ESEIAAT

CleanOrbit: Laser-based Space Debris Deorbiter

(CO-LSDD)

Deliverable 3
Procurement, Quality, Risk and Communication Management

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1 Plan procurement management

In this first chapter, the Plan Procurement Management is introduced. This aspect is crucial for companies that need any outside support, from manufacturing to logistics. Then, it is mandatory to identify these tasks or processes and the possible sellers related to them, following the company requirements. In addition, not only the activity is important, but also the deadlines, quantities and possible risks associated must be considered. These variables mentioned previously must be documented, and the process of it is the Plan Procurement Management function.

1.1 Make or Buy decisions

All the WBS work-packages that will be outsourced are listed in the table below, considering the reason to outsource them, cost estimation, the type of contract used, the possible risks associated and possible European suppliers. Finally, special considerations or constraints are mentioned for each work-package.

WBS ID	Work package Name	Reasons for BUY	Cost estimate	Type of contract	Possible risks	List of suppliers	Special considerations or constraints
6.3.1.4	Electronics manufacturing	There are plenty of electronics needed for the laser that are common to other aerospace projects (power units, dividers, etc.)	22.500 €	Cost Plus Fixed Fee	Possible delays and cost increase due to material shortages. Performance requirements may not be entirely met.	RUAG: experienced aerospace company with several laser-related "in-house" products. Supplier chosen for the task. Lithium Lasers: proven experience in laser production. Oriented to industrial processes.	The supplier must follow the electronics procurement guide (5.2.1).
6.3.2	Assembly with electronics	An specialized assembler is needed to assemble high precision electronics with the laser.	60.000 €	Fixed prize incentive fee	Incompatibilities with electronics may arise, what translates into possible redesigns and delay.	OHB Systems AG: over 60 years of expertise in spacecraft integration. Supplier chosen for the task. Mondragon Assembly: 40 years working on automatic product assembly lines. MIFA: assemblers of a wide variety of technologies, focusing on metal assemblies	The supplier must follow the integration procurement guide (5.2.2). If the assembly with electronics is completed before scheduled, an incentive of 5% of the global price of the service will be granted.
6.4.2	Laser assembly	An specialized assembler is needed for a high precision project, where mirror calibration is key for an optimal functioning	45.000 €	Fixed prize incentive fee	Incompatibilities with the laser parts may arise, what translates into possible redesigns and delay	OHB Systems AG: over 60 years of expertise in spacecraft integration. Supplier chosen for the task. Mondragon Assembly: 40 years working on automatic product assembly lines. MIFA: assemblers of a wide variety of technologies, focusing on metal assemblies	The supplier must follow the integration procurement guide (5.2.2). If the assembly with the scaled laser parts is completed before scheduled, an incentive of 5% of the global price of the service will be granted.
6.4.5	Prototype transportation	Each part of the laser system, manufactured in its corresponding factory, must be transported to the final destination where the laser is meant to operate	15.000 €	Fixed prize incentive fee	Fuel prices can produce a margin reduction, inducing to a change request. Unforseen complications may appear, becoming a delay in transportation	AP Moller - Maersk: among the largest transportation companies in Europe. Specialized on container logistics. Supplier chosen for this task due to IAC location (Canary Islands). DSV: among the largest transportation companies in Europe. More diversified transportation.	The supplier must follow the logistics procurement guide (5.2.3). If environmental impact is reduced during transportation, an incentive of 5% over the global price of the service will be granted.

Figure 1: List of procurement items

1.2 Statement of Work

The statement of work (SOW) for procurement is developed from the project scope baseline and defines the part of the project scope that is included within the related contract. It describes each procurement item with sufficient detail to allow expected sellers to identify whether they are capable of delivering such products, services or results. Enough detail may vary depending on the nature of the needs of the buyer, the item or the expected contract form. Among the information which can be presented in a SOW, there can be quality levels, performance data, period of performance, quantity desired, work location, specifications and other different requirements.

For each foreseen buying decision, a SOW has been prepared providing the essential information of each one. This comprises: a detailed description of the procurement item; the requirements to be met by the procurement item; the type of contract to be used; the arrangement of the scheduled dates in each contract for the contract deliverables (milestones) and coordinating with the schedule project development; any constraints and assumptions that could affect planned procurements; identification of the requirements for performance bonds or insurance contracts to mitigate some forms of project risk; the establishment of the form and format to be used for the procurement/contract statements of work; the identification of pre-qualified sellers, if any, to be used and finally the procurement metrics to be used to manage contracts and evaluate sellers.

1.2.1 Electronics manufacturing

Expertise in electronics engineering is required in order to manufacture the components that feature the laser debris deorbit system. An external company is hired to ensure that all the electronic parts are properly manufactured. The requirements that have to be met in the electronics manufacturing tasks are:

- Electronics components manufacturing that provide compatibility with the electronics assembly of the laser debris deorbit system will be done.
- All components must ensure proper operation for the different laser system performance configurations.

The type of contract of the task is a cost plus fixed fee contract where the buyer reimburses the seller for the seller's allowable costs (which are defined by the contract) plus a fixed amount of fee. The total cost if the seller meets the allowable costs is 22500€.

Both delivered and received material transportation costs are in charge of the outsourced company.

A percentage of 25% of the total cost of 22500€ will be paid for each milestone.

The service will start in the development of the project week 104, its duration will be of 11 months and thus it will finish at the end of week 148.

The task is identified in WBS-ID as the 6.3.1 activity.

The milestones of the task are:

Milestone	Explanation	Date estimated
Initiation	The activity of electronics manufacturing starts.	Week 104
Midterm review	Review of the work so far in order to evaluate and correct possible confusions.	Week 126
Final examination	Final review where all requirements initially set are assessed and ensured to be reached.	Week 147
Task finalization	Once task is considered valid and delivered with sufficient quality, the task ends.	Week 148

Table 1: Milestones of electronics manufacturing.

The constrains of the task are:

- The electronics design have to be done and the list of materials to be used have to be identified.
- The delay on the task would suppose a delay on the assembly with electronics task and thus prototype manufacturing.
- The outsourced company should perform the task under the budget defined.

The company should not share any information provided to external companies neither be made public and daily communication will be done between the two companies. Furthermore, the outsourced company should not have any risk that can affect the company and project in a direct way.

The penalisation applied due to incorrect delivery will be of 5% of the whole payment for each requirement that has been established in the agreement that is not met. Besides, if the task is delivered beyond deadline, a penalisation of 5% of the total cost for each delayed week will be applied.

The form of the procurement statement of work are deliveries in *.pdf* file sent by email that contain reports with description of the activities done through the task and present the results of the components performance in order to be compatible with the rest of laser system components. Additionally, a report containing the extended list of components cost and the total budget task will be included.

The components that shall be manufactured in this task are:

- High Power Laser Diode Drivers (TEC controllers with up to 4 channels, maximum current range from 10 to 100AQCW with maximum compliance voltages from 3.3 to 32 V).
- High Power Laser Diode.
- High Performance Single Board Computer.

The pre-qualified sellers candidates that can carry out the task are: *RUAG* and *Lithium Lasers*.

In order to choose the supplier, the metrics are that the company shall have large experience in aerospace engineering with special emphasis on laser-related products. Additionally, they have to be able to perform the task under the budget and schedule. Therefore the one which offers the lowest cost will be selected. If the same cost is offered, the prioritization will be to the one who offers the least task duration.

The procurement metrics consist of different key performance indicators in order to assess the work which will be reviewed under the form of deliveries based on the components performance results and

task budget reached. These are distributed among: the quality of the product (35% of the weight), its reliability (20%), its performance (15%), the total cost (15%) and the delivery time offered (15%). This scale has been selected because the electronics manufacturing is a part that directly affects the performance of the overall system.

1.2.2 Assembly with electronics

Expertise in electronics and systems engineering is required to carry out the assembly of the system, considering the physical laser itself, the software written and the electronic components. An external company is hired to guarantee that the assembly is completed properly. The requirements that have to be met in the assembly with electronics task are:

- An assembly that assurances the correct performance of the laser debris deorbit system will be carried out.
- All components must fit in the assembly and operate in the desired criteria.

The type of contract of the task is a fixed price plus incentive fee contract (FPIF) where an incentive fee depending on the performance is agreed so that the outsourced company is encouraged to implement a reliable assembly and improve the overall laser system performance. The cost of the task is a fixed fee of 60000€ plus 10% of it as incentive fee if the seller meets the defined performance criteria.

A payment of 25% of the total cost of 60000€ will be made for after milestone has been reached.

The transportation costs of the materials needed to carry out the assembly are in charge of the outsourced company. The sent material is not in charge of them.

The service will start in the development of the project week 149, its duration will be of 23 weeks and thus it will finish at the end of week 172.

The task is identified in WBS-ID as the 6.3.2 activity.

The milestones of the task are:

Milestone	Explanation	Date estimated
Initiation	The activity of assembly with electronics starts.	Week 149
Midterm review	Review of the work so far in order to assess and correct possible errors.	Week 160
Final examination	Final review where all requirements initially set are evaluated and ensured to be accomplished.	Week 171
Task finalization	Once task is considered valid and delivered with sufficient quality, the task ends.	Week 172

Table 2: Milestones of assembly with electronics.

The constrains of the task are:

- The reliability and operation of each component must be ensured before the whole system is assembled.

- Any incompatibility between components that require a change on the assembly design or factors such as damages or accidents that require repairs can cause a delay on the task, which would suppose a delay on the prototype assembly task.

The company shall not share any technical information provided to external companies neither be made public and daily communication will be done by the two companies. Moreover, the outsourced company shall not face any risk that can directly affect the project.

Whether all the requirements previously stated in the agreement are not met, a penalisation of 10% of the whole payment for each requirement not met will be applied. Additionally, if the task delivery is done beyond deadline, a penalisation of 1% of the total cost for each delayed day will be applied. The outsourced company will be in charge of any damage, defect or required repair produced during the task activity.

The form of the procurement statement of work are deliveries in *.pdf* extension sent by email. The deliveries include a report that describe the assembly procedure, a report showing and explaining the assembly scheme, a report containing the system performance results after the assembly and a report that contains the performance results after corrections and updates from the original assembly scheme have been done.

The components that shall be assembled are:

- Hardware implementation and integration in the system.
- High Power Laser Diodes, its drivers and High Performance Single Board Computer are integrated to the laser system.
- Electronic protective devices in order to guarantee safe operation.
- Tracking electronics components incorporation.

The pre-qualified sellers candidates that can complete the task are: *OHB Systems AG, Mondragon Assembly* and *MIFA*. All of them . Specially, *OHB Systems AG* have expertise in spacecraft systems integration.

In order to choose the supplier, the metrics are that the company shall have large experience in assembly and integration. Furthermore if they have expertise in spacecraft systems integration will be a plus. Obviously, they have to be able to perform the task under the budget and schedule. Hence, the one that offers the lowest cost will be selected. Whether the same cost is offered, the prioritization will be to the one who offers the least task duration.

The procurement metrics consist of different key performance indicators to evaluate the work which will be reviewed under the form of deliveries based on the performance results of the system once the assembly has been completed. These are distributed among: the quality of the product (30% of the weight, its reliability (20%), its performance (20%, where 20% of that refers to energy consumption reduction, 20% to emissions reduction, 20% to weight reduction and the rest to performance results), the total cost (10%) and the delivery time offered (10%). This scale has been selected due to the influence of the assembly with electronics to the laser system performance.

1.2.3 Laser assembly

Expertise in optics engineering with special emphasis on laser is required in order to complete the assembly of the scaled laser pieces. An external company is hired to ensure that the assembly is done properly. The requirements that the task shall meet are:

- The laser assembly must reach a laser illumination maximum range of 900 km without losing quality with the aim of slowing-down debris targets such that they are burnt up when re-entering the atmosphere.

- The laser assembly must provide re-operation with a maximum re-targeting time less than 1 minute in order to enable quick response against debris.
- The assembly infrastructure shall be modular and capable of mounting different types of laser depending on the characteristics of the debris target to be deorbited. Furthermore, it has to include a configuration selection aiming on being optimal in different laser powers adapting to various densities and materials of space debris.
- The laser assembly shall comprise a pulsed-laser type which will generate plasma jets on the targets and will need to have the sufficient power to deorbit targets.
- The laser assembly should be in tune with the mirror design in respect to laser pulse delays, frequencies and precise control of the pointing and signal tuning to compensate for the debris motion and Doppler shift.
- The assembly must be compatible with the technical specifications of the laser design.

The type of contract of the task is a fixed price incentive fee (FPIF) so that the outsourced company is encouraged to implement a reliable assembly and improve the overall laser system performance. The cost of the task is a fixed fee of 45000€ plus 10% of it as incentive fee if the seller meets the defined performance criteria.

25% of the total cost will be paid for each milestone reached.

The transportation costs of the received materials needed to carry out the assembly are in charge of the outsourced company. The sent material is not in charge of them.

The service will start in the development of the project week 104, its duration will be of 11 months and it will finish at the end of week 148.

The task is identified in WBS-ID as the 4.2.2 activity.

The milestones of the task are:

Milestone	**Explanation**	**Date estimated**
Initiation	The laser assembly activity starts.	Week 104
Midterm review	Review of the work so far in order to evaluate the task and correct possible errors.	Week 126
Final examination	Final review where all requirements initially set are assessed and ensured to be reached.	Week 147
Task finalization	Once task is considered valid and delivered with sufficient quality, the task ends.	Week 148

Table 3: Milestones of laser assembly.

The constrains of the task are:

- Possible incompatibility between any laser component could lead to redesign and task delay, and thus generate a delay on the prototype assembly task.
- All the laser components shall be identified and reliable.

The company shall not share any information provided to external companies neither be made public and daily communication will be done by both companies. On top of that, the outsourced company shall not face any risk that can affect the company and project in a direct way. Any damage or defect occasioned to the laser components shall be in charge of the outsourced company.

If all the requirement defined in the agreement are not met, a penalisation of 10% of the whole payment for each requirement not met will be applied. Additionally, any delay on the task delivery will suppose a penalisation of 1% of the total cost for each delayed day.

The form of the procurement statement of work are deliveries in *.pdf* file sent by email that contain a report on the laser assembly procedure and a report that includes the results of the laser performance before and after modifications have been done.

The components that the laser assembly shall comprise are:

- Ground-based structure, which holds the laser system.
- High power laser.
- Laser system modules, in order to provide the system with different laser configurations.
- Additional components needed for tracking.

The pre-qualified sellers candidates that can complete the task are: *Kohoku, Contexo Automation* and *Laser Technologies*.

In order to choose the supplier, the metrics are that the company shall have large experience in laser assembly and integration. On top of that, they shall perform the task under the budget and schedule. Hence, the company offering the lowest cost will be selected. Whether the same cost is offered, the prioritization will be to the one who offers the least task duration.

The procurement metrics are different key performance indicators so that the work is assessed. They will be reviewed inside the deliveries and will be based on the laser performance results, which directly affect the performance of the overall laser debris deorbit system. These are distributed among: the quality of the product (30% of the weight), its performance (25%, where 20% of that refers to energy consumption reduction, 20% to emissions reduction, 20% to weight reduction and the rest to performance results)), its reliability (25%), the total cost (10%) and the delivery time offered (10%). This scale has been selected because the electronics manufacturing is a part that directly affects the performance of the overall system.

1.2.4 Prototype transportation

Transportation is required to move the prototype from the assembly room location ot the Telescope IAC location where it will operate during the project activity. An external company is hired to carry out the transportation. The requirements that shall be met in the task are:

- The prototype transportation must ensure all necessary objects for prototype operation and be delivered in good conditions without any damage or defect occasioned by travelling.

The type of contract is a fixed price incentive fee where a fixed fee of 15000€ plus a 10% incentive of the total cost is delivered if the task is executed properly.

A payment of 1/3 of the total cost will be made for each milestone reached.

The cost of receiving/sending the material is not in charge of the outsourced company, since it is a transportation task.

The service will start in the development of the project week 172, its duration will be of 2 weeks and it will finish at the end of week 174.

The milestones of the task are:

Milestone	Explanation	Date estimated
Initiation	The activity of prototype transportation is initiated.	Week 172
Examination	Review of the status of the prototype after delivery.	Week 174
Task ending	Once task is considered valid and delivered with sufficient quality, the task ends.	Week 174

Table 4: Milestones of prototype transportation.

The main constraints of the task are:

- The transportation shall be made under the conditions set by regulations to ensure safety travelling.
- Defects or damages occasioned by transportation shall be repaired. The repair costs shall be done by the outsourced company.

The company should not share any information provided to external companies neither be made public and daily communication will be done between the two companies. Besides, the outsourced company should not have any risk that can directly affect the company and project. Any damage done to the prototype will be in charge of the company.

Whether all the requirements that have been established in the agreement are not met, a penalisation of 10% of the whole payment for each requirement not met will be applied. In addition, if the task is delivered beyond deadline, a penalisation of 5% of the total cost for each delayed day will be applied. Since the key performance indicators contain pictures of the critical parts after travelling and of any defect, these are qualified in different categories depending on if they are critical, modifiable and despicable. Critical and modifiable defects repairs will be fully charged to the transportation company and a penalisation of 5% of the total cost despicable will be applied for each despicable defect found.

The form of the procurement statement of work are deliveries in *.pdf* file sent by email that contain a document that show the status of the critical prototype parts before and after the transportation have been done, a report identifying all defects occurred during travelling will also be delivered, and a document that ensures that travelling has been made under regulations and contains a list of all certifications used for travelling.

The components that have to be transported is the prototype once it has been fully assembled and tested.

The pre-qualified sellers candidates that can complete the task are: *AP Moller* and *DSV*. Both are among the largest transportation companies in Europe.

In order to choose between the pre-qualified sellers the metrics are that they shall have large experience in prototype transportation. The task that offers the lowest cost will be chosen and if the same cost is offered it will be selected by the least duration.

The procurement metrics are key performance indicators included in the deliveries that reflect the changes on the prototype conditions occurred during transportation. These are distributed among: the quality of the product delivered (50% of the weight), the delivery time offered (35%) and the total cost (15%).

2 Quality management plan

As we are facing a high-level challenged project with specific requirements and a substantial investment, it is important ensure the quality of the project and the corresponding parameters and factors that we are going to be based.

In this section, the most relevant factors which can have significant impact in the quality measurement are defined. Different thresholds and controls need to be carried out in order to control possible deviations in planning and results and, with thus, anticipate, mitigate or correct possible effects and results that could be out of the plan.

This section include also possible different improvements that can be leaded with the aim of enhancing the quality of the different processes described in this project. Finally, roles with higher responsibility within the quality area and consequently more impact in the resulting LODR project.

2.1 Quality Assurance Approach

To ensure the accomplishment of all the requirements and thus guaranteeing finishing the prototype and alignment of the laser system within four years, an identification process is carried out to define parameters and characteristics that are key to accomplish all the requirements.

At the same time the different processes are being performed, periodic reports will be done with every member of the consortium in order to ensure that both the time and quality management (as well as budget) are being accomplished successfully and are meeting the forecasts. Different areas of quality assurance requirements have been established, being the prototype and final testings the most determining ones.

For technical requirements, quality assurance approach is based on performing test and analysis, as explained below. Previous to the prototype building which will be the one of the most determining stage of quality, some test will be carried out in order to ensure the accomplishment of all the technical requirements.

Project Management

PM key points are defined with the aim of ensuring a correct management of time, resources and procedures.

- Feasibility of this project need to be guaranteed and it might be accomplished with the time and budget established.
- Cost baseline and budgeting are a crucial aspects to monitor since they will allow to correct any minimal cost deviation in time.
- The budget computation must be time-phased, in which the amount of money that will be spent at each time period will be specified in order to measure, monitor and control the cost performance of the project.
- The establishment of a degree of deviation is needed, at which the estimation of the cost of the activities will be rounded up or down taking into account the magnitude of the project and the scope of the activities.
- The time schedule is an important factor too, time management will be one of the main aspects to control, which is in charge of the corresponding managers.
- Legal concerns and the impact that different parameters of this project may cause in it and how it would affect to quality, schedule or budget.

Environment

A list of potential impact in the environment in terms of pollution, footprint and damage, in order to guaranteeing not only a green-friendly project but the mitigation of possible side-effects.

- Environmental impact need to be analysed, as well as the waste pollution and footprint caused by the materials used and logistic operations.
- Waste and remains of the construction of both prototype and final version and their assemblies need to be managed and guarantee that they do not cause a notable impact in the environment.
- Social-economic study has to be carried in order to ensure safety of the population.

Marketing

Strategical points that need to be assessed so the presence and visibility of this project is achieved and a strong impact can be obtained.

- Market evolution and its forecast analysis in terms of figures, technology, demand and offer, so we can be conscious about current and future needs of deorbiting of space debris.
- SWOT analysis (strengths, weaknesses, opportunities and threats) of the service proposed need to be done in order to establish solid strategies that will help to make this project successful.
- Improvements and protocols to take care of the visibility and marketing plan once the system is built and operative.

Prototype

Building of a prototype in order to test and analyse performances, with these, the detection of possible deviations or errors and their improvements can be done.

- Small-scale model construction taking care of the materials selected, they might be done with the same or similar materials from the real model design.
- Once the corresponding test are done, a scalability analysis to transfer the required characteristics to the real model will be need.
- Some extra studies will be needed if obstacles and structural issues are found in order to improve them before construction the final laser system.
- Once the corresponding assembly and testing is carried out, we will be able to translate these improvements to the final version before building it.

Technical

Technical aspects that need to be monitored with the aim of ensure the correct design, construction and testing through the process of this project.

- The proposed design need to be validated by the viability analysis described previously.
- Once its established, the assembly process has to be determined as a means of safety allocation of all parts of the laser system.
- The main components will be analysed for the purpose of ensuring the correct fabrication and integrity of every one.

Three main aspects of the deorbiter require more attention: laser system, mirrors and software. The high power laser diode and wavelength stabilizer require several tasks of monitoring and alignments, the mirror require a procedure to select the materials properly, as it will be one of the most important parts of the deorbiter.

- Software approach and analysis will be carried out and run with theoretical inputs similar to the real environment.
- Quality standards and deviation have to be established to be sure the tolerances and deviations that we can assume without compromising the functionality neither the quality of the system.

Testing among final system

Once the final system is assembled and ready to operate, previous tests need to be run.

- Mechanical, stress and strain test to guarantee the physical integrity of the laser system and the assembly system.
- Frequency, wavelength oscillation and beam divergence test to assure the correct behavior of the laser.
- Thermal and power loss test are needed to control heat transfer between components and losses of power efficiency.
- Software and performance test will be implemented to ensure the correct execution of the laser system with all its parts running together.

2.2 Quality Control Approach

Some controls and procedures must be applied in order to ensure the achievement of the quality requirements mentioned in the previous section. The quality control will have two phases, first it will be performed by the manager of each department, working in the tasks to meet the forecasts. If some of the quality assurance aspects can not be carried out, they will be paying more attention to key points, prioritising the most critical and if the delay can not be recovered, it will be put in the report and shown in the schedule planning. When they are reviewed and approved by the department manager probing that they transmit the advances of each task faithfully, they will be delivered to the project manager, who must review that the global project meets all the requirements with the established tolerances and thresholds set through the testing process. The project manager will control if the project is over the budget, for setting a control on the expenses of the departments, and also if the project does not suffer an important delay that can mean a potential obstacle. In addition, some audits will be performed in order to assure that the operators accomplish the normative, and some working tests will be done in the facilities to see if all parts perform properly, or some of them need to be calibrated or changed because they do not operate inside the established thresholds.

Project Management

QC-PM01: Schedule and time management: Description of the schedule of the project in terms of tasks duration. Activities related to the organisation of the project have to be allocated in the schedule to fit the requirements, resources and deadlines. The corresponding managers are in charge of making sure that the schedule is reached successfully, and if it is not, how the delay can be recovered and how it will affect the final deliverable.

QC-PM02: Cost monitoring and baseline: Monitoring of the economic variables of the project, in order to ensure that the budget established is being followed. Three categories of deviation and contingencies will be defined in function of the importance and priority of the task: 5%, 10% or 15% of the assigned cost. An audit will take part of the cost monitoring to ensure that this project is assessed properly in economic terms. Once the audit is done, an analysis of the results will be done to identify each deviation and how to assess them following the ISO 9000 standard.

QC-PM04: Legal procedures and documentation: Definition of the documents and activities required to safely and legally operate the deorbiter. Also, documents explaning the security measures taken by both CO-LSDD and ESA, following the legal parameters given by the latter. A study regarding the data protection of the tracked satellites is needed too in order of not having legal issues because of competencies. An audit will be carried out to ensure the legality of the project.

Weekly reports between project partners and monthly reports with members of the consortium will be carried out to assure the proper communication.

Environment

QC-EN01: Environmental impact: Has the aim of establishing the aspects/impacts against environment of the activities carried out during the project.

QC-EN02: Materials and logistics footprint analysis: Referred to the ambient cost of extraction, refinement, and transportation of the materials. Also, the identification of the environmental impact of the different activities that are part of the operational and logistics process of the project are needed. A carbon footprint calculation will be done following the ISO 9000 standard. Protocols to manage waste remains of this project need to be assessed to guarantee the minimum impact. Operational performance will be tested following the ISO 9000 standard which includes measures of regulatory stringency to account for the potential effect of environmental regulation on waste generation.

QC-EN03: Operational socio-economic study: Investigation on how the operating laser could affect the nearby population.

Environmental related analysis and procedures might be reflected into the corresponding documentation in order to establish properly the protocols.

Marketing

QC-MK01: Market evolution and forecast analysis: Analysis of the evolution of the debris deorbit market, paying special attention to the situation in the last few decades and the current one. Forecast analysis on the future of the market and how it will evolve in terms of figures, technology, demand, offer and other relevant parameters need to be assessed in order to guarantee a successful impact of this project. An external company will assess the market study.

QC-MK02: SWOT analysis: Analysis of the strengths, weaknesses, opportunities and threats of the service proposed in order to establish solid strategies that will help to make it successful following ISOo standards.

Prototype

QC-PR01: Viability analysis following ISO standard.

QC-PR02: Small-scale material analysis: The materials of which the prototype is made might not all be the same as the ones in the real-scale model, depending on the kind of test that will be made afterwards. The analysis of how these affect the structure and the laser itself is made in this section. Lately, an analysis of which elements can be substituted by cheaper alternatives in the different tests, and how this will (or will not) affect the results. Study of how the results obtained from the tests might me translated to the bigger model.

QC-PR03: Prototype testing: Testing of the prototypes of mechanical, structural and laser capabilities, the prototype will be subjected to different stimuli similar to the real model. Root analysis of the problems and results found during maintenance in order to find an optimal solution for said case to ensure optimal performance.

Technical

QC-TC01: Primary and Validated design: Initial drawings and calculations, in order to get a rough estimate of the values for sizes, materials and weights. Indications regarding how the different parts of the mechanical system will be put together are needed, and how will the system move and respond as a function of said parts following ISO standard. Classification of most to least critical regarding the operation and precision of the deorbiter. Results from testing of prototype will be taken into account.

QC-TC02: HP laser diode and wavelength stabilizer: Tasks to be carried out regarding the laser itself, and how it must be designed. The laser requires a high-power diode in order to send the signal to the satellite to be deorbited. The sent signal should have a constant wavelength in order to avoid power input and output oscillations.Test will be made via Volume Bragg Grating. Calibration tests too.

QC-TC03: Testing and integration: Run the software with the deorbiter, and excite it in different manners to see how it responds to said perturbation. Comparison of the obtained results with the expected ones.

QC-TC04: Quality standard evaluation and tolerance: Re-evaluation of the quality standards gotten previously, in comparison with the actual performance of the laser. It is an iterative process, which means these might get tighter as time goes on. Once the testing of the prototype is done, an analysis and calculation of parameters are needed. Some tolerances and thresholds will be established and with the final testing, they will be confirmed and, if necessary, re-written.

QC-TC05: Short term and long term maintenance: All maintenance which must be made periodically every 30 days or less, and every year or in other period time established, a more accurate one will be done.

Testing among final system

QC-TS01: Mechanical, stress, strain and thermal tests: different structural tests in order to obtain the most critical points in the structure and predict possible failures, the assembled system will be put under its most usual loads and we will be increasing them at a 5% until reach 80% of theoretical collapse load. An excitement of different increments of temperature will be tested in order to assure the correct behavior of the laser system in different temperature environments and a threshold for the accurate laser performance will be established.

QC-TS02: Frequency, wave and beam test: The structure will have its own eigenmodes and, thus, eigenfrequencies, which must be analyzed in order to be avoided when operating the laser system. A resonance testing will be assessed with random vibration, sine vibration and acceleration. Different measures will be done of wavelength deviation at each point in time during normal operation, and how that affects the power supply. When travelling through the atmosphere, the laser will tend to have a slight angle of divergence, which tells how much the beam width is amplified at each point.

QC-TS03: Mirror design: Selection of the material to ensure optimal optical properties and avoid heat-caused distortions. Visual testing and test with high sensitivity laser to detect possible micro-breakage during transportation that could affect the performance of mirrors.

QC-TS04: Power loss test: Identify, for different atmosphere cases, how much the power of the beam is mitigated because of atmospheric effects, such as humidity, clouds, rain and/or snow, and how that affects the power necessary to deorbit the satellite. Different environments will be simulated and operational parameters will be set to thresholds. Also, measures of power losses in the electronics.

QC-TS05: Software test: The software must be adapted and tested on the smaller scale laser before being introduced to the real scale. But once is transferred, a second test will be done to be sure about the software performance.

QC-TS06: Performance test: Once the software has been checked and the mechanical and thermal analysis have been carried out, the performance of the laser under different working conditions can be measured.

QC-TS010: Comparison to numerical results and data adjusting: Calculations and analysis of difference between final results of testing and the expected ones.

2.3 Quality Improvement Approach

Throughout the duration of the project, in order to enhance its overall quality, a continuous improvement cycle of activities will be implemented based on the PDCA (or Deming) cycle: Plan, Do, Check and Act. This tool allows testing in a continuous feedback loop, thus making evident what needs to be changed and whether the corrective measures are actually making a difference or not.

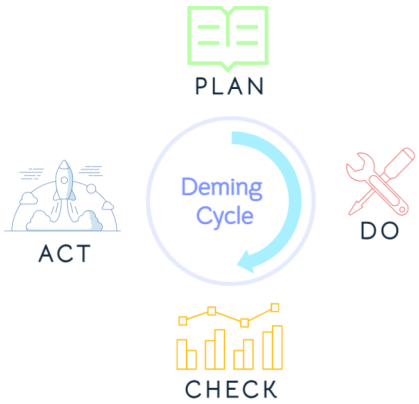

Figure 2: PDCA cycle

As shown in figure 2, the Deming cycle consists of four main steps that are performed repeatedly during the project.

- **Plan.** The first step is to identify the source of the quality decrease or those areas where there is room for improvement. Then in order to address the issues, a plan has to be developed considering that the established success criteria has to be as measurable as possible, as it will be required in the Check stage.
- **Do.** Once the layout of the implementation plan is clear, a small-scale test has to be performed. In that way one will be able to see whether the proposed changes are accomplishing the expected results. The data gathered during the implementation will be analysed in further stages.
- **Check.** In this step the data gathered in the previous pilot test is analysed. The criteria established in step one will be used to evaluate the initial plan and check if it was successful or not.
- **Act.** If the plan has been successful, it is going to be widely implemented in this step. Note that, although an improvement has been achieved at this point, the cycle may begin again taking the outcome of this first iteration as input, thus making the final result even better.

In order to make sure that the PDCA cycle tackles every aspect of the project, the managers of all the departments have to work closely along with the project managers. For that purpose, special care is being taken with the communication plan. Additionally, all the stakeholders should also be involved, which is why periodic meetings should be established. Lastly, a proper feedback system is being established in order to assess accurately the impact of the corrective measures that derive from the implementation of the Deming Cycle.

To achieve the continuous improvement previously described, the approach followed will be based on a combination of three continuous improvement methodologies: Lean, Six-Sigma and TOC (Theory Of Constraints). They are complementary as they focus on different aspects of quality improvement, and so they compensate each other's deficiencies, thus allowing a more effective quality enhancement.

2.4 Quality Roles and Responsibilities

The table presented in this section shows a compilation of the roles defined to ensure a proper quality control, along with their main responsibilities.

Role	Responsibilities
Project Manager	1. Coordinate the implementation of the quality plan in every department 2. Make final decisions regarding strategy changes or corrective actions 3. Ensure that there is no deviation from the initial project objectives
Quality Manager	1. Develop an adequate quality plan and ensure its compliance 2. Identify project weaknesses and establish quality standards 3. Monitor the work developed by all departments and subcontractors 4. Suggest corrective measures when needed and drive continuous improvement 5. Set periodic meetings with all managers to discuss quality assurance, control and improvement
Technical Managers (Laser and Electronics)	1. Lead and monitor all technical processes involved in the project 2. Ensure proper communication with the quality department 3. Explain to their team and implement the changes suggested to enhance overall quality 4. Supervise that all the consortium members meet the established standards
Accounting Manager	1. Control and track the project's revenues and expenses 2. Balance the quality improvements with the financial restrictions
Quality Engineers	1. Carry out the processes involved in the Deming Cycle 2. Report non-conformities found when performing their job 3. Report to the Quality Manager and share data with the Quality Data Analysts for processing
Quality Data Analyst	1. Collect data from the Quality Engineers 2. Monitor Key Performance Indicators 3. Check the effect of the implemented changes on the continuous quality improvement 4. Report their findings to the Quality Manager
Quality Auditors	1. Evaluate the overall quality of the project 2. Detect and report non-conformities to the Project Manager 3. Make sure that the European Commission requirements are met at all times
Consultants	1. Advise on H2020 and European Commission related issues 2. Advise on ESA regulations and environmental legislation before implementing any changes

Table 5: Quality roles and responsibilities definition

3 Risk management plan

Risk assessment and management is a tool to minimize the effect of situations that may occur during the development of the project. It is a four stage process comprising:

1. Risk detection, description and classification.
2. Risk assessment under a dual criterion of probability and impact.
3. Risk preliminary management (risk avoidance, mitigation, transfer or acceptation).
4. Risk contingency plan (specific measures).

3.1 Risk Matrix

A risk matrix visualizes risks together with the possible extent of impact and their probability of occurrence. This tool is very helpful to identify the gravest project risks, presenting the risk situation visually and comprehensively. Hence, it allows to detect which are the critical ones and which is the most effective way to reduce their effect in a suitable way.

		IMPACT				
		Negligible (1)	Minor (2)	Moderate (3)	Significant (4)	Severe (5)
PROBABILITY	Very High (5)	5	10	15	20	25
	High (4)	4	8	12	16	20
	Medium (3)	3	6	9	12	15
	Low (2)	2	4	6	8	10
	Very Low (1)	1	2	3	4	5

Table 6: Risk Matrix

3.2 Definition of Probability

In the following Table 7 it is presented how the risks will be classified regarding their probability to happen and its respective score from 1 (less likely) to 5 (most likely).

Probability	**Description**	**Probability Score**
Very High (80%-100%)	Events that are considered facts that will occur	5
High (60%-80%)	Events that its occurrence is considered with a high probability	4
Medium (40%-60%)	Events that its occurrence is considered with a medium probability	3
Low (20%-40%)	Events that its occurrence is considered with a minor probability	2
Very low (0%-20%)	Events that are supposed to be neglected	1

Table 7: List of definitions of probability

3.3 Definitions of Impact

3.3.1 Quality/scope Impact

The impact related to quality and scope is defined according to the percentage of the scope that is affected due to the risk's impact. The complete score levels are shown in Table 8.

Quality Impact	**Description**	**Quality Impact score (IQ)**
Severe	Events that will lead to dramatic consequences in terms of the project expected quality (over the 50% of the scope).	5
Significant	Events that will affect the quality of the project in a highly important way (30% to 50% of the scope).	4
Moderate	Events that will affect significantly the project expected quality (15% to 30% of the scope).	3
Minor	Situations which will have minimum effects on the quality of the project (5% to 15% of the scope).	2
Negligible	Events that will not have any effects on the quality of the project (less than the 5% of the scope).	1

Table 8: Definition of Quality Impact and its score levels.

3.3.2 Schedule Impact

The impact related to schedule is defined according to the percentage increase of the project's duration due to the risk's impact. The complete score levels are shown in Table 9.

Schedule Impact	**Description**	**Schedule Impact score (IS)**
Severe	Events that will have dramatic effects on the schedule and might result as failing to meet a deadline. The duration of the project will be extended by more than a 50% of the initial schedule.	5
Significant	Situations that will affect the planned schedule in a important way. It will increase the project duration more than a 35% of its planned duration and less than a 50%.	4
Moderate	Events that will affect the project schedule significantly. The duration will be extended by more than 25% of its initial schedule and less than 15%	3
Minor	Events that will have small effects on the project schedule. The duration of the project will be extended by less than a 25% of its initial duration	2
Negligible	Events which not affect the project schedule. The duration of the project will not be extended	1

Table 9: Definition of Schedule Impact and its score levels.

3.3.3 Cost Impact

The impact related to cost is defined according to the additional cost in percentage of budget that is produced due to the risk's impact. The complete score levels are shown in Table 10.

Cost Impact	**Description**	**Cost Impact score (IC)**
Severe	Any event which provokes a catastrophic damage / a catastrophic economical loss. The cost impact shall suppose more than the 50% of the budget.	5
Significant	Any event which provokes a great damage / a great economical loss. The expected cost impact is quantified as the 30% - 50% of the budget.	4
Moderate	Any event which provokes a significant damage / a significant economical loss. The expected cost impact is quantified as the 15% - 30% of the budget.	3
Minor	Any event which provokes a minor damage / a minor economical loss. The expected cost impact is quantified as the 5% - 15% of the budget.	2
Negligible	Any event which provokes no damage / has an insignificant impact on the budget. The cost impact shall be under the 5% of the budget.	1

Table 10: Definition of Cost Impact and its score levels.

3.4 Risk rating methodology

3.4.1 Risk Identification Methodology

The main objective behind the risk identification methodology is to uniquely define and categorize each risk. These will be labelled according to the area they belong to and a certain numeric value, according to the code shown below.

- Budget: *B.i*
- Communication: *COM.i*
- Design: *D.i*
- Human Resources: *HR.i*
- Maintenance: *MT.i*
- Logistics: *L.i*
- Manufacturing: *MF.i*
- Marketing: *MKT.i*
- Procurement: *P.i*
- Quality: *Q.i*
- Schedule: *S.i*
- Simulations: *SIM.i*
- Testing: *T.i*

For example, the code *Q.3* would be assigned to the 3^{rd} risk associated to the Quality area.

3.4.2 Risk Rating Calculation

The Overall Impact Score for each risk will be calculated through three values: the Quality Impact Score (IQ), Schedule Impact Score (IS) and the Cost Impact Score (IC). These three values will be taken into consideration as a linear combination of these three, such that

$$OI = a \cdot IQ + b \cdot IS + c \cdot IC \tag{1}$$

Where the parameters a, b and c are normalized, i.e.

$$a + b + c = 1 \tag{2}$$

As an example, if we were to take $a{=}b{=}c$, the Overall Impact Score would just be the average value between the three individual impact scores. In order to get a more accurate result for these three values, the relative weights were decided among the consortium members and key stakeholders. The main conclusion was that the focus for the project was to ensure maximum quality of the final product obtained. It must be kept in mind that the H2020 proposal budget is itself limited, and the possible income from investors is not predictable at such an early stage. Taking all of this into account means

$$OI = 0.5 \cdot IQ + 0.2 \cdot IS + 0.3 \cdot IC \tag{3}$$

However, the risks must also be categorized as a function of their probability. A certain risk might be extremely harmful for the project, but its occurrence probability is extremely low. Therefore, the OI values must be multiplied by another value corresponding to the probability of it happening, such that

$$RS = PS \cdot OI \tag{4}$$

Where PS is the Probability Score explained in section 3.2.

3.4.3 Risk Preliminary Actions Summary

Preliminary actions are the set of measures to be performed immediately after a risk appears. These are not specific actions, but general ideas of what should be done to minimize the possible effects on the project outcome. These can be classified into four categories, according on which kind of action must be taken:

- **Avoidance**: Avoid or eliminate the risk by considering other alternatives, modifying the design or flexibilizing certain requirements. This will directly eliminate said risk, but might make another one (with lower RS) appear.
- **Mitigation**: Take measures to reduce the likelihood and/or impact of a risk through a certain set of control actions.
- **Transfer**: Reduce the probability and/or impact of a risk by transferring a part or all of the responsibilities to another department of the project or to another company, or by redesigning the parts of the project and/or prototype that might be affected by said risk.
- **Acceptance**: Allow the risk to exist within the project until a certain threshold is surpassed. This might require a set of reserves in economic, time and human resources to be considered, in case said risk finally occurs.

3.5 Risk identification and assessment

Risk ID	Risk Statement	PS	Impact				RS	Preliminar Action
			IQ	IS	IC	OI		
B.1	Lack of accuracy in budget estimation	3	2	1	4	(2.4) → 2	6	Mitigation
B.2	Unpredictable occurrences: Pandemic, natural disaster...	1	5	5	5	(5) → 5	5	Mitigation
B.3	Base material cost increase	2	2	2	4	(2.6) → 3	9	Mitigation
B.4	Uneven / wrong cost distribution among departments	2	3	2	3	(2.8) → 3	6	Mitigation
COM.1	Lack of internal communication	2	4	3	2	(3.2) → 3	6	Mitigation
COM.2	Lack of external communication	3	4	4	3	(3.7) → 4	12	Mitigation
COM.3	Lack of commitment of external members	2	4	4	4	(4) → 4	8	Mitigation
D.1	Incompatibility between different parts of the design	2	5	4	3	(4.2) → 4	8	Mitigation
D.2	Performance decrease in possible alternative design	2	4	3	3	(3.5) → 4	8	Mitigation
HR.1	Lack of commitment of internal members	1	4	4	4	(4) → 4	4	Mitigation
HR.2	Mobbing, racism, physical/verbal abuse and/or discrimination	3	4	3	2	(3.2) → 3	9	Avoidance
L.1	Supplier material shortage	2	4	4	4	(4) → 4	8	Mitigation
L.2	Closing of supplier companies	1	4	5	4	(4.2) → 4	4	Mitigation
L.3	Logistics cost increase	3	2	2	4	(2.6) → 3	9	Mitigation
MF.1	Lack of quality in the resources used for the prototype	1	5	2	4	(4.1) → 4	4	Mitigation
MF.2	Misunderstanding between design plans and fabrication	2	5	4	4	(4.5) → 5	10	Mitigation
MKT.1	Miscalculation in market forecast for the product	3	1	2	3	(1.8) → 2	6	Mitigation
MKT.2	Unsuccessful marketing presentation of the project	2	1	2	3	(1.8) → 2	4	Mitigation
MT.1	Careless maintenance, usage of damaging materials	2	5	2	4	(4.1) → 4	8	Avoidance
MT.2	Unexpected part damage	4	4	4	4	(4) → 4	16	Mitigation
MT.3	Wrong RCA findings, which may result in unnecessary redesign	2	4	4	4	(4) → 4	8	Mitigation
P.1	Lack of legal aspects consideration within the project	2	2	4	3	(2.7) → 3	6	Avoidance
P.2	Legal requirements modification during project development	3	2	3	3	(2.5) → 2	6	Mitigation
P.3	Unwanted information filtering	2	1	4	4	(2.5) → 3	6	Avoidance
Q.1	Lack of quality in iterative deorbiter design	2	5	5	5	(5) → 5	10	Mitigation
Q.2	Lack of deliverable quality	3	4	4	2	(3.4) → 3	9	Mitigation
Q.3	Damaged manufactured parts because of incorrect transport to hub	3	5	4	4	(4.5) → 5	15	Mitigation

Table 11: List of risk identification and assessment

Risk ID	Risk Statement	PS	Impact IQ	IS	IC	OI	RS	Preliminar Action
S.1	Supplier time delay	4	2	5	4	(3.2) $\rightarrow$ 3	12	Mitigation
S.2	Manufacturing delay	3	3	5	4	(3.7) $\rightarrow$ 4	12	Mitigation
S.3	Delay in design technologies	3	5	4	2	(3.9) $\rightarrow$ 4	12	Mitigation
S.4	Unnecessarily dense meshing within simulations	3	4	4	5	(4.3) $\rightarrow$ 4	12	Avoidance
SIM.1	Use of imprecise / wrong methods in CFD and structural simulations	2	3	5	4	(3.7) $\rightarrow$ 4	8	Avoidance
SIM.2	Unexpected performance values in simulations	4	4	4	2	(3.4) $\rightarrow$ 3	12	Mitigation
T.1	Imprecise test definition	2	3	3	3	(3) $\rightarrow$ 3	6	Avoidance
T.2	Insufficient test selection	2	3	4	3	(3.2) $\rightarrow$ 3	6	Mitigation
T.3	Parts non-compliant with test standards	4	4	3	4	(3.8) $\rightarrow$ 4	16	Mitigation
T.4	Non-matching results between simulations and testing	4	2	4	4	(3) $\rightarrow$ 3	12	Mitigation
T.5	Unsuccessful prototype verification & validation	2	2	4	4	(3) $\rightarrow$ 3	6	Avoidance

Table 12: List of risk identification and assessment (continuation)

		IMPACT				
		Negligible (1)	Minor (2)	Moderate (3)	Significant (4)	Severe (5)
PROBABILITY	Very High (5)					
	High (4)			S.1 SIM.2 T.4	MT.2 T.3	
	Medium (3)		B.1 MKT.1 P.2	HR.2 L.3 Q.2	COM.2 S.2 S.3 S.4	Q.3
	Low (2)		MKT.2	B.3 B.4 COM.1 P.1 P.3 T.1 T.2 T.5	COM.3 D.1 D.2 L.1 MT.1 MT.3 SIM.1	MF.2 Q.1
	Very Low (1)				HR.1 L.2 MF.1	B.2

Table 13: Preliminar Risk Assessment Matrix

Risk ID	Contingency Measure	Revised Probability	Revised Impact				Revised Score	Owner
			Quality	Schedule	Cost	Overall		
B.1	Mitigation	2	1	1	2	(1.3) → 1	2	Budget Manager
B.2	Mitigation	1	3	3	3	(3) → 3	3	Budget & Schedule Managers
B.3	Mitigation	2	2	2	3	(2.3) → 2	4	Budget & Procurement Managers
B.4	Mitigation	2	2	2	1	(1.7) → 2	4	Budget Manager
COM.1	Mitigation	1	3	2	2	(2.5) → 3	3	Communications & HR Managers
COM.2	Mitigation	2	3	3	3	(3) → 3	6	Communications & HR Managers
COM.3	Mitigation	2	3	3	3	(3) → 3	6	Communications & Procurement Managers
D.1	Mitigation	1	2	3	3	(2.5) → 3	3	Design Manager
D.2	Mitigation	2	3	2	3	(2.8) → 3	6	Design, Simulation & Testing Managers
HR.1	Mitigation	1	2	3	3	(2.5) → 3	3	HR & Quality Managers
HR.2	Avoidance	1	2	3	2	(2.2) → 2	2	HR Manager
L.1	Mitigation	2	3	3	4	(3.3) → 3	6	Logistics, Procurement, Schedule & Budget Managers
L.2	Mitigation	1	3	3	4	(3.3) → 3	3	Logistics, Procurement, Schedule & Budget Managers
L.3	Mitigation	3	2	1	2	(1.8) → 2	6	Logistics & Budget Managers
MF.1	Mitigation	1	3	2	4	(3.1) → 3	3	Manufacturing, Testing & Procurement Managers
MF.2	Mitigation	1	3	4	4	(3.5) → 4	4	Manufacturing & Quality Managers
MKT.1	Mitigation	2	1	1	2	(1.3) → 1	2	Marketing, Quality, Schedule & Budget Managers
MKT.2	Mitigation	1	1	2	3	(1.8) → 2	2	Marketing & Quality Managers
MT.1	Avoidance	0	3	2	2	(2.5) → 3	0	Maintenance & Quality Managers
MT.2	Mitigation	2	2	4	4	(3) → 3	6	Maintenance Manager
MT.3	Mitigation	1	2	4	4	(3) → 3	3	Maintenance Manager
P.1	Avoidance	0	2	4	3	(2.7) → 3	0	Procurement Manager & Legal Expert
P.2	Mitigation	3	1	3	3	(2) → 2	6	Procurement Manager
P.3	Mitigation	1	1	4	4	(2,5) → 3	3	Procurement Manager
Q.1	Mitigation	1	2	5	5	(3.5) → 4	4	Quality Manager
Q.2	Mitigation	1	4	4	2	(3.4) → 3	3	Quality Manager
Q.3	Mitigation	1	5	4	4	(4.5) → 5	5	Quality & Design Managers
S.1	Mitigation	2	2	2	4	(2.6) → 3	6	Schedule Manager
S.2	Mitigation	2	3	2	3	(2,8) → 3	6	Schedule Manager
S.3	Mitigation	1	5	4	2	(3.9) → 4	4	Schedule Manager
S.4	Avoidance	0	4	4	5	(4.3) → 4	0	Schedule Manager
SIM.1	Avoidance	0	3	5	4	(3.7) → 4	0	Simulations Manager
SIM.2	Mitigation	2	2	2	2	(2) → 2	4	Simulations Manager
T.1	Avoidance	0	3	3	3	(3) → 3	0	Testing Manager
T.2	Mitigation	1	1	4	3	(2,2) → 2	2	Testing Manager
T.3	Mitigation	3	4	3	1	(2.9) → 3	9	Testing, Manufacturing & Quality Managers
T.4	Mitigation	2	2	4	4	(3) → 3	6	Testing Manager& Simulation Managers
T.5	Avoidance	0	2	4	4	(3) → 3	0	Quality Auditor

Table 14: List of revised risk identification and assessment

		IMPACT				
		Negligible (1)	Minor (2)	Moderate (3)	Significant (4)	Severe (5)
PROBABILITY	Very High (5)					
	High (4)					
	Medium (3)		L.3 P.2	T.3		
	Low (2)	B.1 MKT.1	B.3 B.4 S.1 SIM.2	COM.2 COM.3 D.2 L.1 MT.3 S.2 T.4		
	Very Low (1)		HR.2 MKT.2 T.2	B.2 COM.1 D.1 HR.1 L.2 MF.1 P.3 Q.2	MF.2 Q.1 S.3	Q.3

Table 15: Revised Risk Assessment Matrix

3.6 Risk data sheet

Risk ID: B.1	**Risk Description:** Lack of accuracy in budget estimation					
Status: Open	**Risk Cause:** At early stages of the project is easy to not take into account some delays or material that will incur to additional costs of the project.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	2	1	4	6	In order to reduce large deviations in budget due to possible modifications, the budget will be updated periodically according to the needs of the project. If any change is needed, this will be considered critical.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	1	1	2	2	Budget Manager.	Mitigation
Secondary Risks: Lack of budget on later stages.						
Residual Risk: If the revision is not dilligent, there may still be a lack of accuracy.						
Contingency Plan: Carry out an accurate estimation of tasks when Preliminary Design Review (PDR) milestone cannot be fulfilled.	**Contingency Funds:** 288 €					
	Contingency Time: 8 days					
Comments: Project Management Tools will be very useful to ensure the proper evaluation of the budget periodically.						

Risk ID: B.2	**Risk Description:** Unpredictable occurrences: Pandemic, natural disaster, ...					
Status: Open	**Risk Cause:** Some external global and natural events may happen during the project and this is almost unpredictable.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
1	5	5	5	5	Since unpredictable occurrences cannot be predicted, a measure for redistribution of economic resources will be destined to cover such consequences and will only be effectuated if such phenomena happens. If needed, a schedule-impact study and re-scheduling task will be carried out by the Scheduling dept.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	3	3	3	3	Budget and Schedule managers.	Mitigation
Secondary Risks: Lack of disaster recovery plans (DRP) in the case of one of these scenarios become real.						
Residual Risk: Over-estimation of the budget						
Contingency Plan: Stop current tasks and cancel scheduled ones.	**Contingency Funds:** Dependence on the moment in which it occurs within the course of the project.					
	Contingency Time: Undefined					
Comments: Being aware of the climate conditions and having external advisory will be useful to enhance the reaction to the scenarios						

Risk ID: B.3	**Risk Description:** Base material cost increase					
Status: Open	**Risk Cause:** As the market prices are not fixed, the values of the price for the material may change.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	2	2	4	6	Procurement dept. will be assigned to find possible funding sources in order to solve such cost increases. Budget dept. will have to update the budget accordingly.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	2	3	4	Budget and Procurement Managers.	Mitigation
Secondary Risks: N/A						
Residual Risk: The procurement dpt. may not find any external funding source.						
Contingency Plan: Carry out a material cost estimate when Project Feasibility milestone cannot be fulfilled.				**Contingency Funds:** 9.643 €		
				Contingency Time: 17 days		
Comments: -						

Risk ID: B.4	**Risk Description:** Uneven / wrong cost distribution among departments					
Status: Open	**Risk Cause:** The departments must have similar or proportional to the work load cost distribution.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	3	2	3	6	A budget update will have to be done after reassessing the economical needs of each department.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	2	1	4	Budget Manager.	Mitigation
Secondary Risks: N/A						
Residual Risk: If this is not due periodically the risk may persist						
Contingency Plan: Redistribution of the available budget when a department estimates that it will run out of funds.				**Contingency Funds:** 288 €		
				Contingency Time: 4 days		
Comments: -						

Risk ID: COM.1	**Risk Description:** Lack of internal communication					
Status: Open	**Risk Cause:** It is a key factor to keep all the departments and managers continuously communicating the progress and problems.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	4	3	2	6	Keep active the means of communication with internal members and create new ones if needed. HR dept. to perform possible feedback meetings with members.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	3	2	2	3	HR and Communications Manager	Mitigation
Secondary Risks: -						
Residual Risk: Lack of internal communication						
Contingency Plan: Schedule regular meetings to improve communication between departments.	**Contingency Funds:** 231 €					
	Contingency Time: 3 days					
Comments: Using meetings to deliver information is a possible solution to keep up with the information of all the departments.						

Risk ID: COM.2	**Risk Description:** Lack of external communication					
Status: Open	**Risk Cause:** It is a key factor to keep all the external entities and stake-holders continuously communicating the progress and problems.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	4	4	3	12	Keep active the means of communication with external members and create new ones if needed. HR dept. to perform possible feedback meetings with members.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	3	3	3	6	HR and Communications Manager.	Mitigation
Secondary Risks: Lost of trustworthiness of the project.						
Residual Risk: Lack of external communication						
Contingency Plan: Schedule regular meetings to improve communication between suppliers and subcontractors.	**Contingency Funds:** 231 €					
	Contingency Time: 5 days					
Comments: Using meetings to deliver information is a possible solution to keep up with the information between all the external sources.						

Risk ID: COM.3	**Risk Description:** Lack of commitment of external members					
Status: Open	**Risk Cause:** The lack of information due to low commitment of the external members can lead to several problems such as delays and budget increase.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	4	4	4	8	Promote and enhance the means of communication with external members in order to receive feedback and search for points of agreement and improvement. Business negotiations to be led by the Procurement dept.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	3	3	3	6	Communications and Procurement Manager.	Mitigation
Secondary Risks: Lack of communication with the external members.						
Residual Risk: Lack of commitment of the external members.						
Contingency Plan: Progress presentations to keep stakeholders' attention.				**Contingency Funds:** 288 €		
				Contingency Time: 28 days		
Comments: -						

Risk ID: D.1	**Risk Description:** Incompatibility between different parts of the design					
Status: Open	**Risk Cause:** As the system is composed of different subsystems, some problems may arise due to some misunderstanding in the specifications.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	5	4	3	8	Perform an incompatibility study in order to analyse the causes and possible design solutions. Finally, implement the changes in the model.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	2	3	3	3	Design Manager.	Mitigation
Secondary Risks: Not taking into account non-critical systems may lead to some incompatibilities.						
Residual Risk: Incompatibilities of non-critical systems.						
Contingency Plan: Redesign the parts when First Prototype Arrangement milestone cannot be fulfilled.				**Contingency Funds:** 15.556 €		
				Contingency Time: 3 months		
Comments: -						

Risk ID: D.2	**Risk Description:** Performance decrease in possible alternative design					
Status: Open	**Risk Cause:** As the design may change from the original one, this variation can decrease the overall performance of the systems.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	4	3	3	8	A performance study of the alternative design will be carried out by the Simulations department and then the Testing department will validate the results. If poor performance is obtained with the model, send back the re-design task to the Design department.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	3	2	3	6	Design, Simulation and Testing Manager.	Mitigation
Secondary Risks: Unavailability of improvement of the performance for the alternative design.						
Residual Risk: Decrease in the overall performance of the systems.						
Contingency Plan: Modular design of the components for better adaptability.	**Contingency Funds:** 4.444 €					
	Contingency Time: 3 months					
Comments: Always communicate the changes in the performance of the systems to all the internal and external members. Also communicate the actions taken to minimize this performance decrease.						

Risk ID: HR.1	**Risk Description:** Lack of commitment of internal members					
Status: Open	**Risk Cause:** The lack of information due to low commitment of the internal members can lead to several problems such as delays and budget increase.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
1	4	4	4	4	Perform periodic meetings in order to ask for feedback with the uncommitted member and assess the possible outcomes. The Quality dept. will keep a monitoring of the behaviour and performance of the member in order to track his progress and give this data back to the HR dept. for the sake of information.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	2	3	3	3	HR and Quality Managers.	Mitigation
Secondary Risks: Lack of communication with the internal members.						
Residual Risk: Lack of commitment of the internal members.						
Contingency Plan: Progress meetings and presentations to keep internal members attention.	**Contingency Funds:** 231€					
	Contingency Time: 2 days					
Comments: -						

Risk ID: HR.2	**Risk Description:** Mobbing, racism, physical/verbal abuse and/or discrimination					
Status: Open	**Risk Cause:** A bad behaviour concerning the way the internal members are treated.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	4	3	2	9	When detecting any sign that could lead to unacceptable behaviours, take preventing measures by doing a meeting with the person in observation and take actions if needed. These kind of behaviours will be eradicated before even being produced, so they will be avoided.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	2	3	2	2	HR Manager.	Avoidance
Secondary Risks: Internal members trustworthiness loss.						
Residual Risk: Bad public image of the company.						
Contingency Plan: Unemployment of the member and search for new candidates.	**Contingency Funds:** 173€					
	Contingency Time: 7 days					
Comments: Always try to keep the values of the company as the standard for integration.						

Risk ID: L.1	**Risk Description:** Supplier material shortage					
Status: Open	**Risk Cause:** The market stocks are always changing, and it can be possible an scenario where there is no material in a suitable time for the project.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	2	2	4	9	Assign, in first instance, to the Procurement dept. the task of searching for new material suppliers. Assign, in second instance, to the Scheduling dept. the task of performing a schedule-impact study due to the material shortage. Assign, in last place, to the Budget dept. the task of updating the budget according to the new supplier's material.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	3	3	4	6	Logistics, Procurement, Schedule and Budget Mngr.	Mitigation
Secondary Risks: Delays in the scheduling, increase of the overall budget.						
Residual Risk: Lack of quality of the resources used to replace the material that is needed.						
Contingency Plan: Budget recalculation and search for new suppliers.	**Contingency Funds:** 16.071 €					
	Contingency Time: 50 days					
Comments: -						

Risk ID: L.2	**Risk Description:** Closing of supplier companies					
Status: Open	**Risk Cause:** During the schedule of the project, some companies planned to provide some resources may close.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	2	2	4	9	Assign, in first instance, to the Procurement dept. the task of searching for new material suppliers. Assign, in second instance, to the Scheduling dept. the task of performing a schedule-impact study due to the material shortage. Assign, in last place, to the Budget dept. the task of updating the budget according to the new supplier's material.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	3	3	4	3	Logistics, Procurement, Schedule and Budget Mngr.	Mitigation
Secondary Risks: Delays in the scheduling, increase of the overall budget.						
Residual Risk: Lack of quality of the resources used to replace the material that is needed.						
Contingency Plan: Budget recalculation and search for new suppliers.				**Contingency Funds:** 16.071 €		
				Contingency Time: 50 days		
Comments: -						

Risk ID: L.3	**Risk Description:** Logistics cost increase					
Status: Open	**Risk Cause:** As the logistics are externalised, the costs can be increased due to external conditions such as increase on the prices.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	2	2	4	9	Procurement dept. will be assigned to find possible funding sources in order to solve such cost increases. Budget dept. will have to update the budget accordingly.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
3	2	1	2	6	Logistics and Budget Managers.	Mitigation
Secondary Risks: Delays in the delivery of the systems.						
Residual Risk: The procurement dpt. may not find any external funding source.						
Contingency Plan: Previous fixed price with logistics subcontractors.				**Contingency Funds:** 1.607 €		
				Contingency Time: 13 days		
Comments: -						

Risk ID: MF.1	**Risk Description:** Lack of quality in the resources used for the prototype					
Status: Open	**Risk Cause:** The resources used can be of lower quality than the one needed in the final systems.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
1	5	2	4	4	Testings of the defective product to be performed by the Testing dept. in order to study the causes of this low quality. Then a study and assessment of the usage of more high-quality resources will be done by the Procurement dept.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	3	2	4	3	Manufacturing, Testing and Procurement Mngrs.	Mitigation
Secondary Risks: Lack of test quality or diligence.						
Residual Risk: Not enough quality resources found for the systems.						
Contingency Plan: Review the quality of the resources if the First Prototype Arrangement milestone is not fulfilled.					**Contingency Funds:** 16.071€	
					Contingency Time: 2 months	
Comments: -						

Risk ID: MF.2	**Risk Description:** Misunderstanding between design plans and fabrication					
Status: Open	**Risk Cause:** The design plans and the manufacturing process must be very aligned, otherwise some problems may arise.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	5	4	4	10	Assign a root cause analysis to the Quality dept. in order to track and solve this misunderstanding.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	3	4	4	4	Manufacturing and Quality Managers.	Mitigation
Secondary Risks: Having to re-start all the manufacturing process for not finding a root cause.						
Residual Risk: Increase of the budget, delays on the schedule.						
Contingency Plan: Check the feasibility of manufacturing with the companies in charge.					**Contingency Funds:** 4.444€	
					Contingency Time: 3 months	
Comments: -						

Risk ID: MKT.1	**Risk Description:** Miscalculation in market forecast for the product					
Status: Open	**Risk Cause:** Not properly calculating the prices and volume needed of the resources.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	1	2	3	6	Study the economical and scheduling effects of having experienced errors in the market forecast by assigning it to the Budget and Scheduling depts. In addition, the Quality department will analyse the causes of this worse forecast.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	1	1	2	2	Marketing, Quality, Schedule and Budget Mngrs.	Mitigation
Secondary Risks: Making assumptions of the market forecast.						
Residual Risk: Budget increase, schedule delay.						
Contingency Plan: Recalculate resources periodically to adapt to market changes.				**Contingency Funds:** 288€ **Contingency Time:** 9 days		
Comments: -						

Risk ID: MKT.2	**Risk Description:** Unsuccessful marketing presentation of the project					
Status: Open	**Risk Cause:** When presenting the project to the market, not being precise or not having the impact expected.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	1	2	3	4	Mitigate the effects at long term by performing a reassessment of the presentation approach and assigning a detailed review of the presentation to the Quality dept.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	1	2	3	2	Marketing and Quality Managers.	Mitigation
Secondary Risks: Lost in project impact and excellence.						
Residual Risk: Lost in project impact and excellence.						
Contingency Plan: Check influence with marketing specialist company.				**Contingency Funds:** 3.462€ **Contingency Time:** 2 months		
Comments: -						

Risk ID: MT.1	**Risk Description:** Careless maintenance, usage of damaging materials					
Status: Open	**Risk Cause:** Having bad habits in the maintenance processes and/or usage damaging materials.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	5	2	4	8	The Quality dept. will make sure to have implemented manuals and high-standards to be followed in the maintenance process so this risk doesn't happen.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	3	2	2	0	Maintenance and Quality Managers.	Avoidance
Secondary Risks: The improvements may lead to a budget increase.						
Residual Risk: Budget increase and schedule delays.						
Contingency Plan: Appropriate training for quality maintenance.	**Contingency Funds:** 1.667€					
	Contingency Time: 1 month					
Comments: -						

Risk ID: MT.2	**Risk Description:** Unexpected part damage.					
Status: Open	**Risk Cause:** Lack of previous knowledge about the possible failures of each part.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	4	4	4	16	For each part, make a study of similarly working parts in similar machines, so as to have a list of possible failures.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	4	4	6	Maintenance Manager	Mitigation
Secondary Risks: Not finding similar parts because it is a new technology.						
Residual Risk: -						
Contingency Plan: Study the reason for the unexpected damage and try to improve the design.	**Contingency Funds:** 1.111€					
	Contingency Time: 2 months					
Comments: -						

Risk ID: P.1	**Risk Description:** Lack of legal aspects consideration within the project.					
Status: Open	**Risk Cause:** Lack of communication with the authorities.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	2	4	3	6	Have one responsible in the team, if possible from ESA, who is responsible of knowing and informing us of every legal aspect to be taken into account.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	2	4	3	0	Procurement Manager and Legal Expert	Avoidance
Secondary Risks: -						
Residual Risk: Bad communication between the legal responsible and each department.						
Contingency Plan: Contracting more responsible people to assure the consideration of legal aspects in the project.					**Contingency Funds:** 1.154€	
					Contingency Time: 7 days	
Comments: -						

Risk ID: P.2	**Risk Description:** Legal requirements modification during project development.					
Status: Open	**Risk Cause:** Legal authorities modify some legislation affecting the project.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	2	3	3	6	Negotiate with ESA & EU so as to have flexibility regarding the initial conditions given for the production and functioning of the deorbiter.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
3	1	3	3	6	Procurement Manager	Mitigation
Secondary Risks: Difficulty for the later legalization of the system.						
Residual Risk: Unexpected legal requirement modifications witch would not allow the project to continue.						
Contingency Plan: Changing the necessary parts of the project to fulfill the requirements if possible.					**Contingency Funds:** 82€	
					Contingency Time: 3 days	
Comments: -						

Risk ID: P.3	**Risk Description:** Unwanted information filtering.					
Status: Open	**Risk Cause:** Lack of some kind of filter for unwanted information.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	1	4	4	6	Before any information is sent via e-mail, it must pass, if possible, through a filter checking if the receiver is in a given list of accepted e-mail receivers. If not, a warning message will be sent, and the person who sent it must confirm that the receiver is the expected one.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	1	4	4	3	Procurement Manager	Avoidance
Secondary Risks: Filtering information that is actually wanted.						
Residual Risk: -						
Contingency Plan: If any incident occur, it must be communicated to the procurement department to solve the problem.					**Contingency Funds:** Undefined **Contingency Time:** Undefined	
Comments: -						

Risk ID: Q.1	**Risk Description:** Lack of quality in iterative deorbiter design.					
Status: Open	**Risk Cause:** Not following the quality guides. Lack of inspection from the quality department.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	5	5	5	10	Through State of the Art and reverse engineering, every part must be designed so as to follow the quality requirements of the company, following the development of a quality management plan.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	2	5	5	4	Quality manager	Mitigation
Secondary Risks: Spending too many resources in quality.						
Residual Risk: -						
Contingency Plan: Quality manager must search for the source of the problem and take the necessary actions to assure the quality of the deliverables.					**Contingency Funds:** 6.667€ **Contingency Time:** 7 months	
Comments: -						

Risk ID: Q.2	**Risk Description:** Lack of deliverable quality.					
Status: Open	**Risk Cause:** Not following the quality guides. Lack of inspection from the quality department.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	4	4	2	9	Every deliverable must strictly follow the guidance given by the quality department, following the quality management plan explained in Q.1.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	4	4	2	3	Quality manager	Mitigation
Secondary Risks: Spending too many resources in quality.						
Residual Risk: -						
Contingency Plan: Quality manager must search for the source of the problem and take the necessary actions to assure the quality of the deliverables.					**Contingency Funds:** 2.308€ **Contingency Time:** 1 month	
Comments: -						

Risk ID: Q.3	**Risk Description:** Damaged manufactured parts because of incorrect transport to hub.					
Status: Open	**Risk Cause:** Incorrect communication with the transport. Transport not following the indications provided.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	5	4	4	15	Procurement must provide detailed explanations of how every single part should be transported so as not to be damaged, following recommendations given by the design department.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	5	4	4	5	Quality and Design Managers	Mitigation
Secondary Risks: Increase in the cost of transportation of manufactured parts.						
Residual Risk: If all parameters and instructions are followed correctly there should be no problems.						
Contingency Plan: In case a damaged part is delivered, it will be revised and fixed if possible or manufactured again.					**Contingency Funds:** 1.607€ **Contingency Time:** 15 days	
Comments: -						

Risk ID: S.1	**Risk Description:** Supplier time delay.					
Status: Open	**Risk Cause:** Supply shortage.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	2	5	4	12	If possible, the materials to be supplied must be ordered in advance, and a fee depending on the delay must be agreed when signing the contracts.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	2	4	6	Schedule Manager	Mitigation
Secondary Risks: Difficulty to find suppliers disposed to the conditions.						
Residual Risk: Delivery delay from the suppliers even the mitigation actions.						
Contingency Plan: Reorganize the necessary parts of the schedule to minimize the impact of such delay.				**Contingency Funds:** 173€ **Contingency Time:** 2 days		
Comments: -						

Risk ID: S.2	**Risk Description:** Manufacturing delay.					
Status: Open	**Risk Cause:** Unexpected complexity for the manufacturers. Supply shortage. Manufacturers not following the agreed schedule.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	3	5	4	12	Similar to S.1, the manufacturer must be prepared to build whatever parts are required in advance. A fee for delay must also be agreed.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	3	2	3	6	Schedule Manager	Mitigation
Secondary Risks: Difficulty to find manufacturers disposed to take the risk.						
Residual Risk: Delivery delay from the manufacturers even the mitigations actions.						
Contingency Plan: Reorganize the necessary parts of the schedule to minimize the impact of such delay.				**Contingency Funds:** 173€ **Contingency Time:** 2 days		
Comments: -						

Risk ID: S.3	**Risk Description:** Delay in design technologies.					
Status: Open	**Risk Cause:** Choosing very modern technologies that are very time consuming.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	5	4	2	12	Alternative designs must be considered when investigating, other than the most breakthrough technologies. Sometimes these may not be available due to costs, time or production capabilities.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	5	4	2	4	Schedule Manager	Mitigation
Secondary Risks: Not being able to reach the desired improvement compared to actual technics because of not using technologies modern enough.						
Residual Risk: When creating a new technology there is always some uncertainty in the time consumed for the design.						
Contingency Plan: In case the delay increases significantly the project should choose better known technologies.				**Contingency Funds:** 3.111€ **Contingency Time:** 1 month		
Comments: -						

Risk ID: S.4	**Risk Description:** Unnecessarily dense meshing within simulations.					
Status: Open	**Risk Cause:** Overprotecting in simulations pre-processing.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
3	4	4	5	12	Previous studies from similar parts must be considered, especially the mesh convergence analysis section. Correctly interpreting these results will be translated in negligible time delays due to incorrect meshing.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	4	4	5	0	Schedule Manager	Avoidance
Secondary Risks: Inaccurate meshing. Drag previous mistakes to this project.						
Residual Risk: Simulations are never 100% accurate to reality						
Contingency Plan: Revise the study that lead to the use of such methods and correct the wrong assumptions and possible errors.				**Contingency Funds:** 1.111€ **Contingency Time:** 3 days		
Comments: -						

Risk ID: SIM.1	**Risk Description:** Use of imprecise/wrong methods in CFD and structural simulations.					
Status: Open	**Risk Cause:** Incorrect assumptions and methods used in study previous to simulations.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	3	5	4	8	Every single structural or fluidic case has a certain preferred model (such as turbulence models in fluids), which will be studied and considered before beginning any simulations.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	3	5	4	0	Simulations Manager	Avoidance
Secondary Risks: -						
Residual Risk: Simulations are never 100& accurate to reality.						
Contingency Plan: Revise the study that lead to the use of such methods and correct the wrong assumptions and possible errors.				**Contingency Funds:** 1.111€ **Contingency Time:** 10 days		
Comments: -						

Risk ID: SIM.2	**Risk Description:** Unexpected performance values in simulations.					
Status: Open	**Risk Cause:** Inaccurate simulation. Incorrect assumptions in simulation.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	4	4	2	12	The simulations must accurately follow the parameters given by the design, so the pre-processing is the most important part of the simulation. Study how to accurately depict the reality (even if so means building a bigger model in simulations) is key to avoid unexpected results.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	2	2	4	Simulations Manager	Mitigation
Secondary Risks: Increase time needed to perform simulations.						
Residual Risk: Simulations are never 100% accurate to reality.						
Contingency Plan: Revise simulations accurately follow the parameters given by the design. Improve and fine tune simulation definitions.				**Contingency Funds:** 1.111€ **Contingency Time:** 10 days		
Comments: -						

Risk ID: T.1	**Risk Description:** Imprecise test definition.					
Status: Open	**Risk Cause:** Not investing the necessary resources in test definition.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	3	3	3	6	Assign enough resources to test design. Every single detail must be considered in test definition considering what can go wrong in every step. This will be checked with similar tests done by previous engineering teams, which will help reducing uncertainties.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	3	3	3	0	Testing Manager	Avoidance
Secondary Risks: Differences between previous tests and our tests may lead to errors. Drag previous mistakes to this project.						
Residual Risk: -						
Contingency Plan: Revise test design and improve existing tests or create new tests to obtain all the necessary information.				**Contingency Funds:** 4.444€		
				Contingency Time: 7 days		
Comments: -						

Risk ID: T.2	**Risk Description:** Insufficient test selection.					
Status: Open	**Risk Cause:** Test design not taking in to account all the necessary parameters to acquire.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	3	4	3	6	Every single parameter of the deorbiter must be obtained by at least one test, and, if possible, by two or more (such as maximum heat transfer, maximum tension, maximum temperature...) so as to confirm both analysis and the results obtained.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
1	1	4	3	2	Testing Manager	Mitigation
Secondary Risks: Increase in time and cost spending due to more tests than necessary.						
Residual Risk: Neglect dependencies between some parameters of the deorbiter.						
Contingency Plan: Revise test design and improve existing tests or create new tests to obtain all the necessary information.				**Contingency Funds:** 4.444€		
				Contingency Time: 1 month		
Comments: -						

Risk ID: T.3	**Risk Description:** Parts non-compliant with test standards.					
Status: Open	**Risk Cause:** Not following test standards in design phase. Manufacturers not following the necessary quality. Bad information exchange between test standards responsible and manufacturers.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	4	3	4	16	Correctly defining the designed parts and having the manufacturers strictly follow the quality parameters given. Also, when designing, certain margins of safety must be imposed.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
3	4	3	1	9	Testing, Manufacturing, and Quality Managers	Mitigation
Secondary Risks: -						
Residual Risk: Manufacturers not following the quality parameters.						
Contingency Plan: Verify again the assumptions taken in the simulations and assure the correct behavior of the test machinery.				**Contingency Funds:** 173€ **Contingency Time:** 2 days		
Comments: -						

Risk ID: T.4	**Risk Description:** Non-matching results between simulations and testing					
Status: Open	**Risk Cause:** Incorrect assumptions taken in the simulation. Errors committed during test phase.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
4	2	4	4	12	All machinery in the tests must be certified, and simulations must be verified before going into the testing phase. By combining these two factors, the differences caused by the result might be decreased.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
2	2	4	4	6	Testing and Simulation Managers	Mitigation
Secondary Risks: Increase cost of simulation and testing.						
Residual Risk: Simulations are never 100% accurate to reality.						
Contingency Plan: Verify again the assumptions taken in the simulations and assure the correct behavior of the test machinery.				**Contingency Funds:** 173€ **Contingency Time:** 2 days		
Comments: -						

Risk ID: T.5	**Risk Description:** Unsuccessful prototype verification and validation					
Status: Open	**Risk Cause:** Not being able to pass the required test for the verification and validation.					
Probability	**Impact**			**Score**	**Responses**	
	Scope/Quality	**Schedule**	**Cost**			
2	2	4	4	6	Some activities within the project might not be following the quality standards set by the company. By performing an external audit, these can be found and corrected, if necessary.	
Revised Probability	**Revised Impact**			**Revised Score**	**Owner**	**Actions**
	Scope/Quality	**Schedule**	**Cost**			
0	2	4	4	0	Quality Auditor	Avoidance
Secondary Risks: Adding too much complexity to the quality management work.						
Residual Risk: Unexpected events.						
Contingency Plan: Look for an external audit to correct the quality mistakes made.					**Contingency Funds:** 16.071€ **Contingency Time:** 5 months	
Comments: -						

4 Plan communication management

This plan's aim is to define all the aspects related to the communications involved in the project, both internally and externally. This will be used as a guide through the whole project and that needs to be followed to guarantee that all the involved parties have the necessary information from the other parts in order to develop their role. It is susceptible to change in the event that it is needed further on.

This Communication Management Plan will include, among others, the roles and responsibilities of each person or team involved in terms of communication, the people/agents involved in each type of communication and its requirements (communication matrix), a guide for the meetings and a project team directory specially designed for the stakeholders directly involved in the project. It will also define how the meetings will be conducted by stating the channels through which the information will be communicated (both formal and informally), the frequency of the communications and the structure of the formal communications.

4.1 Participants roles and responsibilities

In this section, the roles and responsibilities of the CO-LSDD staff with regard to the Communication Plan are described. The project organization is briefly listed, as it pertains to the internal flow of communication (vertically and horizontally), and the relationships between the different teams, the project sponsor and the project manager are also described. The oversight agencies and the stakeholders involved in managing communications are also identified.

In Figure 3, all of the mentioned participants, as well as the relationships between them and the kind of meeting (see section 4.2.2) they would conduct, are presented in a schematised way.

Communications Manager

The CO-LSDD communications manager is responsible for the definition of the internal tools and procedures which will be used to make announcements and transmit/receive information and data inside the company, in order to ensure a fluent communication between all the parts. The CO-LSDD communications manager is also in charge of identifying the people in charge of communications among the different departments as well as defining the meetings between these contact points in terms of frequency, agenda and participants.

Project Manager

The CO-LSDD project manager is responsible for communicating status for scope, schedule, and cost, as well as monitoring, controlling, and communicating the risks. The manager also has the responsibility to guarantee that all information related to the project is consistent, correct, accurate, and timely; and will be in charge of reviewing and approving all the information that is being provided to the various stakeholders. The project manager will make sure that continued user involvement and requirements remain relatively stable throughout the project life.

Steering Committee

The CO-LSDD Steering committee will be responsible for providing and maintaining the necessary resources needed for the successful completion of the CO-LSDD project, especially in terms of strategic direction, as well as resolve conflicts or expedite processes which may not be resolved at a lower level. Besides, the committee will offer leadership, support, and assist in implementing departmental policies as required to support the CO-LSDD.

Advisory Committee

The CO-LSDD Advisory Committee, similarly to the Steering Committee, will provide leadership and direction by communicating directly with the Project Management team and making recommendations to the project sponsor. From an external (and more independent) point of view, it will be in charge of reviewing the progress, risks, and issues as well as recommend resolutions to those. The Advisory Committee will also have an educating role by providing means for training and support for its implementation among the program staff. Finally, it will provide independent and expert advice on both technical and policy affairs.

Business Project Team

The CO-LSDD Business Project Team is responsible for defining the adequate requirements based on the market demands and provide the information extracted from the analysis of the CO-LSDD viability to the project manager. The CO-LSDD Business Team has the responsibility of performing user tests in order to improve different areas of the CO-LSDD and make the entering to the laser debris deorbit sector feasible by accepting or not the different products and solutions proposed.

Technical Project Team

The CO-LSDD Technical Project team will have the key role of designing and manufacturing the laser infrastructure, documenting the whole process, converting data, implementing the software and assembly, and finally provide the ongoing operational support of the CO-LSDD, all of this in a prosperous manner. The technical team will also be responsible for developing, providing, and conducting training to the state for the CO-LSDD project. Because of this, the technical team will need to be in constant communication, first, between the different technical departments (e.g. the laser and the electronics design teams) or the members of each individual team (horizontally and vertically), but also between those departments and other non-related like the Business Project Team or, obviously, the Project Management.

The CO-LSDD technical team flow of communications is essential in order to manufacture, assembly and finally deliver a system that meets all the functional requirements of the contract. The CO-LSDD technical team shall deliver the system per the schedule that will be described in the state approved CO-LSDD Project Management Plan.

The CO-LSDD technical project lead (assumed part of CleanOrbit staff) will oversee the other technical personnel working on the solution, including any contractors, like the rest of the Consortium partners, and subcontractors (e.g. RUAG or OHB Systems AG). The CO-LSDD technical project lead will be responsible for collecting and gathering all CO-LSDD related information from the subcontractors under their current contract.
This technical project lead is also responsible to report any issues impacting the project, especially in costs/time aspects, provide recommendations to resolve the issues that may appear, and assist and collaborate with the project manager, whom it will report directly to, in the successful implementation of the whole CO-LSDD project by providing all the project information related to the technical side to him/her.

Oversight

The CO-LSDD project will be supervised by the European Commission through the whole duration by means of the Project Coordinator (EC National contact point). The CO-LSDD Project Manager will be in charge of notifying the European Commission with the updates and/or changes in the project schedule. The European Commission will make sure the project is correctly developed following the predicted schedule and costs.

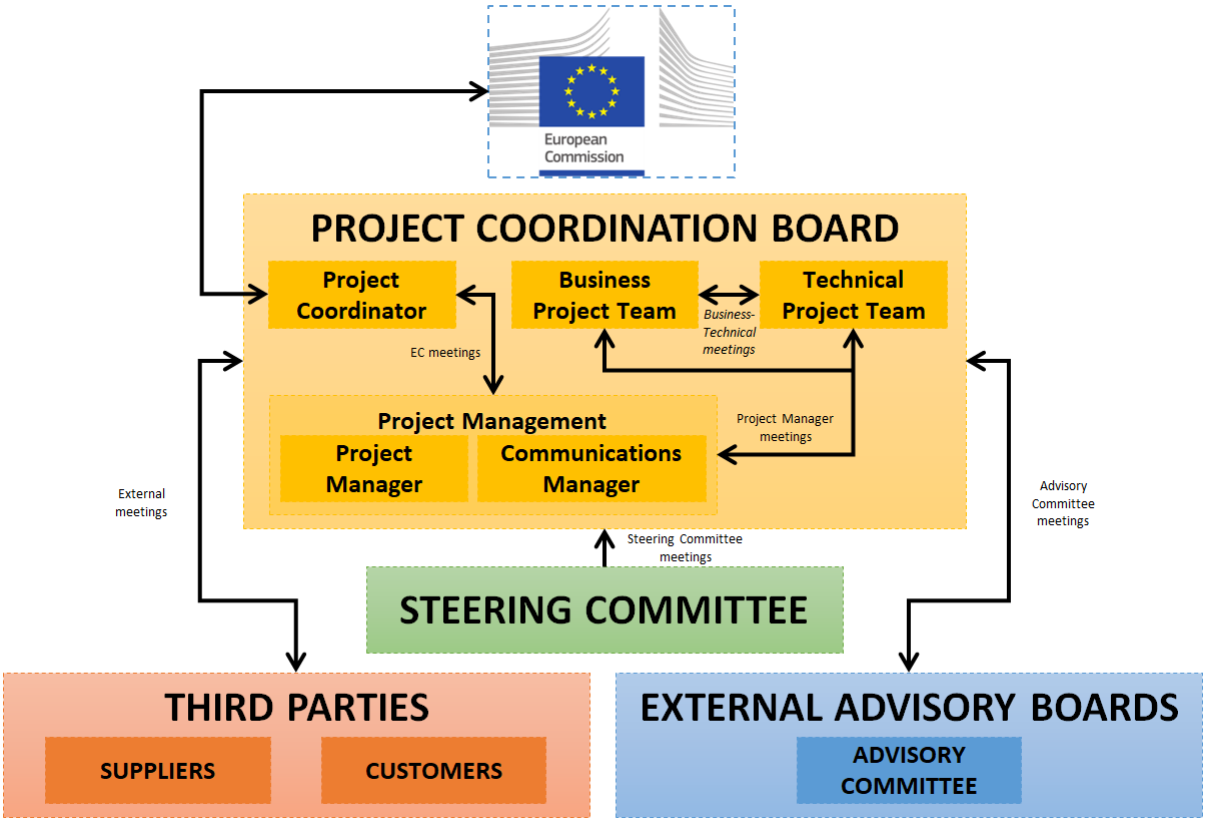

Figure 3: Communication plan scheme with the oversight agencies involved

4.2 Communication process

In this subsection, different procedures are proposed in order to ensure an effective communication between all the agents of the project, both in an informal and a formal environment.

To avoid restricting the communication internally, upward, downward, horizontal and diagonal communications will be encouraged to promote a creative and free atmosphere. In this way, an engineer in charge of developing the laser's technology will be able to contact the quality manager to discuss common aspects of both departments. At the same time, the engineer will also be able to contact the laser technical manager and other co-workers at his/her same level.

4.2.1 Informal

Due to the nature of informal communications, it is difficult to track and monitor them and, consequently, they are not explicitly discussed in the plan and there will not be an official record of them, even though they are essential. Its usage avoids misunderstandings and clarifies aspects of the project, enhancing in this way the formal procedures. The types of informal communication channels recommended are e-mails, phone calls and informal meetings and conversations that can take place at any moment.

4.2.2 Formal

The formal communication, unlike the previous, can be planned and controlled, so it is possible to define several aspects related to it, such as its frequency or objective. In this way, the different channels that will be used to keep the internal agents and stakeholders informed are described below, alongside its main characteristics.

Meetings

Meetings are fundamental to track the project, but also to discuss important aspects of it and make decisions. Throughout the development, different types of meetings will be carried out between the project coordination board, the external advisory boards, the steering committee and third parties.

It is worth emphasising that these meetings will have a clear objective/s and will follow a pre-established agenda to avoid wasting any time and resources on them.

- **General meetings:** This type of meetings are considered to be necessary at very specific moments of the development of the project. In this way, all the departments and agents will be featured in them, due to the broad nature of the content that will be addressed. Because of this, they will have to be scheduled much more in advance than a regular meeting. These meetings will take place at the beginning of the project (kick-off meeting), before presenting the proposal to the European Commission, after the acceptance of the proposal (if applicable) or at the end of the project.
- **Design review meetings:** These meetings are more specific than the previous, since they are focused on analysing the designs of the systems/components. In them, the designs will be evaluated to determine if they fulfil the requirements and criteria already established. In addition to this, feedback from different agents will also be provided in form of possible challenges, opinions or questions, among others. The participants of this type of meetings will be the Technical Project Team and the managers of the technical departments.
- **Technical status meetings:** Throughout the development of the project, it will be necessary to conduct meetings between the Technical Project Team and the departments (or the teams inside the departments) to inform them of the tasks to be carried out, the people in charge of them and other relevant aspects. In addition to this, regular meetings to inform the Technical Project Team about the status of the tasks will also be conducted. In this case, the meetings will be held with a regular and scheduled frequency, specially to monitor the work done.

- **Team meetings:** These will be the meetings conducted at the lowest level between the members of a specific team or department to address topics related to the tasks that need to be developed by the group itself. Unlike the previous, they will not be strictly scheduled, but organised when necessary. It should be noted that this type of meeting will also be used by the Business and Technical Project Teams to discuss assignments and share information. In this case, they could be scheduled.
- **Business-Technical meetings:** These meetings are of special importance to ensure a fluid and efficient communication between the Business and Technical Project Teams. In them, the status of the project will be discussed, as well as other common relevant aspects.
- **Advisory Committee meetings:** The Advisory Committee will meet with the Business and Technical Project Teams to address those topics associated to its responsibilities (stated previously), such as the risks or the review of the progress.
- **Steering Committee meetings:** As in the previous case, the Steering Committee will also conduct meetings with the Business and Technical Project Teams, specially due to its responsibility of providing the necessary resources to complete the project.
- **EC meetings:** To keep the European Commission informed about the development of the project, meetings between the corresponding National contact point and the Project and Communication Managers will be scheduled, with the attendance of other agents, if necessary.
- **Exceptional meetings:** These meetings will only take place in very exceptional occasions, when a very rapid response is required. Thus, it is not expected to need them if things go as planned, since all the topics to discuss would be already covered by the previous types of meetings.

Finally, it should be mentioned that the Project Manager and the Communications Manager will attend some of the meetings mentioned previously. This will allow not having to schedule additional meetings between them and the rest of agents, which sometimes lead to important amounts of time invested in these gatherings. In this way, they will be part of those meetings conducted between the Business and Technical Project Teams, in those of the Advisory Committee and the Steering Committee and, if necessary, in the external ones. Their roles also involve having meetings with the stakeholders.

Status Reports

The status reports are essential to provide regular information on the project. They will address multiple topics and will be delivered to different agents (stakeholders, team members, managers, Project Teams) during specific moments of the development depending on their type. In addition to this, they will also be used as a support material in certain meetings (e.g. the Technical status meetings).

Regarding the channel through which they will be transmitted, it will be via email, since this will bring important advantages, such as not having to use excessive amounts of paper and ink, reducing the expenses on the previous resources or improving the access to the documents and make its storage easier.

Hence, the status reports (together with their frequency) are listed below, and they coincide with those already presented in a previous document (D2), except for the Project Management Monthly Report, that will be described later.

- **Research Report (4.1):** Delivered every two weeks.
- **Mechanical Design Report (4.2.1):** Delivered every week.
- **Laser Design Report (4.2.2):** Delivered every week.
- **Mirror Design Report (4.2.3):** Delivered every week.
- **Software Functionality Report (4.2.4):** Delivered every week.

- **Production Report (6.3):** Delivered every week.
- **Maintenance Checklist (4.4.2):** Delivered every two weeks.
- **Maintenance Report (4.4.5):** Delivered every two weeks.
- **Economic Monitoring Report (1.3.6):** Delivered every month.
- **Monthly Control Report (1.6.6):** Delivered every month.
- **Project Management Monthly Report (PM):** Delivered every month.
- **RCA Report (6.6):** Delivered every two months.
- **Biannual Control Report (1.6.7):** Delivered every six months.

Regarding the content of these reports, it will vary depending on the topic they cover. However, many of them will share the same structure:

- **Status Reports 4.1, 4.2.X and 6.3:** They will include a brief introduction to what will be addressed in the report and a description of the status of the main activities being developed at that moment, as well as their situation regarding the schedule (e.g. if they are behind, on or ahead schedule). Furthermore, any new problem or issue not considered in the design/production will be detailed alongside its solution. Finally, a table with the status of the action items (including mainly the person working on it, the priority and the due date) and a list of the activities/tasks to be developed in the near future will also be provided. This type of reports will be delivered to the Project Manager, the Technical Project Team, the Steering and Advisory Committees and the managers of the different technical departments.
- **Status Report 1.3.6:** In this case, the reports will be focused on tracking the economic side of the project. Therefore, each document will include a description of the expenses of the period under consideration of the departments. Any additional cost not considered on the budget, but already approved, will have to be indicated and justified. To track the situation, different parameters, such as the earned value or actual cost, will be computed in order to determine if the project is under, on or over the budget. The targets of these reports will be the Project Manager, the Technical and Business Project Teams, the Steering and Advisory Committees and some stakeholders, such as the investors or the ESA.
- **Status Reports 1.6.X:** As indicated previously, this type of reports will be delivered to different stakeholders (both internal and external), such as investors, the National Contact Point, the Project Manager or the Communications Manager and, consequently, they will be a summary of the main aspects of the project in terms of each major sub-project or department (e.g. technical design, production). In this way, the content of these documents will be collected from the weekly reports (4.1, 4.2.X and 6.3) and the Economic Monitoring Report, so the stakeholders can have a general vision of both the design/production part and the economic one.
- **Status Reports PM:** In this case, the document focuses on tracking multiple aspects more related to the project management, such as the schedule, the quality and the risks. Therefore, information to determine if the project is behind, on or ahead of schedule will be provided, alongside data relative to the Quality and Risks Management Plans. This documents will be delivered to the Project and Communications Managers, the Steering and Advisory Committees and some stakeholders, such as the investors or the Contact Point.
- **Status Reports 4.4.X and 6.6:** These reports, unlike the previous, will be created once the system starts working, since they are related to its maintenance and the control of the components. Hence, each document will have a specific structure to accomplish its purpose. In a previous document (D2), the aspects that each report will cover were already specified. Regarding the targets, these reports will be addressed to the Technical Project Team, the Quality department, the Steering and Advisory Committees and the Project Manager.

It is worth mentioning that each status report will indicate the person in charge of creating/editing the document, the one responsible for its revision, and the department to which the report belongs.

Announcements

To make important announcements of both organizational and technical aspects that different agents of the project have to be aware of, two main mechanisms will be used: emails and notice boards. The emails will be used to inform about general and specific aspects. In the latter case, this channel is preferred, as it is easier to attach support documents to complement the main data or include sensitive information. Regarding the notice boards, they will be used to inform about more general aspects that have to be known by a whole department or team and they will work as a reminder.

4.2.3 External Communication

The external communication will be used to interact with the companies outside the consortium, the customers and the general public.

External companies

This type of communication is related to the procurement sub-project (or department). In this way, there will be different channels to contact the external companies with whom the consortium have agreements when necessary. Hence, emails and phone calls will be the preferred channels, however, it will be also possible to set physical or online meetings in case the content under discussion requires it.

Customers

It is necessary to establish some channels and procedures to contact the customers in order to receive their feedback or inform them about any relevant data they need to be aware of. Thus, the communication by email will be the predefined one, and it will be mainly used to transmit general information, obtain feedback (by means of surveys) or exchange information with the customer. In addition to this, meetings and phone calls will also be allowed and encouraged if the situation requires it, to provide a closer and personalised service.

General public

In this case, the communication with the general public is comprised inside the marketing plan and, in consequence, techniques and methodologies of this field will be used to promote the service and the system used among not only possible customers and future stakeholders, but also the society.

Thus, the external communications considered under this classification are:

- **Congresses and Fairs:** The company and the consortium will participate in congresses and fairs to publicise the service in specialised segments, both before and after the system starts to operate.
- **Specialised media/press:** It is expected to make publications in research journals and magazines to explain the system developed and prove its strengths among the scientific community.
- **General media/press:** The presence in printed (newspapers) or visual (documentaries, outreach programs) formats addressed to the general public is essential to gain visibility.
- **Social media:** Multiple profiles in different social networks will be created. This will allow having visibility among the general and non-specialized public by means of regular posts during the development of the project, but also once it is functional. The creation of a website will also be necessary to have a dedicated source to inform about the service, the consortium and other aspects.

- **Awareness campaigns:** Conferences and talks aimed at both private companies and public institutions will also be of high importance. The objective of these campaigns is to raise awareness of the danger of space debris and how the system proposed minimises their hazardous effects.

4.3 Communication management plan matrix

Communication Type	Objetive of communication	Medium	Frequency	Audience	Owner	Deriverable	Format
Kickoff Meeting	Introduce the project team and the project. Review the project objectives and management approach.	-Face to face	Once	-Project Sponsors -Project Team -Stakeholders	Project Manager	-Agenda -Meeting Minutes	Soft copy archived on SharePoint site and project website.
Project Team Meeting	Review status of the project with the team.	-Face to Face -Conference call	Weekly	-Project Team	Project Manager	-Agenda -Meeting Minutes -Project Schedule	Soft copy archived on SharePoint site and project website.
Technical Design Meetings	Discuss and develop technical design solutions for the project.	-Face to Face -Conference call	As needed	-Project Technical Staff	Technical Leader	-Agenda -Meeting Minutes -Status	Soft copy archived on SharePoint site and project website.
Monthly Project Status Meetings	Report on the status of the project to management.	-Face to Face -Conference call	Monthly	- Project Management Office (PMO)	Project Manager	- Slide updates -Project Schedule	Soft copy archived on SharePoint site and project website.
Project Status Reports	Report the status of the project including activities, progress, costs and issues.	-Email	-As assigned in previous section	- Project Sponsor - Project Team - Stakeholders - PMO	Project Manager	- Project Status Report -Project Schedule	Soft copy archived on SharePoint site and project website.

Communication Type	**Objective of communication**	**Medium**	**Frequency**	**Audience**	**Owner**	**Deriverable**	**Format**
Advisory Committee Meetings	Review progress and risks of the project and make recommendations.	-Face to Face -Conference call	Monthly	- Advisory Committee - Project Manager - Business team -Project Technical Staff	Project Manager	- Meeting Minutes -Status Report PM	Soft copy archived on SharePoint site and project website.
Steering Committee Meetings	Solve conflicts and provide necessary resources	-Face to Face -Conference call	Monthly	- Steering Committee - Project Manager - Business team -Project Technical Staff	Project Manager	- Meeting Minutes -Status Report PM	Soft copy archived on SharePoint site and project website.
Business plan Meetings	Development of the business plan and track the economic side of the project.	-Face to Face	Monthly	- Business team - Project Manager	Business Manager	- Meeting Minutes -Business plan -Economic Monitoring Report	Soft copy archived on SharePoint site and project website.
Stakeholder Meetings	Provide information of the project to the main stakeholders.	-Face to Face -Conference call	Monthly	- Project Manager - Stakeholders	Project Manager	- Meeting Minutes -Monthly Control Report	Soft copy archived on SharePoint site and project website.
European Commission Meetings	Provide information of the project to EC.	-Face to Face -Conference call	Quarterly	- PMO - National EC representative	Project Manager	- Meeting Minutes	Soft copy archived on SharePoint site and project website.

Communication Type	Objetive of communication	Medium	Frequency	Audience	Owner	Deriverable	Format
Exceptional Meetings	When a very rapid response is required.	-Email -Conference call -Face to face	As needed	- Anyone who is important for the discussion	Department coordinator	- Meeting Minutes	Soft copy archived on SharePoint site and project website.
External Meetings	Meetings with the clients and suppliers of the project.	-Email -Conference call	As needed	- Project Manager -Project Costumers -Project Suppliers	Project Manager	- Meeting Minutes -Budget	Soft copy archived on SharePoint site and project website.
Congresses and Fairs	To publicise the service in specialised segment.	-Face to face	Periodically	- Project Manager -Marketing Department -Project Costumers -Sector companies	Project Manager	- Feedback report	Soft copy archived on SharePoint site and project website.
Specialised media	Make publications in sector research journals and magazines.	-Online	Periodically	- Technical project staff	Technical Leader	- Report issued	Soft copy archived on SharePoint site and project website.
General media	Articles in printed or visual formats for the general public.	-Online	Periodically	- Technical project staff	Technical Leader	- Article issued	Soft copy archived on SharePoint site and project website.

Communication Type	Objective of communication	Medium	Frequency	Audience	Owner	Deriverable	Format
Social media	Profiles in different social networks and Project website to update the information.	-Online	Periodically	-Marketing project staff	Marketing Department Leader	- Posts -Articles	Soft copy archived on SharePoint site and project website.
Awareness campaigns	Conference to raise awareness of space debris danger and explain how CO-LSDD minimizes it.	-Face to Face	Periodically	- Project Manager -General Public - Media	Project Manager	-Presentation -Feedback reports	Soft copy archived on SharePoint site and project website.
Final Meeting	Presentation of the project to the European Commission.	-Face to face	Once	- PMO -Technical Leaders -EC representatives	Project Manager	- Final Presentation -Final Reports	Soft copy archived on SharePoint site and project website.