

# Arriscraft.NOTE Series

## Volume 2

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### Introduction

This ARRISCRAFT•NOTE discusses the causes and mechanisms of efflorescence including the possible sources of soluble compounds and moisture needed to dissolve these compounds. The purpose is to provide a rudimentary understanding of efflorescence occurrence.

Efflorescence is a crystalline deposit of water-soluble compounds on the surface of unit masonry. It differs from cryptoflorescence in that it occurs only on the surface of the masonry rather than within the masonry itself.

Although it is unsightly and considered a nuisance to remove, it is not normally harmful.

Efflorescence is usually white in colour. Coloured stains can be produced by acid-soluble vanadium and magnesium compounds in clay masonry, but they do not apply to this discussion of efflorescence.

### Causes of Efflorescence

In the simplest of terms soluble salts in solution are drawn to the surface of the masonry wall where they are deposited upon evaporation of the moisture. These soluble salts can migrate through the pore structure of the mortar of the masonry units, across surfaces of units, or between the masonry units and the mortar.

Certain conditions must exist in order for efflorescence to occur:

- soluble salts must be present within the wall construction;
- a source of water must be present and in contact with the soluble salts for a sufficient period of time to permit them to dissolve; and
- the migration of these salts in solution to the masonry surface where the moisture is allowed to evaporate.

### Sources of Salts

When constructing with masonry, it is certain that soluble salts will be present. They can be found within the masonry units, within ingredients used for the production of mortar, introduced at various stages of the construction phase, or subsequently introduced from exterior sources, such as salt-laden soils and air pollution.

The chemical composition of efflorescent salts is usually alkali hydroxides or sulphates, such as sodium, potassium, and calcium. These may be inherent in the raw materials or formed during material processing. Upon exposure to atmospheric carbon dioxide, these may change to a carbonate form.

Chlorides have also been found to be present, usually as a result of calcium chloride being used as a mortar accelerator, contamination of the masonry materials by

sea water, or the improper use of hydrochloric acids during the cleaning process.

### Sources of Moisture

**Rain Water** and other forms of precipitation are the primary source of moisture for the occurrence of efflorescence. Precipitation in the form of rainwater and melting snow or ice, if allowed to penetrate the wall and remain in contact with the masonry, will be sufficient to dissolve soluble salts within the wall.

**Condensation** is another source of water in walls. This may occur when the humidity and temperature on one side of a wall are greater than on the other, and either no air/vapour barrier has been installed or it has been installed incorrectly. Warm, moist air from the building's interior is allowed to travel through the wall assembly towards the exterior. The air may reach its dew point as it passes through the wall insulation, and the moisture then condenses on the first available colder surface, such as the rear face of masonry units.

**Ground Water** may be considered a source of both salts and moisture in masonry walls. Soluble salts in soil are dissolved by water penetrating the ground; and if the resulting salt-laden moisture is not prevented from being wicked up into the masonry, could saturate the masonry units and the result is efflorescence.

### Reducing Efflorescence Potential

**Careful Selection of Materials** to minimize soluble salts is a prudent first step towards minimizing the potential for efflorescence. It is not considered practical, however, to attempt to preclude all soluble salts from within masonry wall construction.

**Designing Walls to Reduce Moisture** is a more realistic way of minimizing the potential for efflorescence. There are essentially two design considerations which must be addressed to successfully reduce efflorescence-causing moisture within the wall construction:

- prevent sufficiently large quantities of water from penetrating the wall; and
- ensure that any water penetrating the wall is allowed to quickly leave the wall assembly, thus minimizing absorption by the masonry units and the mortar.

Masonry walls designed and constructed to prevent water penetration need to include:

- impervious sills, watertables, caps or copings of sufficient length to minimize the number of joints, properly sloped to direct water away from the masonry, and designed with adequate overhangs and drip mechanisms;

- flashing membranes at parapets, sills, lintels, and any other locations where water may collect;
- dampproof flashing membranes at ground level;
- neatly tooled mortar joints that are compressed to provide a weather-resistant skin;
- caulked joints between masonry and wall openings; and
- caulked joints between individual sill, watertable, and cap or coping units.

Masonry walls designed and constructed to properly drain moisture and encourage drying of the wall system need to include:

- drainage cavity spaces devoid of mortar fins, protrusions or bridges;
- through-wall flashing membranes at the base of all cavities; and
- adequate numbers of weep hole vents located at the same level as the through-wall flashing.

Another beneficial feature may be to include vents at the top of the walls. By incorporating weep hole vents at the bottom of the wall and vents at the top of the wall, this should encourage air to flow through the cavity and this should aid in drying the wall system.

**Construction Practices** can also affect a wall's tendency to effloresce. The following recommendations will help minimize potential problems:

- protect partially completed masonry walls during construction from rain and other elements to ensure the wall is kept dry;
- store masonry units and cementitious materials off the ground, adequately protected from precipitation and ground water;
- store aggregates for mortar off the ground to prevent contamination from dirt, plant life, organic materials and ground water;
- keep mixers, mortar boxes and boards free of contamination; and
- keep tools free of rust, salts, and other contaminants.

### Coatings

Clear water repellent coatings are sometimes recommended to reduce or prevent efflorescence. Their use, however, on a wall which has a tendency to effloresce, without first stopping the mechanisms causing the efflorescence, may lead to more serious damage. We do not recommend the use of water repellent sealers to replace good masonry wall design and construction methods.

### Summary

This ARRISCRAFT•NOTE discusses the causes and mechanisms of efflorescence. Careful selection of materials combined with proper design and construction to minimize water saturation are key to the reduction of efflorescence.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft International architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

The information contained herein must be used in conjunction with good technical judgement and a competent understanding of masonry construction. Final decisions on the use of the information contained in this ARRISCRAFT•NOTE are not within the purview of Arriscraft International and must rest with the project designer or owner, or both. It remains the sole responsibility of the designer to properly design the project, ensure all architectural and engineering principles are properly applied throughout, and ensure that any suggestions made by Arriscraft International are appropriate in the instance and are properly incorporated through the project.

### Related References

1. Brick Industry Association, Technical Notes on Brick Construction 23 (Revised), Efflorescence, Causes and Mechanisms, Part I of II, May 1985 (Reissued February 1997).
2. Brick Industry Association, Technical Notes on Brick Construction 23A (Revised), Efflorescence, Prevention and Control, Part II of II, June 1985 (Reissued January 2000).
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### Introduction

This ARRISCRAFT•NOTE discusses cleaning materials and methods for masonry walls and, more specifically, their relevance to Arriscraft masonry products. These recommendations are appropriate both during building commissioning and throughout the building's life cycle.

The first step in assuring an aesthetically-pleasing wall surface is to keep the masonry clean during its construction. Careful laying of the masonry materials combined with on-site protective measures and the progressive removal of hardened mortar will make post-construction cleaning a simple task.

It is understood that even the most beautifully designed and constructed wall can be irreparably damaged if not properly cleaned. There are many factors which must first be considered to determine the appropriate materials and methods before actual cleaning operations can commence.

It is always recommended that prior to the start of any cleaning operation the masonry manufacturer should be contacted to ensure the proposed cleaning method will not have an adverse effect on the appearance of the wall.

### Factors Affecting Cleaning Choices

The science of cleaning masonry units depends upon striking a successful balance between removing the undesirable material and not harming the substrate. Before undertaking masonry cleaning projects, it is important to recognize the sensitivities of the substrate and to identify the nature of the substances being removed.

Methods for the removal of stains must also be taken into consideration relative to the cleaning materials being proposed. All cleaning methods are not equally efficient with different cleaners. Thus, the nature of the stain will dictate the cleaning method required.

The nature of the substrate will play a major part in determining the appropriate combination of materials and methods. Many manufactured masonry products, including Arriscraft masonry units, are classified as acid-sensitive. When contacted by acidic solutions, their colour will change and surface etching may occur.

### Failure to Clean and Cleaning Failures

*Failure to Clean:* Defining "clean" is an essential step during the cleaning process in order to determine the success or failure of the cleaning operation. Many stains may not be totally removed after having been cleaned but rather, may only fade. As well, the appearance of the cleaned substrate may be altered to some extent from its original condition. Because of this, it is important everyone involved agrees ahead of time on a definition of "acceptably cleaned". To do this an inconspicuous patch

of wall of the jobsite mock-up panel should be cleaned using the proposed methods and materials to determine their applicability and the level of clean deemed acceptable.

*Cleaning Failures:* Inconsistent cleaning (resulting from improper or inappropriate cleaning operations) can typically be attributed to four major causes:

- Failure to uniformly pre wet the wall surface prior to the application of a cleaning solution;
- Failure to thoroughly rinse the cleaning solution from the wall's surface once cleaning operations have commenced;
- Failure to use a suitable combination of cleaning materials and methods relative to the substrate's nature; and
- Failure to protect adjacent materials from the effects of the cleaning solution or operation.

### General Cleaning Guidelines

The first step towards achieving clean masonry walls is careful workmanship during the masonry construction. It is advisable to keep the masonry free from mortar smears. We recognize that at times, where jobsite conditions are challenging, this can sometimes prove difficult.

#### *Construction Precautions:*

- Protect the base of the wall from rain-splashed mud and mortar splatter. Use straw, sand, sawdust, pine needles or plastic sheeting spread out on the ground, extending approximately 1 metre (3 ft.) from the wall surface and up the face of the veneer;
  - At the end of each day's work turn any scaffold boards near the wall on their edge to prevent possible precipitation from splashing mortar and dirt directly onto the completed masonry;
  - Cover walls at the end of each work day with protective waterproof coverings to prevent mortar joint wash out and entry of water into the completed masonry;
  - Store masonry products on skids, off the ground and under protective coverings; and
- Prevent excessive mortar droppings by cutting off excess mortar with a trowel as the masonry units are laid. Tool mortar joints when they are "thumbprint" hard. After tooling, any excess mortar and dust should be brushed from the masonry surface using a soft bristle brush. Avoid rubbing or pressing the mortar into the units. Do not attempt any "wet" removal methods such as sponging.

### *Test Cleaning Agents and Methods:*

Before any cleaning operations are permitted to commence, it is essential that the proposed materials and methods are tested. Such testing should be conducted either on a mock-up panel, or if no mock-up panel is available, then on a small, inconspicuous part of the wall area. Sample testing should be conducted under similar environmental conditions as those anticipated for final cleaning operations. Temperature and humidity are the two critical environmental factors which could impact on the appropriateness of the proposed cleaning operations. The test area should be at least 2 m<sup>2</sup> (20 ft<sup>2</sup>.) in size to adequately implement the proposed procedures and solutions; however, larger areas may be necessary to accommodate the needs of different cleaning procedures. The effectiveness of the cleaning operation should be judged by visual inspection of the tested area once it has been allowed to fully dry.

### *Cleaning Preparation:*

Proper wall preparation is essential prior to the commencement of cleaning operations. If required, metal, glass, wood, and other surfaces should be properly masked or otherwise protected to prevent damage.

Regardless of the cleaning method being contemplated, it is essential to pre-wet the masonry surface before applying any type of cleaning solution. Pre-wetting the masonry units will help minimize their absorption of the cleaning agent. It is equally important to keep the units wet during cleaning operations and upon completion to thoroughly rinse any cleaning solution from the wall surface. This must be done in a timely manner to ensure minimal exposure of the masonry to the cleaning agent.

Industry cleaning recommendations vary on whether cleaning operations should commence at the bottom of the wall surface and work their way progressively up or visa versa. In either case, it is imperative to ensure the lower parts of the wall are pre-wetted and remain wetted throughout the entire cleaning and rinsing process. This prevents cleaning agents and residue contained in the rundown from above from penetrating into the pores of the masonry below.

Heat, direct sunlight, warm masonry and drying winds will all affect the drying time and reaction rate of cleaning solutions. It is advisable to always clean areas of wall that are shaded to avoid rapid evaporation of the cleaning solution.

### **Cleaning Methods:**

To achieve the best results when cleaning masonry units it is recommended that the gentlest means possible be used. The strength and intensity of the cleaning procedure should be increased incrementally until the stain is effectively cleaned.

*Dry Brushing:* Dry brushing can be effective in removing loose dust, sand and some types of efflorescence from the

surface of newly constructed masonry. Where care has been taken to limit mortar smears and other sources of staining during construction, dry brushing alone is often adequate.

*Bucket and Brush Cleaning:* Although the most tedious and labour intensive, cleaning with a bucket and brush is also the safest and most effective method of cleaning masonry. Following pre-wetting, apply cleaning agent with a masonry cleaning brush. The brush should then be used to scrub the masonry surfaces vigorously. Focus scrubbing efforts on unit surfaces and not the mortar joint surfaces. Once a section of wall has been cleaned, it should then be thoroughly rinsed of any remaining cleaning solution.

*Pressurized Water:* The application of clean water to the wall surface under a specified amount or pressure, sometimes by the use of pressure gun and nozzle equipment, is a commonly utilized cleaning approach. The Brick Industry Association (BIA), in its Technical Note 20 – Cleaning Brick Masonry, describes three distinct categories of pressurized water cleaning: low, medium and high. Low-pressure is defined as 700-2100 kPa (100 – 300 psi), medium-pressure as 2100- 4850 kPa (300 – 700 psi), and high-pressure as any pressure greater than 4850 kPa (700 psi).

Initial cleaning of masonry using anything greater than low-pressure water is not recommended. Medium-pressure rinsing may be acceptable provided the nozzle spray is fan-shaped or conical and the nozzle is maintained an adequate distance from the face of the masonry. The volume of water is more important than pressure for proper rinsing.

Never apply cleaning chemicals to the masonry surfaces under pressure as this will drive the cleaning agents into the masonry pores. High-pressure methods should be avoided for cleaning manufactured masonry products as it may result in etching of the surface finish of the masonry unit. High-pressure methods may also damage mortar joints.

*Mechanically Applied Abrasives:* include sandblasting, wet sand cleaning, wet aggregate cleaning, and other such methods, wherein an abrasive agent is used to assist with the removal of the stain. Such methods should only be used when all other milder methods of cleaning have been unsuccessful. The effects of such cleaning can be damaging to masonry products, including mortar, and extreme caution must be exercised with their use. Slight modifications in the finished appearance of the masonry are inevitable as they accomplish their cleaning action by removing a very thin layer of material from the face of the masonry. This will expose new material and aggregate in both the masonry units and the mortar which could result in changes in colour and texture.

### **Cleaning Agents:**

Cleaning agents must be selected to tackle the type of stain being cleaned while recognizing the properties and potential sensitivity of the masonry substrate materials. As with cleaning methods, it is recommended that the gentlest possible cleaning agent be utilized.

Plain detergents are commonly available and are not considered high environmental risks. They are generally safe to handle and represent a minimum amount of risk to the masonry. Examples of detergents to use include laundry detergent and tri-sodium phosphate (TSP).

Many types of stains require harsher cleaning agents such as alkaline- and acid- based cleaners, usually in the form of proprietary cleaning products. Most acid-based detergents and proprietary cleaners will alter the colour of the masonry units. Caution must be exercised whenever using such cleaning solutions. If improperly or inconsistently prepared or used, they could result in unsightly streaking of the masonry.

Proper dilution of these chemicals with water is essential to ensure the cleaning solution will not be too harsh for the particular substrate. Proprietary chemicals should always be diluted in accordance with the chemical manufacturer's recommendations for the particular substrate being cleaned. In the case of materials not listed by the chemical manufacturer then the manufacturer of the substrate material should be consulted for its recommendation.

Where buildings incorporate both clay brick and Arriscraft calcium silicate products, care must be taken during the cleaning of the brick to protect the Arriscraft products from inconsistent exposure to strong cleaning solutions. Always utilize the mildest cleaner and dilution that will yield acceptable results. On a building that combines Arriscraft with clay masonry, *if cleaning is commenced early enough*, the same gentle cleaner and dilution that is safe for Arriscraft products should also effectively clean the clay brick masonry.

Repeated applications of the chemical cleaning solution may be necessary and are commonly applied using similar methods to those used when cleaning with low-pressure water. It is possible for cleaning solutions to be driven into the masonry when applied under pressure, thus becoming a potential source for streaking and inconsistent colouration. If the walls are sufficiently pre wetted with clean water prior to the application of the cleaning solution, then the risk of penetration is reduced. It can be expected that this cleaning method will darken or alter the texture of some masonry products and any other acid-sensitive materials allowed to come into contact with the cleaning solution.

The figures below show sample walls of the Renaissance colors with the right half cleaned using EaCo Chem. NMD80 diluted 4:1 as per the manufactures

recommendation. Each of these walls show an estimated color change that may be expected.

### **Cleaning New Masonry**

The need to clean new masonry is inversely proportional to the care and quality of work exercised by the mason during the erection of the walls. Careful workmanship will in most cases limit the extent of necessary cleaning; whereas, sloppy, hurried work will necessitate more extensive cleaning operations.

The extent and nature of the stains will dictate the appropriate materials and methods needed to properly clean the wall.

Certainly, before any cleaning operations are allowed to commence, proposed materials and procedures should be tested. This can usually be accomplished by test-cleaning the jobsite mock-up panel. Refer to the test cleaning criteria discussed as part of the General Cleaning Guidelines.

The following factors should also be considered when cleaning new masonry:

- Schedule cleaning operations no sooner than seven days after the masonry has been completed to allow the mortar to achieve sufficient strength so as not to disturb the masonry during cleaning operations;
- Keeping the first point in mind, schedule cleaning operations relatively soon after wall construction has been completed as mortar smears and splatters that are allowed to remain on the wall surface for extended periods of time (over one month) can cure on the masonry and become difficult to remove; and
- Remove larger mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.

### **Removing Efflorescence**

The removal of efflorescent salts is relatively easy compared to some other types of stains as most forms are water soluble and will generally disappear on their own under normal weathering conditions.

It is usually not advisable to *wash* efflorescence from masonry except in warm, dry weather, since washing introduces considerably more water, which could bring more salts to the surface. However, if immediate removal is required, then salt deposits might be removed by dry brushing with a stiff fibre brush. Heavy accumulation or stubborn deposits may be removed using a chemical cleaning solution but caution with such methods must be used. Such methods should typically only be used with careful supervision by knowledgeable applicators.

There are other types of stains, sometimes improperly identified as efflorescence, which may occur as a result of other factors. Two such stains are commonly known as "Green Stain" (resulting from the presence of vanadium

salts), and “Brown Stain” (resulting from the presence of manganese). These are more commonly found with clay brick and are not a concern when using Arriscraft products.

### Removing Graffiti

Spray paint removal from porous masonry products can prove difficult, but with a combination of removal methods, an acceptable result can be achieved. Generally, removal can be done either *mechanically* or *chemically*.

Mechanical means of removing graffiti include sanding or grinding and sandblasting. Specialty graffiti cleaners that chemically dissolve paints are also available.

A texture change at the unit surface will result with the use of mechanical means of graffiti removal. Sanding can be performed on smooth face material with a rotary or belt sander, taking care not to gouge the unit surface. A 50-grit silicon carbide sandpaper should be used for best results. Sandblasting will also mechanically remove graffiti but its use may necessitate repointing of mortar joints afterwards. For smooth face material, a 30 grit aluminum oxide or comparable silica sand grit at approximately 60 psi applied with a fan-shaped nozzle from a distance of 1½ to 2 feet away is recommended. There are proprietary gentle-blasting removal systems on the market that may also prove successful. A company that offers a self-contained system that can use various blasting media is Tornado ACS, 1-877.550.7188 (www.tornadoacs.com).

Among other manufacturers, Graffiti Solutions, 1-800-891-0091, ProSoCo at 1-800-255-4255 and Diedrich Technologies at 1-800-323-3565 produce cleaners designed to remove paints, etc. from masonry walls.

Each situation may require a different solution depending on the type of material affected, the paint or graffiti material used and the severity. Talk to these manufacturers for their recommendations as to the proper cleaners and methods. In our experience, these cleaners will remove much of the graffiti, but they may also change the colour and texture of the Arriscraft material. Test for the effect on the masonry substrate prior to widespread use.

### Summary

This ARRISCRAFT•NOTE discusses cleaning of unit masonry walls and more specifically cleaning of Arriscraft manufactured masonry products. Care must be taken whenever cleaning masonry walls not to use materials or methods which could potentially harm the masonry. It is always prudent to contact the masonry manufacturer prior to commencing cleaning operations in order to ensure the proposed cleaning methods will not adversely affect the wall.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

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### Related References

1. Brick Industry Association, Technical Notes on Brick Construction 20 (Revised), Cleaning Brick Masonry, November 1990 (Reissued March 2000).
2. Brick Industry Association, Technical Notes on Brick Construction 23A (Revised), Efflorescence, Prevention and Control, Part II of II, June 1985 (Reissued January 2000).
3. Ritchie, T., Cleaning Brickwork, NRCC Canadian Building Digest, April 1978.
4. Weaver, Martin, Cleaning Masonry, Canadian Heritage Magazine, December 1981; pp 39-42.
5. Arriscraft, ARRISCRAFT•CARE, April 2002

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Cambridge Renaissance® Colors



Adobe



Aurora



Birchbark



Carbon



Driftwood



Ironstone



Nutmeg



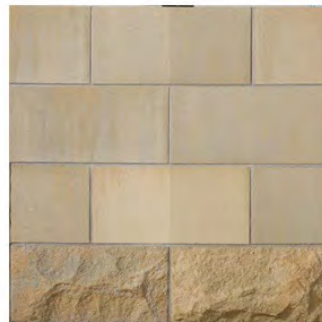
Olive



Ryegrass



Sage



Sandrift



Wheat



White



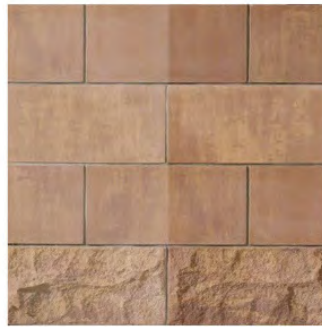
Fort Valley Renaissance® Colors - Satin Finish



Café



Champagne



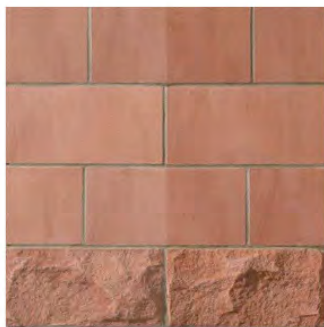
Garnet



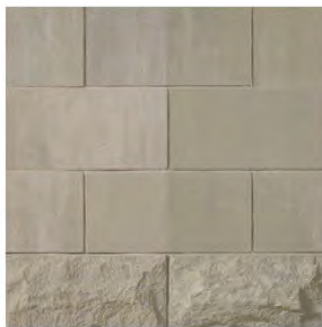
Graphite



Limestone



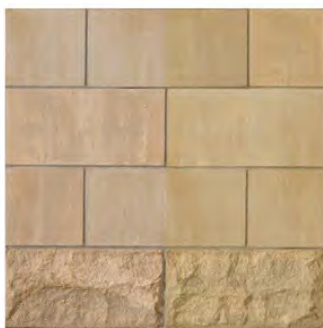
Merlot



Montecito



Suede



Sunset

Fort Valley Renaissance® Colors - Smooth Finish



Café



Champagne



Garnet



Ginger



Graphite



Limestone



Magnolia



Merlot



Montecito



Oak Ridge



Suede



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