [IEC©50(191)]
  The collective term used to describe the availability performance and its influencing factors : reliability performance, maintainability performance and maintenance support performance.
  Note. - Dependability is used only for general descriptions in non-quantitative terms.

- **Capability** [IEC©50(191)]
  The ability of an item to meet a service demand of given quantitative characteristics under given internal conditions.

  Notes.
  1- Internal conditions refer for example to any combination of faulty and not faulty sub-items.
  2- For telecommunications services this is called trafficability performance.

- **ARM - Availability, Reliability an Maintainability** [pr EN 45 543]
  A methodology for the determination of availability from reliability (eg. mean time to failure) and maintainability (eg. mean time to repair).

- **Availability** [IEC©50(191)]
  The ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided.

  Notes.
  1- This ability depends on the combined aspects of the reliability performances, the maintainability performance and the maintenance support performance.
  2- Required external resources, other than maintenance resources do not affect the availability performance of the item.

  . **Design Availability** [PrEN 45543:1995]

  The purchaser would typically, request the anticipated or design availability over the life time of the power plant with supporting reference information. A Reliability and Maintainability programme should be implemented to provide confidence that the availability targets for the plant can be achieved.

  The definition of availability and the value quoted would be expected to include losses due to both planned constraints like maintenance and unplanned constraints like breakdowns, outage extensions, restrictions etc.

  Availability Factor, AF=AH/PH
  where, AH=PH-(FOH+POH)

  AH = available hours
  PH = period hours
  FOH = forced outage hours
  POH = planned outage hours

. **Forced Outage FO**
Any unplanned failure that requires removal tram service before the next planned outage

. **Forced Outage Hours FOH**
The summation of the times associated with all forced outages during the time period

. **Planned Outage PO**
The removal from service needed to perform work scheduled well in advance and which has a predetermined duration eg. annual overhaul etc.

. **Planned Outage Hours POH**
The summation of the times associated with all planned outages during the time period

Its achievement should be demonstrated:

1. by providing evidence that the system-level plant has a design which has demonstrated successful service elsewhere;

2. or, if the system-level plant is a new design with little or no service experience, by undertaking a reliability assessment from a knowledge of the failure mechanisms or failure data or both.

The approach for stating the expected availability would be adopted by the supplier for all individual plant items within each system.

. **Forced Outage Rates (FOR)**
Forced Outage Rates FOR: The most commonly used measure for breakdown reliability or running reliability; the measure is over a period and is more applicable to base load machines

FOR = FOH/(FOH + SH)

where, FOH = forced outage hours
SH = service hours

If hydraulic power plant is forced to operate at reduced power due to a defect, to allow for this, the concept of equivalent forced outage rate (EFOR) can be used:

EFOR = (FOH + EFDH)/(FOH + SH + EFDH)

where, EFDH = (FDH x Forced Power Reduction)/Max continuous Rating

FDH = Summation of derating hours in time period

To substantiate the anticipated availability values, the supplier would typically be requested to provide:

1. Information on the design annual forced outage rates (FORs) for the plant systems identified and how this figure is calculated from the individual FORs. Substantiation for the FOR values should be given from equivalent reference plant operating elsewhere.

2. Planned maintenance schedules for the system level items of machine indicating the duration and frequency of the maintenance outage. The basis for determining the interval between the planned maintenance outages should be stated. If equivalent operating hours are used, the definition and formula shall be given with appropriate values for the constants for starts, shut-downs and trips.

3. Indicative maintenance programmes on how the planned maintenance will be phased with the design life in order to maximise the availability.

4. For all areas of supply, the consequences of breakdown in terms of loss of power may be requested.

- **Reliability** [IEC©50(191)]
  The ability of an item to perform a required function under given conditions for a given time interval.

  Notes.
  1- It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.
  2- The term "reliability" is also used as a measure of reliability performance.

  . Reliability Guarantee [PrEN 45543:1995]

  The purchaser may further request that the reliability or availability profiles be guaranteed, with any qualifying conditions such as the cost for the guarantee plus maintenance contract etc.

  Such guarantees may be subjected to separate negotiations and all the relevant terminology will require agreement.

- **Maintainability** [IEC©50(191)]
  The ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources.

  Note. - The term "maintainability" is also used as a measure of maintainability performance.

- **Maintenance support performance** [IEC©50(191)]
  The ability of a maintenance organisation, under given conditions, to provide upon demand, the resources required to maintain an item, under a given maintenance policy.
  Note. - The given conditions are related to the item itself and to the conditions under which the item is used and maintained.

3.3. MAINTENANCE CONCEPTS (A)

- **Maintenance** [IEC©50(191)]
  The combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function.

- **Maintenance philosophy** [IEC©50(191)]
  A system of principles for the organisation and execution of the maintenance.

- **Maintenance policy** [IEC©50(191)]
  A description of the interrelationship between the maintenance echelons, the indenture levels and the levels of maintenance be applied for the maintenance of an item.

- **Maintenance echelon line of maintenance** [IEC©50(191)]
  A position in an organisation where specified levels of maintenance are to be carried out on an item.

  Notes.
  1- Examples of maintenance echelons are : field, repair shop, manufacturer.
  2- The maintenance echelon is characterised by the skill of the personnel, the facilities available, the location, etc.

- **Indenture level (for maintenance)** [IEC©50(191)]
  A level of subdivision of an item from the point of view of a maintenance action.

  Notes.
  1- Examples of indenture levels could be a subsystem, a circuit board, a component.
  2- The indenture level depends on the complexity of the item's construction, the accessibility to sub-items, skill level of maintenance personnel, test equipment facilities, safety considerations, etc.

- **Level of maintenance** [IEC©50(191)]
  The set of maintenance actions to be carried out at a specified indenture level.

  Note. - Examples of a maintenance action are replacing a component, a printed circuit board, a subsystem, etc.

- **Maintenance at the first level** [NFX060-010]
  It represents on the one hand, the adjustments foreseen by the vendor and practicable thanks to accessible elements without disassembly or opening of the equipment, and on the other hand, the change of "consumable" elements which are attainable in a safe way (as leds, fuses,...).

- **Maintenance at the second level** [NFX060-010]
  This maintenance regroups the repairing realised by the element standard changes, and the minor preventive maintenance operations (as greasing or checking of the normal functioning).

- **Maintenance at the third level** [NFX060-010]
  It is composed of the breakdown identification and diagnostic, of the repairing by the change of components or functional elements, of the minor mechanical repairing and of the whole of the current preventive maintenance operations (as global adjustment or realigning of the measuring instrument).

- **Maintenance at the fourth level** [NFX060-010]
  This level contains the whole of important works linked to the corrective or preventive maintenance except for the retro-fitting and the reconstruction. It also integrates the measuring instrument adjustment used for the maintenance and possibly, the verifying of the work calibre done by certified organisms.

- **Maintenance at the fifth level** [NFX060-010]
  This maintenance is composed of the retro-fitting, reconstruction or execution of the major repairing which are made by the central shop or an external unit.

- **Preventive maintenance** [IEC©50(191)]
  The maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.

- **Corrective maintenance** [IEC©50(191)]
  The maintenance carried out after fault recognition and intended to put an item into a state in which it can perform a required function.

- **Controlled maintenance** [IEC©50(191)]
  A method to sustain a desired quality of service by the systematic application of analysis techniques using centralised supervisory facilities and/or sampling to minimise preventive maintenance and to reduce corrective maintenance.

- **Scheduled maintenance** [IEC©50(191)]
  The preventive maintenance carried out in accordance with an established time schedule.

- **Unscheduled maintenance** [IEC©50(191)]
  The maintenance carried out, not in accordance with an established time schedule, but after reception of an indication regarding the state of an item.

- **Palliative Maintenance** [NFX060-010]

The palliative maintenance integrates the corrective maintenance activities which allow a system to carry out, for a time being, a part or the whole of the required function.
Note. - This maintenance is commonly called repairing and is mainly based on temporary actions which have to be followed by curative actions.

- **Curative Maintenance** [NFX060-010]

The curative maintenance integrates the corrective maintenance activities which re-establish a "system" in a specified state or allow it to carry out a required function.
The result of the realised activities has to present a permanent characteristic. These activities can be of repairing, modifying or conditioning which remove the failure(s).

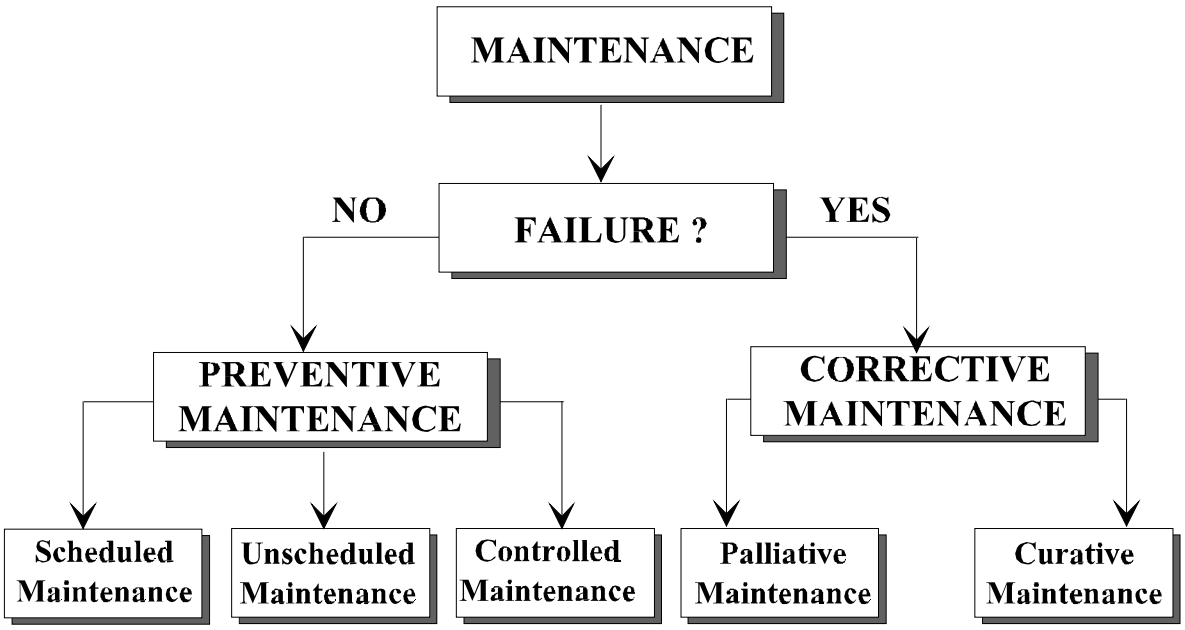


Fig. MAINT-I : REMAFEX Maintenance type

- **Remote maintenance** [IEC©50(191)]
  Maintenance of an item performed without physical access of the personnel to the item.

- **On-site maintenance** [IEC©50(191)]
- **In situ maintenance**
- **Field maintenance**
  Maintenance performed at the location where the item is used.

- **Off-site maintenance** [IEC©50(191)]
  Maintenance performed at a location different from where the item is used.

  Note. - An example of off-site maintenance is the repair of a sub-item at a maintenance centre.

- **Automatic maintenance** [IEC©50(191)]
  Maintenance accomplished without human intervention.

- **Deferred maintenance** [IEC©50(191)]
  Corrective maintenance which is not immediately initiated after a fault recognition but is delayed in accordance with given maintenance rules.

- **Elementary maintenance activity** [IEC©50(191)]
  A unit of work into which a maintenance activity may be broken down at a given indenture level.

- **Maintenance action** [IEC©50(191)]
- **Maintenance task**
  A sequence of elementary maintenance activities carried out for a given purpose.

  Note. - Examples are fault diagnosis, fault localisation, function check-out, or combinations thereof.

- **Repair** [IEC©50(191)]
  That part of corrective maintenance in which manual actions are performed on the item.

- **Fault recognition** [IEC©50(191)]
  The event of a fault being recognised.

- **Fault localisation** [IEC©50(191)]
- **Fault location (deprecated in this sense)**
  Actions taken to identify the faulty sub-item or sub-items at the appropriate indenture level.

- **Overhaul** [IEC 545]
  Complete inspection with necessary repairs and/or modifications intended to bring the unit or part of if to, or nearly to, the optimum functioning condition.

- **Fault diagnosis** [IEC©50(191)]
  Actions taken for fault recognition, fault localisation and cause identification.

- **Fault correction** [IEC©50(191)]
  Actions taken after fault localisation to restore the ability of the faulty item to perform a required function.

- **Function check-out** [IEC©50(191)]
  Actions taken after fault correction to verify that the item has recovered its ability to perform the required function.

- **Restoration** [IEC©50(191)]
  That event when the item regains the ability to perform a required function, after a fault.

- **Supervision monitoring** [IEC©50(191)]
  Activity, performed either manually or automatically, intended to observe the state of an item.

- **Maintenance entity** [IEC©50(191)]
  Any sub-item of a given item which can have a fault and which, by alarm or any other means, can be unambiguously identified for replacement or repair.

- **Function-affecting maintenance** [IEC©50(191)]
  A maintenance action during which one or more required functions of the item under maintenance are interrupted or degraded.

- **Function-preventing maintenance** [IEC©50(191)]
  Function-affecting maintenance that prevents a maintained item from performing a required function by causing complete loss of all the functions.

- **Function-degrading maintenance** [IEC©50(191)]
  Function-affecting maintenance that degrades one or more of the required functions of a maintained item, but not to such extent as to cause complete loss of all the functions.

- **Function-permitting maintenance** [IEC©50(191)]
  Maintenance action during which one of the required functions of the item under maintenance are interrupted or degraded.

3.4. FAILURES

- **Failure** [IEC©50(191)]
  The termination of the ability of an item to perform a required function.

  Notes.
  1- After failure the item has a fault.
  2- "Failure" is a event, as distinguished from "fault", which is a state.
  3- This concept as defined does not apply to items consisting of software only.

- **Critical failure** [IEC©50(191)]
  A failure which is assessed as likely to result in injury to persons, significant material damage or other unacceptable consequences.

- **Non-critical failure** [IEC©50(191)]
  A failure which is assessed as not likely to result in injury to persons, significant material damage or other unacceptable consequences.

- **Sudden failure** [IEC©50(191)]
  A failure that could not be anticipated by prior examination or monitoring.

- **Gradual failure** [IEC©50(191)]
- **Drift failure**
  A failure due to a gradual change with time of given characteristics of an item.

  Note. - A gradual failure may be anticipated by prior examination of monitoring and can sometimes be avoided by preventive maintenance.

- **Cataleptic failure** [IEC©50(191)]
- **Catastrophic failure**
  A sudden failure which results in a complete inability to perform all required functions of an item.

- **Primary failure** [IEC©50(191)]
  A failure of an item, not caused either directly or indirectly by a failure or a fault of another item.

- **Secondary failure** [IEC©50(191)]
  A failure of an item, caused either directly or indirectly by a failure or a fault of another item.

- **Complete failure** [IEC©50(191)]

A failure which results in the complete inability of an item to perform all required function.

- **Partial failure** [IEC©50(191)]
  A failure which results in the complete inability of an item to perform some, but not all, required functions.

- **Degradation failure** [IEC©50(191)]
  A failure which is both a gradual failure and a partial failure.

- **Misuse failure** [IEC©50(191)]
  A failure due to the application of stresses during use which exceed the stated capabilities of the item.

- **Mishandling failure** [IEC©50(191)]
  A failure caused by incorrect handling or lack of care of the item.

- **Weakness failure** [IEC©50(191)]
  A failure due to a weakness in the item itself when subjected to stresses within the stated capabilities of the item.

  Note. - A weakness may be either inherent or induced.

- **Design failure** [IEC©50(191)]
  A failure due to inadequate design of an item.

- **Manufacturing failure** [IEC©50(191)]
  A failure due to non-conformity during manufacture to the design of an item or to specified manufacturing processes.

- **Wearout failure** [IEC©50(191)]
  A failure whose probability of occurrence increases with the passage of time, as a result of processes inherent in the item.

- **Relevant failure** [IEC©50(191)]
  A failure that should be included in interpreting test or operational results or in calculating the value of a reliability performance measure.

- **Non-relevant failure** [IEC©50(191)]
  A failure that should be excluded in interpreting test or operational results or in calculating the value of a reliability performance measure.
  Note. - The criteria for the exclusion should be stated.

- **Failure cause** [IEC©50(191)]
  The circumstances during design, manufacture or use which have led to a failure.

- **Failure mechanism** [IEC©50(191)]
  The physical, chemical or other process which has led to a failure.

- **Systematic failure** [IEC©50(191)]
- **Reproducible failure**
  A failure related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors.

  Notes.
  1- Corrective maintenance without modification will usually not eliminate the failure cause.
  2- A systematic failure can be induced at will by simulating the failure cause.

3.5. FAULTS, ERRORS AND MISTAKES

- **Fault** [IEC©50(191)]
  The state of an item characterised by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to a lack of external resources.

  Note. - A fault is often the result of a failure of the item itself, but may exist without prior failure.

- **Faulty** [IEC©50(191)]
  Pertaining to an item which has a fault.

- **Fault mode** [IEC©50(191)]
  One of the possible states of the faulty item, for a given required function.

  Note. - The use of the term « failure mode » in this sense is now deprecated.

- **Error** [IEC©50(191)]
  A discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition.

  Note. - An error can be caused by a faulty item, e.g. a computing error made by faulty computer equipment.

- **Mistake** [IEC©50(191)]
- **Human error**
  A human action that produces an unintended result.

3.6. MAINTENANCE RELATED TIMES (A)

- **Maintenance time** [IEC©50(191)]
  The time interval during which a maintenance action is performed on an item either manually or automatically, including technical delays and logistic delays.
  Note. - Maintenance may be carried out while the item is performing a required function.

- **Maintenance man-hours** [IEC©50(191)]
- **MMH (abbreviation)**
  The accumulated durations of the individual maintenance times, expressed in hours, used by all maintenance personnel for a given type of maintenance action or over a given time interval.

- **Active maintenance time** [IEC©50(191)]
  That part of the maintenance time during which a maintenance action is performed on an item, either automatically or manually, excluding logistic delays.

  Note. - A maintenance action may be carried out while the item is performing a required function.

- **Preventive maintenance time** [IEC©50(191)]
  That part of the maintenance time during which preventive maintenance is performed on an item, including technical delays and logistic delays inherent in preventive maintenance.

- **Corrective maintenance time** [IEC©50(191)]
  That part of the maintenance time, during which corrective maintenance is performed on an item, including technical delays and logistic delays inherent in corrective maintenance.

- **Active preventive maintenance time** [IEC©50(191)]
  That part of the active maintenance time, during which actions of preventive maintenance are performed on an item.

- **Active corrective maintenance time** [IEC©50(191)]
  That part of the active maintenance time during which actions of corrective maintenance are performed on an item.

- **Undetected fault time** [IEC©50(191)]
  The time interval between failure and recognition of the resulting fault.

- **Administrative delay (for corrective maintenance)** [IEC©50(191)]
  The accumulated time during which an action of corrective maintenance on a faulty item is not performed due to administrative reasons.

- **Logistic delay** [IEC©50(191)]
  That accumulated time during which a maintenance action cannot be performed due to the necessity to acquire maintenance resources, excluding any administrative delay.

- **Fault correction time** [IEC©50(191)]
  That part or active corrective maintenance time during which fault correction is performed.

- **Technical delay** [IEC©50(191)]
  The accumulated time necessary to perform auxiliary technical actions associated with the maintenance action itself.

- **Check-out time** [IEC©50(191)]
  That part of active corrective maintenance time during which function check-out is performed.

- **Fault diagnosis time** [IEC©50(191)]
  The time during which fault diagnosis is performed.

- **Fault localisation time** [IEC©50(191)]
- **Fault location time (deprecated)**
  That part of active corrective maintenance time during which fault localisation is performed.

- **Repair time** [IEC©50(191)]
  That part of active corrective maintenance time during which repair actions are performed on an item.

- **Operating period** [pr EN 45 543]
  Time between overhauls.

Refer to the Maintenance time diagram

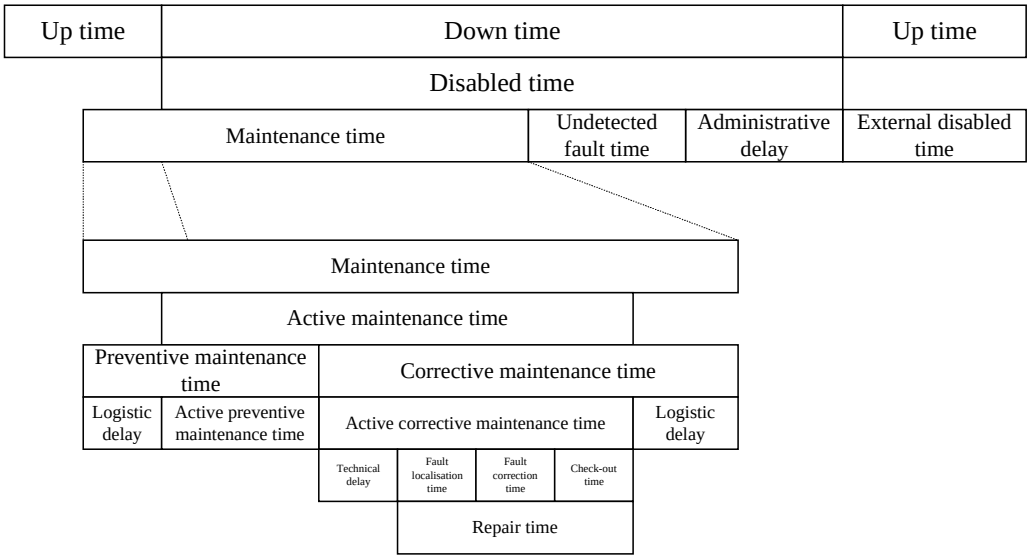


Fig. TIME : Maintenance time diagram

3.7. ARM RELATED TIMES (A)

- **Mean up time** [IEC©50(191)]
  MUT (abbreviation)
  The expectation of the up time.

- **Mean down time** [IEC©50(191)]
  MDT (abbreviation)
  The expectation of the down time.

- **Mean time to first failure** [IEC©50(191)]
  MTTFF (abbreviation)
  The expectation of the time to first failure.

- **Mean time to failure** [IEC©50(191)]
  MTTF (abbreviation)
  The expectation of the time to failure.

- **Mean time between failures** [IEC©50(191)]
  The expectation of the time between failures.

  Note. - In English, the use of the abbreviation MTBF in this sense is now deprecated.

- **Mean operating time between failures** [IEC©50(191)]
  MTBF (abbreviation)
  The expectation of the operating time between failures.

- **Mean repair time** [IEC©50(191)]
  MRT (abbreviation)
  The expectation of the repair time.

- **Mean time to restoration** [IEC©50(191)]
- **Mean time to recovery**
  MTTR (abbreviation)
  mean time to repair (deprecated)
  The expectation of the time to restoration.

3.8. FUNDAMENTAL STATE RELATED TIMES

- **Operating time** [IEC©50(191)]
  The time interval during which an item is in an operating state.

- **Non-operating time** [IEC©50(191)]
  The time interval during which an item is in a non-operating state.

3.9. ANALYSIS CONCEPTS

- **Prediction** [IEC©50(191)]
  The process of computation used to obtain the predicted value(s) of a quantity.

  Note. - The term « prediction » may also be used to denote the predicted value(s) of a quantity.

- **Reliability model** [IEC©50(191)]
  A mathematical model used for prediction or estimation of reliability performance measures of an item.

- **Fault modes and effects analysis** [IEC©50(191)]
- **FMEA**
  Failure modes and effects analysis (deprecated)
  A qualitative method of reliability analysis which involves the study of the fault modes which can exist in every sub-item of the item and the determination of the effects of each fault mode on other sub-items of the item and on the required functions of the item.

- **Fault modes, effects and critical analysis** [IEC©50(191)]
- **FMECA**
  Failure modes, effects and criticality analysis (deprecated)
  A qualitative method of reliability analysis which involves a fault modes and effects analysis together with a consideration of the probability of their occurrence and of the ranking of the seriousness of the faults.

- **Stress analysis** [IEC©50(191)]
  Determination of the physical, chemical or other stresses an item experiences under given conditions.

3.10. LIST OF THE USED INTERNATIONAL STANDARDS (A)

IEC-50(191): International Electrotechnical Vocabulary - Chapter 191 « Dependability and quality of service »

X60-010 : Norme Française - Maintenance « Concepts et définitions des activités de Maintenance »

Pr EN45543 : Guide for procurement - Turbines - Hydraulic Machines

IEC 545 : International Electrotechnical Commission - Guide for commissioning, operation and maintenance of hydraulic machines.

4. MAINTENANCE REMAFEX TERMS (A)

- **C.M.M.** [PRIAM Dictionary]
  CMM=Control, Maintenance, and Technical Management

  Note1. - The acronym CMM was invented by DIAS Esprit 2 project to express the fact that the end-users of automation require an extension of the role of the automation in the plant in order to have an efficient support for their organisation, not only for the Control (C) but also for a more efficient Maintenance (M), and Technical Management (M) of the plant.

  Note2. - Users judge the efficiency of the support given by the automation to their organisation (= operators + procedures) in terms of the resulting improvement of the efficiency and operating performances of their plant.

- **C.M.M.S.** [PRIAM Dictionary]
  Control, **M**aintenance and **M**anagement **S**ystem (CMMS); a distributed system composed of intelligent field devices, real-time computers and management computers which is used to operate an industrial process, according to the CMM concept.

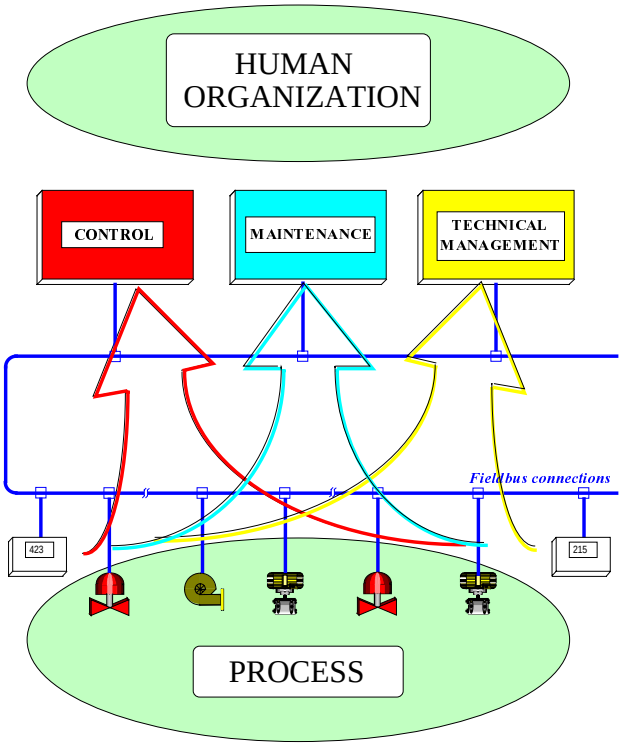


FIG. CMMS-I: A practical representation of the automation of a plant which supports the Control, Maintenance and Technical Management (including Agency Compliance).

- **Data needs**
  The data needs are the data produced by the process and the other automation systems which are necessary to realise the functions (innovative or not) which satisfy the user needs.

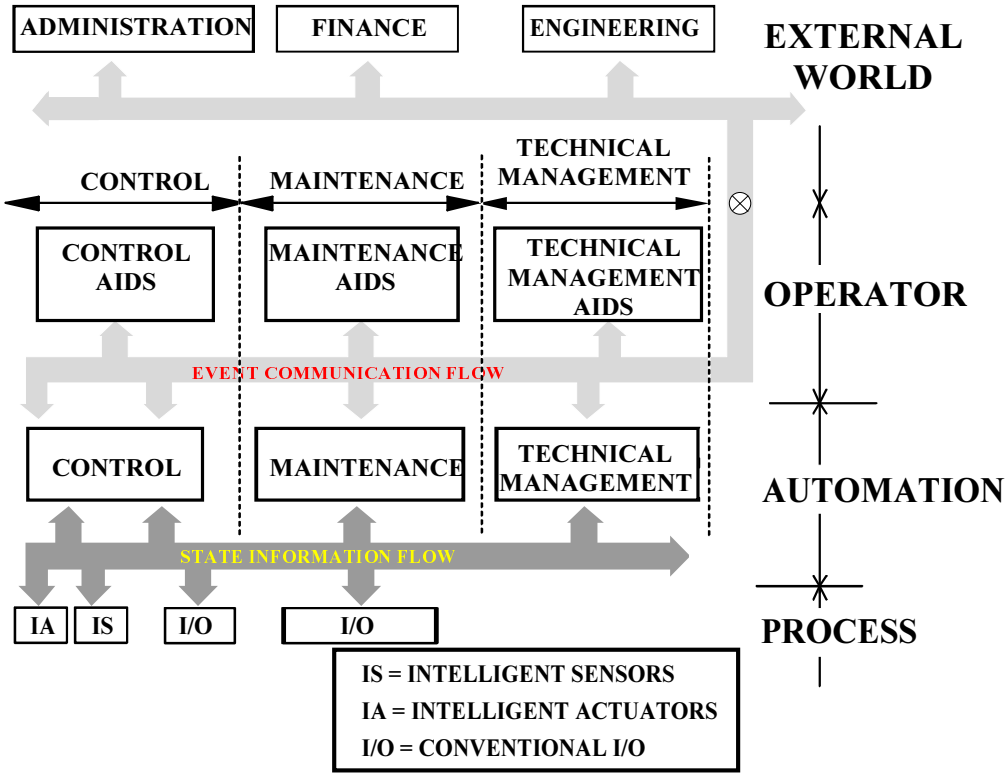


Fig. CMMS-II : CMMS architecture

- **Distributed Maintenance System**
  The distributed maintenance system has to help maintenance operator to take the right decision at the right time in order to manage continuously all maintenance activities and to move in a stepwise fashion from corrective to predictive maintenance.

  REMAFEX will be integrated into the CMMS, as shown on the following diagram.

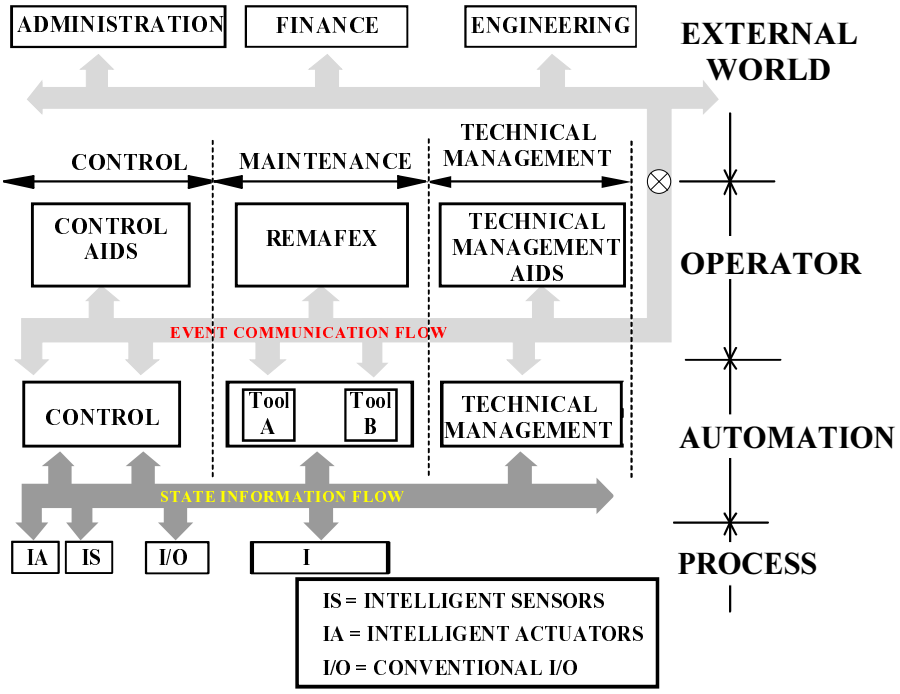


Fig. REMA-I : REMAFEX integrated in the CMMS

- **Innovative function**
  The innovative maintenance functions allow to customise the distributed maintenance system in accordance with industrial facility constraints and requirements.
  The innovative maintenance functions are new functions that are not available in the maintenance systems of today.

- **Life cycle**
  Life-cycle concept encompasses all the phases of the life of a system as analyse, specification, designing, configuring, parametrizing, tuning, commissioning, operating, maintaining.

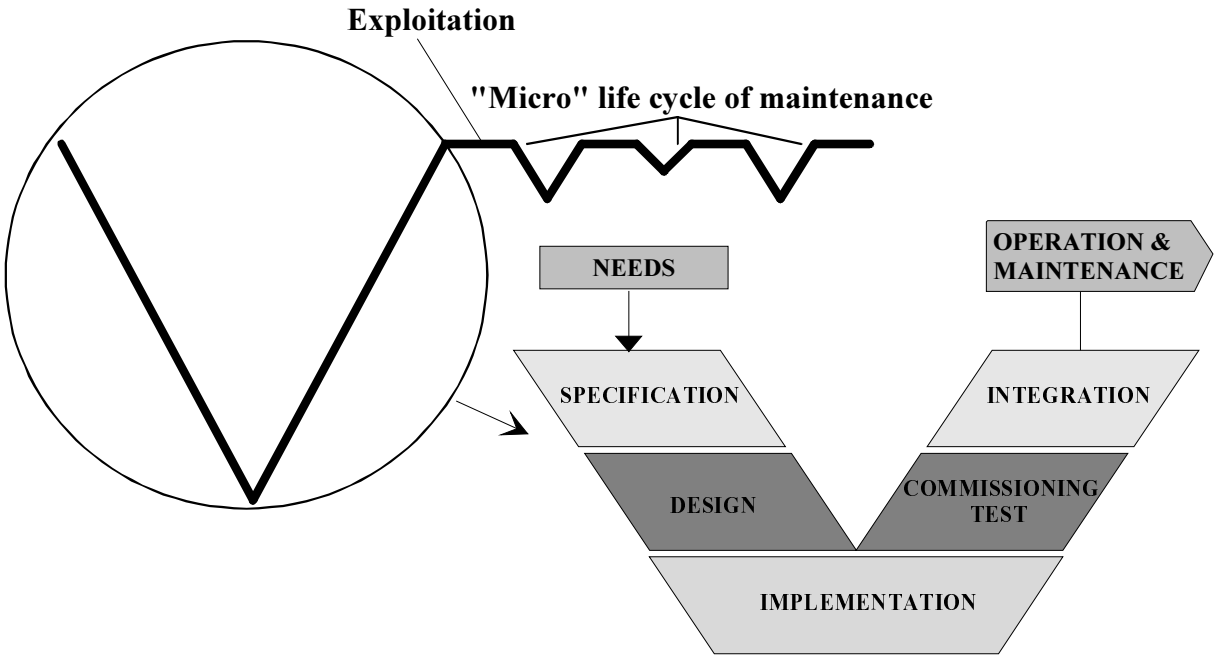


Fig. LIFE : Example of a system life cycle

- **Maintenance database**
  The maintenance database store all the maintenance information.

- **Maintenance domain, key domains and activities**
  At a conceptual level, the maintenance domain is a manufacturing domain in the same way as the control or the marketing one.
  It is composed of key maintenance domains such as maintenance management, fault diagnosis, execution...
  A key maintenance domain is composed of a set of activities.
  For example the fault diagnosis key domain is composed of fault recognition, fault location and cause identification activities.

- **Maintenance Focus Area**
  The maintenance focus area is the all possible maintenance activities which define the global maintenance manufacturing domain.

- **Maintenance technical platform architecture**
  The maintenance technical platform provides the hardware architecture necessary to support the maintenance database, and all IT functions constitute the kernel maintenance set of functions.

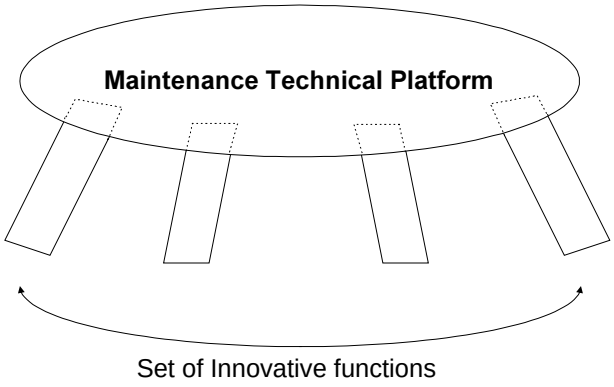


Fig. PLT-REMA : REMAFEX technical platform architecture

- **Maintenance user needs or user requirements**
  The user-needs relevant to maintenance system. They express the support the users need from the maintenance system. This support is defined in terms of:

  - The "requests" and "reports" exchanged between all the users of maintenance system and CMMS;
  - The functional support given by the "maintenance functions".

  Note. - REMAFEX suggests that users should establish complete and explicit maintenance user needs independently from limits of the current implementation of maintenance system and independently from the limits of the current technology for maintenance system.

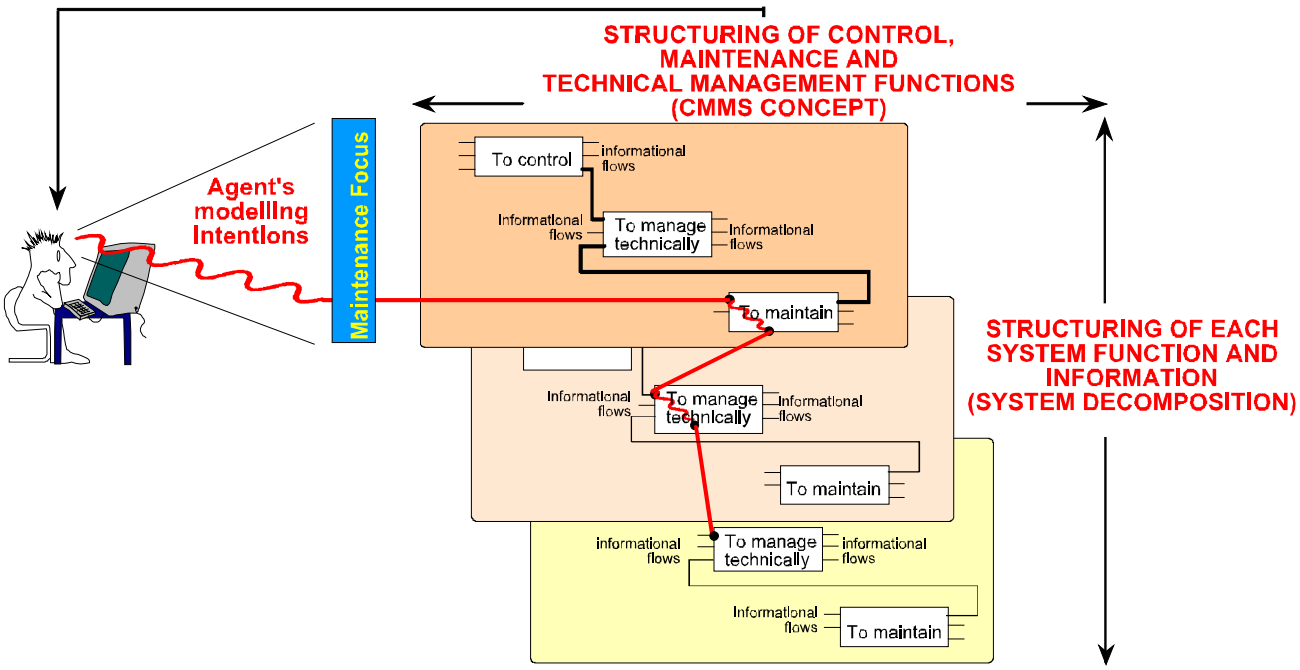
- **Technical Location**
  The technical location is the location of each equipment in the power plant architecture.

5. MAINTENANCE FOCUS AREA (A)

5.1. USERS NEEDS DEFINITION THROUGH THE MAINTENANCE FOCUS AREA

The users objective is to express their maintenance needs at each level of the system decomposition considering the Maintenance function as integrated with the Control and the technical Management functions (C.M.M.S. concept). In this way, the maintenance focus area is the main element of the methodological framework because it represents a reference grid (key maintenance domains and activities) to assist the user in order not to forget a maintenance need.

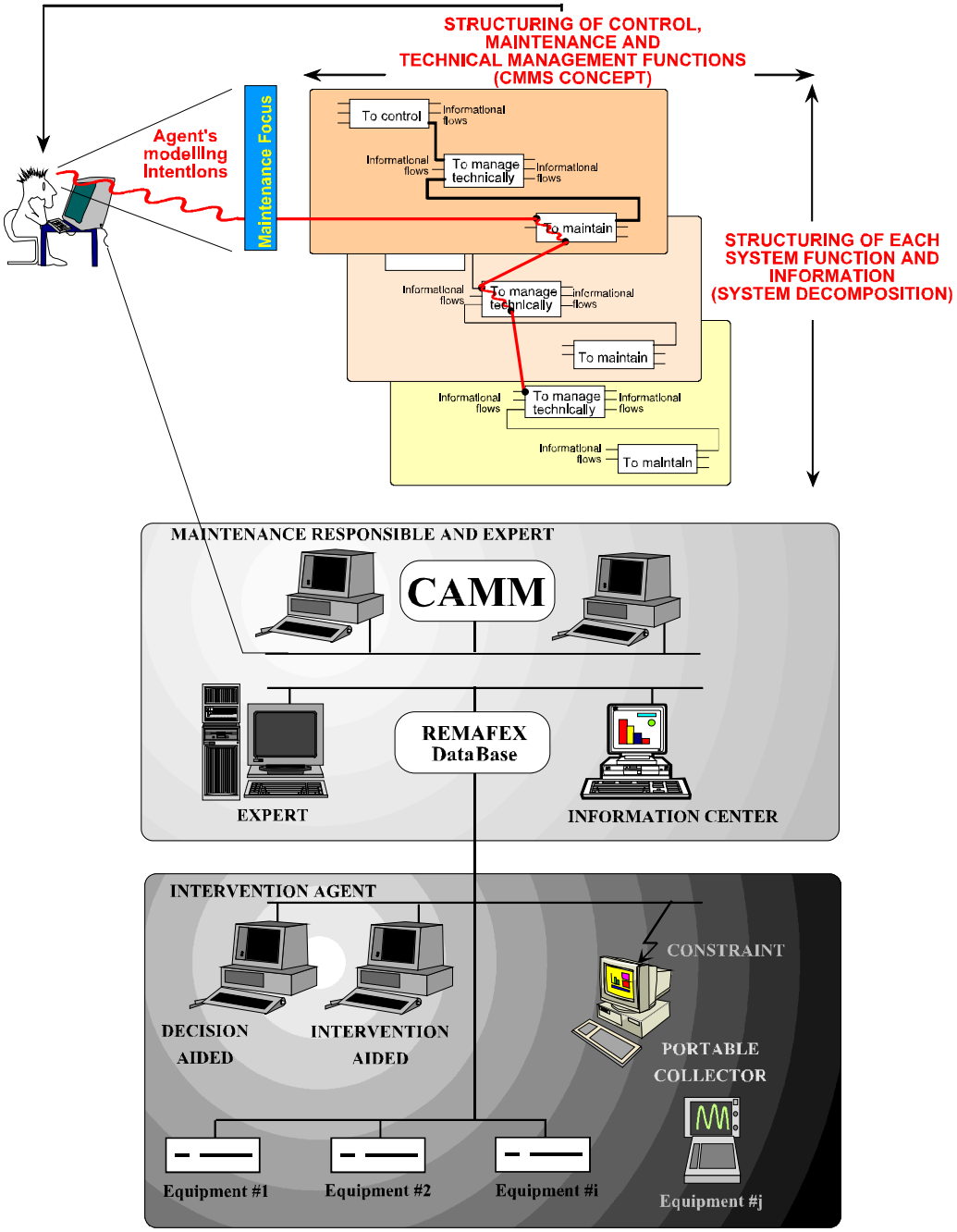
Therefore, in accordance with the systemic principles (Functioning, Engineering, Technology), the maintenance focus area allows to identify functional and no functional needs, and constraints, through the relations between domains and activities.



From a technological point of view, a REMAFEX postulate, in relation to the state of the art of the energy process, is to model a maintenance architecture (a distributed maintenance system) by three levels which are:

1) the management level,
2) the expert level,
3) and the intervention one.

So, the functional users needs definition has to take also into account specific needs linked to the particular «technological» architecture (particular distributed maintenance system) and its maintenance organisation.


STRUCTURING OF CONTROL,
MAINTENANCE AND
TECHNICAL MANAGEMENT FUNCTIONS
(CMMS CONCEPT)
Agent's
modelling
Intentions
Maintenance Focus
To control
Informational flows
To manage technically
To maintain
STRUCTURING OF EACH
SYSTEM FUNCTION AND
INFORMATION
(SYSTEM DECOMPOSITION)
MAINTENANCE RESPONSIBLE AND EXPERT
CAMM
REMAFEX
Data Base
EXPERT
INFORMATION CENTER
INTERVENTION AGENT
DECISION
AIDED
INTERVENTION
AIDED
CONSTRAINT
PORTABLE
COLLECTOR
Equipment #1
Equipment #2
Equipment #i
Equipment #j

5.2. THE KEY MAINTENANCE DOMAINS AND ACTIVITIES

The Maintenance Focus Area (MFA) is the all possible maintenance key domains and activities linked to the operation phase, which define the global Maintenance Function and which support the REMAFEX users needs definition.

Each key maintenance domain, identifying a functional maintenance finality (e.g. management, fault diagnosis, forecasting...), is composed of a set of activities, knowing that one activity belongs only to one domain.

Starting from a functional level (independent of the selected maintenance architecture : **functioning** point of view), a decomposition process of the MFA key domains allows to do to emerge the activities related to the organisation (**engineering** point of view) and to the selected architecture (**technological** point of view).

The MFA key domains and main activities are illustrated in the following figure, and each MFA domain with its activities is explained in the following text.

The **philosophy and strategy** domain plays an important role when deciding the maintenance activities, and the **evaluation** domain of all activities, both maintenance and others, is important as feedback to both the philosophy and the activities.

The **mid section** of the figure is divided in three parts in relation to the different needs other than those defined in philosophy and evaluation domains :

- functional needs (functioning)
- non-functional needs (engineering, technology)
- technological constraints (engineering, technology)

The **finalities/primary activities** represents the key maintenance domains composed of primary maintenance activities necessary to satisfy the functional needs.
The **organisation** represents the secondary maintenance activities, emerging from the primary ones, necessary to satisfy the non-functional needs.
The **systems/tools** supports the implementation of the primary and secondary activities including the technological constraints imposed by the distributed system.

There is a strong link between the domains crosswise in this section. Moreover, the whole of the domains from the philosophy to the evaluation, have also to take into account environmental, temporal, economical,... constraints leading to the characterisation of the needs (properties) and of the physical architecture.

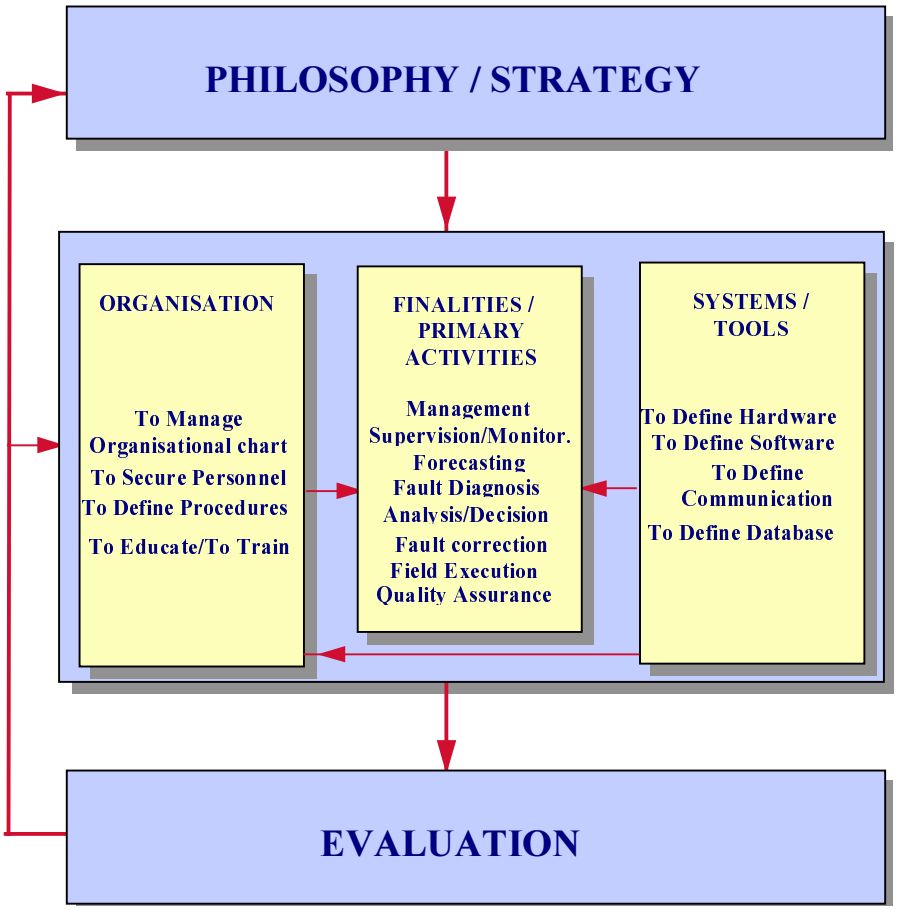
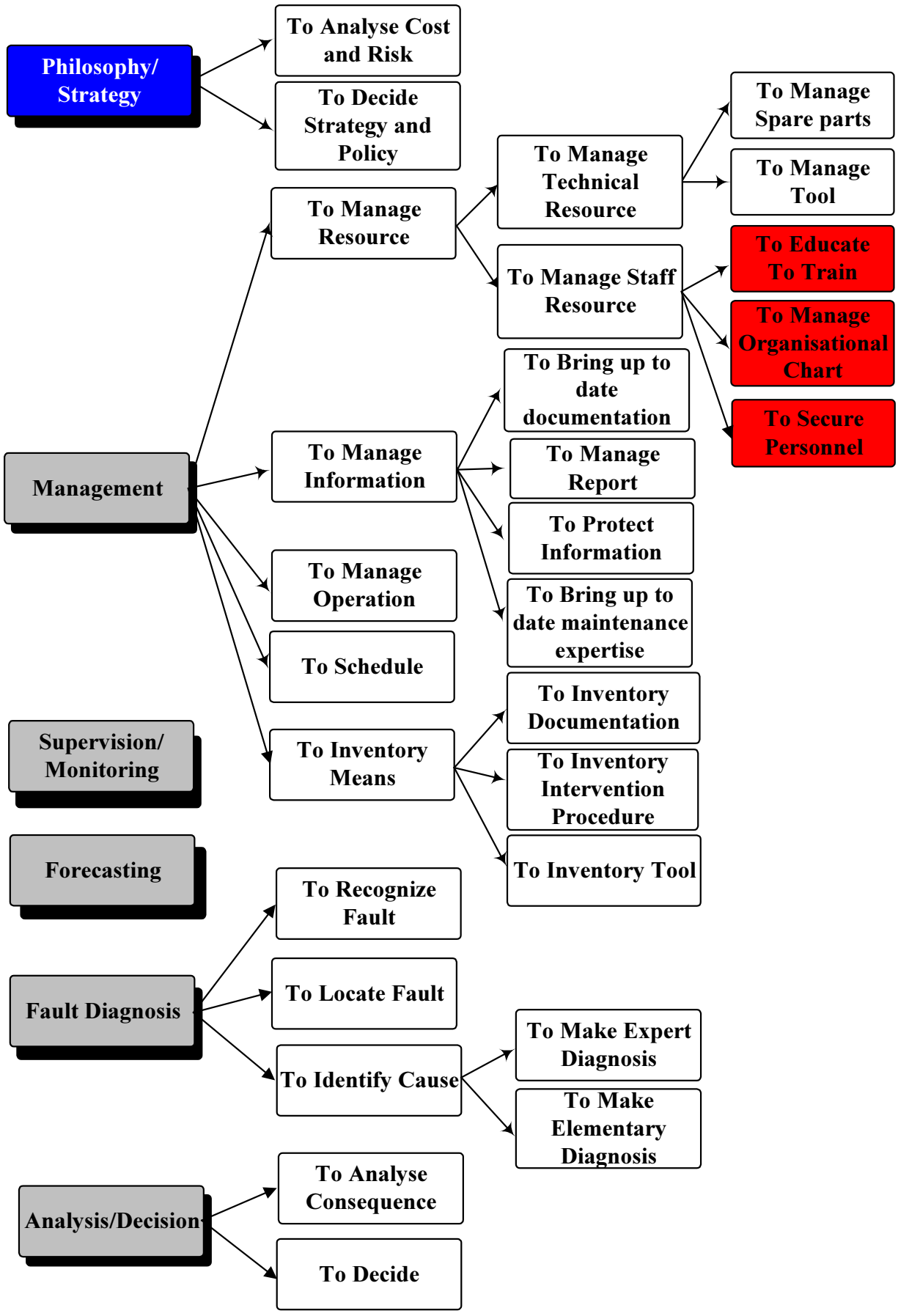


Fig. MFA-1 : Non formalised Maintenance Focus Area

A first formalisation of the relations between domains and the whole of the functional and operational activities, in accordance with the functioning, engineering and technological points of view, led to a first REMAFEX reference model (figure MFA-2) which will allow to guide the users in the needs definition phase.

This model integrates only the activities which satisfy the maintenance operation phase, and not the activities related to the design phase as defined in the Systems/Tools box.

This first REMAFEX model is synthetised by the following diagrams.


Philosophy/ Strategy
To Analyse Cost and Risk
To Decide Strategy and Policy
Management
To Manage Resource
To Manage Technical Resource
To Manage Spare parts
To Manage Tool
To Manage Staff Resource
To Educate To Train
To Manage Organisational Chart
To Secure Personnel
To Manage Information
To Bring up to date documentation
To Manage Report
To Protect Information
To Bring up to date maintenance expertise
To Manage Operation
To Schedule
To Inventory Means
To Inventory Documentation
To Inventory Intervention Procedure
To Inventory Tool
Supervision/ Monitoring
Forecasting
Fault Diagnosis
To Recognize Fault
To Locate Fault
To Identify Cause
To Make Expert Diagnosis
To Make Elementary Diagnosis
Analysis/Decision
To Analyse Consequence
To Decide

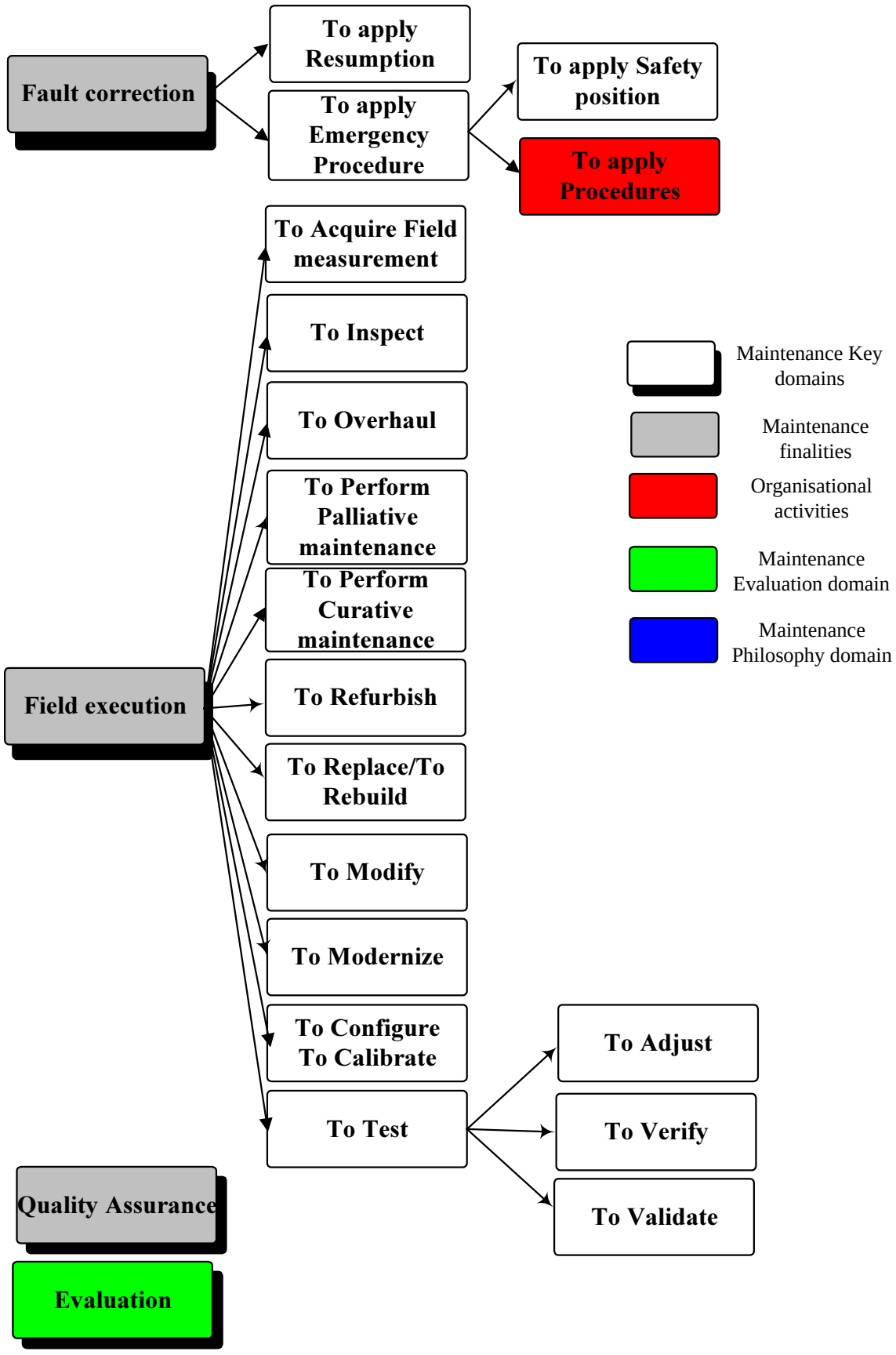


Fig. MFA-2 : A first MFA formalisation integrating the relation between key domains and activities

■ PHILOSOPHY / STRATEGY

These domains aim at defining the philosophy and the strategies which are the basis for the global maintenance activities.

- **To Decide Strategy and policy**
  This activity aims at deciding the strategy and policy to be followed when carrying out maintenance activities.

- **To Analyse Cost and risk**
  This activity aims at analysing the risk and the cost of a system failure according to criteria such as availability, environment, finance or social requirements.

■ ORGANISATION

The Organisation aims at defining the organisation that support the global maintenance activities.

- **To Manage Organisational Chart**
  This activity aims at defining the positions, duty assignments and range of responsibilities.

- **To Secure Personnel**
  This activity aims at securing optimal personnel resources involved in maintenance activities.

- **To Define Procedures**
  This activity aims at defining pre-defined procedures on how to handle given situations.

  This activity is composed of activities like :

  - To define Instructions : company-defined instructions.
  - To define Safety regulations : regulations regarding personnel safety given by authorities.

- **To Educate/To Train**
  This activity aims at maintaining the personnel's knowledge about the maintenance operation through education or periodical training.

■ FINALITIES / PRIMARY ACTIVITIES

These domains aim at defining the primary activities necessary to carry out both preventive and corrective maintenance.

- **Management**
  This key domain aims at managing all the maintenance activities and information required for the maintenance system activity. For example : to manage the alarm dissemination or to bring up to date the turbine's technical documentation.

  This key domain is composed of activities like :

  To Manage Resource : to manage the resources both from a staff and a technical point of view, like
  - To Manage Technical Resource : to manage all the necessary technical resources.
  - To Manage Staff Resource : to manage the maintenance staff.

  To Manage Information : to maintain the information consistency necessary for the maintenance activities, like

  - To Bring up to date Documentation : to bring up to date the technical documentation.
  - To bring up to date Maintenance expertise : to bring up to date the maintenance expertise of the diagnosis system, of the intervention procedure, of the equipment parameters.
  - To Protect Information : to allocate a protection level to the information for the consulting or modifying operations.
  - To Manage Report : to store and analyse the intervention report.

  To Manage Operation : to order the operator to intervene or the fault correction to be apply taking into account the habilitation, the key locking...

  To Schedule : to schedule the maintenance intervention.

  To Inventory Means : To gather all the necessary documents and tools to intervene.
  For example : a specific tool, the valve's wiring diagram.

  This activity is composed of activities like :

  - To Inventory Documentation : the necessary technical documentation to intervene.

  - To Inventory Intervention procedure : the intervention procedure applied when the operator repairs or overhauls.

  - To Inventory Tool : the list of necessary tools used when the operator repairs or overhauls.

- **Supervision/Monitoring**
  This key domain aims at observing the state of an item, performed either manually or automatically.

- **Forecasting**
  From process validated information, this key domain aims at forecasting the state, fault or degradation of the system.
  For example : MTBF, torque curve, response time curve.

- **Fault correction**
  This key domain aims at positioning the system in a specific state before or after a failure or a degradation.
  IEC definition : Action taken after fault localisation to restore the ability of the faulty item to perform a required function.

  This key domain is composed of activities like :

  To apply Resumption : intervention on the system mode to put it in a functional and mechanical state which is observable and controllable.

  To apply Emergency procedures : procedures to be applied to position the system in a safe working state or to protect the operator. For example : turbine stopping.

- **Fault Diagnosis**
  From process validated information, this key domain aims to recognise and to localise the faulty item, and to identify the cause.

  This domain is composed of the following sub-domains :

  To Recognise Fault : IEC definition : To recognise a fault of the event.

  To Locate Fault : IEC definition : Actions taken to identify the faulty sub-item or sub-items at the appropriate indenture level.

  To Identify Cause : identification of the cause of the failure.
  - To Realise elementary diagnosis : to elaborate a pre-diagnosis of simple system failure which is identify with procedural reasoning (if...and... or... then...).
  - To Realise expert diagnosis : to elaborate the diagnosis of a complex system failure which requires expert knowledge.

- **Analysis/Decision**
  From process validated information, this key domain aims at analysing the present state of the system, and make decisions for future maintenance actions to be applied to the system.
  This key domain is composed of activities like :

  To Analyse Consequence : quantification of a failure value. For example : critical failure.

  To Decide : deciding the maintenance actions which must be applied to the system.

- **Field Execution**
  This key domain aims on the one hand, to define the necessary preventive and corrective actions to be carried out, and on the other hand, to gather and to validate the process data.

  This key domain is composed of activities like :

  To Acquire field data : actions to acquire with particular instrumentation some process data.

  To Inspect : actions intended to detect possible problems by using human senses.

  To Overhaul : actions intended to reduce the probability of failure or the degradation of the functioning of an item.

  To Perform Palliative maintenance : actions intended to repair the item in a provisional way.

  To Perform Curative maintenance : actions intended to repair the item in a definitive way.

  To Refurbish : to bring into play an operation to lead to a all "new" item (to adjust some dimensional exigency, to change some parts...).

  To Replace/To Rebuild : to change some parts of or the whole item without any modification on the functioning.

  To Modify : the combination of all technical and administrative actions intended to change an item.

  To Modernise : to change the hardware or the software of the item to improve its use thanks to technological improvement.

  To Configure/To calibrate : configuration and/or calibration of the item.

  To Test : verification of the item's capability to perform the required functions.
  For example : input/output status response of a numerical controller.

  - To Adjust : setting a parameter and/or making technical adjustment.
  - To Verify : verification of the normal operating of the item.
  - To Validate : validation of the test of the item.

- **Quality Assurance**
  This key domain aims at evaluating all maintenance activities.

■ SYSTEMS / TOOLS

From an engineering point of view, the systems/tools is a set of activities which the aim is to define the systems and tools that support the global maintenance activities.

- **To define Hardware**
  This activity aims at defining the hardware necessary to utilise the global maintenance system. For example : System architecture.

- **To define Software**
  This activity aims at defining the software necessary to utilise the global maintenance system. For example : Functional architecture.

- **To define Communication**
  This activity aims at defining the communication between different items necessary to utilise the global maintenance system.

- **To define Database**
  This activity aims at defining the database necessary to utilise the global maintenance system.

■ EVALUATION

This domain aims at evaluating results related to objectives, i.e. regarding performance, cost etc.