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Satellite Systems
Agency

D1.2 Quality assurance plans

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Hybrid UAV-UGV for Efficient Relocation of Vessels (HUUVER)

Contribution by

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Abstract

The document was developed for the purposes of providing quality management guidelines related with HUUVER project realization by consortium members. The guidelines are covering issues directly connected with project management, hardware and software architecture, hardware and software development, standardization, regulations and validation.

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1. Management requirements

1.1. Organization and management

The HUUVER consortium combines competences related to electronics, mechanics, drones, navigation and legal issues. The aim of the project is to develop an innovative system offering a new type of services related to the use of drone, distinguished by better drone parameters and wider possibilities of its use, which will work with the GNSS Navigation System, which will enable higher precision of navigation and also allow for authentication. An important part of project realization are also the competences related to legislation because the product developed under HUUVER is a completely new type of drone, which must meet European regulations and standards necessary for the entry into service in real conditions.

HUUVER consortium management system covers all work performed in its permanent facilities, at sites away from its permanent facilities, and mobile facilities.

1.2. Members of the consortium

a) Have management and technical personnel with the authority, responsibility, and resources needed to carry out their duties including the implementation, maintenance and improvement of the management system, and to identify the occurrence of departures from the quality

system/ procedures for performing tasks, and to initiate actions to prevent or minimize such departures;

b) Has arrangements to ensure that management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work;

c) Has policies and procedure QP10 “Protecting confidentiality and proprietary rights” to ensure the protection of its customer’s confidential information and proprietary rights including for protecting the electronic storage and transmission of results;

d) Has procedures and the following policies to avoid employee and company involvement in activities that would diminish confidence in its competence, impartiality, judgment or operational integrity:

- **o** Engineers are not permitted to compete (race) one another regarding the number of tasks processed.

e) Has defined the organization and management structure (Organizational Chart) of the relationships between quality management, technical operations and support services;

f) Has specified the responsibility, authority and interrelationships of all personnel who manage, perform or verify the quality of tasks

g) Provides adequate supervision of working staff, including trainees, by persons familiar with methods and procedures, purpose of each work, and with the assessment of the work results;

h) Has a Technical Manager with the overall responsibility for the technical operations and the provision of the resources needed to ensure the required quality of laboratory operations;

i) Has a Quality Manager that has direct access to the highest level of management at which decisions are made on laboratory policy or resources; i.e., reports directly to the President of the company. The Quality Manager is responsible for promoting communication of customer requirements.

j) Appoints deputies for key managerial personnel. The Lab Manager is the deputy Technical Manager and the Technical Manager is the deputy Quality Manager.

k) Ensures that personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system.

The Quality and Lab Managers are responsible for ensuring that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management system.

1.3. Management System

HUUVER top management provides evidence of commitment to the development and implementation of its management system and to continually improving its effectiveness.

Management communicates to its employees the importance of meeting customer requirements, statutory and regulatory requirements.

Top management ensures that the integrity of the management system is maintained when changes to the management system are planned and implemented.

1.4. Quality planning

Quality planning is consistent with other requirements of the quality system and is documented in a format to suit the consortium companies' method of operation. Consideration is made to the following activities;

A. Preparation of quality plans

B. Identification and acquisition of controls, processes, and standards

C. Training for the skills required to achieve required quality

D. Updating inspection, test and quality control techniques

E. Clarification of standards of acceptability for requirements

F. The identification and preparation of quality records.

1.5. Document Control

HUUVER document control procedure ensures that:

a) authorized documents are available on the computer network to all employees where operations essential to the effective functioning of the consortium;

b) documents are reviewed and revised to ensure continuing adequacy, suitability and compliance with applicable requirements;

c) invalid or obsolete documents are promptly removed from all points of issue or use, or otherwise assured against unintended use'

d) obsolete documents retained for either legal or knowledge preservation purposes are suitable marked.

All quality system documents generated by HUUVER are uniquely identified with a revision number, the date of issue and/or revision, title, page number, and the issuing authority.

1.6. Document changes

Changes to documents are reviewed and approved by the same function that performed the original review unless specifically designated otherwise. The designated personnel have access to pertinent background information upon which to base their review and approval.

Altered or new text is identified in the document or with appropriate attachments.

HUUVER documentation control system allows for the amendment of documents by hand pending the re-issue of the documents, the procedures and authorities for such amendments are defined. Amendments are clearly marked, initialed and dated. A revised document is formally re-issued as soon as practicable. These amendments must be approved by the Quality Manager.

1.7. Review of requests, tenders and contracts

Records of reviews, including any significant changes, are maintained. Records are also maintained of pertinent discussions with a GSA or the results of the work during the period of execution of the contract. The GSA is informed of any deviation from the contract.

If a contract needs to be amended after work has commenced, the same contract review process is repeated and any amendments are communicated to the affected personnel.

1.8. Purchasing services and supplies

HUUVER consortium members have a procedures for selection and purchasing of services and supplies it uses that affect the quality of prototyping. Procedures exist for the purchase, reception, inspection and storage of laboratory consumable materials relevant for prototypes.

HUUVER ensures that purchased supplies that affect the quality of prototypes are not used until they have been inspected or otherwise verified as complying with standard specifications or requirements defined in the methods for the products concerned. These services and supplies used comply with specified requirements.

Purchasing documents for items affecting the quality of products contains data clearly describing the services and supplies ordered including but not limited to the type, class, grade, quality system standard to comply to, and other technical requirements. These purchasing documents are reviewed and approved.

The consortium evaluates suppliers of critical components, supplies and services that affect the quality of prototypes on the basis of their ability to meet quality system requirements, and maintains records of these evaluations and an Approved Vendors Listing of those that are approved.

The materials (parts) are inspected by the technician before work is certified. The technician ensures parts and consumable equipment is inspected prior to use, to verify conformance with any specification relevant to the item.

1.9. Service to the GSA

HUUVER consortium affords GSA or their representative's cooperation to clarify the customer's request and to monitor performance in relation to the work performed.

HUUVER consortium seeks potential customer feedback, both negative and positive. Surveys are used to analysis customer service trends to improve the management system, testing and activities and customer service.

1.10. Control of nonconforming work

HUUVER consortium companies have a policy and Quality Procedure that is implemented when any aspect of its work, or the results of this work, do not conform to its own

procedures or the agreed requirements of the customer. The policy and procedures ensures that:

a) the responsibilities and authorities for the management of nonconforming work are designated and actions are defined and taken when nonconforming work is identified;

b) an evaluation of the significance of the nonconforming work is made;

c) corrective actions are taken immediately, together with any decision about the acceptability of the nonconforming work;

d) where necessary, the GSA is notified and work is recalled;

e) the responsibility for authorizing the resumption of work is defined.

Where the evaluation indicates that the nonconforming work could recur or that there is doubt about the compliance of HUUVER operations with its own policies and procedures, the corrective action procedures given in point 11 are promptly followed.

1.11. Continual Improvement

HUUVER consortium continually improve the effectiveness of the quality management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

Improvements to business operations are achieved by using the “process approach” when reviewing quality system element and operations.

1.12. Corrective action

HUUVER consortium has established a policy and Corrective and preventive action procedure and has designated appropriate authorities for implementing corrective action when nonconforming work or departures from the policies and procedures in the quality system or technical operations have been identified.

The procedure for corrective action starts with an investigation to determine the root cause(s) of the problem.
Where corrective action is needed, the consortium identifies potential corrective actions. It selects and implements the action(s) most likely to eliminate the problem and to prevent recurrence.

Corrective actions are to a degree appropriate to the magnitude and the risk of the problem.

HUUVER documents and implements any required changes resulting from corrective action investigations.

The HUUVER consortium monitors the results to ensure that the corrective actions taken have been effective.

1.13. Preventive action

Needed improvements and potential sources of nonconformance, either technical or concerning the quality system, are identified. If preventive action is required, action plans are developed, implemented and monitored to reduce the likelihood of the occurrence of such nonconformance and to take advantage of the opportunities for improvement.

Quality Procedure Corrective and preventive action for preventive actions include the initiation of such actions and application of controls to ensure that they are effective.

The consortium members monitors certain performance trends. Opportunities for preventive actions are identified by analyzing selected data. A decision is made what degree of preventive action effort is required to prevent occurrence.

1.14. Quality management for software development

The HUUVER control and navigation system is responsible for performing many critical functions such as flight along the programmed trajectory, avoiding obstacles, automatic start and landing, and so on. These operations require high precision. Therefore, it is very important to ensure a high quality source code that will be implemented in on-board computers and ground control station. High quality software is required to obtain the highest system reliability.

Accordingly, during the software development process, methods that ensure high quality of the source code should be used. Software development process will be carried out according to the „V" model shown in the figure 1.14. There are two main phases: design phase and testing phase. The „V" method is based on the association of a testing phase for each corresponding development stage. Development of each step is directly associated with the testing phase. The next phase starts only after completion of the previous phase

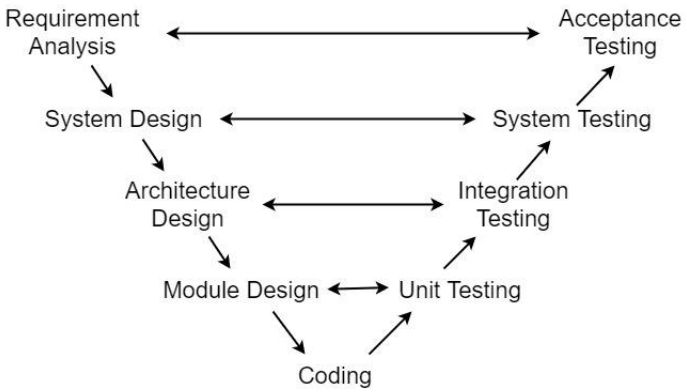

Figure 1 method diagram

The process begins with the specification of the device for which the software is designed and the analysis of the requirements that must be met. System design phase contains the system design and the complete hardware and communication setup for developing product. During next phase, system design is broken down further into modules taking up different functionalities. The data transfer and communication between the internal modules and with the outside world is developed. Module design phase involves developing specifications for each system module. Unit Test Plans are developed during module design phase. These Unit Test Plans are executed to eliminate bugs at code or unit level. After completion of unit testing Integration testing is performed. In integration testing, the modules are integrated and the system is tested. Integration testing is performed on the Architecture design phase. This test verifies the communication of modules among themselves. System testing test the complete application with its functionality, inter dependency, and communication. It tests the functional and non-functional requirements of the developed application. Acceptance testing is performer in a target environment that resembles the production environment.

The software development process will be perform with the use of tool such as GitLab. It is a web-based DevOps lifecycle tool that provides a Git-repository manager providing wiki, issue-traking and CI/CD pipeline features, using an open-source license, developed by GitLab Inc. The testing phase will be based on software-in-the-loop and hardware-in-the-loop tests. During tests, target hardware platforms (autopilot Pixhawk, Nvidia Jetson), simulation environment (Scilab) and a flight simulator (X-Plane) will be used.

1.15. Quality management for hardware development

The hardware development process will be organized like the software development process using the V model. The tasks will be implemented iteratively using Agile methodologies.

Each iteration will last from 1 to 2 weeks, it will start with planning work and will end with a summary of tasks, the entire development team will take part in daily meetings and will consult tasks and issues that arise on a regular basis. Each iteration will end with a summary of what has been achieved and verification of progress.

Components designing will be done using Solid Works / Autodesk inventor tools. For security reasons, in the event of data loss, models will be automatically saved to the Autodesk Vault repository located on the server.

During the development process will be provided an activities:

Mechanical design analysis. The Finite Element Analysis (FEA) of the platform's hardware that includes the stress analysis, in order to confirm component and assembly mechanical properties (stress, flexibility, factor of safety, fatigue).

The quality control of designed components will be subjected to static and dynamic strength simulations in accordance with the data contained in the material cards of the materials from which they will be made. The safety factor will cover the forces during testing minimum 30% greater than the real ones affecting the element. The platform model submission will be subjected to CFD analysis to determine its aerodynamic properties.

Optimization of the components design and preparation of the technical documentation necessary for the component fabrication.

Prototyping will involve fabrication and the assembly of the hardware components. Different materials machining requirements will determine adequate manufacturing processes. This includes, 3D printing, Infusion forming, Vacuum Forming, CNC milling, turning etc. Implementation of the off shelf electronic components such as motors, propellers, power source, ESC etc.

The real-life testing of the PDU will be accomplished by utilizing various off shelf as well as custom made measuring, tools, sensors, testing rings etc. The test objectives include, forces acting on the unit, aerodynamic drag, friction coefficient between ground and the driving system, efficiency, power required, durability and safety etc.

Development of the hardware for the platform, based on the previously designed PDU unit. Preparation (avionic) control system for electronic components, wiring of electronic components, motors, flight control, ESC, battery, power distribution board, driving motors and cover. Considering safety and ease of use. After development of hardware there will be build a first prototype of fully operational drone platform.

After development of first prototype it will be carried out a final prototyping for extending performance for the platform including parameters: operational range, flight time, driving time, payload optimization, components optimization, move in any difficult terrain capabilities. There will be prepared a final test of the system with a final acceptance report and prototype approval.

2. Quality management

The purpose of Quality Management is to ensure that the project satisfies the needs for which it was planned. Quality Assurance (QA) procedures will be applied to all activities in compliance with the ISO 9000 standards. The main goals of the QA procedures are: documenting and assessing the project's progress, evaluating the contribution of the on-going results to the project's objectives and discovering deviations at an early stage and initiating remedial actions (if necessary) as soon as possible. In HUUVER, QA will include

qualitative and quantitative assessment measures for milestones and deliverables. Quarterly internal project reporting will ensure that eventual problems or delays will be detected rapidly and corrective actions will be taken if necessary. Furthermore, relevant documentation (personnel costs, etc.) will be kept for at least five years since all projects are audited.

2.1 Guidelines for documentation

The success of HUVVER heavily depends on the quality and uniformity of all documents issued during the project: deliverables, milestones, reports, etc.

Recommendations related to the document identification are exposed in Table 1.

Document type	ID
Deliverable	DX.Y (as in the proposal)
Milestone	MX.Y (as in the proposal)
Minutes (meeting)	M-yyyymmdd (being yyyy year, mm month and dd day)

Table 1 Recommendations related to document name identification

2.2 Deliverable management

All deliverables will be shared through the HUUVER Google-drive shared space and email, where the different draft versions prior submission will be uploaded.

2.3 Deliverable Naming Convention

Each partner might internally follow their own methodology; however, when information is to be shared within HUUVER consortium the following guidelines will be followed regarding files nomenclature.

There will be 4 types of documents:

1. Working draft:

   Each deliverable site will contain one single file as working draft. Only the deliverable responsible can update this file although it can be delegated to other partners if necessary. Only one partner will be responsible of updating the working version at a time. Deliverable working draft nomenclature will be as follows:

   HUUVER <Deliverable code> <Deliverable name>

2. Contributions:

   Partners who contribute over this working draft can upload their contributions in separate documents or can use the online Google editor. It is important to do so with Changes tracker enabled. The deliverable responsible shall integrate this contributions into the working draft. Contributions nomenclature will be as follows:

   HUUVER <Deliverable code> <Deliverable name>-r<RRR>PARTNER-yyyymmdd

   where: <RRR> is the Version number of the working draft which has been modified.

3. Deliveries:

   Final versions submitted to H2020 portal will be kept as delivered versions of the document. Delivered versions of the deliverable nomenclature will be as follows:

   HUUVER <Deliverable code> <Deliverable name>-v<VV>

   where: <VV> is the Version number of the delivery.

4. Support:

Support documentation can be shared within the deliverable sharing site. Supporting documents for the deliverable nomenclature will be as follows:

S-HUUVER <Deliverable code> <Supporting document name>

2.4 Deliverable structure

A deliverable template has been provided and uploaded to Google drive shared space so all deliverables are homogeneous in look & feel. Furthermore, each deliverable's structure will be provided by the Project Manager and it should stick to the following sections as far as possible:

- Abstract
- Index
- List of figures
- List of tables
- Specific content divided into sections
- Conclusions
- References

2.5 Deliverable review and acceptance procedure

Deliverable review and acceptance procedure is a sequence of actions through which the project outcomes are evaluated. On the one hand, the deliverable review is not a timely action, but a continuous process in which the Deliverable Leader and the Task Leader check its technical quality and completeness. On the other hand, the deliverable acceptance is a programmed process which starts 20 days before the deliverable scheduled deadline and finishes when it is sent to the GSA. Within this period, the Work Package Leader and the Quality Manager review and contrast the deliverable against a set of criteria to demand the necessary changes, if needed, in order to ensure that specific and overall objectives are achieved.

2.5.1 Deliverables workflow

The schedule for the deliverable acceptance and draft production are set by the Deliverable Leader.

Start of the deliverable review procedure. The revision procedure starts when the first contributions to the deliverable are made.

Execution process of the deliverable. During the whole execution process, the Deliverable Leader, in close coordination with the Task Leaders directly involved in it, accounts for the technical quality and appropriateness of the contents generating different draft versions of the deliverable.

Final version of deliverable. When the Deliverable Leader agrees that the deliverable is finished, the deliverable should be sent to the Project Manager and Quality Manager in order to analyze the document from different points of view. At this moment, the deliverable validation procedure starts. Such revisions must start at least 20 days before time of delivery.

Validation process. Task Leader, WP Leader and Quality Manager, should double check separately that the deliverable is compliant with the objectives, scope and structure. If all the project members agree that the deliverable is completely compliant, it is considered approved. If not, some changes must be introduced and it has to be sent back with the comments and the new deadline. Finally, when the deliverable is approved, the Project Manager submits it to the EC, the deliverable might be published depending to the dissemination level.

Deliverable submission to EC is encouraged happen 2 weeks before official submission date in order to allow a first review cycle prior delivery consolidation.

2.6 Quality control

The quality control process is realized by project internal monitoring. Project Manager meets with the entire consortium every 6 months (Progress Meeting) to have a continuous updated

view of the project. The implementation of the activities is monitored through the achievement of the milestones, the continuous follow-up of the project schedule (as set up in timetable for implementation) and the Work Packages Leader's reports (every 6 months). Its outputs are the completed deliverables checklist and conclusions.

2.7 Milestones

Meeting milestones, being relevant moments during the project's calendar, becomes essential for guaranteeing progress according to the expected plan. Table 2 presents the list of milestones which will be subject to close monitoring:

Milestone number	**Milestone name**	**Related WP(s)**	**Due date (in month)**	**Means of verification**
M1	Requirements and system architecture specified	WP2	2	Delivery of D2.3 Hybrid drone architecture and technical specification D2.4 Software application architecture and specification D2.5 on-board navigation and control system architecture and specification including communication standard
M2	High accurate navigation system with elevated credibility	WP3, WP4	13	Delivery of D3.1 A fully assembled hardware platform, D3.2 Consolidated and fully functional HUUVER prototype, D4.1 Application software for controlling the drone, D4.2 On-board navigation and control system software, D4.3 Computer vision support functionalities software

M3	Evaluation completed	WP5	18	Delivery of D5.3 Evaluation report

Table 2 List of project milestones

2.8 Amendment request

The list below provides some examples of the changes that require an amendment to the Grant Agreement:

1. Change of legal representative (Authorized Signatory) or legal address of beneficiary.
2. Change of contact person or mailing address.
3. Change of bank account.
4. Change of name, change in legal personality of beneficiary (merger, split, takeover, reorganization).
5. Addition or replacement of Co-beneficiary Redistribution of tasks.
6. Extension of the project duration / change in starting date.
7. Substantial change(s) regarding objectives, content of project, core staff, i.e. changes affecting the selection of the budget.
8. Non-substantial change(s) regarding meeting venue, number of meetings, i.e. changes not affecting the selection of the budget and with no or minor budgetary impact.

3. Control of records

3.1. Technical records

Observations, data and calculations are recorded at the time they are made and are identifiable to the specific task.

When mistakes occur in records, each mistake is crossed out, not erased, made illegible or deleted, and the correct value entered alongside. All such alterations to records are signed or initialed by the person making the correction. In the case of records stored electronically, equivalent measures are taken to avoid loss or change of original data.

3.2. Management reviews

HUUVER consortium members quarterly conducts a review of HUUVER project quality system to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements.

Findings from management reviews and the actions that arise from them are recorded as meeting minutes. Management ensures that those actions are carried out within an appropriate and agreed timescale.

4. Technical requirements

4.1. General

Many factors determine the correctness and reliability of work performed by HUUVER consortium members. These factors include contributions from:

- human factors;
- accommodation and environmental conditions;
- equipment;

4.2. Personnel

The consortium management ensures the competence of all who operate specific equipment, perform tasks, and evaluate results, and sign reports. When using staff that is undergoing training, appropriate supervision is provided. Personnel performing specific tasks are qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required.

The management of HUUVER companies formulates the goals with respect to the education, training and skills of the personnel. The training program is relevant to the present and anticipated tasks. The effectiveness of the training is evaluated by completion of tests and/or feedback from students.

HUUVER uses personnel who are employed by consortium companies. Where contracted and additional technical and key support personnel are used, consortium companies ensures that such personnel are supervised and competent and that they work in accordance with quality system.

The management of consortium companies authorizes specific personnel to perform particular tasks, to give opinions and interpretations and to operate particular types of equipment.

4.3. Accommodation and environmental conditions

HUUVER companies facilities for product development, including but not limited to energy sources, lighting and environmental conditions, are such as to facilitate correct performance of work.

HUUVER ensures that the environmental conditions do not invalidate the results or adversely affect the required quality of any work. Particular care is taken when tasks are undertaken at sites other than a permanent laboratory facility.

HUUVER consortium monitors, controls and records environmental conditions as required by the relevant specifications, methods and procedures or where they influence the quality of the results. Due attention is paid, for example, ventilation, dust, electromagnetic disturbances, humidity, electrical supply, temperature, and sound and vibration levels, as appropriate to the technical activities concerned. Work activities are stopped when the environmental conditions could threat the end of results.

4.4. Control of data

Calculations and data transfers are subject to quality assurance checks in a systematic manner.

5.4.7.1 When computers or automated equipment are used for the acquisition, processing, recording, reporting, storage or retrieval of data, the consortium ensures that:

a) Computer software developed by the user is documented in sufficient detail and is suitably validated as being adequate for use;

b) Computers and automated equipment are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of data.

4.5. Equipment

Equipment is operated by authorized personnel. Up-to- date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) are readily available for use by the appropriate laboratory personnel.

Each item of equipment and its software used for development and significant to the result is, uniquely identified.

Records are maintained of each item of equipment and its software significant to the work performed. The records include at least the following:

a) the identity of the item of equipment and its software;

b) the manufacturer’s name, type identification, and serial number or other unique identification;

c) checks that equipment complies with the specification;

d) the current location, where appropriate;

e) the manufacturer’s instructions, if available, or reference to their location;

f) the maintenance plan, where appropriate, and maintenance carried out to date;

g) any damage, malfunction, modification or repair to the equipment.