METHOD 510.4

SAND AND DUST

NOTE: Tailoring is essential. Select methods, procedures, and parameter levels based on the tailoring process described in Part One, paragraph 4.2.2, and Appendix C. Apply the general guidelines for laboratory test methods described in Part One, paragraph 5 of this standard.

1. SCOPE.

1.1 Purpose.

a. Small-particle dust (≤ 149 µm) procedures. These tests are performed to help evaluate the ability of materiel to resist the effects of dust that may obstruct openings, penetrate into cracks, crevices, bearings, and joints and to evaluate the effectiveness of filters.

b. Blowing sand (150 to 850 µm particle size) procedures. These tests are performed to help evaluate if materiel can be stored and operated under blowing sand conditions without degrading performance, effectiveness, reliability, and maintainability due to abrasion (erosion) or clogging effects of large, sharp-edged particles.

1.2 Application.

Use this method to evaluate all mechanical, optical, electrical, electronic, electrochemical, and electromechanical devices likely to be exposed to dry, blowing sand, blowing dust-laden atmosphere, or settling dust.

1.3 Limitations.

This method is not suitable for determining erosion of airborne (in flight) materiel because of the particle impact velocities involved, or for determining the effects of a buildup of electrostatic charge. Additionally, because of control problems, this method does not address sand or dust testing out-of-doors.

2. TAILORING GUIDANCE.

2.1 Selecting the Sand and Dust Method.

After examining requirements documents and applying the tailoring process in Part One of this standard to determine where sand and dust environments are foreseen in the life cycle of the materiel, use the following to confirm the need for this method and to place it in sequence with other methods.

2.1.1 Effects of sand and dust environments.

Although the blowing sand and dust environment is usually associated with hot-dry regions, it exists seasonally in most other regions. Naturally-occurring sand and dust storms are an important factor in the deployment of materiel, but with the increased mechanization of military operations, they cause less of a problem than does sand and dust associated with man's activities. Consider the following typical problems to help determine if this method is appropriate for the materiel being tested. This list is not intended to be all-inclusive.

a. Abrasion and erosion of surfaces.

b. Penetration of seals.

c. Degradation of electrical circuits.

d. Obstruction/clogging of openings and filters.

e. Physical interference with mating parts.

f. Fouling/interference of moving parts.

g. Reduction of thermal conductivity.

h. Interference with optical characteristics.

i. Overheating and fire hazard due to restricted ventilation or cooling.

2.1.2 Sequence among other methods.

a. General. See Part One, paragraph 5.5.

b. Unique to this method. This method will produce a dust coating on, or severe abrasion of a test item, which could influence the results of other MIL-STD-810 methods such as Humidity (method 507.4), Fungus (method 508.5), and Salt Fog (method 509.4). Therefore, use judgment in determining where in the sequence of tests to apply this method. Additionally, results obtained from the High Temperature test method (501.4) may be required to define temperature parameters used in this method. On the other hand, the presence of dust in combination with other environmental parameters can induce corrosion or mold growth. A warm humid environment can cause corrosion in the presence of chemically aggressive dust.

2.2 Selecting Procedures.

This method includes three test procedures, Procedure I (Blowing Dust), Procedure II (Blowing Sand), and Procedure III (Settling Dust). Determine the procedure(s) to be used.

2.2.1 Procedure selection considerations.

When selecting procedures, consider:

a. The operational purpose of the materiel. From the requirements documents, determine the functions to be performed by the materiel in a sand or dust environment and any limiting conditions such as storage.

b. The natural exposure circumstances.

c. The test data required to determine if the operational purpose of the materiel has been met.

d. Procedure sequence. If both sand and dust procedures are to be applied to the same test item, it is generally more appropriate to conduct the less damaging first, i.e., settling dust, blowing dust, and then blowing sand.

2.2.2 Difference among procedures.

While all procedures involve sand and dust, they differ on the basis of particle size and type of movement. These test procedures are tailorable to the extent that the user must specify the test temperature, dust composition, test duration, and air velocity.

a. Procedure I - Blowing Dust. Use Procedure I to investigate how susceptible materiel is to concentrations of blowing dust (< 149 µm).

b. Procedure II - Blowing Sand. Use Procedure II to investigate how susceptible materiel is to the effects of blowing, large particle sand (150 µm to 850 µm).

c. Procedure III - Settling Dust. Use Procedure III to investigate the effects of settling dust (≤ 105 µm) on materiel (usually electrical) in sheltered or enclosed areas with negligible airflow (e.g., offices, laboratories, store rooms, tents) where dust may accumulate over long periods. Settling dust can also affect the heat dissipation of materiel with accumulated dust on the top surface. Also, use the settling dust test to verify the quality of air filters used in the inlet of air pollution samplers for outdoor use.

2.3 Determine Test Levels and Conditions.

Having selected this method and relevant procedures (based on the materiel's requirements documents and the tailoring process), it is necessary to complete the tailoring process by selecting specific parameter levels and special test conditions/techniques for these procedures based on requirements documents, Life Cycle Environmental Profile, Operational Environment Documentation (see Part One, figure 1-1), and information provided with this procedure. From these sources of information, determine the functions to be performed by the materiel in sand and dust environments or following storage in such environments. Then determine the sand and dust levels of the geographical areas and micro-environments in which the materiel is designed to be employed. To do this, consider the following in light of the operational purpose and life cycle of the materiel.

2.3.1 Identify climatic conditions.

Identify the appropriate climatic conditions for the geographic areas in which the materiel will be operated and stored, and whether or not test item needs to be operated during the test.

2.3.2 Determine exposure conditions.

Base the specific test conditions on field data if available. In the absence of field data, determine the test conditions from the applicable requirements documents. If this information is not available, use the following guidance:

2.3.2.1 Test item configuration.

Use a test item configuration that reproduces, as close as possible, the anticipated materiel configuration during storage or use, such as:

a. Enclosed in a shipping/storage container or transit case.

b. Protected or unprotected.

c. Deployed realistically or with restraints, such as with openings that are normally covered.

2.3.2.2 Temperature.

Unless otherwise specified, conduct the blowing sand and blowing dust tests with the test item at the high operating or storage temperature obtained from the temperature response of the test item in the high temperature test (method 501.4). Unless otherwise specified, perform the settling dust test at 23 ±2°C which is in the standard ambient range.

2.3.2.3 Relative humidity.

High levels of relative humidity (RH) may cause caking of dust particles. Consequently, control the test chamber RH to not exceed 30% for both blowing and settling tests.

2.3.2.4 Air velocity.

a. Blowing dust. The air velocities used in the blowing dust (small particle) test procedure include a minimum air velocity of 1.5 m/s (300 ft/min) to maintain test conditions, and a higher air velocity of 8.9 m/s (1750 ft/min) typical of desert winds, to be used in the absence of specified values. Use other air velocities if representative of natural conditions and if the capabilities of the test chamber allow.

b. Blowing sand. Winds of 18 m/s (3540 ft/min) capable of blowing the large particle sand are common, while gusts up to 29 m/s (5700 ft/min) are not unusual. If the induced flow velocity around the materiel in its field application is known to be outside of this range, use the known velocity. Otherwise use an air velocity in the range of 18-29 m/s to maintain the blowing sand particles.

NOTE: Ensure the sand particles impact the test item at velocities ranging from 18-29 m/s. In order for the particles to attain these velocities, maintain an approximate distance of 3-m (10 ft) from the sand injection point to the test item. Use shorter distances if it can be proven the particles achieve the necessary velocity at impact.

c. Settling dust. Use only sufficient air velocity to disperse the dust in the air above the test item, and ensure it does not produce an air velocity at the test item of more than 0.2 m/s.

2.3.2.5 Sand and dust composition.

a. Blowing dust. Conduct the small-particle (blowing dust) procedure with any of the following dust compositions, by weight.

(1) Red china clay is common worldwide and contains:

$CaCO_3$, $MgCO_3$, MgO, TiO_2, etc.	5%
Ferric oxide (Fe_2O_3)	10 ±5%
Aluminum oxide (Al_2O_3)	20 ±10%
Silicon dioxide (SiO_2)	remaining percentage

(2) Silica flour has been widely used in dust testing and contains 97 to 99 percent (by weight) silicon dioxide.

(3) Other materials may be used for dust testing, but their particle size distribution may fall below that in 2.3.2.5a(4), below. Ensure material to be used is appropriate for the intended purpose and regions of the world being simulated; e.g., for dust penetration, ensure the particle sizes are no larger than those identified for the region. These materials for dust testing include talc (talcum powder) (hydrated magnesium silicate), F.E. (fire extinguisher powder composed mainly of sodium or potassium hydrogen carbonate with a small amount of magnesium stearate bonded to the surface of the particles in order to assist free-running and prevent clogging - must be used in dry conditions to prevent corrosive reaction and formation of new chemicals (reference c.)), quartz (the main constituent of many dusts occurring in nature), and undecomposed feldspar and olivine (which have similar properties to quartz).

****WARNING**:** Refer to the supplier's Material Safety Data Sheet (MSDS) or equivalent for health hazard data. Exposure to silica flour can cause silicosis; other material may cause adverse health effects.

(4) Unless otherwise specified, use a particle size distribution of 100% by weight less than 150 μm, with a median diameter (50% by weight) of 20 ±5 μm. This dust is readily available as a 140 mesh Silica Flour (about 2% retained on a 140 mesh (108 microns) sieve) and should provide comparable results to prior test requirements. National documentation may contain other more specific distributions.

b. Blowing sand. Unless otherwise specified, for the large particle sand test use silica sand (at least 95% by weight SiO_2). Use sand of sub-angular structure, a mean Krumbein number range of 0.5 to 0.7 for both roundness and sphericity and a hardness factor of 7 mhos. Due to the loss of subangular structure and contamination, re-use of test sand is normally not possible. If possible, determine the particle size distribution from the geographical region in which the materiel will be deployed. There are 90 deserts in the world, each with different particle size distributions. Therefore, it is impossible to specify a particle size distribution that encompasses all areas. The recommended particle size distribution for the large particle sand test is from 150μm to 850 μm, with a mean of 90 ±5% by weight smaller than 600 μm and larger than 149 μm, and at least 5% by weight 600 μm and larger. When materiel is designed for use in a region which is known to have an unusual or special sand requirement, analyze a sample of such sand to determine the distribution of the material used in the test. Specify the details of its composition in the requirements documents.

****WARNING**:** The same health hazard considerations as noted for the dust apply. Refer to the supplier's Material Safety Data Sheet (MSDS) or equivalent for health hazard data; exposure can cause silicosis.

c. Settling dust. Although settling dust can be of numerous compositions to include quartz, silica, salts, fertilizers, organic fibers, etc., use the small particle dusts described above to evaluate the potential effects of most settling dust. Do not use dust with particles larger than 105 μm.

2.3.2.6 Sand and dust concentrations.

a. Blowing dust. Unless otherwise specified, maintain the dust concentration for the blowing dust test at 10 ±7 g/m^3 (0.3 ±0.2 g/ft^3) unless otherwise specified. This figure is not unrealistic and is used because of the limitations of most chambers.

b. Blowing sand. Unless otherwise specified, maintain the sand concentrations as follows (reference a):

(1) For materiel likely to be used close to helicopters operating over unpaved surfaces: 2.2 ± 0.5 g/m3 (0.06 ±0.015 g/ft3).

(2) For material never used or exposed in the vicinity of operating aircraft, but which may be used or stored unprotected near operating surface vehicles: 1.1 ±0.3 g/m3 (0.033 ±0.0075 g/ft3).

(3) For material that will be subjected only to natural conditions: 0.18 g/m3, -0.0/+0.2 g/m3 (0.005 g/ft3). (This large tolerance is due to the difficulties of measuring concentrations at low levels.)

c. Settling dust. For the settling dust test, the relationship between severity (duration and concentration) is difficult to determine. Real conditions vary considerably, and this test is intended to standardize a means to demonstrate survival of the materiel, and not necessarily duplicate conditions. Consequently, only guidelines are given in order to provide guidance on the relationship between the severity levels of the test and some values from real conditions. Unless otherwise specified, use a dust settlement rate of 6 g/m^2/day. Table 510.4-I provides average dust deposits for various areas along with a rough guide to acceleration factors for the specified rates (reference d). For example, a 3-day test equates to between 51 days and 1800 days (5 years) for rural and suburban environments, and between 9 days and 18 days for an industrial environment.

TABLE 510.4-I. Settling dust quantities and acceleration factors.

AREA	DUST SETTLEMENT PER DAY (g/m^2)	ACCELERATION FACTOR (with 6 g/m^2/day)
Rural and suburban	0.01 - 0.36	600 - 17
Urban	0.36 - 1.00	17 - 6
Industrial	1.00 - 2.00	6 - 3

2.3.2.7 Orientation.

a. Blowing dust tests. Unless otherwise specified, orient the test item such that the most vulnerable surfaces face the blowing dust. Using the specified test duration, rotate the test item (if required) at equal intervals to expose all vulnerable surfaces.

b. Blowing sand tests. Orient the test item with respect to the direction of the blowing sand such that the test item will experience maximum erosion effects. The test item may be re-oriented at 90-minute intervals.

c. Settling dust tests. Install the test item in the test chamber in a manner representative of its anticipated deployment in service.

2.3.2.8 Duration.

a. Blowing dust. Unless otherwise specified, conduct blowing dust tests for 6 hours at 23°C and an additional 6 hours at the high storage or operating temperature. If necessary, stop the test after the first 6-hour period provided that prior to starting the second 6-hour period the chamber conditions are restabilized.

b. Blowing sand. Perform blowing sand tests for a minimum of 90 minutes per each vulnerable face.

c. Settling dust. Use a basic deposition rate of 6 g/m^2/day. This, combined with the values shown in table 510.4-I provides a rough guide to acceleration factors for the areas shown. If no specific region is identified, use a test duration of three days (for standardization purposes) to provide a reasonable severity.

2.3.2.9 Operation during test.

a. Determine the need to operate the test item during exposure to sand or dust from the anticipated in-service operational requirements. For example, operate heating/cooling test items while exposed to extreme ambient environments, but operate certain materiel, although exposed to severe environments, in an environmentally controlled shelter. If the test item must be operated during the test, specify the time and periods of operation in the test plan. Include at least one 10-minute period of continuous operation of the test item during the last hour of the test, with the test item's most vulnerable surface facing the blowing sand or dust.

b. For the settling dust test, condition the test item which employs forced air cooling with the air cooling system operating to determine the effect of dust trapped in filters; operate heat-generating materiel with ventilation openings for convection cooling during the test; operate heat-generating materiel of closed construction intermittently in order to produce a breathing effect by thermal cycling, or to determine thermal increase due to insulative effects of accumulated dust.

3. INFORMATION REQUIRED.

3.1 Pretest.

The following information is required to conduct sand and dust tests adequately.

a. General. Information listed in Part One, paragraphs 5.7 and 5.9, and Appendix A, Task 405 of this standard.

b. Specific to this method.

(1) Test temperature

(2) Relative humidity

(3) Air velocity

(4) Sand or dust composition

(5) Sand or dust concentration

(6) Operating requirements

(7) Test item orientation and exposure time per orientation

(8) Methods of sand and dust removal as used in service

3.2 During Test.

Collect the following information during conduct of the test:

a. General. Information listed in Part One, paragraph 5.10, and in Appendix A, Task 406 of this standard.

b. Specific to this method.

(1) Periodic dust concentrations.

(2) Periodic relative humidity levels.

3.3 Post Test.

The following post test information is required.

a. General. Information listed in Part One, paragraph 5.13, and in Appendix A, Task 406 of this standard.

b. Specific to this method.

(1) Initial test item orientation and any orientation change during test.

(2) Values of the test variables for each section of the test (temperature, relative humidity, air velocity, sand/dust concentration and duration).

(3) Results of each visual inspection.

4. TEST PROCESS.

4.1 Test Facility.

Ground the test item and facility to avoid buildup of an electrostatic charge. Verify resistance/continuity in accordance with applicable safety requirements for the materiel. Employ a data collection system separate from the chamber controllers to measure the test volume conditions (see Part One, paragraph 5.18). Use charts that are readable to within 0.6°C (1°F) to record temperature. Except for gaseous nitrogen (GN_2), achieve dehumidification, heating and cooling of the air envelope surrounding the test item by methods that do not change the chemical composition of the air, dust, sand and water vapor within the chamber test volume air. The following information is also appropriate.

a. Blowing dust.

(1) Use a test facility that consists of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust-laden air. In order to provide adequate circulation of the dust-laden air, use a test chamber of sufficient size that no more than 50 percent of the test chamber's cross-sectional area (normal to airflow) and 30 percent of the volume of the test chamber is be occupied by the test item(s). Maintain and verify the concentration of dust in circulation within the chamber with suitable instrumentation such as a calibrated smoke meter and standard light source. Introduce the dust-laden air into the test space in such a manner as to allow the air to become as close to laminar as possible, but at least in a manner that prevents excessive turbulence as the flow of dust-laden air strikes the test item.

(2) Use dust in this test as outlined in paragraphs 2.3.2.4 and 2.3.2.5, above.

b. Blowing sand. Test facility design considerations.

(1) In order to provide adequate circulation of the sand-laden air, use a test chamber of sufficient size that no more than 50 percent of the test chamber's cross-sectional area (normal to airflow) and 30 percent of the volume of the test chamber is occupied by the test item(s).

(2) Control the sand feeder to emit the sand at the specified concentrations. To simulate the effects produced in the field, locate the feeder to ensure the sand is approximately uniformly suspended in the air stream when it strikes the test item.

NOTE: Uniform sand distribution is usually easier to obtain when the sand-air mixture is directed downward.

(3) Because of the extremely abrasive characteristics of blowing sand, do not re-circulate the sand through the fan or air conditioning equipment.

c. Settling dust.

(1) Experience has shown that it is best to use a test section with a horizontal area at least twice the area of the test item (see figure 510.4-1) which is large enough to maintain the uniformity of the dust

coating on the test item. Dust uniformity is difficult to achieve with the dust injection system. Use a test section high enough to ensure that during conditioning the air velocity around the test item is near zero (i.e., less than 0.2 m/s). In order to accomplish this, experience shows that a test section height of 4-5 times the longest horizontal test item dimension is necessary.

(2) Inject the dust (constant or hourly) into the test section above the test item (not directly into the test item) using a minimum air flow sufficient to diffuse the dust and produce a uniform dust deposit on the test item at a rate of 0.25 g/m2 each hour (6 ± 1g/m2/day), but ensure it does not exceed 0.2 m/s at the test item. Place collection receptacles in the vicinity of the test item for dust density verification (not near fan intakes). Do not disturb the settled dust during injection. Ensure the test item is centrally located on a horizontal plane, at least 150 mm from any wall or other test item (unless more is required for test item intake fans).

(3) Because of difficulties associated with dust quantities, the following system has worked well:

NOTE: Contain the dust in a glass cylinder with a lid that has a manifold with fine holes through which the compressed air is blown. The air stream stirs the dust and the dust is guided through a tube to the dust injection system. The volume of compressed air per unit of time, the distance between the inlet holes and the top of the dust, and the time control of compressed air determine the amount of dust being injected. Roughly check the amount of dust injected into the chamber by the weight loss of the container.

4.2 Controls.

a. For dust testing, maintain the test chamber relative humidity (RH) at 30% or less to prevent caking of dust particles. Measure the humidity and dust concentration at least once an hour to ensure conditions are within the desired range.

b. For the blowing sand and dust tests, continuously measure the temperature during the test. Measure the humidity at least once an hour to ensure conditions are within the desired range.

c. Verify chamber air velocity and sand concentration prior to test. Calculate the sand feed rate and verify it by measuring the sand quantity delivered over unit time using the following formula:

$$\text{Rate} = (\text{Concentration})(\text{Area})(\text{Velocity})$$

where:

Rate = mass of sand introduced into the test chamber per set time interval

Concentration = sand concentration required by the test plan

Area = cross-sectional area of the wind stream at the test item location.

Velocity = average velocity of air at the test item location

d. For the settling dust test, maintain the air velocity in the vicinity of the test item less than 0.2 m/s to allow settling of the finer dust particles. Use collection plates in the vicinity of the test item to verify the quantity of deposited dust.

4.3 Test Interruption.

a. General. See Part One, paragraph 5.11 of this standard.

b. Specific to this method.

(1) Undertest interruption. Follow any undertest interruption by reestablishing the prescribed test conditions and continue from the point of interruption.

(2) Overtest interruption. Following exposure to excessive sand or dust concentrations, remove as much of the accumulation as possible (as would be done in service) and continue from the point of interruption. If abrasion is of concern, either restart the test with a new test item or reduce the exposure period by using the concentration-time equivalency (assuming the overtest concentration rate is known).

4.4 Execution.

The following steps, alone or in combination, provide the basis for collecting necessary information concerning the test item in sand and dust environments.

4.4.1 Preparation for test.

****WARNING**** The relatively dry test environment combined with the moving air, organic dust, and sand particles may cause a buildup of electrostatic energy that could affect operation of the test item. Use caution when making contact with the test item during or following testing if organic dust is used, and be aware of potential anomalies caused by electrostatic discharge during test item checkout.

4.4.1.1 Preliminary steps.

Before starting the test, review pretest information in the currently approved test plan to determine test details (e.g., procedures, item configuration, cycles, durations, parameter levels for storage/operation, etc.). (See paragraph 3.1, above.)

a. Determine from the test plan which test procedure is required.

b. Determine from the test plan specific test variables to be used.

c. Operate the test chamber without the test item to confirm proper operation.

   (1) Calibrate the sand dispensing system for the sand concentration specified in the test plan.

   (2) Adjust the air system or test item position to obtain the specified air velocity for the test item. See paragraph 4.1c(2), above.

   (3) For the settling dust test, verify the fallout rate over a two-hour period using a one-minute injection period each hour, followed by a 59-minute settling period.

4.4.1.2 Pretest standard ambient checkout.

All items require a pretest standard ambient checkout to provide baseline data. Conduct the pretest checkout as follows:

Step 1. Position the test item as near the center of the test chamber as possible and from any other test item (if more than one item is being tested). For the blowing sand or dust procedures, orient the test item to expose the most critical or vulnerable parts to the sand or dust stream. For the settling dust test, position the test to represent its normal orientation during operation or storage.

NOTE: If required by the test plan, change the orientation of the test item as specified during the test.

Step 2. Prepare the test item in its operating configuration or as specified in the test plan.

Step 3. Ensure the test item is grounded (either through direct contact with the test chamber or with a grounding strap).

Step 4. Stabilize the test item temperature to standard ambient conditions.

Step 5. Conduct a complete visual examination of the test item with special attention to sealed areas and small/minute openings.

Step 6. Document the results.

Step 7. Conduct an operational checkout in accordance with the test plan and record results.

Step 8. If the test item operates satisfactorily, proceed to step 1 of the test procedure. If not, resolve the problem and restart at Step 1 of pretest checkout.

4.4.2 Procedure I - Blowing dust.

****WARNING**** Silica flour (or other dusts of similar particle size) may present a health hazard. When using silica flour, ensure the chamber is functioning properly and not leaking; if a failure of containment is noted and personnel might have been exposed, obtain air samples and compare them to the current threshold limit values of the national safety and health regulations. Make chamber repairs and/or take other appropriate action before continuing use of the chamber. Be extremely careful during all steps where exposure of personnel to the silica dust is possible. Additionally, fine dust becomes potentially explosive when its concentration in air exceeds 20 g/m^3.

Step 1. With the test item in the chamber, adjust the test section temperature to standard ambient conditions and the air velocity to the required value, determined from the test plan. Adjust the test section relative humidity to less than 30% and maintain it throughout the test.
Step 2. Adjust the dust feed control for a dust concentration of 10 ± 7 g/m^3.
Step 3. Unless otherwise specified, maintain the conditions of Steps 1 and 2 for at least 6 hours. If required, periodically reorient the test item to expose other vulnerable faces to the dust stream. SEE ABOVE WARNING NOTES in paragraphs 5.4 and 5.4.2.
Step 4. Stop the dust feed. Reduce the test section air velocity to approximately 1.5 m/s and adjust the temperature to standard ambient conditions or as otherwise determined from the test plan.
Step 5. Maintain the step 4 conditions for 1 hour following test temperature stabilization.
Step 6. Adjust the air velocity to that used in Step 1 and restart the dust feed to maintain the dust concentration as in Step 2.
Step 7. Continue the exposure for at least 6 hours or as otherwise specified. If required, operate the test item in accordance with the test plan.
Step 8. Allow the test item to return to standard ambient conditions, and the dust to settle. SEE THE WARNING AT THE BEGINNING OF THIS PROCEDURE AND IN PARAGRAPH 4.4.1, ABOVE.
Step 9. Remove accumulated dust from the test item by brushing, wiping or shaking, taking care to avoid introduction of additional dust or disturbing any which may have already entered the test item. Do not remove dust by either air blast or vacuum cleaning unless these methods are likely to be used in service.
Step 10. Perform an operational check in accordance with the approved test plan, and document the results for comparison with pretest data.
Step 11. Inspect the test item for dust penetration, giving special attention to bearings, grease seals, lubricants, filters, ventilation points, etc. Document the results.

4.4.3 Procedure II - Blowing sand.

Step 1. Position the test item at the required distance from the sand injection point and adjust air velocity according to test plan.
Step 2. Stabilize the test item at its high operating temperature.
Step 3. Adjust the sand feeder to obtain the sand mass flow rate determined from the pretest calibration.
Step 4. Maintain the conditions of Steps 1 through 3 for the duration specified in the test plan. If required, re-orient the test item at 90-minute intervals to expose all vulnerable faces to the blowing sand and repeat Steps 1-3.
Step 5. If operation of the test item during the test is required, perform an operational test of the item during the last hour of the test and document the results. If not, proceed to Step 6.
SEE THE WARNING IN PARAGRAPH 4.4.2, ABOVE.

Step 6. Allow the test item to return to standard ambient conditions. Remove accumulated sand from the test item by using the methods anticipated to be used in service such as brushing, wiping, shaking, etc., taking care to avoid introduction of additional sand into the test item.
Step 7. Conduct an operational check of the test item in accordance with the approved test plan and record results for comparison with pretest data.
Step 8. Visually inspect the test item looking for abrasion and clogging effects, and any evidence of sand penetration. Document the results.

4.4.4 Procedure III - Settling dust.

SEE THE WARNING NOTE IN PARAGRAPH 4.4.2, ABOVE.

Step 1. With the test item and collection plates in the test chamber, adjust the test section temperature to 23°C or as otherwise specified, and the relative humidity to less than 30%. (Maintain less than 30% relative humidity throughout the test.)

Step 2. Following stabilization of the test item temperature, introduce the required quantity of dust into the test section for 60 ± 5 seconds.
Step 3. Allow the dust to settle for 59 minutes.
Step 4. Verify the dust fallout rate and, if required, repeat steps 2 and 3 above for the required number of cycles as determined from paragraphs 2.3.2.6c and 4.1c(2).
Step 5. Without unnecessarily disturbing the dust deposits, perform an operational check in accordance with the approved test plan, and document results for comparison with pretest data.
Step 6. Inspect the test item for dust penetration, giving special attention to bearings, grease seals, lubricants, filters, ventilation points, etc. Document the results.

5. ANALYSIS OF RESULTS.

In addition to the guidance provided in Part One, paragraphs 5.14 and 5.17, the following information is provided to assist in the evaluation of the test results. Analyze any failure of a test item to meet the requirements of the materiel specifications, and consider related information such as:

5.1 Blowing and Settling Dust Tests.

Determine if:

a. Dust has penetrated the test item in sufficient quantity to cause binding, clogging, seizure or blocking of moving parts, non-operation contacts or relays, or the formation of electrically conductive bridges with resulting shorts.

b. Functional performance is within the specified requirements/tolerances.

c. Protective coatings were compromised.

d. Abrasion of the test item exceeds the specified levels.

5.2 Large-Particle Sand Test.

Determine if:

a. Abrasion of the test item exceeds the specified requirements.

b. The test item operates as required.

c. Protective coatings were compromised.

6. REFERENCE/RELATED DOCUMENTS.

a. Synopsis of Background Material for MIL-STD-210, Climatic Extremes for Military Equipment. Bedford, MA: Air Force Cambridge Research Laboratories, January 1974. DTIC number AD-780-508.

b. Industrial Ventilation. A Manual of Recommended Practice. Committee on Industrial Ventilation, P.O. Box 16153, Lansing, MI 48901.

c. International Electrotechnical Commission Publication 68, Test L, Dust and Sand.

d. International Electrotechnical Commission Publication 721-2-5, Test L: Dust and Sand.

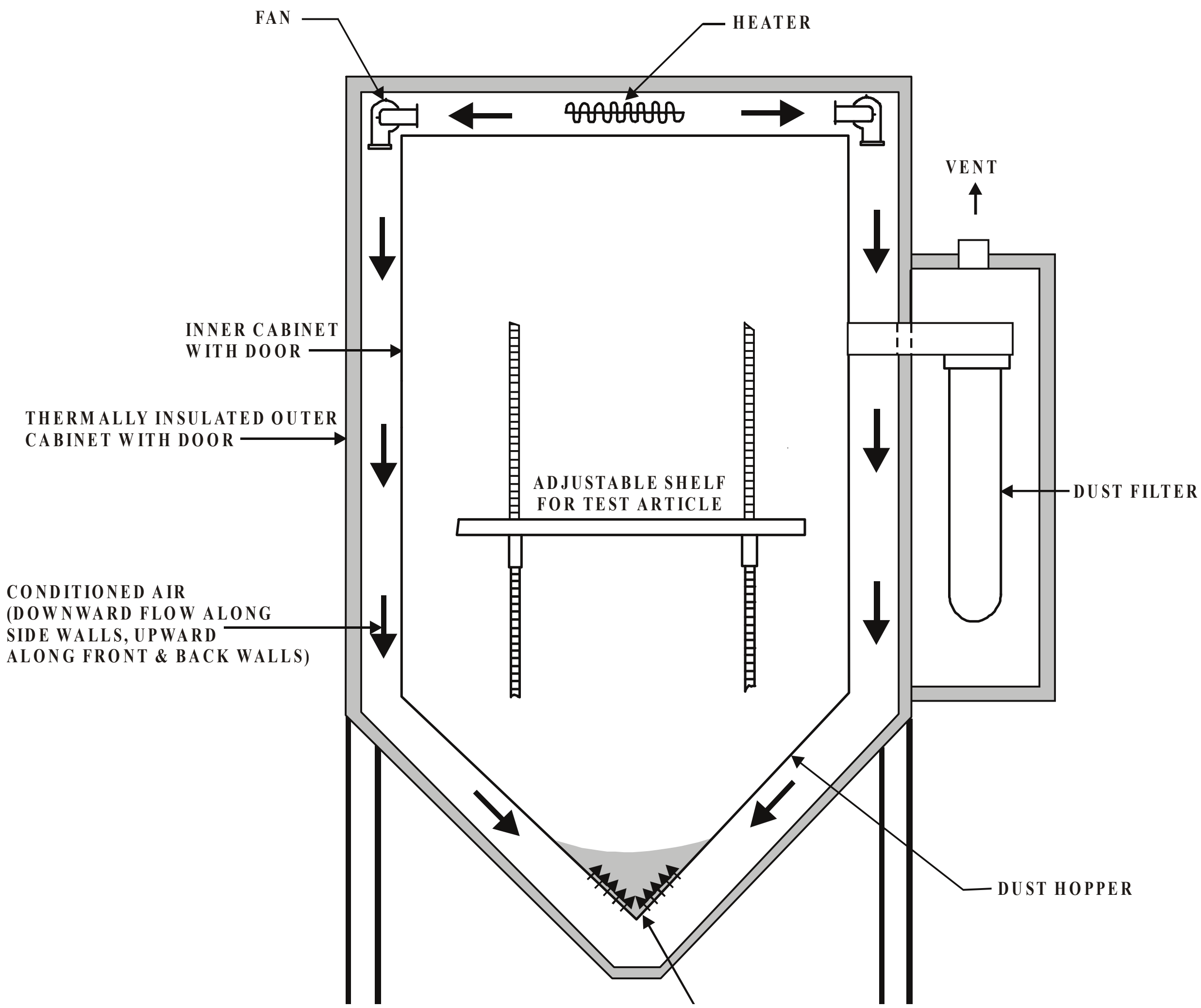

FIGURE 510.4-1. Settling dust test facility (example).