MEASUREMENT OF

SLIP RESISTANCE OF RESILIENT FLOORS

PRINCIPLES AND EVALUATION

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1. GENERAL

1.01 This section reviews the factors affecting the slip resistance of resilient floors and various methods which have been used to evaluate this property. A method for appraising slip resistance by means of the foot is described. Instructions are given for obtaining numerical values representing comparative slip resistance by means of a polishing machine brush test.

1.02 The methods described are particularly designed for checking the slip resistance of resilient floorings maintained with wax or resin finishes. The resilient floorings include:

Asphalt tile

Linoleum - Sheet and tile

Rubber - Sheet and tile

Vinyl asbestos tile

Vinyl - Sheet and tile

The maintenance coatings covered are the following Bell System standards:

LIQUID FLOOR WAX

FLOOR WAX W-8

ANTI-SLIP FLOOR FINISH

1.03 Slip resistance consists of two components: (1) the slip resistance of the surface and (2) the slip resistance of the body of the film. The first represents the resistance to a flat surface, such as the sole of the foot, and is largely controlled by the tackiness of the film. The second represents the resistance to a point contact, such as the heel of the shoe as it meets the floor, and measures the shear resistance of the film once a slip has started. Both types are important. The resistance to the sole of the shoe is the type most obvious to the general personnel. It prevents slips from starting. The shear resistance determines whether the slip, once started, is arrested or results in a fall.

1.04 Testing for slip resistance has certain psychological as well as practical advantages. For example, the floor may have a high gloss as a result of a recent waxing or polishing which may give the occupants the erroneous impression that the floor is slippery. A test with the machine can demonstrate that this is not so and that the floor has a satisfactory slip resistance. If a slip and fall has occurred the test can determine whether or not action on the part of the building people is required.

1.05 The maintenance of resilient floors by waxing or resin application is covered in the following sections:

SECTION H51.109 - CLEANING AND PROTECTING RESILIENT FLOOR COVERINGS

SECTION H51.106 - FLOOR WAXING

SECTION H51.102 - APPLICATION OF ANTI-SLIP FLOOR FINISH

2. FACTORS AFFECTING SLIP RESISTANCE

2.01 Slip resistance is affected by many factors including the nature of the protective finish, the character of the underlying floor, the preparation of the floor and the application of the coating, climatic and atmospheric conditions, traffic conditions, the age of the film, and the type of foot wear worn by the personnel.

2.02 The finishes used to maintain resilient floors represent a balance. For example, to achieve slip resistance, durability and ease

of maintenance must be sacrificed to some extent. The Bell System floor finishes have all been checked and approved by the Underwriters' Laboratories as meeting a specified minimum coefficient of friction. However, while all are considered safe products they vary in slip resistance in the following order of increasing magnitude: Liquid Floor Wax, Floor Wax W-8, and Anti-Slip Floor Finish. Liquid Floor Wax is a high carnauba content wax. Floor Wax W-8 contains an appreciable quantity of "Ludox", a colloidal silica anti-slip ingredient. Anti-Slip Floor Finish is a wax-free resin product.

2.03 The density and resilience of the underlying flooring has a marked effect on the slip resistance of the wax or resin film. In general, the commonly used flooring materials run in the following order of resilience and slip resistance, from least to most: Asphalt Tile, Vinyl Tile, Linoleum, and Rubber. Appreciable differences, however, can be expected between different brands, grades and color of the same type flooring. In general, floorings tend to harden on aging with a corresponding loss in slip resistance.

2.04 To achieve satisfactory slip resistance it is essential that the floor be properly cleaned, and rinsed free from soap residues. Mops that are used for wax must not be subsequently used for Anti-Slip Floor Finish. Failure to observe this precaution may result in a fast, i.e., slippery, floor. In general, two coats give better slip resistance than a single coat. In the case of wax, buffing tends to improve the slip resistance. This is particularly true of freshly applied films where moisture is retained in the film for some time even though the wax appears to be dry. The buffing dries out the film.

2.05 All of the Bell System maintenance coatings are water emulsions. The residual films on the floor are accordingly affected by atmospheric conditions, particularly humidity. Consequently, they tend to be more slip resistant during the more humid summer months than during the winter when heating systems are in operation and humidity levels are low. Similarly the same wax will be appreciably more slip resistant in the south where it is hot and humid than in the north where it is cold and dry.

2.06 Traffic conditions which tend to wear the film thin decrease slip resistance. On the other hand, ground-in abrasive dirt increases the slip resistance. Also as the coating ages it tends to oxidize, harden, and become less slip resistant.

2.07 The presence of tracked in or spilled water greatly decreases the coefficient of friction and creates a hazardous condition. All such water should be promptly mopped up. When the soles of the shoes are damp, the coefficient of friction between the soles and the wax film is appreciably decreased. This, however, is not true of Anti-Slip Floor Finish.

2.08 The type of footwear has a major bearing on slip resistance. Low heeled shoes with a broad contact area insure maximum safety. For this reason slips and falls among men are comparatively rare. Under dry conditions much higher anti-slip coefficients are provided by rubber heels than leather heels. Under wet conditions this difference largely disappears.

2.09 Care should be exercised to minimize so far as possible the difference in slip resistance between parts of the same floor or adjacent floors. If the personnel are not aware of this difference, there is an element of surprise due to the sudden change in the slip resistance of the floor. A change in slip resistance requires a change in pace.

3. SLIP TESTING PROCEDURES

3.01 Many different devices and methods have been proposed for the measurement of slip resistance of floors. These can be divided into two classes: (1) the determination of the coefficient of static friction between the floor surface and a test piece, usually a leather sole, and (2) the measurement of kinetic or dynamic friction. The first evaluates mainly the surface resistance of the film while the second measures to a considerable degree the shear resistance of the coating. In general the static devices have been based on the inclined plane or oblique thrust principles. Kinetic apparatus have varied from pulling a weighted object across the floor and measuring the resistance by means of a spring scale, to a device that propels a steel puck across the floor, the distance slid being a measure of the slip resistance.

3.02 The best known static device is the James machine used by the Underwriters' Laboratories. It operates on the oblique thrust principle. It consists of a 3-inch square test shoe shod with a piece of sole leather that contacts the test surface. A vertically downward load of 75 pounds is applied through a 10-inch arm that is hinged to the shoe. By a controlled mechanism the angle of the test arm to the vertical is progressively increased until the horizontal force becomes sufficient to cause the test piece to slip. By means of a

chart the coefficient of friction is automatically recorded. A minimum safe coefficient of friction of .50 has been established by the Underwriters' Laboratories. All Bell System floor finishes have been tested on this equipment and exceed the minimum requirement.

3.03 The most widely used kinetic tester is the Sigler machine developed by the Bureau of Standards. It consists of a weighted pendulum which sweeps a leather heel across the test surface. The degree to which the swing is retarded by the resistance of the treated flooring gives a direct measure of the anti-slip coefficient. The Bell System floor finishes have been tested on this equipment and give satisfactory values.

3.04 The James and Sigler machines are essentially laboratory equipment that do not lend themselves readily to field testing. They are not easily transported and require exact adjustments to obtain dependable results.

3.05 Experience indicates that the best methods for checking the slip resistance of floors in the field is by practical evaluation with the foot and by means of a polishing brush test as described in the following paragraphs.

4. EVALUATION WITH THE FOOT

4.01 The floor should be tested for the two types of slip resistance, i.e., to the sole of the foot and the point of the heel. Leather soled shoes should be worn. In testing to the sole of the foot, the floor should be appraised both by sliding the sole on the floor and by turning on the ball of the foot. In testing for shear resistance the side of the shoe rather than the heel is used as a matter of convenience, particularly if the heel is rubber which will make any wax seem slow. The test is made by advancing the right foot with the edge of the sole in contact with the floor a little at a time and periodically shifting the weight from the left foot to the right until the foot slips. Before making tests the bottom and side of the shoe should be wiped off with a cloth or paper towel to insure freedom from foreign matter.

4.02 The person testing the floor then appraises the slip resistance of the coating based on his combined impression of the two slip components. It is helpful to use a rating system in recording the results, such as the following: (1) very fast, (2) fast, (3) satisfactory, (4) slow, (5) very slow. It is desirable to have a number of people engage in the rating, and make independent appraisals. After some experience surprisingly close agreement can be obtained.

5. POLISHING MACHINE METHOD

5.01 This test operates on the principle that the amount of current drawn by a polishing machine varies directly with the amount of work performed. If the brushes are not in contact with the floor only sufficient current is required to overcome the frictional resistance of the machine itself. If the brushes are placed on the floor additional current is required to overcome the frictional resistance of the floor. If the floor is coated with a slippery wax less current is required than if the wax is highly slip resistant. Accordingly if an ammeter is connected in series with the polishing machine to measure the current being consumed, a direct measure of the slip resistance of the floor is obtained.

5.02 To obtain significantly different readings, a light two-brush machine should be used. The Congoleum Nairn Model H floor polishing machine which weighs only 17 pounds has been found entirely satisfactory. It is included in the building service supplies section of the List of Bell System Standards, and is obtainable on order from the Western Electric Company. Any suitable ammeter, preferably covering the range 0 to 5 amperes, may be used.

5.03 Before making the test the machine must be run for a period of about 10 minutes to thoroughly warm it up. This is done by laying the machine on its back and running with the brushes in the air. The ammeter readings will slowly decrease as the machine warms up. Finally the pointer will remain steady. A typical value when running free is 1.6 amperes. It is advisable to take a free reading before and after any set of tests to be sure there has been no radical change in electrical current.

5.04 In making the test the brushes are in contact with the floor and the handle is laid in a horizontal position so that the weight on the brushes is constant. Due to the two brush construction very little effort is required to prevent the machine from traveling. Do not apply any downward pressure on the handle in holding the machine in place. Allow a few seconds for the needle to steady, then read. Usually about 10 seconds are sufficient. Prolonged polishing in one spot will create heat and give abnormally high results. Any such reading should be discarded. It is usually advisable to take about 10 readings at different locations and average the results.

5.05 With the Bell System waxes and resin finish there is little tendency for sufficient wax to get on the brushes to affect the test. However, it is desirable to "dry clean" the brushes fairly frequently by pressing a stick, a ruler is suitable, against the brushes as they rotate. On occasion the brushes should be thoroughly washed with a powdered soap solution fortified with pyrophosphate, or a 1 to 16 solution of Liquid Floor Cleaner.

5.06 The polishing machine test has certain advantages. The equipment is inexpensive, readily available, and easily transported. It is simple to operate and suited for testing in the field. The results agree well with complicated laboratory tests and practical foot evaluations in that waxes are rated in the same order. It's greatest value is for checking floors where complaints have been received that the floor is fast or where actual slips and falls have occurred.

5.07 The results should be considered comparative in character and may vary somewhat from machine to machine. Each location may have to establish their own par values. As a guide, however, the following limits are fairly typical:

	Amperes
Liquid Floor Wax	2.3-2.5
Floor Wax W-8	2.6-3.0
Anti-Slip Floor Finish	2.6-3.0

6. SAFETY PRECAUTIONS

6.01 The following paragraphs summarize measures that should prove helpful in minimizing the possibility of slipping and falling accidents on resilient floors.

6.02 Before applying wax or resin finish be sure that the floor has been thoroughly cleaned and rinsed.

6.03 In cutting over from wax to resin, or from resin to wax, be sure all residues of the old finish have been thoroughly removed.

6.04 In applying Anti-Slip Floor Finish do not use mops that have previously been used for waxing.

6.05 Avoid too little or too much wax. In general, following reconditioning cleaning, two coats, full strength, will be found to provide the optimum amount.

6.06 So far as practicable uniform coatings should be maintained over the entire floor. Uneven coatings may produce different resistances to slipping and create a hazardous condition.

6.07 Avoid the use of different types of coatings having different coefficients of friction on the same floor, or so far as practicable on adjacent floors.

6.08 Following the application of wax or Anti-Slip Floor Finish, allow the floor to dry thoroughly before being opened to traffic. For maximum safety, several hours drying time is preferable. In no case should the floor be opened to traffic with less than one-half hour drying time. In such cases, if wax has been used, the floor should be buffed before traffic is permitted.

6.09 Periodic polishing tends to keep wax coatings alive and aids in maintaining maximum resistance to slipping. Under certain conditions a damp mopping prior to the buffing will be found helpful. These suggestions do not apply to Anti-Slip Floor Finish.

6.10 Since resilient floors are slippery when wet, floor mats should be placed at entrances during wet weather to prevent tracking water or snow into the building. The mats should be of a type and size to provide adequate foot wiping to dry the soles of footwear.

6.11 Keep floors clean and dry. Mop up immediately any liquids that are spilled on the floor. Sweep up as soon as practicable such objects as pencil leads, paper clips, rubber bands and cigarette butts that can create a hazardous condition under foot. Encourage occupants to pick up such litter whenever noted.

6.12 Block off floor areas that are being cleaned or waxed so that persons can not inadvertently walk on them. Place caution signs where they may be readily seen and leave them in place until the floor is thoroughly dry.

6.13 If a slip and fall occurs, study the various factors which may have contributed to the accident to avoid similar mishaps in the future. In making these analyses cooperate with other departments who may be concerned.

6.14 Use only the waxes or finishes that are recommended for Bell System use. These standards are delivery inspected and checked periodically for slip resistant properties.