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Subject: CR's,ER's and TP's

Team Honeywell was tasked with creating an Oil Chip Detector Sensor Housing, henceforth known as an OCDH. The OCDH is to meet all requirements set forth by Honeywell; the requirements vary from weight, to pressure and temperature resistances. There have been no major changes in Customer Requirements and Engineering Requirements since the project has started. The preliminary date of early February has been pushed back but only by a few weeks.

1 Customer Requirements (CRs)

Customer requirements have been refined since the beginning of the project. Requirements have been renamed or eliminated as more information has been provided to the team by Honeywell. The Customer Requirements include: Weight, Leak Free apparatus, Fuel and Oil resistance, Temperature resistance, Vibration resistance, overall envelope size, fitting quality, and material choice. The weight, leak free apparatus, fuel and oil resistance, temperature resistance, size, and material choice all had the highest customer weightings meeting the maximum weight of ten on a one to ten scale. Vibration resistance and fitting quality are weighted at an eight due to the lower analysis required for these requirements. The main changes within the customer requirements came from combining and eliminating redundant customer requirements. Many of the customer requirements have not changed but modified to meet Honeywell's requirements. The preliminary requirements of budget, durability, reliability, safe in operation, Oil Chip Detector Interface, burst pressure, force loads, and quality were all eliminated due lack of clarity within the project. Burst pressure, durability, safe in operation, reliability, and force loads were combined within the overall resistance and material choice selections of the project. Interface, and quality assurance were combined into fitting quality to further refine the customer requirements. Table 1 displays all the current customer requirements.

Table 1. Customer Requirements

Customer Requirements	Relative Weights (%)
Low Weight	10
Leak Free	15
Fuel and Oil Resistant	10
Temperature Resistant	13
Vibration Resistant	12
Size	15
Fitting Quality	10
Nonreactive/nontoxic material	10

2 Engineering Requirements (ERs)

Engineering requirements were built off the customer requirements. Many of the old customer requirements have been moved to this section because they better accommodate measurable targets. Engineering requirements are measurable and achievable goals that are set for the project to be completed. No Engineering requirements have been eliminated since they were originally created. Engineering requirements have been added to better encompass the projects goal. Burst pressure will be not included due to no measurable values being provided by Honeywell. Tolerancing will not be included as an Engineering requirement because tolerances will be provided for all other engineering requirements.

2.1 ER #1: Total Weight

2.1.1 ER #1: Weight – Target = 1 lbs.

Everything that goes into the construction of a smaller size turboprop engine has an effective goal for weight vs size/strength. In this case Honeywell decided 1 lbs. was the was the ideal maximum weight for the housing due its static use and relatively simple design.

2.1.2 ER #1: Weight – Tolerance = 0.30 lbs.

Initially, there was no tolerance to the weight of the housing. An aluminum version of the design could weigh as little as 0.67 lbs., but the team has elected to go with stainless steel which will bring the weight up to 1.29 lbs. The decision between stainless and aluminum directly affects the housing's performance in other critical areas, namely the operating and testing temperatures. Recently, the team plied Mr. Temme for a variance on the weight and has received permission to use as much as 1.3 lbs.

2.2 ER #2: Durability

2.2.1 ER #2: Durability – Target = Complete Engine Life

The durability of the OCDH is integral to the life of the engine. If the sensor housing fails, there is a chance that the engine can fail due to metal debris causing damage to the internal function of the engine. The OCDH needs to survive the life of the engine so that the engine can be protected from possible damage by metal debris.

2.2.2 ER #2: Durability – Tolerance = Complete Engine Life

There is no tolerance for the durability. The OCDH is required by the team to last the whole life of the engine. The OCDH will be designed to meet this requirement as the housing is an integral part of protecting and ensuring the lifetime of the engine.

2.3 ER #3 Within Budget

2.3.1 ER #3: Cost under $1,000 – Target = $750

The budget for the project has not changed. The project shall not exceed $1,000 in allocated budget. Based upon the current bill of materials the total for three OCDH units will cost $750 leaving $250 for overflow and emergency funds.

2.3.2 ER #3: Cost under $1,000 – Tolerance = +/- $250

The team has a tolerance of $250 for this project. Team Honeywell has already built in material and product redundancy when ordering materials to help alleviate final costs. The cost should not exceed any more than $750.

2.4 ER #4 Reliability

2.4.1 ER #4: Reliability – Target = 1

The reliability for the project has not changed. The project requires a safety of 1 on a scale of zero to one. The OCDH needs to be able to withstand all forces that come upon it and the part is required to withstand all the forces that it may be affected by.

2.4.2 ER #4: Reliability – Tolerance = +/- 0.1

The tolerance for reliability is 0.1 this means the part can be safer by 0.1 or it can be a little less safe. The reliability tolerance is like factor of safety, but the factors have been minimized from zero to one.

2.5 ER #5 Safe in Operation

2.5.1 ER #5 Safe in Operation – Target = Yes

The OCDH is required to be safe in operation. The target for this engineering requirement is “yes” because the part is required to be safe in operation at all time. To ensure safe in operation the part will meet all proper tolerances.

2.5.2 ER #5 Safe in Operation – Tolerance = N/A

There are no tolerances in safe in operation because the part is always required to be safe in operation.

2.6 ER #6 Envelope Size

2.6.1 ER #6: Envelope Size – Target = 3x3x2 in.

The envelope size shall not exceed 3x3x2 in. The part needs to fit within this envelope because it there are parts that are attached on the engine that will prevent the OCDH from being any larger.

2.6.2 ER #6: Envelope Size – Tolerance = +/-0.001in

The tolerance on the envelope size are required to be accurate. Because the part is being manufactured and placed on an airplane it is required to meet aeronautical standards for tolerancing and accuracy.

2.7 ER #7 Operation Altitude

2.7.1 ER #7 Operation Altitude – Target = -2,000 to 55,000 ft.

The OCDH needs to be able to operate from -2,000 to 55,000 feet. The material selection can guarantee proper altitude requirements.

2.7.2 ER #7 Operation Altitude – Tolerance = +/- 10 ft.

The tolerance for the operating altitude is 10 feet. The operation altitude is an important engineering requirement because it needs to be able to operate at all altitudes that the engine will be operating at.

2.8 ER #8 Operating Pressure

2.8.1 ER #8 Operating Pressure – Target = 5-15 psig

The OCDH is required to operate from 5-15 psi gauge pressure. This is to ensure that the part will not depressurize and therefore fail.

2.8.2 ER #8 Operating Pressure – Tolerance = +/- 1 psig

The tolerance of the operating pressure is 1 psi gauge pressure. The tolerance is very high because the OCDH needs to operate at all pressures internal and external.

2.9 ER #9 Force Loads

2.9.1 ER#9 Force Loads – Target = 2 g's

The OCDH needs to with stand force loads from 0 to two times the weight of gravity. This engineering requirement is needed to guarantee that the OCDH will not fail when faced with high pressures.

2.9.2 ER #9 Force Loads – Tolerance = +/- 0.1 g

The tolerances on the force loads is very high to help prevent possible failure within the OCDH. The tolerance here is extremely high because the more force that the part can take the higher the safety level will be.

2.10 ER #10 Shock Resistance

2.10.1 ER #10 Shock Resistance – Target = 20 g's

The OCDH is required to be shock resistance. If the sensor were to fail the part needs to be able to withstand all shock that can occur. The material selection will be integral in determining the amount of shock resistance that the OCDH can withstand.

2.10.2 ER #10 Shock Resistance – Tolerance = +/- 1 g

The OCDH is required to be able to withstand as much shock as possible but because of the material selection the risk of shock has been reduced greatly.

2.11 ER #11 Internal Interface

2.11.1 ER #11 Internal Interface – Target = 0.75 in.

The internal interfaces are to meet the fitting requirements set forth by Honeywell. All fitting will meet the target goal and must be manufactured accurately and precisely.

2.11.2 ER #11 Internal Interface – Tolerance = +/-0.005 in.

The tolerance on the internal interfaces is required to high to allow for a proper fitting to be placed within the OCDH. This will guarantee a tight seal on the part itself.

2.12 ER # 12 Temperature Resistance

2.12.1 ER #12 Temperature Resistance – Target = -65 to 2,000°F for 5 min., dynamic; 310°F for 2 min., static

The OCDH needs to be able to withstand a high temperature fire test. The OCDH is also required to be able to withstand a static and constant temperature. Material selection will allow for the OCDH to properly withstand the temperature requirements.

2.12.2 ER #12 Temperature Resistance – Tolerance = +/- 5°F

Due to the high temperature resistance required the material should allow for any expansion of the temperature resistance.

3 Testing Procedures (TPs)

Testing procedures for the housing are set forth by Honeywell. There are 4 required tests that will cover all the engineering requirements. A load test, thermal environment, stress and strength test, and a vibration/dynamic test. All tests will be performed by Honeywell, but the processes will be determined prior to the testing date by Team Honeywell. Operating altitude, safe in operation, and reliability will be determined by Honeywell after the tests are concluded.

3.1 Testing Procedure 1: Measured Weight

3.1.1 Testing Procedure 1: Meet the weight engineering requirement

The weight requirement will be met by weighing the OCDH on a scale before all testing will be conducted by Honeywell. The weight must not exceed 1 pound to meet the weight engineering requirement.

3.1.2 Testing Procedure 1: Scale

Testing for the OCDH will be conducted on site at Honeywell in the Phoenix facility. All equipment and testing procedures will be completed by the teams on site. This includes all tests described below, Team Honeywell has been instructed by Honeywell not to attempt the testing procedures as some of the tests can be dangerous and cause bodily harm, such as the fire test.

3.1.3 Testing Procedure 1: Schedule

Currently Team Honeywell is working with Honeywell on when the testing will take place. Currently the engine team at Honeywell is not ready for testing the housing and as such Team Honeywell has been given more time to complete to final prototype for testing. Originally testing was to take place in the second or third week of February but has been delayed to a future date that has yet to be determined. This should not cause any issues for Team Honeywell as everything has been on schedule for the original test date. This will allow Team Honeywell to further streamline the final design and allow for extra housings to be manufactured.

3.2 Testing Procedure 2: Vibration and Dynamic Test

3.2.1 Testing Procedure 2: Meet the durability, reliability, force loads, and safe in operation requirement

The OCDH will undertake a vibration and dynamic test that will be performed by Honeywell. The OCDH will be placed on a vibration table and put through various dynamic and vibration-based test to determine the amount of force that it can withstand. The vibration and dynamic test will determine if the OCDH

meets the durability, reliability and safe in operation engineering requirements.

3.2.2 Testing Procedure 2: Vibration Table

A vibration table will be provided by Honeywell for the purposes of testing the OCDH. The amount of vibration will vary based upon the parameters of the engine. The OCDH needs to be able to meet the Honeywell standards for safety.

3.2.3 Testing Procedure 2: Schedule

Vibration testing will take place when the final product is due with Honeywell. Test are scheduled for late February, but a final date has not been determined yet. The team will finish the OCDH in time for all testing to be completed by Honeywell.

3.3 Testing Procedure 3: Envelope Size Measurement

3.3.1 Testing Procedure 3: Meet the envelope size

The OCDH will be measured to meet the envelope size provided by Honeywell. This test will be performed by the team after manufacturing is complete. This will allow for proper manufacturing and tight tolerancing on the part itself. This meets the envelope size engineering requirement provided by Honeywell.

3.3.2 Testing Procedure 3: Calipers

A pair of calipers that will be provided by the team will be used to measure the OCDH parts. The calipers will measure the x, y, and z dimensions of the manufactured OCDH to ensure that the part meets the proper tolerances for the part.

3.3.3 Testing Procedure 3: Schedule

The OCDH will be measured after manufacturing has been completed. The final week of February is when the OCDH is scheduled to be completed and at the same time the OCDH will be measured.

3.4 Testing Procedure 4: Operating Pressure

3.4.1 Testing Procedure 4: Meet the operation altitude and operating pressure engineering requirement

Operating pressure test will be conducted using internal pressure tapping’s to determine the total pressure that is operating within the sensor housing. Honeywell will perform this test and determine what is appropriate to properly determine the internal operating pressure.

3.4.2 Testing Procedure 4: Internal pressure tapping’s

The tapping’s will be provided by Honeywell as will the parameters for the test. The tapping’s will be used to determine internal pressure, but altitude will be determined later by Honeywell.

3.4.3 Testing Procedure 4: Schedule

The test will conducted the last week of February by Honeywell when the final parts are delivered to Honeywell. An exact date will be determined by Honeywell later.

3.5 Testing Procedure 6: Internal Interface Check

3.5.1 Testing Procedure 6: Meet the internal interface engineering requirement

The internal interfaces will be measured using a pair of calipers to make sure that the fitting will properly fit within the engine. The internal interface fulfills the fitting engineering requirement to allow proper flow through the OCDH housing.

3.5.2 Testing Procedure 6: Calipers

A pair of calipers will be used to check the tolerances of the internal interfaces. The calipers will be provided by the team to measure the interfaces and determine whether the manufactured OCDH will meet the requirements.

3.5.3 Testing Procedure 6: Schedule

The internal interface check is scheduled for the last week of February. This will be used to determine if the parts need to be remanufactured before all the final tests that will be performed by Honeywell.

3.6 Testing Procedure 7: Temperature Resistance Flame Test

3.6.1 Testing Procedure 7: Meet the temperature resistance engineering requirement

The OCDH needs to be able to withstand high temperatures. A flame test will be used with the OCDH attached to the engine where a fire will be started on the engine. The damage will be determined after the test is completed. The fire test will be completed at the end of February and will be conducted by Honeywell during the full testing practice.

3.6.2 Testing Procedure 7: Open Flame

The OCDH needs to be able to withstand a high temperature flame test for a minimum of 5 minutes. The OCDH will subjected to a flame test of 2,000°F for 5 minutes. The housing will also be subject to a constant operating temperature.

3.6.3 Testing Procedure 7: Schedule

The fire test will be conducted during the full systems test done by Honeywell at the end of February. The full test date will be determined by Honeywell at a different date.