



# DESCRIPTION OF THE AGREED DETAILED NEXT LEVEL OF LCC NOMENCLATURE AND STRUCTURE

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## Abstract

This document is the following of D2.2.1\_1 which proposes a European structured Life Cycle Cost nomenclature. It aims to be applicable to aeronautical engine - or engine parts - manufacturers. A fourth level of an LCC structure is here presented. This work completes the first step for an engine LCC modeling.

You will find:

- A four levels distribution of engine costs in its different life cycle phases.
- The definitions of these costs in each level.

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LCC, nomenclature, structure, standard, model, cost, engine, definitions.

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## 1. EXECUTIVE SUMMARY

This document presents the work done by WP2.2 members within the context of 2.2.1 Task "Life Cycle Cost Nomenclature & - Structure". It is the second from the two deliverables of this task.

LCC is used by engine manufacturers to know all costs linked to all life phases of an engine.

Within the Vivace project context, WP2.2 aim is to model these costs in order to reduce engine development time and cost. Its first task (T.2.2.1) is to define generic European LCC nomenclature and structure in order to provide a European standard and to identify all cost elements which have to be taken into account.

After a clarification work on the different LCC existing notions, internal surveys have been conducted among people working on costs in different engine life phases. It has been done in each company taking part in WP2.2. The final step has been the homogenization of this information to reach a common LCC structure and nomenclature.

LCC structure is here presented on four levels, the fourth level is the gap between the two deliverables: D2.2.1\_1 and D2.2.1\_2.

LCC nomenclature defines each term of LCC structure.

This document will be the unique reference - completing the first version (D2.2.1\_1) - for the creation of the LCC model, that's why it presents some identical paragraphs with the first deliverable such as "Definitions" and "Work context".

## 2. DEFINITIONS

In this type of work a common agreement on the used notions definitions is fundamental.

There are many definitions for LCC. The most precise ones are referenced below and are also used within this work.

*Life Cycle Cost definitions:*

- LCC is the sum total of the direct, indirect, recurring, non-recurring, and other related costs expended, or estimated to be expended in the design, Research and Development (R&D), investment, operation, maintenance, and support of a product over its life cycle, i.e., anticipated useful life span. It is the total cost of the R&D, investment, Operating & Support and, where applicable, disposal phases of the life cycle. All relevant costs should be included regardless of funding source or management control.

(Aerospace Information Report 1939, SAE, December 1986)

- LCC is defined as the sum of all monies expended, attributed directly and indirectly to a defined system from its inception to its dissolution: encompassing the acquisition, ownership and disposal phases of a program.

(Aerospace Recommended Practice 4294, SAE, 1992-02-14)

- Cost related to the whole life of a product for a specific use.

(NF X 50-150; "Coût global" definition, "LCC" translation in French)

Here is the definition we chose for Nomenclature:

*Nomenclature*: set of technical terms of a science or of an art.

### 3. WORK CONTEXT

#### 3.1. GENERAL POINTS ABOUT LIFE CYCLE COST

As it appears in §2.definitions, many different LCC definitions exist. Our aim was not to create a new one. We accepted definitions presented above because they are close to each other and describe the same notion from different angles. Some are more precise than others.

LCC notion appeared in the United States in the sixties, at first in some assessments provided by the Department of Defense. This notion arrived in Europe in the seventies, used by companies which wanted to answer to international invitations to tenders, especially in aeronautical industry.

Nowadays all invitations to tenders include an LCC part.

Working on LCC brings many benefits :

- Commercial arguments support,
- Product positioning in competition,
- Maintenance policy preparation,
- Technical choices orientation,
- Life cycle budget forecast.

#### 3.2. PRESENTATION OF WP 2.2 AND TASK 2.2.1

##### ▪ WP2.2

Two Vivace objectives are 30% reduction in the lead time and 50% reduction in development costs for a new or derivative gas turbine.

One way to approach these objectives is to model the LCC of an engine. That's the aim of WP2.2 "Life Cycle Cost Modeling within the virtual Engine Enterprise".

LCC modeling will help to make right design choices early in the development phase, and by that a consistently target oriented functioning reduce the development time and costs.

In VIVACE context, the creation of a unique nomenclature and a unique structure of LCC used by European aeronautical industries will help in understanding of the major parameters and their impact on the product. This is the intend of WP3.3 DtDO platform. The result is to obtain the best compromise in order to have the optimised final product at the A/C level. It will reduce the number of LCC model iterations between A/C and engine. So engine development time and costs will be reduced.

**▪ Task 2.2.1**

To reach these objectives, the first step is to define a common LCC nomenclature which will be used in all European aeronautical companies.

That is the first task of WP2.2: “Life Cycle Cost Nomenclature and Structure”. (Task 2.2.1) These LCC nomenclature and structure standards will allow to reduce cost by reducing travel expenditures and meeting times needed to synthesize different LCC terms and structure. A notably cost reduction in product development may be reached by making the right design decisions early in the development phase.

**3.3. TASK WORK PROCESS**

The aim of the task work is to find a common nomenclature. Then, WP2.2 members proceeded as below.

Work process had three steps:

- LCC notions clarification,
- Internal surveys,
- Homogenization of information.

The first step was to collect information about LCC and to choose a common agreement on definitions. This information comes from different sources, which are representative of different views about LCC. Consequently, customers, engine manufacturers and supply chain points of view are taken into account.

Secondly, internal surveys were made in each WP2.2 member’s company. For different phases of engine life, a cost responsible was interviewed about the way costs are structured. LCC nomenclatures of each participant’s company were presented. Each partner has explained how his company calculates Life Cycle Cost.

After that, the terms were compared. Differences in wording, meaning and cost structures were discussed.

Proposals to harmonize LCC structures and definitions have been made and were discussed internally in companies.

After having had internal agreements, final discussions took place to homogenize the final LCC structure and nomenclature. Each WP member’s agreement has been reached.

This task work process has been iterated to create a fourth level of LCC structure in this deliverable. D2.2.1\_2 is also an update of D2.2.1\_1, in that way, it contains the reference European Standard proposal.

#### 4. STRUCTURE OF AN ENGINE LIFE CYCLE COST

The structure of occurring costs during an engine life cycle is presented below. The detailed structure is presented in Annex 1.

### LCC nomenclature

Level 1	Level 2	Level 3
<b>Development Cost</b>	<b>Pre-development cost</b>	Engineering
		Hardware
		Testing
	<b>Detailed development cost</b>	Engineering
		Hardware
		Testing
	<b>Post-development cost</b>	Engineering
		Hardware
		Testing
<b>Industrialization Cost</b>		Engineering
		Production tools
<b>Production Cost</b>	<b>Purchase and manufacturing</b>	Purchase
		Manufacturing
	<b>Procurement management</b>	Engineering support
		Financial and commercial
<b>Operating and Support Cost</b>	<b>Initial cost</b>	Spares investments
		Ground support equipment
		Logistic Support Analysis
		Training
		Technical publication
		Facilities
	<b>Recurring cost</b>	Maintenance Labour Cost
		Maintenance Material Cost
		Maintenance Logistic Cost
		Customer support
		Fuel, oil
	Operational taxes	
	Financial cost	
<b>Life Termination Cost</b>		Programme management
		Administration cost
		Recycling cost
		Scrapping cost



## 5. NOMENCLATURE

In this part all terms of the engine LCC structure are defined.

### ***Development cost***

All the costs incurred from the product development of an engine. It includes all development costs from the early phases of product development to post-certification development. Product development begins when the Programme management team is installed and ends when there are no more changes in the design.

#### **Pre-development cost**

All the costs incurred during the early phases of product development of an engine; preliminary design, needs analysis, general requirements, global definition and preliminary tests.

The pre-development begins when the Programme management team is installed and ends when the detailed definition begins, in other words when engine architecture, technologies and performance objectives have been chosen.

#### **Engineering**

Costs of all engineering activities for preliminary design: drawings, studies and Programme management activities.

#### **Design**

It corresponds to costs relating to concept studies, specifying and/or analyzing preliminary requirements, technology development connected to the specific Programme, risk analyses, etc, to decide the engine architecture, technology and performance objectives. It also includes software purchase.

#### **Programme management**

Costs relating to Programme planning and coordination, both by internal management and by communication with partners, customers and suppliers.

#### **Hardware**

The cost of hardware needed for pre-development: components, modules or engines for testing, components for test rig construction and tools.

**Components for test rig construction**

Costs relating to all the hardware components needed for the construction of test rigs.

**Components, modules or engines for testing**

Costs relating to all the components, modules or engines that are needed to perform the required testing.

**Tools**

Costs of all tools needed during pre-development; for manufacturing and assembly/disassembly of test objects, and for the test rig construction and maintenance.

**Testing**

It corresponds to the costs linked to all the activities performed to demonstrate new technologies of engine preliminary design; beside preparing and running the tests, it also includes test rig adaptation, instrumentation and results analyses.

**Test rig adaptation**

Costs relating to all activities needed to adapt existing test rig for new test.

**Test object assembly/disassembly**

Costs relating to all the activities in assembling and disassembling modules and engines before and after testing.

**Instrumentation**

Costs linked to all the instrumentation activities, preparing the instruments in the test rig for the specific test.

**Test**

Costs relating to engine and component testing. In pre-development, engine test has a demonstration purpose. All costs regarding running the tests: preparation, labour cost, fuel, test rig fee, etc.

**Test results analyses**

Costs of all analyses needed to evaluate the performed tests.

**Test of new material**

Includes all costs concerning the material tests needed to examine and verify that the new material fulfills the requirements for the new product. This includes also the purchase of data on the new material in the case that the test is not performed.

**Detailed development cost**

All the costs incurred during detailed development of an engine: design, development hardware, safety analyses, tests and Programme management.

**Engineering**

Costs corresponding to all engineering activities to achieve a detailed and certificated design: drawings, studies, instrumentation and project management activities, safety analyses and certification.

**Design drawings**

Costs incurred in all activities to prepare the drawings as well as purchase of software.

**Design studies**

Costs for calculations, material studies – without material test cost –, environmental analysis, verification's studies and validation methods, manufacturability studies and quality analysis.

**Instrumentation Design**

Includes all cost regarding the development of test instrumentation.

**Programme management**

It includes the costs of project planning and Programme coordination, both by internal management and by communication with partners, customers and suppliers. It also includes verification and validation planning, Programme risks and patent analysis.

**Supplier selection**

Costs relating to all engineering activities concerning the evaluation, selection and improvement of suppliers. This only concerns suppliers which have to be integrated during the development phase, e.g. supply of complex systems.

**RAMS Analyses (Reliability, Availability, Maintainability and Safety)**

Costs needed for providing all studies to ensure safety and reliability of the engine, it includes Functional Analyses, FMECA (Failure Mode Effects and Criticality Analysis), Fault Tree Analyses, failure rates calculation and FRACAS (Failure Reporting Analysis, Corrective Actions System).

It includes also all maintainability analyses. The aim is to be sure that the designers integer in their studies requirements for supporting and maintaining the engine. The availability of the engine will be the consequence of its reliability and its maintainability.

**Certification**

Includes all costs to certify the product ; certification documents and engine manufacturer participation in A/C certification are part of it.

**Hardware**

Costs of hardware needed for detailed development: components, modules or engines for testing, components for test rig construction and tools.

**Components for test rig construction**

Costs relating to all the hardware components necessary for the construction of the test rig.

**Components, modules and engines for testing**

Costs of all the components, modules or engines that are needed to perform the required tests.

**Tools**

Costs of all the tools necessary for manufacturing the hardware needed for testing, for assembly/disassembly of test objects, and for test rig construction and maintenance.

**Testing**

All costs regarding testing activities in detailed development phase: test rig adaptation, modules and engines assembly/disassembly, instrumentation, rig and engine tests and results analyses.

**Test rig adaptation**

Costs of all the activities provided to adapt existing test rig for new tests.

**Test object assembly/disassembly**

Costs relating to the assembly/disassembly of modules and engines before and after testing.

**Instrumentation**

Costs linked to all the instrumentation activities preparing the instruments in the test rig for the specific test.

**Test**

Costs regarding engine testing and component testing ; preparation, labour cost, fuel, test rig's fee, etc. During detailed development phase both concept development tests and verification/validation tests are performed.

**Test results analyses**

Including costs of all the analyses needed to evaluate the performed tests.

**Test of new material**

Includes all the costs concerning the material tests needed to examine and verify that the new material fulfills the requirements for the new product. This includes also the purchase of data on the new material in the case that the test is not performed.

**Post-development cost**

All the costs linked to post-certification development activities. Changes in design of a certified engine are most often initiated by problems occurring in the "Operating & Support" phase of the engine life. Post-development engineering can also be initiated to extend engine life duration or by possibilities to improve the design ; if they are estimated to be profitable, to improve safety, to fit with standards evolution (noise, pollution, etc.)

**Engineering**

Costs relating to all post-certification engineering activities: modification assessments, Programme management, and updating of Integrated Logistic Support, system safety analyses and certification.

**Modification analyses**

Costs of all engineering activities to analyze the needs of modification.

**Re-design**

Costs of all design activities to apply the modification to the product.

**Programme management**

Includes costs for Programme planning and coordination, both by internal management and by communication with partners, customers and suppliers. As in earlier phases, it includes verification and validation planning, Programme risks and patent analyses, but in the post-certification phase, the modification realization plan is also of great importance, as well as the configuration management.

**Supplier selection**

Costs of all engineering activities concerning the evaluation, selection and improvement of supplier.

**RAMS analyses update**

All costs related to the update of the studies to ensure safety and reliability of the engine, e.g. FRACAS (Failure Reporting Analysis, Corrective Actions System ) and FMECA (Failure Mode Effects and Criticality Analysis), as well as maintainability studies (Integrated Logistic Support).

**Certification update**

Includes costs of certification documents update and new A/C certification cost participation, in case of integration of the engine in a new A/C.

**Hardware**

It corresponds to the costs of hardware needed for post-certification activities: components for test rig adaptation, components, modules and engine for testing and tools.

**Components for test rig construction**

Costs of all the hardware needed for the construction of test rigs.

**Components, modules or engines for testing**

Costs of all the components, modules or engines that are needed to perform the required rig and flight tests.

**Tools**

Costs of all the tools necessary for the assembly/disassembly of test objects, for the construction and maintenance of test rigs and for manufacturing the hardware needed for tests.

## Testing

All costs regarding testing activities in post-certification development phase: test rig adaptation, modules and engines assembly/disassembly, instrumentation, rig and engine tests and results analyses.

### Test rig adaptation

Costs of all the activities necessary to adapt existing test rig for new test.

### Instrumentation

Costs linked to all the instrumentation activities, preparing the instruments in the test rig for the specific test.

### Test object assembly/disassembly

Costs corresponding to modules and engines assembly and disassembly before and after testing.

### Test

All costs regarding endurance testing and component testing; preparation, labour cost, fuel, test rig fee, etc.

### Test results analyses

Includes costs of all analyses needed to evaluate the performed tests.

### Test of new material

Includes all the costs concerning the material tests needed to examine and verify that the new material fulfills the requirements for the new product. This includes also the purchase of data on the new material in the case that the test is not performed.

## ***Industrialization cost***

All costs incurred to convert a fully developed and certified product into a series production product with a reproducible and continuous quality at least at the certified level. Routinely all of these costs are Non-Recurring Cost (NRC), because they occur during transition from the development phase to the production phase.

## Engineering (3rd level)

Costs relating to all engineering activities required to transfer the product from the development phase to the production phase. This also includes necessary management activities during that period.

### **Production Process**

Costs relating to activities necessary to choose and achieve a stable series production process from the beginning. The production process will be substantiating to prevent the chosen processes from problems. Tooling has to be designed and a management must be set up to handle tools for series production. Quality process must also be set up.

### **Programme Management**

Costs relating to management activities required to solve problems during the transfer from the end of the development phase to the start of the production phase. This also includes trouble-shooting activities.

### **Supply Chain Build-Up**

Costs relating to management activities needed for building up and planning the supply chain. This includes suppliers validation and all the non-recurrent costs needed for initiating the supply chain. This concerns suppliers which were not integrated yet, such as certain raw material suppliers, standardized products suppliers etc.

### **Machine programming**

Costs relating to generating of process sheets and programming of corresponding tapes for series production.

## **Production Tools**

All hardware costs arising with the start of a new engine production line. This includes costs for production tooling, specific machine investments, test stand investments. Not included are all investments, which are current standard in engine parts production. Also not included are investments in hardware, which can be used for similar engine parts, already existing ones or the ones coming up in the near future.

### **Tooling**

These costs are relating to the manufacturing or purchase of all series production tools.

The costs which occur to modify existing tools are also taken into account. This is necessary when some tools have to fit to changed/modified components or processes.

### **Investment**

All investments relating to machines.

Investment is also required for production test stands. This means building new ones or adapting existing ones to a new standard to be able to start with the serial testing of a new engine type.

Not included are all investments, which are current standard in engine parts production. Not included are also investments in hardware which can be used for similar engine parts, already existing ones or the ones coming in the near future.

## ***Production cost***

All costs incurred in purchase and transformation of raw material into a final product. Also included are purchase of completely finished parts, procurement management, inspection, quality assurance and related processes. Production costs are strongly related with the number of delivered sets and can therefore be considered as recurring costs.

## **Purchase and manufacturing**

All costs relating to activities to purchase finished parts or raw material which is needed to manufacture parts. Included are the costs to assemble these parts into modules and to build up the modules to the engine. According to certified procedures, final checks will assure that the engine is delivered to the customer with the defined quality conditions.

### **Purchase**

Purchase of all parts and material which the engine manufacturer buys to build up an engine. It includes raw materials, parts and equipment purchase. Reception quality control is added.

#### **Raw Materials**

Purchase of raw materials which will be worked on to manufacture the final product.

#### **Parts**

Purchase of parts to build up modules which are not manufactured in-house.

#### **Reception Quality Control**

All costs relating to the control of purchased material whether it is raw material, finished parts or equipment in order to fit the required quality conditions.

## **Manufacturing**

What the engine manufacturer pays to transform raw materials into a final product. This includes parts and equipment manufacturing, assembly, quality control, and tests. The production tools and machines have to be maintained.

**Parts manufacturing**

All costs relating to the work up of raw material to get finished parts.

**Assembly**

All costs relating to the assembly of the manufactured and purchased parts into modules and then into engines if required.

**Maintenance of Tools and Machines**

All costs relating to routinely check, repairs and maintenance of all tools and machines during the total production process.

**Quality Control**

All costs generated to ensure Quality during the whole process. Specific quality control steps are mandatory.

**Tests**

All costs relating to the tests necessary to guarantee the certified product Quality.

**Procurement Management**

All management costs directly incurred from the purchase and manufacturing of parts to the engine assembly. This includes negotiations with supplier, workflow control and production process supervision. Sales contracts have to be debated and care has to be taken on patents and licenses.

**Engineering support**

All costs of engineering support activities for production are considered in this item. This means that the supply chain management, such as supply and storage linked activities, production global supervision, as scheduling, optimization and quality controls, is taken into account as engineering support activities in procurement management.

**Purchase**

Costs linked to the management of purchases. Certain parts will be chosen and negotiated with the supplier.

**Production Management**

All costs relating to the preparation of all the planning processes necessary to manufacture finished parts and assembly modules and engines. This activity also includes optimisation processes in order to reduce production costs.

**System Management**

All costs relating to the traceability and update of systems, processes and data bases.

**Supply Chain Management**

This corresponds to the recurrent costs incurred in managing the supply chain during the production phase. This includes a continued follow-up and the planning of this supply chain. It also corresponds to costs for storage management.

**Quality Management**

All costs incurred for insuring that the final product respects quality requirements.

**Financial and commercial**

This corresponds to costs related to financial and commercial activities during the production phase. It concerns payment of rights, if external Patents and Licences are used, and wording of special contracts with suppliers.

**Sales Contracts**

Sometimes contract will be worded for special suppliers. As this is not very often in Production phase, it will not tremendously influence Life Cycle Cost but it should be mentioned that it can happen.

**Patents and Licences**

This concerns the payments of rights and copyrights, if external patents and licences are used. In this case, the payments are proportional to the number of manufactured systems.

***Operating and support cost***

All the costs incurred from the initial engine deployment until the end of engine operations. It includes costs relating to activities such as operating, maintaining, and supporting the engine. Due to customer contracts, it may happen that not all of the illustrated costs are calculated, fuel for example.

**Initial cost**

All the costs linked to the initial engine deployment, i.e. to build up the engine support.

**Spares investments**

Investments in spare engines, modules and accessories supporting the fleet and building the initial stock. This aims to insure fleet availability.

**Spare engines**

Initial investments in spare engines. It corresponds to the initial stock of engines. The aim is to insure the availability of all the aircrafts of the fleet.

**Spare modules**

Initial investments in spare modules. It corresponds to the initial stock of the engine modules. Its aim is to avoid to be out of stock for this kind of sub-systems and to ensure the availability of all the aircrafts of the fleet.

**Spare accessories**

Initial investments in spare accessories. It corresponds to the initial stock of the engine accessories. Its aim is to ensure the availability of the aircraft fleet.

**Spare Parts**

Initial investments in spare parts.

Routinely an amount of spare parts will be recommended to cover the possible usage of parts during at least the first year after EIS (Entry Into Service).

Its aim is to ensure the availability of the aircraft fleet.

**Ground support equipment**

All the costs of the equipments needed for supporting engines: tools, test equipment and transportation containers.

**Tools**

All the costs linked to the tools necessary for providing ground maintenance actions (assemblies, disassemblies and repairs).

**Test equipment**

Costs of equipments needed for testing the engines, in the following cases:

- Test check consistency of the engine behaviour with the flight computer diagnostic;
- Test to know which kind of maintenance action has to be provided;
- Test realized after maintenance actions, in order to know if the engine can be reinstalled on wing.

**Transportation containers**

Costs of equipments used to transport and protect parts, modules and engines during transportation phases.

**Logistic Support Analysis (LSA)**

Costs of all necessary activities for organizing engines support: level of repair analyses, spares modeling and maintenance analyses.

**Level Of Repair Analysis (LORA)**

Costs of analyses which aim to evaluate repair workshops and to identify which one will provide repairs for each degradation case of each component.

**Spares modeling**

All the costs linked to the creation and utilization of mathematical models for predicting needs of spare systems (spare engines, spare modules, spare parts...).

**Maintenance Tasks Level and Skill analyses**

Costs of analyses made in order to manage, dimensionate and optimize maintenance actions for the whole engine.

**Training**

All the costs relating to employees training and line operating courses for the engine support. This aims to provide appropriate skills about different topics related to maintenance activities, such as specific tasks, mechanics, logistics, security, management etc.

**Technical publication**

Costs relating to the publication of documents such as illustrated part catalogues, engine and components maintenance publications and maintenance plan. All of them aim to help engine support.

**Illustrated Part Catalogue**

All the costs linked to the creation of this document. It presents information about all the components of the engine: Part numbers, pictures, localization on the system etc.

**Component maintenance publication**

All the costs relating to the wording of one of the most important maintenance document, i.e. the Engine Shop Manual. It describes the actions, component per component, which have to be done in order to maintain these parts in service (criterion for repairs and replacements, corresponding actions, materials and tools to be used by the operator, etc).

**Maintenance plan**

Costs incurred by the creation of the maintenance plan, predicting and planning the maintenance actions, which will be provided on a defined future period.

**Line maintenance manual**

Costs incurred by the creation of this document. It presents information on how managing in-line maintenance and how in-line actions have to be provided.

**Facilities**

Costs needed to modify or build facilities and to fulfill technical and environmental requirements.

**New facilities build-up**

All the investments needed for building up new facilities. It includes, e.g., the fulfillment of technical and environmental requirements.

**Modification of older facilities**

All the costs relating to the modification of older facilities in order to have ones corresponding to new needs. It includes, e.g., the fulfillment of technical and environmental requirements.

**Facilities planning**

All the costs needed for planning tasks in order to have required facilities.

**Recurring cost**

All the costs that occur during the engine operational life.

### **Maintenance labour cost**

All labour costs to maintain the engine during its operational life.

#### **Line maintenance**

Labour cost for maintenance tasks on wing.

#### **Module exchange at intermediate level**

Labour cost for module exchange.

#### **Module repair at shop level**

Labour cost incurred in module and pieces of module repairs provided in Shop-Visit.

#### **Line Removable Units (LRU) repair**

Labour cost of LRU repairs.

### **Maintenance material cost**

All costs linked to components, LLP (Life Limited Parts) and materials needed to maintain the engine during its operational life.

#### **Line maintenance**

Material cost relating to line maintenance activities. It only includes costs for spares replacement, i.e. costs of spare parts.

#### **Shop visit**

Material cost linked to maintenance activities provided in Shops. This only includes spares cost.

#### **Life Limited Parts**

Cost related to the replacement of LLPs. As this kind of spares is unserviceable and is not repairable after reaching the Life Limit, this corresponds to new spares costs.

#### **Repair cost**

It represents costs of necessary material needed to repair components. This includes all the material used for repairs provided by every maintenance activities, on wing and in shops.

### **Maintenance Logistic cost**

All the logistic costs related to the activities needed for providing spare parts and repair material during the engine maintenance phase. This includes all the supply and storage costs. It also includes engines and modules transportation costs between the Line and the Shops.

### **Customer support**

Cost of all support activities provided by the engine manufacturer for the customer, except engine maintenance. These activities are programme management, configuration control, engineering support, field service, and ground support equipment maintenance.

#### **Programme management**

Costs of all activities which the engine manufacturer provides to the customer in a commercial context.

#### **Engineering Support**

It represents all the costs linked to engineering activities to answer customer's technical questions, solve technical problems and provide engine reliability follow-up. These activities won't perform any definition changes, otherwise they would be taken into account as post-development activities.

#### **Field service**

This incurs the costs linked to staffs which represent the engine manufacturer on the customer field.

#### **FRACAS**

It corresponds to the cost of analyses which are jointly made by airline companies, engine manufacturer and maintenance societies in order to solve engine failures.

#### **LSA updates**

This includes all the costs of activities needed to update Logistic Support Analyses. This can be necessary in the case of engine configuration changes, improvement of the knowledge concerning the engine in-service behaviour or improvement of the state-of-the-art on this topic.

#### **Technical publication updates**

This includes all the costs of activities needed to update Technical publications. This has to be done in the case of engine configuration changes, improvement of the knowledge concerning the engine in-service behaviour or improvement of best maintenance practices.

These updates can be temporally limited or definitive. In certain cases, authorities' agreement is needed before updating these documents, such as for increasing inspection intervals, deleting maintenance actions and also changing spares design.

### **Training updates**

This includes all the costs of activities needed to update Trainings and courses. This can be necessary in the case of engine configuration changes, improvement of the knowledge concerning the engine in-service behaviour or improvement of best maintenance practices.

### **Ground Support Equipment maintenance**

It incurs all the costs needed for keeping in state Ground Support Equipments.

### **Fuel, Oil**

Costs linked to engine fuel and oil consumption.

### **Operational taxes**

Taxes related to noise and gas emissions paid by the airline company.

### **Noise**

Noise emissions are one of the worst effects of air transportation and are generally considered as a pollution. Therefore taxes exist and are applied to airline companies.

### **Gas emissions**

As keeping clean our environment is a problematic issue, some taxes have been created few years ago. It aims to limit gas emissions, and their impact on Earth weather. Therefore these taxes concern all polluting activities, such as air transportation.

### **Financial cost**

This item corresponds to the costs incurred in a financial point of view, during all the operating life of the engine.

**Interests**

As buying an engine is a big investment, it can happen that customers ask for raising a loan. This item aims to take into account interests related to this loan.

**Insurances**

Costs related to the engine insurances taken by the customer. This only takes into account typical insurances, such as natural disasters, terrorism risks etc., which cover engine integrity against uncontrollable events.

***Life Termination cost***

All the costs occurring at the end of engine operational life. This includes all costs linked with the scrap or the reuse of whole engine, engine modules or spares. Parts must be removed from inventory and the associated data must be deleted within all related systems. Some costs maybe offset by residual value, e.g. salvage or resale of components.

**Programme Management**

Technical and economical analyses have to be made to make a plan for the termination of the engine programme. It is necessary to check up all legal regulations concerning all occurring kinds of material, plan all administrative activities and to plan how the programme most economically should be shut down.

**Administration cost**

This corresponds to the cost of all the administrative issues which have to be fulfilled before being allowed to remove material from storage and to delete parts nomenclature from system and data base (Reconditioning of facilities, removing of special equipment and machines, environmental decontamination etc.).

**Recycling cost**

All the costs linked to recycling material physically and any possible payments due to government regulations.

**Scrapping cost**

Costs linked to the logistic and physical disposal of components. This includes all scrapping activities, e.g. scrap of a whole engine or scrap of components.

**Logistic**

This includes the cost of all the activities aiming to manage the engine, or module, disassembly into the shop. Kind of follow on activities (scrap or reuse) must be recorded.

**Material and components treatment**

Due to the kind of material and legal regulations, the treatment of scrapped components must be done according given rules. To set off some of the occurring costs, parts should be controlled for salvage of material or resale possibility to other applications.

**CONCLUSION**

This deliverable has presented the work achieved in the Task 2.2.1. It completed the D2.2.1\_1 by adding a fourth level to the LCC structure. This fourth level LCC nomenclature has been built by many engine cost experts and reached an agreement between partners, and so corresponds to LCC structure view of the three participating companies.

These LCC nomenclature and structure are the necessary basis for preparing an LCC modeling. They clarify all LCC notions and identify all LCC cost elements.

**GLOSSARY**

DtDO	Design to Decision Objectives
EIS	Entry In Service
FMECA	Failure Mode Effects and Criticality Analysis
FRACAS	Failure Reporting Analysis, Corrective Action System
ILS	Integrated Logistic Support
LCC	Life Cycle Cost
LLP	Life Limited Part
LORA	Level Of Repair Analysis
LSA	Logistic Support Analysis
LRU	Line Removable Units
O&S	Operating and Support
RAMS	Reliability, Availability, Maintainability and Safety
R&D	Research and Development
VMC	Vivace Management Committee
WP	Work Package

## ANNEX 1

Cf. LCC Structure. Xls



"LCC Structure.xls"