Test Protocol
Search and Rescue - Land

Version 1.0

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Document History

Version	Date	Changes made	Sign	Reviewer
0.1	2022-11-28	First draft	RW, SF	Jakob Åslund
0.2	2022-11-30	Second draft	DG, SF	Jakob Åslund
0.3	2022-12-05	Third draft	SF, RW	Jakob Åslund
1.0	2022-12-05	First version	SF, RW	Jakob Åslund

Contents

1 Introduction

This document is a test plan for the project Search and Rescue - Land in the course TSRT10, Reglerteknisk projektkurs, CDIO, at Linköping University. This document will act as a guidance and protocol for all the tests that will be conducted in the project.

1.1 Test structure

To make the tests clear, all tests include a description of how they will be conducted. This description should make it clear how the user should start the test and what the environment should look like. What is expected from each test is explained under "Expected results". There is also a box to write if a test is conducted in simulation or on hardware. Many requirements are tested in both environments, since the project should include SIL.

The results from a test will be written in "Test result" and any comments is written in "Comments". Depending on the result, each test is marked as Pass or Fail.

1.2 Pass, Fail or Not Conducted

A test will be marked as Pass if the test is conducted according to the description while also meeting the requirements. If the requirements are not met, it will be marked as fail. If the test could not be conducted, it will be marked as not conducted.

1.3 Definitions

Below some definitions and acronyms are explained which are recurring in this document.

- **Rover** - Tracked vehicle driving autonomously that maps the test area and seeks distressed persons.
- **UAV** - A quadcopter flying autonomously and seeks distressed persons.
- **Agent** - participant in a mission, Rover and/or UAV.
- **Base Station** - A computer that handles the information from the Rover and UAV.
- **Distressed person** - In simulation, this is a virtual marker that should be found by the Rover and UAV. When doing real tests, this will be RC-cars colored with bright colors.
- **SLAM** - Simultaneous Localization and Mapping.
- **LIDAR** - Light Detection and Ranging.
- **SIL** - Software In The Loop.
- **Qualisys** - Sensor system in the room Visionen that uses cameras and reflective targets to deliver position data.
- **ROS2** - "Robot Operating System", Framework for robot software development.
- **No-fly zone** - A zone where the UAV is restricted from flying into.
- **PDDL** - Planning Domain Definition Language.

- **RPi** - Raspberry Pi.
- **Pixhawk** - The flight controller *Pixhawk 4* that is mounted on the UAV.
- **HW** - Hardware.
- **SW** - Software.
- **Rviz2** - A visualization manager that displays the generated map and agent positions during the mission.
- **Gazebo** - Simulation environment.
- **RC-car** - Small RC-cars controlled by the user, that are used to simulate distressed persons.

1.4 Test Protocol

A test protocol will be used to test the requirements from the requirement specification. The template can be seen below.

Test No.:		**Test dependencies:**	
Resources:			
Req. no.:	**Req. description:**		**Priority:**
Test description:		**Expected results:**	
Hardware/Simulation:			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:**
Comments:			
Test approved by:			

2 Rover

Test No.:		**Test dependencies:** -	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
17	The Rover shall receive its ground truth position in simulation to emulate the Qualisys system		1
21	The area shall be mapped with SLAM using a LIDAR on the Rover		1
Test description:		**Expected results:**	
Start a simulation with 8 obstacles evenly placed in the test area. Simulate a Rover. Add "Nav2 Goal" in RViz2 and observe how the map is updated as the Rover moves and compare the position that is posted by the Rover with the actual position in the simulation.		The map of the simulation environment should continuously be updated in Rviz2 when the Rover drives around. The position that is posted by the Rover should be the same as the position in the simulation.	
Hardware/Simulation: Simulation			
Executed by: DG	**Participants:** DG	**Test week:** 45	**Test date:** 9/11
Test result: The Rover mapped the area successfully. By observing the position and comparing it to the ground truth, it was concluded that the Rover has a good estimate of its position.			**Pass/Fail:** Pass
Comments: The ground truth was simulated with IMU data.			
Test approved by: DG			

Test No.:		**Test dependencies:** -	
Resources: Visionen, Rover			
Req. no.:	**Req. description:**		**Priority:**
17	The Rover should receive its position from Qualisys positioning system while running HW		1
21	The area should be mapped with SLAM using a LIDAR on the Rover		1
Test description:		**Expected results:**	
Start Qualisys, calibrate the system and implement the Rover as a body. Drive the Rover manually in Visionen and observe how the map is updated and compare the position that is posted by the Rover with the position in Qualisys, as well as the rover's actual position.		The map of the test area should continuously be updated in Rviz2 when the Rover is driven around. The position that is posted by the Rover should be the same as the position in Qualisys as well as the rover's actual position.	
Hardware/Simulation: Hardware			
Executed by: AL **Participants:** AL, SF		**Test week:** 47	**Test date:** 21/11
Test result: The Rover received position data from Qualisys and continuolsy mapped the area.			**Pass/Fail:** Pass
Comments: The position posted from the Rover was the same as the position from Qualisys, however only odometry data was posted by the Rover. These two were only the same since the Rover started in (0,0). If it had started anywhere else, they whould not coincide. If one were to add a static transform between the Rovers start position and the map origin to the odometry data, the positions would always coincide.			
Test approved by: SF			

Test No.:		**Test dependencies:** 1, 37	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
15	The Rover must be able to navigate using a motion plan that avoids collisions		1
16	The Rover must not deviate more than 15 cm from the motion plan at any specific sample		1
Test description:		**Expected results:**	
Place one obstacle in the simulation. Start the Rover on one side of the obstacle and select a goal node on the other side. The motion planner should plan a path that goes around the obstacle. Display the planned path in Rviz. Observe how much the Rover deviates from the plan.		The Rover navigates along the planned path, to the goal node and stays on the path without deviating more than 15 cm and without colliding with the obstacle.	
Hardware/Simulation: Simulation			
Executed by: DG	**Participants:** DG	**Test week:** 46	**Test date:** 17/11
Test result: The Rover navigated along the planned path and avoided the obstacle. The path was replanned from the Rover and did not noticeable deviate from the path at any sample.			**Pass/Fail:** Pass
Comments:			
Test approved by: DG			

Test No.:		**Test dependencies:** 1, 2, 3	
Resources: Visionen, Rover, Obstacles			
Req. no.:	**Req. description:**		**Priority:**
15	The Rover must be able to navigate using a motion plan that avoids collisions		1
16	The Rover must not deviate more than 15 cm from the motion plan at any specific sample		1
13	The motion planner, controller and SLAM-module should work in the same way on HW and in simulation		1
Test description:		**Expected results:**	
Place one obstacle in Visionen. Start the Rover on one side of the obstacle and select a goal node on the other side. The motion planner should plan a path that goes around the obstacle. Display the planned path in Rviz. Observe how much the Rover deviates from the plan. Compare the results to Test No. 3.		The Rover navigates along the planned path, to the goal node and stays on the path without deviating more than 15 cm and without colliding with the obstacle. The results should be similar to the results in Test No. 3. The motion planer should show a similar path in Rviz and make a similar map.	
Hardware/Simulation: Hardware			
Executed by: AL	**Participants:** AL, RW	**Test week:** 47	**Test date:** 21/11-2022
Test result: The Rover navigated past the obstacles while planning its path along the way.			**Pass/Fail:** Pass
Comments: There was no deviation since the path was planned continuously.			
Test approved by: AL			

Test No.:		**Test dependencies:** 1, 2, 3	
Resources: Visionen, Rover			
Req. no.:	**Req. description:**		**Priority:**
23	It should be possible to take control of the Rover manually		1
Test description:		**Expected results:**	
Start the Rover on one side of Visionen, select a goal node on the other side, and switch to manual mode in the middle of the path and try to stop the Rover.		The Rover stops when switching to manual mode.	
Hardware/Simulation: Hardware			
Executed by: AL	**Participants:** AL, DS	**Test week:** 48	**Test date:** 29/11-2022
Test result: The Rover stopped when the controller switched to manual mode.			**Pass/Fail:** Pass
Comments:			
Test approved by: AL			

Test No.:		**Test dependencies:** 37	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
18	The Rover must identify static distressed persons with the camera		1
20	The Rover must be able to differentiate between different types of distressed persons		1
Test description:		**Expected results:**	
Spawn two static persons in a simulation with an empty environment. Make the Rover drive to one distressed person at the time. Observe Rviz2 and check if the color of the bounding box is the same as the distressed person. Confirm that two different distressed persons have been found by comparing the identified colors.		Both distressed persons are identified.	
Hardware/Simulation: Simulation			
Executed by: SF **Participants:** SF,ES		**Test week:** 44	**Test date:** 2022-10-31
Test result: The Rover managed to identify two different static distressed persons. The yellow distressed person had a yellow bounding box and the blue distressed person had a blue bounding box.			**Pass/Fail:** Pass
Comments: -			
Test approved by: ES			

Test No.:		**Test dependencies:** 6	
Resources: Rover, RC-cars, Visionen			
Req. no.:	**Req. description:**		**Priority:**
18	The Rover must identify static distressed persons with the camera		1
20	The Rover must be able to differentiate between different types of distressed persons		1
Test description:		**Expected results:**	
Place two static persons in a test area without obstacles. Drive the Rover manually to one distressed person at the time. Observe Rviz2 and check if the color of the bounding box is the same as the distressed person. Confirm that two different distressed persons have been found by comparing the identified colors.		Both distressed persons are identified.	
Hardware/Simulation: Hardware			
Executed by: SF **Participants:** SF, ES		**Test week:** 45	**Test date:** 2022-11-11
Test result: The Rover identified one yellow and one blue car and showed a yellow bounding box around the yellow car and a blue bounding box around the blue car.			**Pass/Fail:** Pass
Comments: The Rover was not driven manually since the hardware has been malfunctioning.			
Test approved by: ES			

Test No.:		**Test dependencies:** 3, 6, 39	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
19	The Rover must identify moving distressed persons with the camera		1
25	The Rover shall be able to track and follow an identified distressed person		1
Test description:		**Expected results:**	
Make sure that the Rover has the tracking behavior engaged. Place a distressed person outside the Rover's camera's field of view in an empty environment. Then drive the distressed person past the rover (3 meters away) and drive for 5 meters.		The Rover should reorient itself and start following the distressed person after it has entered the camera frame.	
Hardware/Simulation: Simulation			
Executed by: ES	**Participants:** SF, ES	**Test week:** 47	**Test date:** 23/11
Test result: The Rover stayed at a distance of about 1.5 meter following the movement of the distressed person by trying to keep the distressed person in the middle of its field of view.			**Pass/Fail:** Pass
Comments: The distressed person was moving in a circle.			
Test approved by: SF			

Test No.:		**Test dependencies:** 4, 7, 8	
Resources: Rover, RC-cars, Visionen			
Req. no.:	**Req. description:**		**Priority:**
19	The Rover must identify moving distressed persons with the camera		1
25	The Rover shall be able to track and follow an identified distressed person		1
Test description:		**Expected results:**	
In an empty test area, set the Rover to autonomous mode and drive a distressed person through the Rover's field of view and listen to the topic that publishes information about missing persons and confirm that the missing person has been found and that the rover starts to track the missing person		The Rover should reorient itself and start following the distressed person after it has entered the camera frame.	
Hardware/Simulation: Hardware			
Executed by: SF	**Participants:** ES, SF	**Test week:** 45	**Test date:** 11/11-2022
Test result: The Rover identified the distressed person when it was moving.			**Pass/Fail:** Pass
Comments: Requirement no. 25 no longer a requirement on hardware.			
Test approved by: ES			

Test No.:		**Test dependencies:** 8	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
26	The Rover must not collide with distressed persons		1
Test description:		**Expected results:**	
In an empty simulation environment, make sure that the Rover's tracking behavior is engaged. Place the distressed person 3 meters away, directly in front of the Rover. Start driving the distressed person towards the Rover, stop once it has driven 6 meters.		The Rover should initially start driving towards the distressed person, but once the distressed person is within the safety distance, then it should start backing until the distressed person has stopped.	
Hardware/Simulation: Simulation			
Executed by: SF	**Participants:** SF, DG	**Test week:** 47	**Test date:** 25/11
Test result: The Rover started to back away from the distressed person at a safe distance.			**Pass/Fail:** Pass
Comments: If the distressed person is driven abnormally fast towards the Rover, it will probably drive in to the Rover.			
Test approved by: DG			

Test No.:		**Test dependencies:** 9, 10	
Resources: Rover, Visionen, RC-cars			
Req. no.:	**Req. description:**		**Priority:**
26	The Rover must not collide with distressed persons		1
Test description:		**Expected results:**	
In an empty test area, make sure that the Rover's tracking behavior is engaged. Place the distressed person 3 meters, directly in front of the Rover. Start driving the distressed person towards the Rover, stop once it has driven 6 meters.		The Rover should initially start driving towards the distressed person, but once the distressed person is within the safety distance, then it should start backing until the distressed person has stopped.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 47	**Test date:**
Test result:			**Pass/Fail:** Not conducted
Comments: No longer a requirement on hardware			
Test approved by:			

3 UAV

<table>
<tr><td colspan="2">Test No.:</td><td colspan="2">Test dependencies: -</td></tr>
<tr><td colspan="4">Resources: UAV, Visionen, Base Station</td></tr>
<tr><td>Req. no.:</td><td colspan="2">Req. description:</td><td>Priority:</td></tr>
<tr><td>30</td><td colspan="2">The Pixhawk and Raspberry Pi shall be able to communicate with each other</td><td>1</td></tr>
<tr><td>31</td><td colspan="2">The UAV shall be able to receive and utilize position and orientation data from its sensors and the Qualisys system when running on HW</td><td>1</td></tr>
<tr><td colspan="2">Test description:</td><td colspan="2">Expected results:</td></tr>
<tr><td colspan="2">Test in an empty environment. Start Qualisys, calibrate the system and implement the UAV as a body in the system. Start the UAV and connect to the RPi with a computer using SSH. Call the launch file for the UAV to start all SW. Listen to the ROS2 topic that publishes the position data from Qualisys and the topic that publishes UAV odometry and compare them. Send a position 1 meter above its current position to the UAV from the computer, turn on the RC-controller, arm the UAV, and switch to offboard mode with the RC-controller.</td><td colspan="2">The position from Qualisys should be the same as the position the UAV publishes. When switching to offboard mode, the UAV should take off and hover 1 meter above the ground.</td></tr>
<tr><td colspan="4">Hardware/Simulation: Hardware</td></tr>
<tr><td colspan="2">Executed by: DS Participants: DG, DS</td><td>Test week: 47</td><td>Test date: 21/11-2022</td></tr>
<tr><td colspan="3">Test result: The UAV took off and hovered one meter above the floor.</td><td>Pass/Fail: Pass</td></tr>
<tr><td colspan="4">Comments:</td></tr>
<tr><td colspan="4">Test approved by: DG</td></tr>
</table>

Test No.:		**Test dependencies:** 37	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
33	A motion planner must be implemented on the UAV		1
37	The UAV must follow the trajectory set by the motion planner and not deviate from the path more than 20 cm at any specific sample		1
Test description:		**Expected results:**	
Start Qualisys and test in an empty environment, select a goal node 4 meters forward with an orientation 90 degrees from the start orientation. The motion planner will plan a path to this point, and the UAV will follow. Save the position topics in a ROS2 and calculate the maximum deviation from the path.		The UAV should navigate to the goal node and should stay on the path without deviating more than 20 cm.	
Hardware/Simulation: Simulation			
Executed by: AL **Participants:** AL,DS,SF		**Test week:** 45	**Test date:** 2022-11-10
Test result: The UAV followed a trajectory around a No-fly zone without deviating more than 20 cm.			**Pass/Fail:** Pass
Comments: The UAV did not follow the orientation since it was decided that the UAV should have the same orientation all the time for simplicity and to remove oscillations.			
Test approved by: SF, DS			

Test No.:		**Test dependencies:** 12, 13	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
33	A motion planner must be implemented on the UAV		1
37	The UAV must follow the trajectory set by the motion planner and not deviate from the path more than 20 cm at any specific sample		1
Test description:		**Expected results:**	
Start Qualisys and test in an empty environment, select a goal node 4 meters forward with an orientation 90 degrees from the start orientation. The motion planner will plan a path to this point, and the UAV will follow. Save the position topics in a ROS2 and calculate the maximum deviation from the path.		The UAV should navigate to the goal node and stay on the path without deviating more than 20 cm.	
Hardware/Simulation: Hardware			
Executed by: DS **Participants:** DS, ES		**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV navigated to the goal while replanning its path along the way, thus never deviating from its path.			**Pass/Fail:** Pass
Comments: The UAV held the same orientation throughout the whole test as programmed.			
Test approved by: DS			

Test No.:		**Test dependencies:** 13, 38	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
34	No-fly zones shall be avoided by the UAV motion planner with a distance of at least 20 cm		1
Test description:		**Expected results:**	
Start a simulation in an empty environment. Place a 2x2 meter no-fly zone in the middle of the environment. Set a path with a start point on one side of a no-fly zone and a goal point on the other side.		The motion planner should plan a rout that avoids the no-fly zone with at least 20 cm of distance. This should be visible in Rviz.	
Hardware/Simulation: Simulation			
Executed by: AL	**Participants:** AL	**Test week:** 47	**Test date:** 2022-11-25
Test result: The UAV successfully planned a path which avoided the No-Fly Zone with more than 20cm			**Pass/Fail:** Pass
Comments: The safety distance to the No-fly zone is achieved with inflation layers, one can tune the inflation layers for harder/looser constraints on safety distance.			
Test approved by: AL			

Test No.:		**Test dependencies:** 14, 15	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
34	No-fly zones shall be avoided by the UAV motion planner with a distance of at least 20 cm		1
Test description:		**Expected results:**	
Set a 2x2 meter no-fly zone in the middle of the environment. Set a path with a start point on one side of a no-fly zone and a goal point on the other side. Save the position topics in a ROS2 and calculate the maximum deviation from the path and from the no-fly zone.		The UAV avoids the no-fly zone and does not fly closer than 20 cm, the UAVs position does not deviate more than 20 cm from the path.	
Hardware/Simulation: Hardware			
Executed by: DS	**Participants:** DS, ES	**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV successfully planned its path around the No-fly zone and did not fly too close.			**Pass/Fail:** Pass
Comments: The UAV planned its path continuously and thus never deviated from its path. The safety distance to the No-fly zone is achieved with inflation layers, one can tune the inflation layers for harder/looser constraints on safety distance.			
Test approved by: DS			

Test No.:		**Test dependencies:** 37	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
35	The UAV shall be able to take off autonomously and rise to an altitude between 2 and 4 meters where it holds its position		1
Test description:		**Expected results:**	
Start a simulation in an empty environment and set the UAV to autonomous flight. Arm the motors of the UAV and call the take-off service from a computer. When the UAV has reached its correct altitude and held the position for 5 seconds, change to manual mode and land the UAV.		The UAV does a correct take-off and holds a position at an altitude between two and four meters.	
Hardware/Simulation: Simulation			
Executed by: DS **Participants:** DS, RW		**Test week:** 45	**Test date:** 8/11-2022
Test result: The UAV took off and held the position at two meters above the ground.			**Pass/Fail:** Pass
Comments: When the take-off service was called the UAV was armed and flew to the specified height.			
Test approved by: DS, RW			

Test No.:		**Test dependencies:** 12, 17	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
35	The UAV shall be able to take off autonomously and rise to an altitude between 2 and 4 meters where it holds its position		1
45	It shall be possible to manually take control of the UAV		1
Test description:		**Expected results:**	
In an empty environment, start Qualisys and the UAV, set the UAV to autonomous flight. Arm the UAV and call the take-off service from a computer. When the UAV has reached its correct altitude and held the position for 5 seconds, change to manual mode and land the UAV.		The UAV does a correct take-off and holds a position at an altitude between 2 and 4 meters. When the RC-controller switches to manual mode, the user has control over the UAV.	
Hardware/Simulation: Hardware			
Executed by: DS **Participants:** DG, DS		**Test week:** 47	**Test date:** 21/11-2022
Test result: The UAV was armed, took off and held a position two meters above the floor. When the RC controller switched to manual mode, the UAV was controlled manually			**Pass/Fail:** Pass
Comments: -			
Test approved by: DS			

Test No.:		**Test dependencies:** 12	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
36	The UAV shall be able to land and shut down the propellers autonomously		1
Test description:		**Expected results:**	
In an empty simulation environment, simulate a Base Station and a UAV, set the UAV to autonomous flight. Arm the UAV and call the take-off service from a computer. When the UAV has reached its correct altitude, call the land service from a computer.		The UAV does a correct landing and shuts down the propellers.	
Hardware/Simulation: Simulation			
Executed by: DS	**Participants:** DS, RW	**Test week:** 47	**Test date:** 25/11-2022
Test result: The UAV landed on the correct coordinates and shut down the propellers.			**Pass/Fail:** Pass
Comments: -			
Test approved by: DS, RW			

Test No.:		**Test dependencies:** 18, 19	
Resources: UAV, Visionen, Base Station			
Req. no.:	**Req. description:**		**Priority:**
36	The UAV shall be able to land and shut down the propellers autonomously		1
Test description:		**Expected results:**	
Start Qualisys and the UAV and set it to autonomous flight. Arm the UAV and call the take-off service from a computer. When the UAV has reached its correct altitude, call the land service from a computer.		The UAV does a correct landing and shuts down the propellers.	
Hardware/Simulation: Hardware			
Executed by: DS	**Participants:** DS, ES	**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV navigated to and landed at the correct position. When landed, it shut down the propellers.			**Pass/Fail:** Pass
Comments: -			
Test approved by: DS			

Test No.:		**Test dependencies:** -	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
38	The UAV must identify static distressed persons with the camera		1
41	The UAV must be able to differentiate between different types of distressed persons		1
Test description:		**Expected results:**	
Start a simulation and a UAV. Place two static persons in an empty environment. Select goal point manually so that the UAV should see both of the distressed persons with the camera. Listen to the topic that publishes information about distressed persons and confirm that two different missing persons have been found by comparing the identified colors.		The UAV correctly identifies the persons.	
Hardware/Simulation: Simulation			
Executed by: SF	**Participants:** SF, ES	**Test week:** 46	**Test date:** 18/11
Test result: The UAV found both distressed persons and displayed one yellow bounding box around the yellow car and none blue around the blue car.			**Pass/Fail:** Pass
Comments: Compared color of bounding box instead of listening to topic.			
Test approved by: ES			

Test No.:		**Test dependencies:** 21	
Resources: UAV, Visionen, RC-cars			
Req. no.:	**Req. description:**		**Priority:**
38	The UAV must identify static distressed persons with the camera		1
41	The UAV must be able to differentiate between different types of distressed persons		1
Test description:		**Expected results:**	
Place two static persons in the environment without obstacles. Fly the UAV manually to one distressed person at the time. Listen to the topic that publishes information about distressed persons and confirm that two different missing persons have been found by comparing the identified colors.		The UAV correctly identifies the persons.	
Hardware/Simulation: Hardware			
Executed by: SF	**Participants:** ES, SF	**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV identified the distressed persons.			**Pass/Fail:** Pass
Comments: The UAV was not flown manually, instead held over the distressed persons.			
Test approved by: ES			

Test No.:		**Test dependencies:** 21	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
39	The UAV must identify moving distressed persons with the camera		1
47	The UAV shall be able to follow distressed persons by tracking them using the camera		1
Test description:		**Expected results:**	
Start a simulation and simulate a UAV. Set the UAV to autonomous mode and hover 2 meters above the ground, simulate a distressed person moving through the UAVs field of view and listen to the topic that publishes information about distressed persons and confirm that the missing person has been found and that the UAV starts to track the missing person.		The UAV identifies and follows the distressed person.	
Hardware/Simulation: Simulation			
Executed by: SF	**Participants:** SF, DS	**Test week:** 47	**Test date:** 25/11
Test result: The UAV identified a distressed person moving in a circle and followed it.			**Pass/Fail:** Pass
Comments: -			
Test approved by: DS			

Test No.:		**Test dependencies:** 23	
Resources: RC-car, Visionen, UAV			
Req. no.:	**Req. description:**		**Priority:**
39	The UAV must identify moving distressed persons with the camera		1
47	The UAV shall be able to follow distressed persons by tracking them using the camera		1
Test description:		**Expected results:**	
Start Qualisys and the UAV. Set the UAV to autonomous mode and hover 2 meters above the ground, drive a distressed person through the UAVs field of view and listen to the topic that publishes information about distressed persons and confirm that the missing person has been found and that the UAV starts to track the missing person.		The UAV identifies and follows the distressed person.	
Hardware/Simulation: Hardware			
Executed by: ES	**Participants:** DS, ES, SF	**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV identified the distressed person and started following it as it moved.			**Pass/Fail:** Pass
Comments: The UAV lost the distressed person once since it was driven too fast.			
Test approved by: SF			

Test No.:		**Test dependencies:** 19, 23	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
48	A minimum safety distance of 50 cm shall always be held to distressed persons		1
Test description:		**Expected results:**	
Start a simulation and simulate a UAV. Land the UAV at a point where it is known that a distressed person is located. Simulate another landing where a distressed person moves to the landing zone when the UAV is approaching the ground.		The UAV lands at least 50 cm away from the distressed person and is always at least 50 cm from the distressed person during both landings.	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result: -			**Pass/Fail:** Not Conducted
Comments: The UAV flies 2 meter above the ground at all times except when landing and delivering supplies. When delivering supplies, the UAV only drops to 1.3 meters, which is outside the safety distance. The UAV should land at a position known to be empty. Thereby, the UAV never has to have a safety distance to distressed person when landing and the requirement is fulfilled anyways.			
Test approved by:			

Test No.:		**Test dependencies:** 20, 24	
Resources: RC-car, Visionen, UAV			
Req. no.:	**Req. description:**		**Priority:**
48	A minimum safety distance of 50 cm shall always be held to distressed persons		1
Test description:		**Expected results:**	
Start Qualisys and the UAV. Place a static distressed person in the middle of a empty environment. Command the UAV to hover above the distressed person. Command it to land the UAV at the same position as the distressed person. Make the UAV hover again and command it to land. When it is approaching the ground, drive the distressed person under the UAV.		The UAV lands at least 50 cm away from the distressed person and is always at least 50 cm from the distressed person during both landings.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments: No longer a requirement on hardware.			
Test approved by:			

Test No.:		**Test dependencies:** 13, 23	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
46	The UAV shall be able to deliver supplies to distressed persons by hovering over them and signaling a supply drop by lowering its altitude.		1
Test description:		**Expected results:**	
Start a simulation. Place a distressed person in the field. Send a task to the UAV to get supplies.		The UAV flies to a simulated supply center, stays there for a few seconds to simulate picking up supplies and then returns to the distressed person, descends 100 cm from its current altitude to indicate a drop off.	
Hardware/Simulation: Simulation			
Executed by: RW	**Participants:** AW, RW	**Test week:** 48	**Test date:** 2022-11-29
Test result: The UAV successfully simulates a supply drop.			**Pass/Fail:** Pass
Comments:			
Test approved by: RW			

Test No.:		**Test dependencies:** 14, 24, 27	
Resources: UAV, Visionen, RC-cars			
Req. no.:	**Req. description:**		**Priority:**
46	The UAV shall be able to deliver supplies to distressed persons by hovering over them and signaling a supply drop by lowering its altitude.		1
Test description:		**Expected results:**	
Start Qualisys and a UAV. Place a distressed person in an empty test environment. Send a task to the UAV to get supplies.		The UAV flies to a supply center, stays there for a few seconds to simulate picking up supplies and then returns to the distressed person, descends 50 cm from its current altitude and shakes.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not conducted
Comments: Requirement no. 46 is no longer a requirement on hardware.			
Test approved by:			

4 Base Station

Test No.:		**Test dependencies:**	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
49	The Base Station should handle communication between the Rover and UAV using ROS2		1
Test description:		**Expected results:**	
Simulate a Rover, a Base Station and an UAV. Let the Rover and the UAV listen to one topic each, which comes from the Base Station. Publish a topic which tells the Rover and UAV to move. The Rover and UAV will send on a different topic when the action is complete.		The Rover and the UAV should move, and the Base Station computer will receive information that the actions are complete.	
Hardware/Simulation: Simulation			
Executed by: DS	**Participants:** DS, DG	**Test week:** 48	**Test date:** 29/11-2022
Test result: Both the Rover and the UAV sent confirmation that they had reached the goal positions.			**Pass/Fail:** Pass
Comments: The response was received from the navigation action.			
Test approved by: DS			

Test No.:		**Test dependencies:** 29	
Resources: Rover, UAV, Base station			
Req. no.:	**Req. description:**		**Priority:**
49	Base station should handle communication between the Rover and UAV using ROS2		1
Test description:		**Expected results:**	
Start a Rover, a Base Station and an UAV. Let the Rover and the UAV listen to one topic each, which comes from the Base Station. Publish a topic which tells the Rover and UAV to move. The Rover and UAV will send on a different topic when the action is complete.		The Rover and the UAV should move, and the Base Station computer will receive information that the actions are complete.	
Hardware/Simulation: Hardware			
Executed by: DS	**Participants:** AL, DS	**Test week:** 48	**Test date:** 29/11-2022
Test result: Both the Rover and the UAV sent confirmation that they had reached the goal positions.			**Pass/Fail:** Pass
Comments: The response was received from the navigation action.			
Test approved by: DS			

Test No.:		**Test dependencies:** 3, 29	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
52	The Base Station shall be able to order the Rover to explore an indicated area autonomously		1
Test description:		**Expected results:**	
Start a simulation. Simulate a Rover and Base Station. Let the Base Station command the Rover to explore a specific area.		The Rover should explore the indicated area completely and in such a way that it gains information about the area, which is the same as in Gazebo.	
Hardware/Simulation: Simulation			
Executed by: RW	**Participants:** RW	**Test week:** 45	**Test date:** 2022-11-09
Test result: The test was successful. After sending a ROS2 command to the Rover, it started exploring the simulated world while also mapping and keeping track of its position relative to the surrounding environment.			**Pass/Fail:** Pass
Comments: Some issues can arise if the world includes obstacles that form "hallways". If the obstacles are too close to each other, the Rover cannot navigate the "hallways" successfully.			
Test approved by: RW			

Test No.:		**Test dependencies:** 4, 30, 31	
Resources: Visionen, Rover, Base Station			
Req. no.:	**Req. description:**		**Priority:**
52	The Base Station shall be able to order the Rover to explore an indicated area autonomously		1
Test description:		**Expected results:**	
Start the Rover, Base station and Qualisys. Let the Base Station command the Rover to explore a specific area.		The Rover should explore the indicated area completely and in such a way that it gains information about the area that corresponds to the real world area.	
Hardware/Simulation: Hardware			
Executed by: AL	**Participants:** AL, RW	**Test week:** 47	**Test date:** 21/11-2022
Test result: The Rover explored the whole area autonomously. The area visible in Rviz2 was similar to the real world area.			**Pass/Fail:** Pass
Comments:			
Test approved by: AL			

Test No.:		**Test dependencies:** 3, 8, 27, 29, 37	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
53	The Base Station shall keep track of the map, the Rover, the UAV and distressed persons		1
54	The Base station should be able to tell the Rover to track a distressed person while the UAV collects supplies.		1
Test description:		**Expected results:**	
Start a simulation in an environment with at least one obstacle. Simulate a Rover, Base station and an UAV. Let the Base station command the Rover to search and track for distressed persons and simultaneously drive around with the RC car. Once the distressed persons are identified, let the Base station command the UAV to collect supplies		The Base station should get updated information when a Rover, an UAV or distressed persons moves in Rviz and also be able to command the Rover to track distressed persons while the UAV collects supplies	
Hardware/Simulation: Simulation			
Executed by: RW	**Participants:** SF,RW	**Test week:** 48	**Test date:** 1/12
Test result: The Base station got updated information about the map and the Rover tracked the distressed person while the UAV collected supplies.			**Pass/Fail:** Pass
Comments: The distressed person is not visible in Rviz.			
Test approved by: SF			

Test No.:		**Test dependencies:** 4, 9, 28, 30, 33	
Resources: Base station, Visionen, UAV, Rover, RC car			
Req. no.:	**Req. description:**		**Priority:**
53	The Base Station shall keep track of the map, the Rover, the UAV and distressed persons		1
54	The Base station should be able to tell the rover to track a distressed person while the UAV collects supplies		1
Test description:		**Expected results:**	
Start the Rover, Base station, the UAV and Qualisys. In an environment with at least one obstacle, let the Base station command the Rover to search and track for distressed persons and simultaneously drive around with the RC car. Once the distressed persons are identified, let the Base station command the UAV to collect supplies		The Base station should get updated information when a Rover, an UAV or distressed persons move in Rviz and also be able to command the Rover to track distressed persons while the UAV collects supplies	
Hardware/Simulation: Hardware			
Executed by: **Participants:**		**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not conducted
Comments: No longer a requirement on hardware.			
Test approved by:			

5 Simulation

Test No.:		**Test dependencies:** -	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
56	The simulation environment shall be able to simulate an UAV		1
57	The simulation environment shall be able to simulate a Rover		1
58	Different stationary distressed persons must be simulated in the environment		1
Test description:		**Expected results:**	
Start a Base Station container, Rover container and an UAV container. Start a Base Station with simulation engaged, using a mission with distressed persons. Then, spawn a Rover and finally an UAV.		One Rover, one UAV, one or two distressed persons depending on mission should be visualized and simulated.	
Hardware/Simulation: Simulation			
Executed by: ES	**Participants:** ES, SF	**Test week:** 41	**Test date:** 2022-10-13
Test result: One Rover, one UAV and two static distressed persons were visualized and simulated.			**Pass/Fail:** Pass
Comments:			
Test approved by: ES			

Test No.:		**Test dependencies:**	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
62	The simulation environment must be able to simulate a no-fly zone		1
Test description:		**Expected results:**	
Start a Base Station container. Start a Base Station with simulation engaged, and specify a no-fly zone.		A no-fly zone should be visualized and simulated.	
Hardware/Simulation: Simulation			
Executed by: AL	**Participants:** AL	**Test week:** 47	**Test date:** 2022-11-25
Test result: A map containing a No-Fly Zone successfully spawned inside Rviz2.			**Pass/Fail:** Pass
Comments:			
Test approved by: AL			

Test No.:		**Test dependencies:** 35	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
59	The simulated distressed persons must be able to move along a line or a circle		1
Test description:		**Expected results:**	
Start a Base Station container and run the Base Station code, starting Gazebo and a mission with two distressed persons. Issue a command to one of the distressed persons to move in a circle, and then issue a command to the second to move in a line.		The first distressed person should move in a circle, and the second distressed person in a line.	
Hardware/Simulation: Simulation			
Executed by: DG **Participants:** DG, RW		**Test week:** 45	**Test date:** 9/11
Test result: One distressed person moved in a circle. The other moved back and forth in a line. However, it deviated slightly in one direction, but the main point of moving in a pattern was achieved.			**Pass/Fail:** Pass
Comments: If we have time, someone could try to fix it so that the line formation is a straighter line.			
Test approved by: RW			

6 Mission

Test No.:		**Test dependencies:** 31, 33	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
1	Distressed persons should be able to move up to 5 m from their start position		1
2	If a distressed person is identified by the Rover, the UAV should cancel any activity except delivery of supplies and start fetching supplies		1
3	If a moving distressed person is identified by the UAV, the Rover should cancel any activity and intercept the distressed person and then start tracking		1
Test description:		**Expected results:**	
Start a simulation with a Base Station, a Rover, and an UAV, in an environment as specified in Figure 1. Place the Rover with the UAV on top at one end of the test area, and make sure that the Rover's field of view does not include the middle of the test area. Place a no-fly zone in the middle of the room of size 2x2 m, and place a distressed person in the middle of it. Start the mission and wait until the Rover locates the first distressed person. Once it is located, start moving it outside the no-fly zone and drive around it in a circular path, always keeping 2 meters of distance from the no-fly zone. Once the UAV has delivered the supplies, drive the second distressed person inside the UAV's field of view first (make sure by issuing manual command). Drive the distressed person in the same pattern as the first, until the UAV has delivered the supplies.		In the first case, when the Rover locates a distressed person, it should track it until the UAV has delivered supplies. In the second case, when the UAV locates a distressed person, it should track it until the Rover can take over the tracking and then start to deliver supplies.	
Hardware/Simulation: Simulation			
Executed by: RW **Participants:** SF, RW		**Test week:** 48	**Test date:** 1/12
Test result: The UAV identified a blue distressed person and tracked it until the Rover took over the tracking. When the Rover was tracking, the UAV flew to collect supplies and then delivered them. The yellow distressed person was then driven into the Rover's field of view and the Rover started to track it, meanwhile, the UAV flew to collect supplies and deliver them.			**Pass/Fail:** Pass
Comments: The test was not exactly done as specified but had the same effect.			
Test approved by: SF			

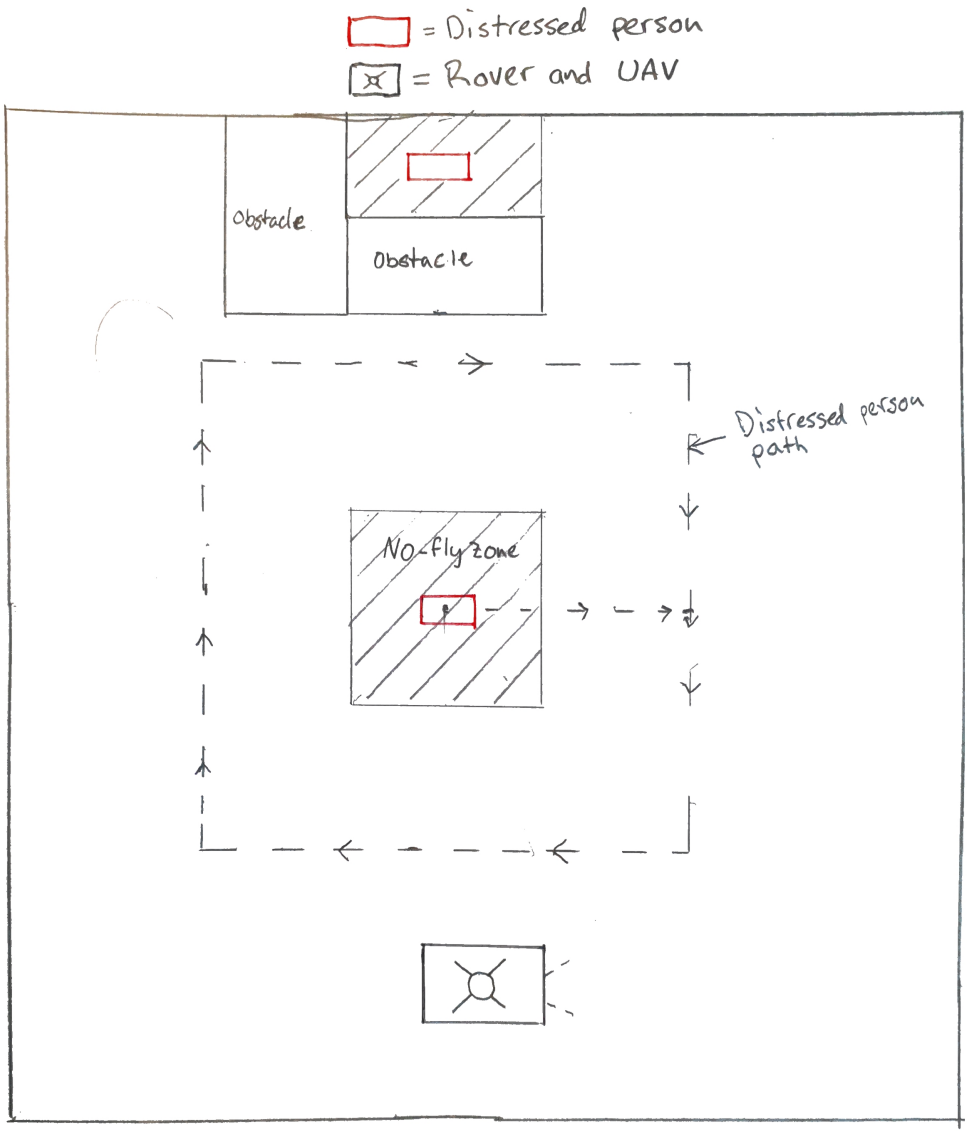

Figure 1: Test no. 39 and 40 test area.

Test No.:		**Test dependencies:** 34, 38	
Resources: Base station, Rover, UAV, RC-car, Obstacles, Visionen			
Req. no.:	**Req. description:**		**Priority:**
1	Distressed persons should be able to move up to 5 m from their start position		1
2	If a distressed person is identified by the Rover, the UAV should cancel any activity except delivery of supplies and start fetching supplies		1
3	If a moving distressed person is identified by the UAV, the Rover should cancel any activity and intercept the distressed person and then start tracking		1
Test description:		**Expected results:**	
Place the Rover with the UAV on top at one end of Visionen and make sure that the Rover's field of view does not include the middle of the test area, see Figure 1. Place a no-fly zone in the middle of the room of size 2x2 m, and place a distressed person in the middle of it. Place two obstacles 2 meters from the opposite wall from where the Rover and UAV started and a no-fly zone above it and place a distressed person there. Start the mission and wait until the Rover locates the first distressed person. Once it is located, start moving it outside the no-fly zone and drive around it in a square, keeping 2 meters of distance from the no-fly. Once the UAV has delivered the supplies, drive the second distressed person inside the UAV's field of view first (make sure by issuing manual command). Drive the distressed person in the same pattern as the first, until the UAV has delivered the supplies.		In the first case, when the Rover locates a distressed person, it should track it until the UAV has delivered supplies. In the second case, when the UAV locates a distressed person, it should track it until the Rover can take over the tracking and then start to deliver supplies.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not conducted
Comments: No longer a requirement on hardware			
Test approved by:			

Test No.:		**Test dependencies:** 15, 38	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
4	The system should be able to handle up to 2 distressed persons		1
5	The system should be able to handle an environment with maximum 8 obstacles		1
6	An obstacle should be 1-9 m wide and have a rectangular shape		1
7	The system should be able to handle an environment with 1 no-fly zone		1
9	A no-fly zone should be 1-4 m^2, have a rectangular shape and stretch from the floor to the ceiling		1
10	It shall be possible to specify a no-fly zone as a mission parameter		1
11	The system should be able to complete a mission in an environment specified earlier, in simulation		1
50	A mission planner shall be implemented to carry out the mission		1
Test description:		**Expected results:**	
Start a simulation with a Base Station, a Rover, and an UAV on top of the Rover in an environment with 2 distressed persons at two different start positions outside the Rover's field of view. The test area shall include 8 rectangular obstacles that are 1-9 m wide. Specify a no-fly zone somewhere in the test area. Send a message to the mission planner to start a mission. Repeat the mission and vary the size of the no-fly zone from 1 to 4 m^2 and vary the width of the obstacles from 1 to 9 m.		The mission should be successfully executed, no matter of obstacle or no-fly zone size.	
Hardware/Simulation: Simulation			
Executed by: RW **Participants:** SF, RW		**Test week:** 48	**Test date:** 2/12
Test result: Two distressed persons were rescued.			**Pass/Fail:** Pass
Comments: Did not vary the size of obstacles and no-fly zone because of lack of time. If the Rover only sees the distressed person a short time and looses it, the mission will fail since the rescue procedure begins when the Rover sees the distressed person and can not be aborted. This can happen if the Rover sees the distressed person from far away and does not get there until the distressed person is gone. If given more time, this would be fixed.			
Test approved by: SF			

Test No.:	**Test dependencies:** 16, 40
Resources: Base station, Rover, UAV, RC-car, Obstacles, Visionen	

Req. no.:	**Req. description:**	**Priority:**
4	The system should be able to handle up to 2 distressed persons	1
5	The system should be able to handle an environment with maximum 8 obstacles	1
6	An obstacle should be 1-9 m wide and have a rectangular shape	1
7	The system should be able to handle an environment with 1 no-fly zone	1
9	A no-fly zone should be 1-4 m^2, have a rectangular shape and stretch from the floor to the ceiling	1
10	It shall be possible to specify a no-fly zone as a mission parameter	1
12	The system should be able to complete a mission in an environment specified earlier, while running on HW	2
50	A mission planner shall be implemented to carry out the mission	1

Test description:	**Expected results:**
Start Qualisys, the UAV, the Rover and the Base station. Place out 2 RC-cars and 8 obstacles. Initialize one no-fly zone and start a mission. Repeat the mission and vary the size of the no-fly zone from 1 to 4 m^2 and vary the width of the obstacles from 1 to 9 m.	The mission should be successfully executed, no matter of obstacle or no-fly zone size.

Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments: No longer a requirement on hardware.			
Test approved by:			

Test No.:		**Test dependencies:** 40	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
70	The system must be able to complete 3 out of 4 missions successfully		1
71	The system must be able to complete 4 out of 4 missions successfully		2
72	The Rover must not stop for longer than 5 seconds while exploring during the mission		3
Test description:		**Expected results:**	
Start a simulation with a Base station, UAV and Rover. Test in an environment as specified in test no. 42. Command the robots to search and rescue distressed persons. When the distressed persons are rescued, reset the map of the world and place the distressed persons far away from the robots and command the robots to search and rescue again, repeat this 4 times.		In at least 3 of 4 missions, all distressed persons should be identified, rescued and delivered supplies. It should be able to do the missions without stopping for more than five seconds.	
Hardware/Simulation: Simulation			
Executed by: RW	**Participants:** RW, SF, AL, AW	**Test week:** 48	**Test date:** 4/12
Test result: The blue and yellow distressed persons were delivered supplies and rescued approximately 3 out of 4 times when nothing crashed.			**Pass/Fail:** Pass
Comments: It was hard to conduct a full mission without one of our nodes crashing at some point, most often in startup. This resulted in a lot of failed missions. However, when nothing crashed and the distressed persons weren't driven too complicated, the missions succeeded. Therefore, we still believe that requirement no. 70 is fulfilled. Requirement no. 72 was not tested and requirement no. 71 can not be considered fulfilled since the system can crash because our computers were too slow.			
Test approved by: SF, AL			

Test No.:		**Test dependencies:** 41, 42	
Resources: Base station, Rover, UAV, RC-car, Obstacles, Visionen			
Req. no.:	**Req. description:**		**Priority:**
70	The system must be able to complete 3 out of 4 missions successfully		1
71	The system must be able to complete 4 out of 4 missions successfully		2
72	The Rover must not stop for longer than 5 seconds while exploring during the mission		3
Test description:		**Expected results:**	
Start the Base Station, The UAV and the Rover. Test in an environment as specified in test no. 43. Command the robots to search and rescue distressed persons. When the distressed persons are rescued, reset the map of the world and place the RC-cars far away from the robots and command the robots to search and rescue again, repeat this 4 times.		In at least 3 of 4 missions, all distressed persons should be identified, rescued and delivered supplies. It should be able to do the missions without stopping for more than five seconds.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not conducted
Comments: No longer a requirement on hardware			
Test approved by:			

7 Safety

Test No.:		**Test dependencies:** -
Resources: UAV, Visionen		
Req. no.:	**Req. description:**	**Priority:**
93	The UAV must have a kill switch on the RC-controller which cuts the power to all the actuators	1
Test description:		**Expected results:**
Start the UAV, and fly manually or autonomous in an empty environment and fly it to a height of about 0.5 m. Place a mattress under the UAV and flip the kill switch on the RC-controller		The rotor blades stop moving.
Hardware/Simulation: Hardware		
Executed by: DS **Participants:** DS,SF,AL	**Test week:** 41	**Test date:** 2022-10-14
Test result: The rotors blades stopped moving and the UAV slammed into the floor.		**Pass/Fail:** Pass
Comments: -		
Test approved by: SF, DS		

Test No.:		**Test dependencies:** -
Resources: UAV, Visionen		
Req. no.:	**Req. description:**	**Priority:**
94	The UAV shall make an audible signal when the battery is low.	1
Test description:		**Expected results:**
Start the UAV, preferably with low battery, and command it to autonomously fly to and hold a position at a height of about 0.5 m. Keep it at that height and observe what happens when the battery level is too low.		The UAV should make an audible sound when the battery level is too low.
Hardware/Simulation: Hardware		
Executed by: DS,AL **Participants:** DS,AL,SF	**Test week:** 41	**Test date:** 2022-10-14
Test result: The UAV started to beep when the battery was to low.		**Pass/Fail:** Pass
Comments:		
Test approved by: DS		

Test No.:		**Test dependencies:** -	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
95	The UAV shall land if it loses its RC-connection		1
Test description:		**Expected results:**	
Start the UAV, fly it manually in an empty environment and fly it to a height of about one meter, keep it at that height and then turn off the RC controller		The UAV should land autonomously when the RC connection is lost.	
Hardware/Simulation: Hardware			
Executed by: DS **Participants:** DS,AL,SF		**Test week:** 41	**Test date:** 2022-10-14
Test result: The UAV landed autonomously when the RC-connection was lost.			**Pass/Fail:** Pass
Comments: -			
Test approved by: DS,SF			

Test No.:		**Test dependencies:** 12	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
96	The UAV shall land if the Pixhawk loses its connection to the RPi		1
Test description:		**Expected results:**	
Start the UAV, fly it manually in an empty environment and fly it to a height of about one meter, keep it at that height and then kill the node between the RPi and the Pixhawk (microRPTS bridge).		The UAV should land autonomously when the Pixhawk loses its connection to the RPi.	
Hardware/Simulation: Hardware			
Executed by: DS **Participants:** DS, ES		**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV landed autonomously when the node was terminated.			**Pass/Fail:** Pass
Comments: The test was conducted while the UAV was flying autonomously.			
Test approved by: DS			

Test No.:		**Test dependencies:** 12	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
97	The UAV shall land if it loses connection to Qualisys over two seconds		1
Test description:		**Expected results:**	
Start the UAV, fly it autonomously in an empty environment and fly it to a height of about 1 meter, keep it at that height and then turn off the Qualisys system.		The UAV should land autonomously when the connection to the Qualisys system has been lost for over 2 seconds.	
Hardware/Simulation: Hardware			
Executed by: DS	**Participants:** DS, ES	**Test week:** 48	**Test date:** 29/11-2022
Test result: The UAV landed after not receiving Qualisys data for over two seconds.			**Pass/Fail:** Pass
Comments: After two seconds the ROS2 node stopped sending the heartbeat messages to the Pixhawk, resulting in a landing.			
Test approved by: DS			

Test No.:		**Test dependencies:** -	
Resources: Rover, Visionen, Base Station			
Req. no.:	**Req. description:**		**Priority:**
98	The Rover shall stop if it loses connection to the Base Station.		2
Test description:		**Expected results:**	
Start the Rover and drive it in autonomous mode, in an empty environment and turn off the Base Station.		The Rover should stop autonomously when the connection to the Base Station is lost longer than 2 seconds.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 44	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments: Did not have time to implement this. Mostly a problem on hardware, since the Rover will become uncontrollable.			
Test approved by:			

8 Test priority 2 and 3

Test No.:		**Test dependencies:** 17, 19	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
42	The UAV must be able to start autonomously from the Rover while the Rover is stationary		2
43	The UAV must be able to land autonomously on the Rover while the Rover is stationary		2
Test description:		**Expected results:**	
Start a simulation. Simulate a UAV in the center of the platform on the Rover. Fly the UAV to an altitude of 2 meters and set a point 5 meters away from the Rover for the UAV to fly to. Finally, call the UAV to land on the Rover.		The UAV should lift from the Rover and fly to the set point. Once, the landing has been called, it should land on top of the Rover's platform.	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 18, 20, 50	
Resources: UAV, Rover, Visionen			
Req. no.:	**Req. description:**		**Priority:**
42	The UAV must be able to start autonomously from the Rover while the Rover is stationary		2
43	The UAV must be able to land autonomously on the Rover while the Rover is stationary		2
Test description:		**Expected results:**	
Start Qualisys and the UAV. Place the UAV in the center of the platform on the Rover. Set a point 5 meters away at an altitude of 2 meters from the Rover for the UAV to fly to. Finally, call the UAV to land on the Rover.		The UAV should lift from the Rover and fly to the set point. Once, the landing has been called, it should land on top of the Rover's platform.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:** 48	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 40, 41	
Resources: Base station, Rover, UAV, RC-car, obstacles, Visionen			
Req. no.:	**Req. description:**		**Priority:**
8	The system should be able to handle an environment with 4 no-fly zones		2
Test description:		**Expected results:**	
Repeat test No. 42 and 43 with 4 no-fly zones.		All distressed persons are rescued.	
Hardware/Simulation: Both			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 11	
Resources: Rover, Visionen, RC-cars			
Req. no.:	**Req. description:**		**Priority:**
26	The Rover must keep a safety distance of 0.25 meters to distressed persons		2
Test description:		**Expected results:**	
Start the Rover and place a distressed person in front of it. Send a position behind the distressed person to the Rover's motion planner.		The Rover should not be closer than 0.25 meters to the distressed person.	
Hardware/Simulation: Both			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** -	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
61	The simulation shall have the option to choose between custom maps		2
Test description:		**Expected results:**	
Start a simulation and change map.		A new map should be simulated	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 35	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
63	The simulation shall be able to simulate more than one Rover		2
Test description:		**Expected results:**	
Start a simulation and spawn two Rovers. Give each Rover a point to drive to.		Two Rovers are spawned. They follow the path set by the corresponding motion planner.	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 35	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
64	The simulation shall be able to simulate more than one UAV		2
Test description:		**Expected results:**	
Start a simulation and spawn two UAVs. Give each UAV a point to fly to.		Two UAVs are spawned. They follow the path set by the corresponding motion planner.	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:** 49	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** -	
Resources: Base station, Obstacles, Rover, UAV, Visionen, RC-cars			
Req. no.:	**Req. description:**		**Priority:**
66	The GUI should give the user the same visualization of the map as the same one that Rviz2 enables		2
67	The GUI should have a start and stop button for the mission at hand		2
Test description:		**Expected results:**	
Start a mission with an at least 1 m^2 obstacle in the middle of the test area using the start button in the GUI, compare the map in the GUI with Rviz2. Stop the mission using the stop button after a few minutes.		The mission is started, the obstacle appears in the GUI in the same way as in Rviz2.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 4	
Resources: Rover, Visionen			
Req. no.:	**Req. description:**		**Priority:**
24	An IMU shall be mounted and implemented to increase the positioning accuracy of the Rover		3
Test description:		**Expected results:**	
Start the Rover, but without position feedback from Qualisys. Set a position the Rover will drive to and compare the error in path following to the result in test No. 4.		The rover follows the path closer than before when comparing to test number four.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 28	
Resources: UAV, Visionen			
Req. no.:	**Req. description:**		**Priority:**
41	The UAV shall be able to drop off real supplies with the HW		3
Test description:		**Expected results:**	
Manually attach an object (supply) to the UAV. Start the UAV and fly it to a height 2 m and then send it a command to drop off supplies.		The UAV should fly down to the ground, release the object, and then fly back up.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 51	
Resources: Visionen, Rover, UAV, computer			
Req. no.:	**Req. description:**		**Priority:**
47	The UAV must be able to land autonomously on the Rover while the Rover is moving		3
Test description:		**Expected results:**	
Start Qualisys and test in an empty test environment. Place the UAV on the Rover. Send a command to hover the UAV at a height of 2 meters. Send a command to Rover to follow a path around Visionen at a constant velocity. Send a command to land the UAV on the Rover.		The UAV should land on the Rover.	
Hardware/Simulation: Both			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** -	
Resources: Base station, Visionen, RC-cars, Obstacles, UAV, Rover. Computer			
Req. no.:	**Req. description:**		**Priority:**
51	A PDDL task planner shall be implemented to carry out the mission		3
Test description:		**Expected results:**	
Run the mission using a PDDL planner in simulation and on hardware.		The mission is completed successfully in both cases.	
Hardware/Simulation: Both			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 27	
Resources: Computer			
Req. no.:	**Req. description:**		**Priority:**
65	The simulated UAV shall be able to simulate picking up supplies and dropping them in Gazebo		3
Test description:		**Expected results:**	
Start a simulation and command the UAV to pick up supplies at one location and then drop them at another location		The UAV should pick up supplies where they are located and drop deliveries at a desired location	
Hardware/Simulation: Simulation			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 55	
Resources: Base station, UAV, Rover, Obstacles, RC-cars, Visionen			
Req. no.:	**Req. description:**		**Priority:**
68	A user shall be able to change control parameters for the Rover and UAV controller during a mission		3
Test description:		**Expected results:**	
Start Qualisys, the Base station, the Rover and the UAV. Place out a distressed person near obstacles so the Rover and the UAV cannot drive straight to the distressed person. Start a mission and once the distressed person is detected change the control parameters for the Rover and the UAV to a "bad" value and observe the trajectory and then change to some "good" control parameters and observe the trajectory. Be ready with the kill switch so that the robots don't run in to walls. All changes of control parameters are changed in the GUI.		There should be a significant difference for the Rover and the UAV trajectories for the different control parameters.	
Hardware/Simulation: Hardware			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			

Test No.:		**Test dependencies:** 32	
Resources: Base station, Visionen, RC-cars, Obstacles, Rover, UAV, Computer			
Req. no.:	**Req. description:**		**Priority:**
69	A user shall be able to change between two search strategies prior to a mission		3
Test description:		**Expected results:**	
Start the system to perform a mission. Change to the second search algorithm and start the mission.		The selected search algorithm is used throughout the mission.	
Hardware/Simulation: Both			
Executed by:	**Participants:**	**Test week:**	**Test date:**
Test result:			**Pass/Fail:** Not Conducted
Comments:			
Test approved by:			