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**Pressure environment test methods for the sealed cabins of
manned spacecraft**

载人航天器密封舱压力环境试验方法

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7 Test Conditions

7.1 Pressure relief and repressurization test The requirements for the pressure relief and repressurization test conditions are as follows:

- a) Normal depressurization and repressurization conditions should be set up, and the normal depressurization and repressurization process should be verified;
- b) Failure modes that significantly affect the depressurization and repressurization processes should be identified, and corresponding failure conditions should be set to verify the performance under these failure modes. Depressurization and repressurization process;
- c) Normal operating conditions should be tested first, followed by fault operating conditions.

7.2 Emergency Pressure Test of Sealed Chamber The requirements for the emergency pressure test of the sealed chamber are as follows:

- a) The simulated leak diameter should at least cover the hull leak diameter determined by conditions such as maintenance time requirements, gas inventory, and pluggability. Upper limit. The number and size of simulated leaks should be determined based on design requirements and experimental resource constraints to obtain the chamber pressure descent rate. The rate and pressure are trending downward.
- b) The no-pressure test should be performed first (to obtain the rate of pressure drop and the pressure drop trend), followed by the pressure-maintaining test (to obtain the pressure maintenance data). (The time during which the total pressure of the sealed chamber is not lower than the required value).
- c) For both non-air-replenishing and air-replenishing operating conditions, a small-diameter leak test should be performed first, followed by a large-diameter leak test.

7.3 Emergency depressurization test of the sealed chamber The requirements for the emergency depressurization test of the sealed chamber are as follows:

- a) The initial total pressure of the sealed chamber should at least cover the upper limit of the normal control range of total pressure;

- b) If conditions such as test progress and gas supply permit, other initial total pressure conditions may be set as needed;
- c) The upper limit of the normal control range of total pressure should be tested first, and then other initial total pressure conditions should be tested.

7.4 Sealed Chamber Pressure Control Test The requirements for the pressure control test conditions of the sealed chamber are as follows:

- a) A test should be conducted to determine if the total pressure exceeds the allowable upper limit and to check the automatic pressure relief function when the total pressure exceeds the upper limit.

8 Test Procedure

8.1 Experimental Preparation The main tasks and requirements for the test preparation phase are as follows:

- a) Analyze the test system's capabilities based on the test inputs, develop a test plan for the pressure environment of the sealed chamber, and conduct joint debugging tests if necessary. verify;
- b) The instruments and meters with metrological attributes used in the sealed chamber test system and ground test system must have been calibrated and certified by the metrology department. Use within the validity period;
- c) Check the status of the environmental simulation equipment and pressure control system of the ground test system to ensure they are working properly, and perform a leak rate test on the pressure control system. Test to ensure that design requirements are met;
- d) Confirm that the leak rate of the sealed chamber meets the requirements, check the status of the sealed chamber test system, and ensure that it is working properly;
- e) Hoist the entire device into the space environment simulation chamber, connect it to the test support, and secure it firmly;
- f) Connect the test cables and conduits, and perform sealing tests and checks on the ground test system;
- g) Conduct pre-test condition checks on the sealed chamber test system and the ground test system;
- h) Close the door to the space environment simulation chamber and begin the experiment.

8.2 Test Procedure

8.2.1 Pressure relief and repressurization test The pressure relief and repressurization test procedure should meet the following requirements.

- a) Use the roughing unit of the ground-based test system to evacuate the space environment simulation chamber to its initial pressure, and ensure throughout the entire test process that... The roughing unit is in operation.
- b) Initial chamber pressure adjustment of the airlock chamber is performed using the pressure control system of the ground test system.
- c) Use the cabin depressurization and repressurization system and conduct the test according to the normal depressurization and repressurization procedure. 1) Pre-control of oxygen concentration in the airlock chamber. 2) Astronauts inhale oxygen and expel nitrogen. 3) Depressurize the airlock until the requirements for opening the exit hatch are met, then stop, record the depressurization time, and confirm the equipment status. 4) Repressurize the airlock until it is pressurized to match the pressure of the sealed chamber. Record the repressurization time and confirm the equipment status. If the onboard repressurization system is not functioning... The airlock was repressurized, and the pressure control system of the ground test system was used to supplement the repressurization.
- d) Conduct a fault relief and repressurization test. When the cabin depressurization and repressurization system fails, conduct airlock depressurization and repressurization according to the fault relief and repressurization procedure. The test procedure is the same as 8.2.1c.

8.2.2 Sealed Chamber Pressure Control Test The pressure control test procedure for the sealed chamber should meet the following requirements.

- a) Use the roughing unit of the ground-based test system to evacuate the space environment simulation chamber to its initial pressure, and ensure throughout the entire test process that... The roughing unit is in operation.
- b) Conduct a total pressure control test on the sealed chamber. Inflate the sealed chamber using the pressure control system of the ground test system. When the total pressure exceeds the control limit... When the pressure drops to the set pressure, the venting assembly will automatically open and depressurize. Once the pressure drops, the venting assembly will automatically close. After depressurization is complete, ensure that... The pressure inside the sealed chamber is an order of magnitude greater than the simulated indoor pressure in the space environment, but not greater than the maximum operating pressure of the roughing pump unit; (

Note. The original text contains some inconsistencies and unclear grammatical structure. A more accurate translation would require the full context.) Record the actual cabin pressure when the exhaust assembly is opened and closed, and confirm the status of the pressure control system and pressure control program.

- c) Use the pressure control system of the ground test system to evacuate the sealed

chamber. When the total pressure falls below the control limit, automatically activate the nitrogen supply assembly. When the chamber pressure increases to the set pressure, nitrogen supply will automatically stop; the actual chamber pressure during the opening and closing of the nitrogen supply components will be recorded. Pressure, confirming the status of the pressure control system and pressure control program.

d) Conduct an oxygen partial pressure control test in the sealed chamber. Use the pressure control system of the ground test system to evacuate the sealed chamber. When the oxygen partial pressure is lower than the control pressure... When the oxygen pressure reaches the lower limit, the oxygen supply unit automatically turns on to supply oxygen. When the oxygen partial pressure rises to the set pressure, the oxygen supply automatically stops. The oxygen supply unit is recorded. The actual cabin oxygen partial pressure when the components are opened and closed is used to confirm the status of the pressure control system and pressure control program.

e) The test ends after the ground test system repressurizes the sealed chamber to the required pressure.

8.2.3 Emergency Pressure Test of Sealed Chamber The emergency pressure test of the sealed chamber consists of two parts. First, a background test of the leakage rate without emergency gas supply should be conducted, followed by a test with emergency gas supply. Pressure emergency test.

8.3 Trial withdrawal The requirements for test withdrawal are as follows:

8.4 Test Faults and Handling

8.4.1 The general principles for handling equipment failures in the ground testing system are as follows:

a) If the test is suspended due to a malfunction of ground equipment such as environmental simulation equipment or pressure control system, first activate the backup equipment to ensure the test continues. The test will continue until the faulty equipment is repaired after the test is completed.

b) If an oxygen concentration alarm is triggered, immediately stop the test operation and simultaneously open the purification and ventilation system to exhaust the gas outdoors. Wait for the gas to dissipate. Once the concentration is restored to a safe level, the leak point will be investigated and repaired. Once repairs are completed and an assessment confirms there is no risk of further leakage, the process can continue. Conduct an experiment.

8.4.2 If a test is suspended due to a malfunction of the test chamber product, the first step should be to analyze and locate the fault, confirming its impact on the test objectives and testing procedures. The extent of validity should be verified before taking any action. The