



## Standard Guide for Cleaning of Exterior Dimension Stone, Vertical And Horizontal Surfaces, New or Existing<sup>1</sup>

This standard is issued under the fixed designation C1515; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This guide describes materials and procedures which may be used to clean dimension stone exteriors as well as the conditions under which they may be used. It is intended to aid owners, maintenance supervisors and building managers, architects and engineers, and contractors in cleaning vertical exterior dimension stone on commercial, residential and institutional structures. This guide may also be helpful to those who wish to clean stone masonry on bridges, retaining walls, ramps, and plazas, and free-standing stone objects such as statuary, memorials and grave markers.

1.2 This guide relates primarily, to routine maintenance of the surface finish of exterior dimension stone. The techniques noted herein may not be appropriate or cost effective with regard to restoration of disfigured, severely soiled or stained stonework, or of stonework of particular historic importance. In cases where staining occurs on surfaces which have cultural, civic, historic or architectural significance, consultation with a specialist is recommended.

1.3 The user of this guide should also obtain and have on file at both the job site and the office Material Safety Data Sheets (MSDS) describing the nature of all chemical products utilized during the cleaning process.

1.4 A file of literature from the manufacturers of all products involved within the scope of each project should be available for reference.

1.5 These procedures are not intended for interior stonework.

1.6 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to repre-

sent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.7 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

C119 Terminology Relating to Dimension Stone

C503 Specification for Marble Dimension Stone

E1971 Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings

### 3. Terminology

3.1 Terms used in this guide are defined in Terminology C119.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *exterior dimension stone*—a general term for a stone installed in a location where temperature, moisture and wind-carried contaminants are regulated solely or primarily by the forces of nature.

3.2.2 *qualified contractor*—a person, persons or organizations having expertise in stone cleaning, proved by documented projects demonstrating successful work, consistency in business or consultancy for a period of five or more years.

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee C18 on Dimension Stone and is the direct responsibility of Subcommittee C18.07 on Environmental Properties, Behavior, and Cleaning.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

## 4. Significance and Use

4.1 Exterior dimension stone is chosen for use in contemporary architecture in part because of its aesthetic appeal. Aesthetics can be significantly diminished when dirt, grime, fly ash, algae and other contaminants collect on the surface of stone.

4.2 This guide is intended to assist those who wish to preserve the original appearance of a new structure or to return a stone-clad building to its original color and appearance.

4.2.1 Note that cleaning may not be able to return discolored or faded stone to its original appearance.

4.3 This guide may be used as a construction document.

## 5. General Information

5.1 Exterior stone is used in honed, textured, or polished finishes in many modes in exterior environments. However, trade experience discourages the use of a polished finish marble or limestone on exterior applications due to susceptibility to damage by acids in rain or snow, and by wind-driven dirt particles.

5.2 The use of dark colored marbles and limestones for exteriors is discouraged because fading in direct sunlight has been experienced. Discolored or faded stone may not be able to be returned to its original color by cleaning.

5.3 Only marbles with an “A” Soundness Classification should be used for exterior installations. An exception is travertine marble (“C” Soundness Classification) which may be installed with its natural voids either filled or unfilled. See Specification **C503** for soundness classification of marbles.

5.4 Stone installed in a mortar bed should be allowed to cure properly. Do not apply surface treatments to stone set horizontally in a mortar bed for at least four weeks following installation.

5.5 Carefully identify all wet pedestrian areas with barricades, “danger” signs or bright red or orange-colored “danger” pylons.

5.6 Always test any cleaning method on a sample area to determine its effectiveness. Always refer to the manufacturer’s instructions.

5.7 When choosing the materials and procedures for cleaning dimension stone, the most appropriate materials and procedures should be chosen to promote eco-efficiency and avoid adverse impacts on humans, the structure itself, and the environment, see Guide **E1971**. The alternative cleaning processes, cleaning products and their storage, use, and disposal, equipment choices, and training of personnel involved in the work need to be assessed.

5.7.1 Certain pertinent questions should be considered here: (1) how is the building used? (2) are there any special cleaning requirements caused by the type or finish of dimension stone used? If so, identify the cleaning task and performance requirements, (3) are there any at-risk human populations to consider? (4) are there any issues relating to building age or architecture? (5) what criteria or measures will be used to evaluate the quality of cleaning and repairs?

## 6. Normal Maintenance

6.1 In accessible areas, routinely follow maintenance procedures as specified for Polished Stone, Honed Stone or Textured Finish Stone as applicable. The large expanses of stone traditionally found on exterior multi-story installations should be cleaned as often as necessary to remove accumulated pollutants.

6.1.1 A practice as simple as a hosing down with potable water on a regular basis will prevent accumulation of dust and acidic deposits left by rain or snow.

6.1.2 The cleaning of stone should be done only by qualified contractors who have the craftsmen, equipment, resources, and technical expertise to do the work, as well as make any repair, resetting, or repointing that may be necessary.

6.1.3 Generally, the processes used in multi-story cleaning will be similar to normal procedures, except that pumps for pressure wash, or steam and rinse water may be employed to economize on the amount of time necessary to the work.

6.1.4 Consult material suppliers and qualified contractors to obtain their recommendations for maintenance, materials or repairs.

6.1.5 Always test any cleaning method on a sample area to determine its effectiveness. Always refer to the manufacturer’s instructions.

6.1.6 Always try the least aggressive cleaning media (potable water) first.

6.1.7 Evaluate project conditions with regard to required protection of adjacent properties and public safety. The protection needed for cleaning multi-story structures will differ from that needed for one or two-story buildings.

## 7. Polished Dimension Stone

7.1 Polished Stone has a glossy surface that reflects light and emphasizes the color and markings of the material.

7.1.1 Normal maintenance involves only periodic washing with clean, potable water and neutral (pH7) cleaners. “Soapless” cleaners are preferred because they minimize streaking and filming. Abrasive cleaners should be avoided.

7.1.2 Stone surfaces should first be wetted with clean, hot (not boiling) water. Then, using the cleaner solution (following manufacturer’s directions) wash in small, overlapping sweeps from top down, or follow manufacturer’s directions if different. Rinse thoroughly with clean, potable water to remove all traces of soap or cleaner solution. If rinsing is done by hand, change the water in the rinse pail frequently. Dry with a soft cloth, cotton flannel or chamois, wiping carefully to avoid streaks. The surface may also be allowed to air-dry.

7.1.2.1 **Warning**—Do not use bleach, acid, or strong alkali solutions on marble or limestone because colors may be lightened and the surface etched.

7.1.2.2 Select a cleaning agent which suits the nature of the stone.

## 8. Honed Dimension Stone, Normal Maintenance

8.1 A honed finish is a satin smooth surface with relatively little light reflection.

8.1.1 Normal maintenance of a honed finish involves as-needed washing with clean, potable water and neutral (pH7), mildly abrasive cleaners.

8.1.2 Surfaces should be first wetted with hot, clean water. Then, using a mildly abrasive, alkaline cleaner and a medium natural bristle brush, wash in overlapping, swirling strokes. Work from top down or follow manufacturer's directions if different.

8.1.3 Rinse thoroughly then wipe dry with cotton, cotton flannel, or a chamois. Wipe carefully to avoid streaking. Optionally, the stone may be allowed to air-dry.

8.1.4 If further cleaning is needed, make a paste to the consistency of thick syrup by combining a mildly abrasive alkaline cleaning powder and clean, potable water. Apply the paste uniformly over the surface with a broad brush and allow to stand until dry. Then, use a medium bristle brush with additional water and scrub vigorously. (More cleaning powder may be applied at this point.) Rinse thoroughly and dry as described above. Follow manufacturer's directions.

8.1.4.1 See 10.1 and 10.3 for poultice information.

8.1.5 **Warning**—Do not use bleach, acid, or strong alkali solutions on marble or limestone because colors may be lightened and the surface etched.

8.1.5.1 Select a cleaning agent which suits the nature of the stone.

## 9. Textured Finish Dimension Stone, Normal Maintenance

9.1 Examples of textured finish dimension stone include Thermal Finish Granite, Thermal Finish Limestone, Unfilled Travertine, Rock Face, Split Face, Natural Cleft Slate and Natural Cleft Quartz-Based (Sandstone) Stone. Abrasive, bush-hammered, and sand-blasted finishes are also included in this category.

9.1.1 Regular maintenance becomes difficult if dirt is allowed to accumulate on the uneven surfaces of these stones. If convenient, textured finished stone may be vacuumed clean.

9.1.2 Normal maintenance of textured finish stones involves as-needed washing with clean, potable water and neutral (pH7), mildly abrasive cleaners.

9.1.3 Surfaces should first be wetted with hot, (not boiling) clean water. Then, using a mildly abrasive, alkaline cleaner and a medium bristle brush, wash in overlapping, swirling strokes. Work from top to bottom. Rinse thoroughly with clean water.

9.1.4 **Warning**—Do not use bleach, acid, or strong alkali solutions on marble or limestone because colors may be lightened and the surface etched.

9.1.4.1 Select a cleaning agent that suits the nature of the stone.

## 10. The Poultice Method

10.1 The Poultice Method is a special cleaning procedure for removal of deep-seated, time-set dirt and grime. The poultice may be applied to honed or textured stone, and is particularly useful on intricate carvings, moldings and other detailing difficult to scrub.

10.1.1 The poultice is essentially a strong fluid cleaner, applied by way of a holding medium with a film or membrane, that concentrates its effort over a period of time.

10.1.2 The mechanism within this practice relies on the ability of the poultice to reliably wick a fluid out from the stone fabric, carrying the staining agent with it. The staining agent is effectively drawn out backwards on the same path that it entered the stone.

10.1.3 The fluid must be capable of dissolving the staining agent and may be water based or solvent based, depending on the origin of the stain. The fluid may have additional chemicals added to further increase its effectiveness. Water, hydrogen peroxide, acetone, and mineral spirits are commonly used fluids.

10.1.4 Holding mediums are powders such as clays, Fuller's earth, talc, diatomaceous earth, baking soda, and even flour. Cloth or paper products, such as cotton balls, paper towels, and gauze pads can also be used as a holding medium.

10.2 The poultice medium is saturated with the fluid, and when placed on the stone surface, allows the fluid to penetrate the stone. As the poultice medium starts drying, it has a greater affinity to draw the fluid than the stone has ability to retain the fluid. This causes the fluid to wick backwards into the poultice medium, carrying the staining agent with it.

10.2.1 A plastic film or membrane is generally required to be placed over the poultice, which will control the rate of evaporation. If the fluid is allowed to evaporate too quickly, there may be ample opportunity for it to dissolve the stain prior to evaporation.

### 10.3 Preparation and Application of a Typical Poultice:

10.3.1 Mix kaolin or Fuller's earth with either a common laundry bleach or a commercial hair-bleaching solution of hydrogen peroxide ( $H_2O_2$ ) to form a paste the consistency of peanut butter or cake icing. (For estimating purposes, figure a consumption rate of one pound of paste per square foot of surface.)

10.3.2 Moisten the surface of the stone with the same liquid used to make the paste, wetting beyond the extent of the stained areas.

10.3.3 Apply the poultice paste to the stone with a wooden or plastic spatula, ensuring a uniform coat about 1/4-in. (0.635 cm) thick. Cover the entire area to be cleaned and somewhat beyond to prevent the soil from being forced into the clean stone. Ensure the poultice is in full contact with the stone with no entrapped air pockets or voids.

10.3.4 Tape plastic sheeting over the poulticed area to prevent quick drying-out and to allow it to act for 48 h.

10.3.5 After this standing period, dampen the poultice with clean, cool water to prevent undue dust generation. Remove the poultice with a wood or plastic spatula to avoid scratching. Rinse the cleaned area thoroughly with clean water; blot or wipe off excess water; allow it to dry.

10.3.6 When water-spotting has disappeared after complete drying, inspect for remaining soil. A second poultice application may be necessary.

10.4 Commercial "Marble Poultice" base powders are available.

10.4.1 Poultice products are also available commercially through stone equipment supply catalogs. Generally, these are

sold pre-mixed in gel form, and are usually specific to the type of stain that is intended to be removed.

10.4.2 With any commercial poultice, read and follow the manufacturer's directions.

### 10.5 Warnings:

10.5.1 Do not use poultice containing additives (such as bleach or solvent) other than water on dark colored stone.

10.5.2 A poultice applied to polished finish marble will dull the surface, requiring repolishing.

10.5.3 The poultice is used primarily to attack and reduce heavy deposits of normal soiling, or to remove stains resulting from the action of moisture on normal soiling.

10.5.4 For stains resulting from a known origin, see Section 13.

## 11. Graffiti Removal

11.1 Graffiti is writing or drawings that have been scribbled, scratched, or sprayed illicitly on a wall or other surface in a public place. Graffiti ranges from simple written words to elaborate wall paintings.

11.2 One of the keys to preventing the recurrence of graffiti is prompt removal. The graffiti artist will be reluctant to paint in an area or on a building where the graffiti is quickly removed and not seen by many people.

11.2.1 Studies have shown that removal within 24 to 48 h results in a recurrence rate of nearly zero.

11.2.2 An additional benefit of promptness is that the paint will not have had time to fully cure and will respond more favorably to removal methods.

11.3 Paint, particularly spray paint, and marker pens are the most commonly used graffiti materials.

11.3.1 Spray paints consist of a colored pigment suspended in a binder/solvent mixture. When applied, the solvent evaporates, allowing the binder to attach the pigment to the masonry.

11.3.2 Binders can be enamel, acrylic, polyurethane, or latex based. The most widely used graffiti spray paints commonly use some form of acrylic binder.

11.3.3 Identifying the type of spray paint and its binding agent will make it easier to choose a removal process.

11.3.4 The most difficult colors to remove are black and reds because the pigments for those colors tend to be small and can get deeper into the stone substrate.

11.4 Identification of the stone type is also important.

11.4.1 The porosity and absorption properties of the stone are good indicators of the difficulty of graffiti removal. More porous and more absorptive stones will allow the pigment to penetrate into the stone making removal very difficult.

11.5 Typically, graffiti is most easily removed from hard stones with a polished finish. Granites and some of the harder marbles fall into this category. However, some stones, usually used on interiors, achieve a polish by the use of chemicals or waxes. The chemical used for the polish can be damaged by the solvent in the spray paint. The whole stone may have to be re-polished to achieve a match to surrounding stones.

11.6 Flame finished stone is more difficult to treat than polished, but if the grain structure is tight, the graffiti can still be effectively removed.

11.7 Sandstones do not tend to allow the paint to bond well because of their silica base, but the paint can still be trapped between the grains of the stone, causing a shadow or outline of the original drawing.

11.8 Softer stones, such as limestone and some of the travertines, are the most difficult and can require a solvent to penetrate into the pores to dissolve the pigment and draw it out of the stone. Several treatments with a poultice (as outlined in Section 10) may be required to reach an acceptable appearance.

11.9 Several graffiti removal methods are available. They are, in order of least to most aggressive:

11.9.1 pressure washing with water,

11.9.2 detergents,

11.9.3 poultices with organic solvents or alkaline compounds,

11.9.4 bleaches, and

11.9.5 pressure washing with an abrasive medium.

11.10 To avoid damage to the stone, cleaning should start with a gentle procedure and work toward the more aggressive solutions.

11.11 Low-pressure water should be the first treatment tried. If the paint is not more than a day or two old, low-pressure water will generally not harm the stone and will remove most of the not yet fully cured paints and markers. The guidelines for pressure washing in Section 12 must still be followed.

11.12 If low-pressure water does not remove the graffiti, detergent with a stiff bristle brush should be tried next.

11.12.1 The stone should be thoroughly wetted and the detergent applied to the affected area by scrubbing with a stiff bristle brush.

11.12.2 A wire brush should never be used as it will damage the finish.

11.13 If there is still an apparent stain after pressurized water cleaning and scrubbing with a detergent, then a poultice should be applied. See Section 10 on Poultices.

11.13.1 Poultices can be used with a myriad of solvents to soften the binding agent in the paint and draw out the pigments from the stone.

11.13.2 If the poultice is tried before pressurized water, the volume of the pigment available can cause the solvent to drive the pigment deeper into the stone making removal much more difficult.

11.13.3 Stone can be damaged by a solvent that attacks the bonding agent in the stone itself. Some stone reacts negatively with alkali solvents.

11.13.4 A stone consultant with experience in graffiti removal should be consulted before any aggressive technique is tried.

11.13.5 If at all possible, any removal method should be tested in a low traffic area to verify that the chosen method does not damage the stone.

11.14 Sometimes, an organic bleach compound can lighten the remaining shadow of the paint to an acceptable level. The



actual bleach used must be recommended or approved by the stone manufacturer to avoid damaging the stone.

11.15 Often, an abrasive medium, such as sand blasting, is suggested when all else fails. This is almost never a good option and will almost certainly damage the finish of the stone.

11.15.1 Baking soda as an abrasive medium has been used successfully in the past for certain stones because it is less abrasive than other mediums.

11.15.2 Even so, baking soda blasting should be used with extreme caution and only at the recommendation of a stone consultant.

11.16 Preventive treatments are available. These treat the stone with a chemical that lowers the bonding of the binders to the surface of the stone. Theoretically, this makes the graffiti easier to wash off if it occurs. These can be effective, but there are some caveats:

11.16.1 The treatment is usually not permanent and must be reapplied periodically,

11.16.2 Some treatments will change the color of the stone, usually making it darker,

11.16.3 Avoid treatments that seal the exterior surface of the stone by filling up the pores, as they do not allow the stone to eliminate trapped moisture and can cause flaking in the exterior surface of stone with certain ranges of porosity.

## 12. The Abrasive Method

12.1 *Cleaning by mechanical abrasive* is a specialty method used to remove surface soiling from exterior stone masonry and stone cladding using a projected abrasive media, and is often used in conjunction with very low-pressure water. Abrasives may vary in hardness, density, and size depending on the substrate, soiling and project goals. While abrasive cleaning can cause damage, low-pressure (less than 30 psi) gentle abrasive systems using low mass and small diameter abrasives may result in cleaning stone surfaces without damage.

12.1.1 *Abrasive Media:*

12.1.1.1 Crushed glass.

12.1.1.2 Walnut shells.

12.1.1.3 Dry ice.

12.1.1.4 Plastic.

12.1.1.5 Blast furnace slag.

12.1.1.6 Aluminum oxide.

12.1.1.7 Sand.

12.1.2 Abrasive media is sometimes embedded in sponge particles to control dust and evenness of application.

12.1.3 Abrasive media may be reused multiple times. However, the effectiveness of the media diminishes with use. Excessive recycling of media can lead to uneven cleaning.

12.1.4 For historic stone construction, the Secretary of Interior's Standards for the Treatment of Historic Properties should be followed.

12.1.5 Abrasive cleaning is most effective at removing atmospheric deposits, efflorescence, and alteration crusts (formed via a reaction with atmospheric pollutants bonding to the stone) from a variety of stone.

12.1.6 Abrasive cleaning can range from gentle to aggressive, based on the media and delivery pressure used, and

when appropriately matched to the stone substrate, can be implemented in a way that does not result in damage to the stone surfaces.

12.1.6.1 The cleaning system should be conducted in a way as to not damage, etch, discolor, or cause disintegration of any stone masonry surface.

12.1.6.2 Even though using high-pressure and coarse media increase cleaning rate, these aggressive cleaning methods should be avoided because they often lead to excessive and uneven removal of original sound stone, which can significantly and permanently alter the appearance of the stone.

12.1.6.3 Often, the hardness of the media to be used is less than the stone being cleaned in order to minimize damage to the building stone.

12.1.7 Following abrasive cleaning, rinsing of the wall at low pressure may be needed to remove dust and remaining media.

12.1.8 Prior to performing the cleaning, develop a collection and disposal plan describing procedures to control the abrasive medium, dust, and debris during stone cleaning operations.

12.1.9 This cleaning system should be evaluated on each unique project through trials and mock-up samples to confirm the effectiveness and ability to clean the surface without causing damage.

12.1.10 When proprietary abrasive cleaning systems are used, workers should be trained and certified in the use of the abrasive system by the supplier or manufacturer.

12.2 *A mock-up* should be performed using the materials and techniques for each stone type and exposure to be cleaned.

12.2.1 The mock-up should include each protection system or device proposed for protection of the building elements.

12.2.2 Trials and mock-ups should generally be performed over 25 ft<sup>2</sup> in area or greater. Typical architectural elements should be included in the trial area.

12.2.3 Minor adjustments to the method of application, including using different media, nozzle, nozzle size, pressure, abrasive rate, nozzle working distance and length of application will very likely need to be made to achieve the most effective and efficient result that does not damage the substrate.

12.2.4 The result of the cleaning should not be expected to return the façade to a 100 % clean or new appearance, because that level of cleaning typically causes damage to the substrate.

12.2.5 Abrasive cleaning should be performed in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.

12.3 *Evaluating Effectiveness*—For a good evaluation of effectiveness and potential negative reactions of the methods, the trials and mock-ups should be reviewed after the wall is completely dry.

12.3.1 A professional who is familiar with the types of soiling that can be removed using abrasive cleaning may be beneficial to evaluate the types of soiling present to confirm the appropriateness of this cleaning method.

12.3.2 Field or laboratory microscopy should be used to evaluate the trials and mock-ups throughout the project.

12.3.3 *Environmental Limitations and Building Protection*—Where used with water cleaning, the risk of

freezing from absorbed water by the stone could lead to spalling distress, and water can lead to water leakage in the building. Overspray of media can damage adjacent materials.

12.3.3.1 Abrasive cleaning used in conjunction with water cleaning should take place only when air temperature and stone surface temperature are 40°F or above and are predicted to remain so for at least three days after completion of cleaning.

12.3.3.2 Building and site features, and personnel should be protected against wind-driven spread of media and water. Cleaning should not be performed when winds are sufficiently strong to spread media and water to unprotected areas.

12.3.3.3 Windows and doors, joints, and other openings should be protected from projected media because those elements can be damaged by abrasion. Runoff media and water from cleaning operations should be disposed of by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

12.3.3.4 Abrasive may also damage wood, glass, metals and other materials.

12.4 *Water Quality*—Water used for cleaning (if used) and rinsing should be clean, potable water, with iron content less than 2 parts per million, or 0.0002 % (by weight). Water should be checked to confirm that additives, water softeners, or other agents that may be harmful to stone are not present.

12.5 *Application and Sequencing*—Always proceed with cleaning in an orderly manner. Use spray equipment that provides controlled application at volume, distance, and pressure resulting in uniform coverage of all wall surfaces with abrasive media. Adjust pressure and volume to ensure that an even flow of media is achieved. The applicator should be constantly moving. Avoid holding the applicator still for any length of time; this will result in uneven stone surface. Application should overlap to minimize uneven cleaning.

12.5.1 Abrasive nozzles are typically applied by using a hand-held nozzle although automated techniques are available but less common.

12.5.2 Upon final cleaning, rinse stone with water applied by low-pressure spray (less than 200 psi depending on the substrate), rinsing from top of area to bottom of area.

12.5.2.1 Water temperature should not exceed 120°F.

12.5.2.2 A stainless-steel spray tip giving a 45° fan spray, held at least 12 in. from the wall surface should be used as an applicator.

### 13. General Stain Removal

13.1 A regular normal care and maintenance program should help prevent staining. But should accident or neglect contribute to the problem, remedial measures will be completely different from general cleaning and will usually require persistence to achieve the desired results.

13.2 When the source of the stain is not known, the "Poultice Method" should be tried first. If this remedy is not effective, follow specific remedies as explained below, attempting each in turn until results are achieved. Please note the **Warning (10.5.1)** against the application of poultice containing additives other than water on dark colored stone.

13.3 Stains in stone will generally be caused by one of three major category sources: organic materials, metallic materials, or oils and greases.

13.4 As a general rule, as with maintenance begin with simple methods for stain removal and progress to more aggressive treatments as necessary.

### 14. Water Soak Method

14.1 *Cleaning by water soaking*, sometimes referred to as water misting, is a method commonly used to remove surface soiling from exterior stone masonry and stone cladding using very low pressure water to mist exterior stone masonry walls and stone cladding.

14.1.1 This cleaning method employs very low water pressure and is appropriate for historic and non-historic stone masonry.

14.1.2 For historic stone construction, the specifier should refer to and follow the Secretary of Interior's Standards for the Treatment of Historic Properties.

14.1.3 Water misting is typically most effective at removing atmospheric deposits or bioproducts, or both, from acid rain exposure on limestone and marble substrate.

14.1.4 Water misting is a gentle cleaning system that typically does not result in damage to stone surfaces.

14.1.5 In many instances, water soak cleaning is accelerated or improved when used in combination with other spot cleaning techniques or gentle brushing of soiling where spot soiling is pronounced.

14.1.6 This cleaning system should be evaluated on each unique project through trials and mockups to confirm effectiveness and ability to clean the surface without causing damage.

14.1.7 The integrity of the joints should be determined. If repointing is deemed necessary to prevent water penetration through the façade, it should be completed at least 48 h prior to the cleaning.

14.2 A *mock-up* should be performed using the materials and techniques for each stone type and exposure to be cleaned.

14.2.1 The water mist mock-up should include each protection system or device proposed for protection of the building elements, because water leakage due to prolonged water exposure of the wall is a significant concern.

14.2.2 Water misting trials and mock-ups should generally be performed over 25 ft<sup>2</sup> in area or greater. Minor adjustments to the method of application, including water mist positioning, pressure, flow rate and duration will very likely need to be made to achieve the most effective and efficient result.

14.3 *Evaluating Effectiveness*—For a good evaluation of the effectiveness and for negative reactions, the trials and mock-ups should be reviewed no sooner than 14 days after completion.

14.3.1 A professional, who is familiar with the types of soiling that can be removed using water misting, may be able to confirm the appropriateness of this cleaning method on the types of soiling present.

14.4 *Environmental Limitations and Building Protection*—Water mist cleaning should take place only when air temperature and stone surface temperature is 50°F or above and is predicted to remain so for at least 7 days after completion of cleaning.

14.4.1 Cleaning effectiveness is generally improved by avoiding colder temperatures. This has the added benefit of minimizing the risk of freezing of water soaked stone and the associated spalling in the stone face.

14.4.2 Building, site features, and personnel should be protected against wind-driven spread of the water mist. Water mist cleaning should not be performed when winds are sufficiently strong to spread water to unprotected areas. This could result in water leakage or an uneven cleaning of the stone.

14.4.3 Windows and doors, joints, and other openings should be protected from water infiltration and the wall below the area being cleaned evenly wet or protected to prevent streaking from water runoff. Runoff water from cleaning operations should be disposed of by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

14.5 *Water Quality*—Water used for cleaning and rinsing should be clean, potable water, with iron content of less than 2 parts per million, or 0.0002 % (by weight). Water should be checked to confirm that additives, water softeners, or other agents that may be harmful to stone are not present.

14.6 *Application and Sequencing*—Cleaning should proceed in an orderly manner. Spray equipment that provides controlled application at a volume and pressure that results in uniform coverage of all wall surfaces with water should be used. Pressure and volume should be adjusted to ensure that an even flow of water is achieved. Avoid misting in a manner which results in uneven channels of water flow on the stone.

14.6.1 Water misting typically uses a spray rack that applies a fine water mist to the entire surface being cleaned.

14.6.2 Water misting uses very low-pressure water (less than 50 psi; 4 to 6 gpm) and may require multiple cycles of durations from 30 min to several hours.

14.6.3 Upon completion of each cycle of misting, surface encrustations and cleaning effectiveness should be checked.

14.6.4 Brushing between cycles often improves the efficiency and may result in an overall shorter time of application. Brush with a soft natural or manmade fiber brush with a minimum level of effort required to be effective without damaging the stone.

14.6.5 Upon final water misting, the cleaned surface should be rinsed from top of misted area to bottom of misted area, with water uniformly applied by low-pressure spray (less than 200 psi depending on the substrate).

## 15. Removal of Organic Stains

15.1 Most organic (carbon-oxygen based) stains require an oxidizing agent treatment, and will generally respond in varying degrees to hydrogen peroxide or commercial chlorine bleach treatments and poultices. Hydrogen peroxide ( $H_2O_2$ ) in a hair-bleaching solution can be used. Chlorine bleaches in

commercially available strengths as sold for laundry and household use can be used.

15.1.1 **Warning**—Do not combine bleach and ammonia. The combination produces a toxic gas.

15.1.2 **Warning**—Do not use a poultice containing bleach, acid, or strong alkali solutions on marble or limestone because colors may be lightened and the surface etched.

15.1.3 In the presence of moisture, leaves, bark, bird and animal droppings, and foods may cause pinkish-brown stains. When the sources are removed, normal sun and rain action will generally eliminate the stains. Tobacco stains usually respond in the same manner.

15.1.4 Urine stains on light-colored stone can be fully rinsed and allowed to bleach in the sun. If a shorter time is required, urine stains should be attacked with a strong chlorine-bleach poultice, or sprinkled with a chlorine-bleaching powdered cleanser, dampened, and left until dry, then washed with clean water.

15.1.5 Fire and smoke stains, caused by burning wood or paper, can be removed with the application of a commercial Fireplace Cleaner, or by washing the stained surface with a solution of caustic soda (lye: sodium hydroxide) (NaOH).

15.1.6 **Warning**—Caustic soda is corrosive. Care must be taken to protect skin, eyes, and clothing from burns. If contact occurs, rinse the contact area with cool, clean water.

## 16. Removal of Metallic Stains

16.1 Metallic stains require chemical treatment with a reduction agent, that is, an agent that will attack the metallic salts and reduce them to soluble, colorless salts which can be rinsed away or drawn out by poultices.

16.2 *Iron (Ferrous or Ferric) Stains*—These generally appear reddish-brown, resembling rust, and result from the action of moisture on adjacent or embedded iron or steel. Before trying to remove this stain, cure the cause. Clean and paint accessible ferrous items to prevent oversplash and run-off onto the stone. If possible, remove the sources of moisture to prevent further oxidation. Where the iron or steel is embedded in stone little can be done except to cut off the moisture supply to the metal to prevent a continuation of oxidation and resultant staining.

16.2.1 Superficial, fresh stains can usually be removed with a vigorous scrubbing. Seated stains may be removed by the application of a commercial rust remover following manufacturer's directions for use. If these remedies fail, often abrasion with a scouring powder followed by a second application of the commercial rust remover will remove the stain.

16.2.2 Should this fail, apply a poultice for not more than ½ an hour using either sodium hydrosulfite ( $Na_2S_2O_4$ ) or sodium hypochlorite ( $NaOClO \cdot SH_2O$ ). Flush with a sodium citrate solution ( $C_6H_5Na_3O_7 \cdot 2H_2O$ ).

16.2.3 Unfortunately, deep seated, rusty stains caused by prolonged neglect or from embedded metal (anchors, ties, etc.) may not be removable by any means.

16.3 *Copper and Bronze (Cuprous and Cupric) Stains*—These stains appear as green or muddy-brown colorations and result from the action of moisture on nearby or embedded bronze, copper and brass items.

16.3.1 Before attempting stain removal, cure the cause. Clean attached or nearby metal items and coat them with a quick drying, clear coating such as varnish, shellac, or a plastic spray-on or brush-on coating, which may require special methods of expertise. If possible, remove sources of moisture to prevent further oxidation of cuprous metal. When the source of the stain is an embedded anchor, tie or other device, the only remedy is to cut off moisture at its source. Coating would be impossible.

16.3.2 After eliminating the moisture or protectively coating the metal, attack the stain with a poultice. Mix a thick paste composed of kaolin or fuller's earth, ammonia, or sal ammoniac (ammonium chloride) ( $\text{NH}_4\text{Cl}$ ), (which can be purchased at most pharmacies) to the consistency of peanut butter or cake icing. If sal ammoniac is not available, a fairly effective "field expedient" is a solution of household ammonia and table salt mixed in equal quantities into the poultice base. Apply the poultice thickly beyond the limits of the stain, and leave it until dry. Remove with a non-metallic spatula and rinse thoroughly. Cover with plastic and allow to dry. Repeat if necessary.

16.4 *Lead*—Stains caused by lead will appear as yellow or orange colorations and may appear at a distance from the source. There is no use attacking the stain if the source cannot be removed, or even attacking the stain itself inasmuch as lead is virtually non-reactive to chemicals, and any lead salts that may have formed will be extremely difficult to reduce. If the source can be removed, the stains may bleach out through normal weathering.

16.5 *Ink*—Inks are frequently formulated from metallic salts, and the stains caused by these inks should be attacked with the same methods as recommended for iron stains.

16.5.1 Non-metallic ink stains can frequently be removed using a poultice or white blotter soaked with household ammonia. Rinse thoroughly with clean water. Often, a bleaching poultice will be needed to remove any remaining coloration.

16.5.2 **Warning**—Do not combine bleach and ammonia. The combination produces a toxic gas.

## 17. Removal of Oil and Grease Stains

17.1 Oil, grease, linseed oil, and perspiration stains normally must be dissolved chemically so the source of the stain can be flushed or rinsed away.

17.2 Acetone (dimethyl ketone)( $\text{CH}_3\text{COCH}_3$ ) is a compound that dissolves most oils and greases. Mineral spirits and unleaded gasoline can be used as substitutes for acetone.

17.3 **Warning**—The use of flammable or explosive liquids in cleaning operations is dangerous and should be avoided whenever possible.

17.4 After removing as much of the source of the stain as possible, make a poultice, or saturate a white blotter with the solvent, and apply over the remaining stain, covering beyond the stain's limits. Allow the solvent to dry, remove the poultice (if applied) and rinse with water. Repeat if necessary.

17.5 Do not use solvents containing coloring agents or oils. Avoid turpentine, leaded gasoline and kerosene.

## 18. Removal of Paint and Paint Stains

18.1 Paint should be removed only by use of a commercial, "heavy liquid" paint stripper. Such strippers are normally hydroxide types, containing caustic soda or lye. If these products are used, protect face and skin. Rinse with clean water to remove spills.

18.2 **Warning**—Do not use acids or flame tools to strip paint from stone.

18.3 Follow manufacturer's directions for use of commercial products. Flush treated areas profusely with clean water after application. Use only wood or plastic scrapers and stiff natural fiber or jute brushes for removing sludge and curdled paint.

18.4 Normally, latex and acrylic paints will not cause staining. Oil-base paints, linseed oil, putty, and architectural caulks and sealants may cause oily stains. These stains should be attacked as described above.

18.5 When removing paint and paint stains from vertical surfaces, take care to protect unpainted stone from run-off. If oil-based paint is accidentally dripped or overrun, remove immediately with a clean cloth followed at once by wiping with a cloth soaked in acetone or mineral spirits to prevent oil-staining. Latex paint drips should be wiped off or washed away immediately with a damp cloth.

## 19. Keywords

19.1 cleaning; façade; maintenance; natural stone; poultice; stain removal; stains



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