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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

TAPE LIFT PARTICLE COUNTING PROCEDURE

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

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TAPE LIFT PARTICLE COUNTING PROCEDURE

Prepared by:

Billy H. Nerren, EH32
Team Leader, Contamination
Control Team

Date 12-18-89

Approved by:

Salvadore V. Caruso, EH32
Chief, Analytical and
Physical Chemistry Branch

Date 12-20-89

Charles R. McIntosh, EH31
Chief, Non-Metallic
Materials Division

Date 12/21/89

C. F. Key, EH02
Chief, Materials Selection
and Control Office

Date 12/22/89

GEORGE C. MARSHALL SPACE FLIGHT CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TAPE LIFT PARTICLE COUNTING PROCEDURE

1.0 Purpose

This method covers a procedure for counting and sizing particulate matter 5 μ and larger using the tape lift method. The sampling areas are specifically those with contamination levels typical of clean rooms. It is intended for use where normal solvent flushes and wipes are not practical.

2.0 Scope

This method is based on the microscopic examination of particles clinging to a piece of transparent tape which has been applied directly to the sample area. The tape is lifted and applied to a clean particulate glass witness plate, where the particles are counted with the use of a microscope. The apparatus and facilities required are typical for the study of particulate contamination. The operator must have basic training in microscopy and particle sizing and counting.

3.0 References

The following procedures were used in part to provide the basis for the document. Both were taken from the 1970 Annual Book of ASTM Standards.

ASTM F24-65 (Reapproved 1970)	*Measuring and Counting Particulate Contamination on Surfaces.*
ASTM F25-68	*Sizing and Counting Airborne Particulate Contamination in Clean Rooms and Other Dust-Controlled Areas Designed for Electronic and Similar Applications.*

4.0 Description of Terms

4.1 *Particle Size* is the maximum dimension of the particle.

4.2 *Standard Unit of Length* for sizing particles is the micron (μ), which is 0.001 mm or 0.00004 inches. Only particles of 5 μ or larger will be counted.

4.3 *Particulate Contaminant* is a discrete quantity of matter that is foreign to the surface on which it rests.

5.0 Apparatus

5.1. Binocular Microscope with ocular-objective combination to obtain 40 to 45X and 90 to 150X magnifications.

5.2 Mechanical counter (2 gang).

5.3 Microscope lamp - high intensity.

5.4 Ocular micrometer scale.

5.5 Stage micrometer.

5.6 Gridded (two inch by two inch) particulate glass witness plates (clean).

5.7 Transparent polyethylene tape, 5.08 cm (2 inches) wide (3M #480 or equivalent), with an acrylic adhesive.

6.0 Procedure

Samples shall be selected at random from various locations which represent the entire conditions of the significant surfaces. The tape lift sampling and counting methods are as follows:

6.1 Prior to sampling, thoroughly clean particulate glass witness plates with an appropriate solvent or cloth (lint free).

6.2 Discard first two turns of the transparent polyethylene tape.

6.3 Prepare two blanks by applying the transparent tape directly from the roll to the back of the witness plate (See 6.5 below for instructions on applying tape to witness plate). Blanks should be a minimum of 10 cm (3.94 inches) in length. Carefully smooth out air bubbles with firm pressure. Blanks should be analyzed according to the procedure in Section 7 before continuing. If excessively high background counts are obtained, cleaning procedures and handling should be reviewed before proceeding.

6.4 A minimum 10 cm (3.94 inches) length of the transparent tape shall be applied to the surface being tested. Ensure contact is complete by smoothing the tape with firm pressure.

6.5 Remove tape from testing area slowly and transfer to clean glass counting slide (Apply to side opposite of the gridding inlays). Place the two square inches in the center of the tape sample on the 2" x 2" grid square (tape should be two inches wide by a minimum of four inches long; therefore, only the length of the tape must be centered on the grid square, the width of the tape should cover the width of the grid square).

6.6 Repeat steps 6.4 through 6.5 from several sample sights for a representative sample.

6.7 Particulate counts will be determined by following the procedure outlined in Section 7 below.

6.8 Failure of any one sample to meet the specified cleanliness level shall require recleaning and retesting of the hardware as necessary for acceptance.

7.0 Method of Counting Particles

Estimate the number of particles over the effective area by scanning one grid square. If this number is less than 500, manually count the total number of particles in each specified size range over the grid using the mechanical counter. If the total number is estimated to be greater than 500, the Statistical Particle Counting Method (outlined below) may be used.

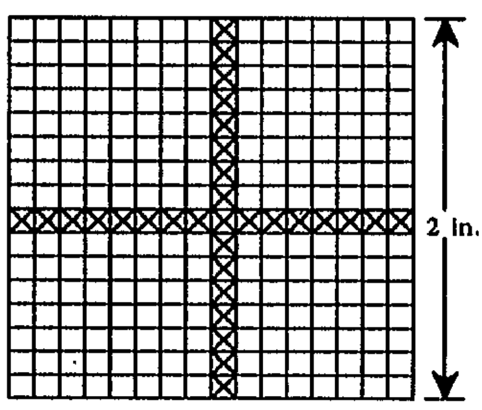
7.1 The Statistical Particle Counting Method estimates the total number of particles by counting a representative group of grid squares. This method incorporates equation 1 to determine how many particles need to be counted for statistical accuracy:

$$F_n \times N_t \geq 500 \qquad (1)$$

Where: F_n is the number of grid squares or unit areas counted.
N_t is the total number of particles counted in F_n areas.

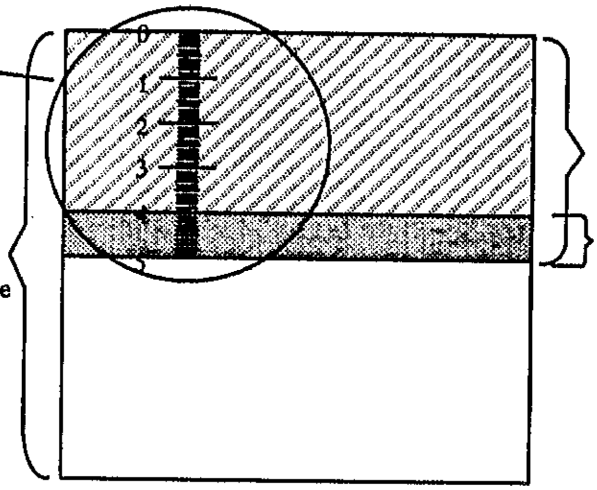
7.2 After establishing that particulate distribution is uniform on low magnification, count the grid squares indicated in Figure 1. Count a number of grid squares until the statistical requirements in paragraph 7.1 are satisfied.

Figure 1.



7.3 The average particle count per grid square should not exceed 50 particles. If this case does not hold, the grid squares should be divided into unit areas so that the average particle count is less than 50 particles. A unit area should have the width of the grid square and the height of a division on the calibrated ocular micrometer scale (See Figure 2 for suggested unit areas for highly contaminated samples). When using the unit area method, one unit area should be chosen from each grid square following the pattern in Figure 1.

Figure 2.



7.4 If a particle lies on the upper or left boundary line of a counting area, count the particle as if it were within the boundaries of the counting area.

7.5 Start and finish a selected grid by counting from the left grid line and continuing to the right counting each particle in the range. If using the unit area method for more contaminated samples, the boundaries will be defined in the width of the grid and desired length of the ocular micrometer so that the particle count within this unit area will not exceed 50. See figure 2.

7.6 Scan grid square (or unit area if highly contaminated) for particles by moving the stage so that the particles to be counted move under the micrometer scale. Only the maximum dimension of the particle is significant. Estimate the size of particles not oriented to scale. Do not reposition the eyepiece containing the ocular micrometer scale to size specific particles. Using a mechanical counter, count all particles in each required range. Record the number of particles in each grid square or unit area counted in order to have a record to meet the requirements of Equation 1.

7.7 To obtain N_p (the total number of particles per grid), count 10 or more grid squares or unit areas on the grid. From this count, calculate the total number of particles that would be present on the entire grid by the following formula:

$$N_p = N_t \cdot u(256/n) \qquad (2)$$

Where: N_t is the total number of particles counted.
n is the number of grid squares or unit areas counted.
u is the number of unit areas per grid square.

7.8 This gives the particle count for the grid (4 square inches). This value is then multiplied by 36 to get the particle count in the units particles per square foot.

7.9 This value is then corrected by subtracting the number of particles obtained in the average of the blanks.

7.10 The entire calculation can be carried out by the following formula:

$$P_t = N_t \cdot (36 \cdot 256 \cdot u/n) - B_c \qquad (3)$$

Where: P_t is the total number of particles per square foot

N_t is the total number of particles counted in n unit areas

n is the number of grid squares or unit areas that were counted

u is the number of unit areas per grid square (equals one if unit areas are not used)

36 is the number of grids in 1 square foot, 256 is the number of grid squares per grid

B_c is the background correction* (in particles/square foot) determined in step 6.3

The above formula works as shown below:

Suppose: $N_t = 520$

$n = 14$

$u = 2$

$B_c = 2000$

Then: $P_t = 520 \times (36 \cdot 14 \cdot 2/256) - 2000$

or: $P_t = (520 \cdot 256 \cdot 2/14) \cdot (36) - 2000 = 683{,}000$ particles/sq. foot

(520•256•2/14): gives number of particles per grid; (36): converts to 1 sq. foot; 2000: background correction in sq. ft.

*Background correction is calculated in the same manner as that outlined in sections 7.1 through 7.8. The value must be in units of particles per square foot to be compatible in formula 3.

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