Designation: E2841 – 11

Standard Guide for Conducting Inspections of Building Facades for Unsafe Conditions[1]

1. Scope

1.1 This guide is intended to establish procedures and methodologies for conducting inspections of building facades including those that meet inspection criteria for compliance with Practice E2270. For the purposes outlined in this guide, unsafe conditions are hazards which could result from loss of facade materials.

1.2 Investigative techniques discussed may be intrusive, disruptive or destructive. It is the responsibility of the investigator to establish the limitations of use, to anticipate and advise of the destructive nature of some procedures, and to plan for patching and selective reconstruction as necessary.

1.3 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. Establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Awareness of safety and familiarity with safe procedures are particularly important for aboveground operations on the exterior of a building and destructive investigative procedures that typically are associated with the work described in this standard.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E2270 Practice for Periodic Inspection of Building Facades for Unsafe Conditions

E2505 Practice for Industrial Rope Access

2.2 *SEI/ASCE Standards:*[3]

SEI/ASCE 7 Minimum Design Loads for Building and Other Structures

SEI/ASCE 37 Design Loads on Structures During Construction

3. Terminology

3.1 *Definitions*—For definitions of general terms, refer to Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *facade*—a wall system including its exterior and interior components, fenestration, structural components, and components for maintaining the building interior environment (also called *building facade*).

3.2.2 *sheds:*

3.2.2.1 *sidewalk shed*—a shed erected along a sidewalk to protection pedestrians from overhead construction.

3.2.2.2 *light-duty shed*—a sidewalk shed designed to support a live-load of 150 psf and as such not intended for material or debris storage.

3.2.2.3 *heavy-duty shed*—a sidewalk shed designed to support a live-load of 300 psf and may be used for the storage of material or debris subject to weight limitations.

4. Significance and Use

4.1 This guide is intended to provide building professionals with a methodology for conducting periodic condition assessments of building facades, for the purpose of determining if conditions exist in the subject facades that represent hazards to persons or property. It addresses the performance expectations and service history of a facade, the various components of a facade, and the interaction between these components and adjacent construction to provide a stable and reliable enclosure system. This guide was written as a parallel document to Practice E2270. Practice E2270 is written in the imperative form as a Standard Practice and is designed for adoption by specifying authorities. This guide is intended as a dissemination of explicit knowledge gained from experience of conducting periodic facade inspections. Implicit in this guide are

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

[3] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

general facade inspection techniques that have been tailored for periodic inspections. These tips and techniques are shared to provide a comprehensive template from which a facade inspection program can be tailored.

4.1.1 *Qualifications*—Use of this guide requires knowledge of basic physics, construction and building exterior wall design principles and practices.

4.1.2 *Application*—The sequential activities described herein are intended to produce a complete and comprehensive evaluation program, but all activities may not be applicable or necessary for a particular evaluation program. It is the responsibility of the professional using this guide to determine the activities and sequence necessary to perform an appropriate condition assessment for a specific building properly.

4.1.3 *Preliminary Assessment*—A preliminary assessment may indicate that localized conditions in a wall system exist which are limited to a specific element or portion of a wall. The evaluation of causes may likewise be limited in scope, and the procedures recommended herein abridged according to the professional judgment of the investigator. A statement stipulating the limits of the investigation should be included in the report.

4.1.4 *Expectations*—Expectations about the overall effectiveness of a condition assessment program must be reasonable, and in proportion to a defined scope of work and the effort and resources applied to the task. The scope and effort of facade inspections is defined by the purchaser and provider of such services. The objective is to be as comprehensive as possible within a defined scope of work. The methodology in this guide is intended to address the intrinsic behavior of a facade system. Since every location throughout the building facade is not likely to be included in the evaluation program, it is possible that localized conditions of distress may not be identified. Conditions that are localized or unique may remain, and require additional evaluation. The potential results and benefits of the condition assessment program should not be over-represented.

4.2 This guide is not intended for use as listed below. In each instance, more appropriate standards or guides exist.

4.2.1 As a design guide, design check, or a guide specification. Reference to design features of a wall is only for the purpose of identifying items of interest for consideration in the condition assessment process.

4.2.2 As a construction quality control procedure, or as a preconstruction qualification procedure.

4.2.3 As a diagnostic protocol for evaluating buildings for water leakage or other performance related problems.

4.2.4 As a sole evaluation of façade damage arising from natural or manmade event/disasters.

SYSTEMATIC APPROACH TO AN EVALUATION

5. Overview

5.1 The methodology presented in this guide is a systematic approach to evaluating the condition of exterior wall systems and is intended to be applicable to any wall system or material. The basic principles are not intended to be material or component specific. Appendices to this document address material and system specific considerations. The sequence of activities is intended to lead to an accumulation of information in an orderly and efficient manner, so that each step enhances and supplements the information gathered in the preceding step.

5.2 *Sequence of Activities*—The recommended sequence of activities, discussed in individual sections below, are:

5.2.1 Review of available documents,

5.2.2 Evaluation of design concept,

5.2.3 Evaluation of known service history,

5.2.4 Inspection, and

5.2.5 Analysis of findings.

5.3 *Analysis and Interpretation*—The information systematically gathered during a condition assessment is analyzed as it is acquired. The sequential activities described in this guide do not imply that analysis and interpretation of the information occurs only at the completion of all activities or at any specified time(s).

6. Review of Available Documents

6.1 Review available documents which may include original construction drawings, specifications, shop drawings, field reports, test reports, reference codes/standards, and previous facade assessment reports. Documents representing local trade practices as published by local trade groups may also exist.

6.2 *Design, Bidding, and Contract Documents*—These documents include architectural and engineering drawings, specifications, and may also include calculations, wind tunnel reports, correspondence, meeting minutes, addenda, substitution proposals, product literature, test reports, etc. They contain the information necessary to understand the performance criteria, the design intent, the required materials, and relationships among wall components according to the original design.

6.2.1 Documents may be revised or supplemented over the course of construction. Revisions to drawings are typically recorded by number and date, with a cross reference to other accompanying documents. Reviewing all revisions and issuances of the documents, and understanding the differences between them and the reason for the differences, is part of a comprehensive evaluation.

6.2.2 Documents with the most recent issue date and the highest revision number establish the final design requirements for the project. Ideally, a set of documents marked "as-built" or "record set" intended to show the actual construction will be available.

6.3 *Referenced Codes and Standards*—Project documents usually contain references to regulatory codes and industry standards. Standards and referenced codes often contain default or minimum criteria that might have been relied upon to establish the performance criteria for the facade. Conflicting requirements between referenced standards and codes, and those explicitly stated in the project documents, should not be assumed to be a cause of distress within a facade without further investigation.

6.3.1 Regulatory codes and industry standards change over time. The version of regulatory codes and industry standards examined as part of the review of project documents should be those listed with dates in the project documents, or if not listed with dates, those in effect when the building permit was issued. Understanding the history and background of referenced codes and standards is part of a comprehensive evaluation.

6.4 *Submittals*—Additional documents are generally generated after the award of contracts, and are submitted to the design professional for review and inclusion in the project record. The submittals usually apply to a specific material, component, assembly or installation method, and the information contained will augment the background review. There are often a number of revisions to submittals prior to final approval. The standard for the project is set by the submittals approved by the design professional. Submittals include some or all of the following: shop drawings, test reports, product literature, manufacturers' recommendations, installation and maintenance guidelines, warranties, etc.

6.4.1 Test reports provided by manufacturers and suppliers should have been performed by an independent laboratory or witnessed by an independent agency. Review the test dates and the description of what was tested to determine if and how the information actually applies to the project.

6.4.2 Manufacturers' and suppliers' information, and the exclusionary language in warranties, may suggest circumstances under which a component may not function properly. Project conditions should be evaluated to determine if an appropriate product selection was made.

6.4.3 Submittals should be reviewed for maintenance recommendations and guidelines.

6.5 *Pre-Qualification: Laboratory Mock-Up and Onsite Mock-Up Reports*—Compliance with project requirements may have been demonstrated by a lab mock-up test. Mock-ups of complex facades rarely pass all tests on the first attempt. The mock-up report should contain a clear and complete description of changes made to pass the test. Project documents should incorporate these changes, and they should be reflected in the actual construction. Failure to incorporate changes should be considered as a potential causes of distress.

6.6 *Additional Construction, Field Inspections, and Field Testing Documents*—Additional construction documents which record changes, decisions and activities during the construction phase may include bulletins, requests for information (RFI), clarifications, change orders, directives, progress photos, field inspection reports, testing documentation and quality assurance reports, test reports, meeting minutes, and correspondence. The information in these documents may augment, modify, or supersede the design documents.

6.7 *Previous Facade Assessment Reports*—Some buildings may have been previously inspected in which case such reports should be reviewed.

6.8 *Local Workmanship Practices*—Knowledge of local and historical practices will permit a more thorough assessment of the project design and construction. The actual construction may be influenced in an undocumented manner by local practices.

6.9 *Missing Documents/Verification of Existing Documents*—Every reasonable effort should be made to verify existing as-built conditions regardless of the quantity or quality of existing documents.

6.10 *Understanding the Information Gathered:*

6.10.1 Reviewing the project documents should lead to a fundamental understanding of the constructed facades. Knowledge gained from reviewing the available documents should be utilized during subsequent tasks.

6.10.2 Where possible, utilize existing building elevation drawings or elevation/detail photographs to document related information for subsequent tasks.

7. Evaluation of Design Concept

7.1 *Performance Criteria*—Review of the available documents should reveal what performance requirements were specified for the wall and how the wall as an assembly and its individual components are structured. Alternatively, the requirements may have been implied through references to industry standards or local codes.

7.2 *Efficacy of the Design*—The facade design should be consistent with the performance criteria so that the desired performance can be achieved. The design should include properly selected components. The details should provide for the interfacing and integration of components so that each one can perform both individually and collectively as a system. The details should also address issues such as construction tolerances, material compatibilities, volume changes, and differential movement of the frame and the facade. A careful evaluation of the efficacy of the design relative to the performance criteria will indicate inconsistencies that may contribute to distress or failure of facade components.

7.2.1 The failure of a single facade component to perform at the specified level does not automatically mean that it was the cause of distress. In evaluating the overall wall, it should not be assumed that the cause of functional or physical distress is a single component simply because it does not satisfy stated or published performance requirements.

7.3 *Exposure*—The performance criteria in the project documents may have assumed exposure conditions that differ from actual exposure conditions of a subject building. Based on an analysis of local weather conditions, and the location and geometry of the building, identify the service conditions from the actual exposure. These conditions can be correlated with the service history, described in the next section, to help establish a protocol for the evaluation process.

7.4 *Understanding Design Intent*—Reviewing the design concept should lead to a fundamental understanding of the intended performance of the constructed facades. Knowledge gained from understanding the design intent should be utilized during subsequent tasks.

8. Determination of Service History

8.1 Gathering information on the service history serves several purposes. First, patterns in the observed behavior and visible damage can provide an indication of the cause(s) of behavior or damage, or both, and where to focus an investigation. Second, and more importantly, the information provides a checklist against which failure theories and conclusions can be evaluated.

8.2 *Interviews*—Interview occupants, maintenance personnel, subcontractors, tradesmen or other first-hand observers. Obtain information which will help correlate distress with building features and other events, such as:

8.2.1 Water leakage,

8.2.2 Unusual noise,

8.2.3 Condensation,

8.2.4 Glass breakage,

8.2.5 Dislocation or failure of wall components,

8.2.6 Thermal movements,

8.2.7 Moisture related expansion/contraction,

8.2.8 Cracking or spalling of components, and

8.2.9 Air infiltration or exfiltration.

8.3 *Maintenance, Repair, and Alteration Records*—Buildings with chronic facade problems are often subjected to several attempts at remediation before a comprehensive evaluation is made. An effort should be made to understand the earlier attempts at repairs because: (*1*) they may indicate a pattern of behavior, such as water leakage; (*2*) although well intended, repairs may be causing or contributing to continuing distress; and (*3*) it will be helpful to distinguish between original construction and attempted repairs during the inspection phases of a systematic evaluation. Where appropriate and possible:

8.3.1 Review the original, maintenance, repair, alteration, or a combination thereof, project closeout comments or "punch list" if available. Problems may occur early in the life of a building, and stop-gap repairs might have been made in an effort to close out the project.

8.3.2 Review purchase orders or contracts, or both, for building maintenance and repair. Consider roofing, caulking and sealants, pointing, painting, waterproofing, removing efflorescence or staining, and other activities that may relate to distress.

8.3.3 Review maintenance work orders which deal with recurring issues with the same performance problem.

8.3.4 Evaluate the performance of previous repair attempts.

8.3.5 Compare original details to actual conditions observed to determine deviations from original design intent or undocumented repair attempts.

8.3.6 Identify repairs or alterations that might have inadvertently sealed weep holes or other openings and paths intended to dissipate water. These might have been sealed in an attempt to stop leaks, and could exacerbate distress of internal and external wall components.

8.3.7 Evaluate the effect of attempted repairs on the original design intent. Common, but often ineffective, repairs made in response to water leaks in walls include the application of sealant and coating of exterior surfaces with clear water repellents or elastomeric coatings. Inappropriate use of these procedures can cause distress of components, such as:

8.3.7.1 Sealant installed at drainage paths which entrap water within the facade. The application of additional sealant should not be made prior to evaluation of the total facade except to correct obvious omissions. Entrapped water can lead to freeze/thaw damage, corrosion of internal and external components, and deterioration of water sensitive components.

8.3.7.2 Water repellents can affect the performances of future repairs, such as the adhesion of sealants or the bond of repointing mortar. These materials can also reduce the water vapor transmission rate of a wall assembly, affecting the weatherability of some materials.

8.3.7.3 Low permeance coatings will reduce the water vapor transmission rate of the facade and can increase the time required for water-saturated facades to dry. The application of these materials can increase the amount of entrapped water if other deficiencies exist.

8.4 Determine extent of known historic distress - Use the information gained above to determine the extent of known historic distress in the facade and indications of performance problems.

8.4.1 Attempt to correlate documented distress with specific building features and details.

8.4.2 A graphical analysis is useful for correlation studies. Distress and leakage occurrences can be superimposed on building elevation and plan drawings to help reveal patterns that might be traceable to specific types of details or component failures.

8.5 *Correlations*—Correlate known distress with other factors such as temperature and exposure.

8.5.1 *Temperature*—Ambient air temperature and wall surface temperature can greatly affect observed distress. Building joints (control and expansion) and cracks in facade materials are most likely at their widest when ambient temperatures are low, and their narrowest when surface temperatures are high.

8.6 *Understanding Service History*—Determining the service history should lead to a fundamental understanding of the past performance of the facade. Documented, relative information gathered and knowledge gained from determining the service history should be utilized during subsequent tasks.

9. Inspection

9.1 Inspections complement and extend the information gathered from the review of project documents and the service history. The major objectives of an inspection program are: to determine as-built conditions, determine the current condition of the wall including both visible and concealed component damage, and to formulate initial hypotheses about cause.

9.2 *Determine As-Built Conditions* —The various components of the facade, including the structural support system, thermal and condensation control systems, sealants, water control systems and connectors should all work together to provide the desired facade performance. Project drawings rarely depict the relationships among all of these components of a facade completely and accurately. The inspection process should result in a clear understanding of the relationships among all the parts of a facade.

9.2.1 *Presentation*—Composite large-scale drawings are helpful in gathering and recording information about as-built conditions. A composite drawing can begin with the best available information from the project documents, including pertinent information from the architectural and structural drawings and specifications, as well as the structural and wall component shop drawings. The investigator must correlate information from these sources based on some reference such as the column centerlines or face-of-wall dimensions. The composite drawing can serve as a form for recording actual field conditions. Differences between information in the project documents and the as-built conditions should be anticipated, and discovery of differences does not necessarily mean that a distress condition has been identified. The purpose of accurately determining the as-built condition is to provide a rational basis for further inspection, testing, analysis and formulating remedial recommendations.

9.3 *Determine Support Mechanisms*— Utilize the inspections to determine and confirm if components are supported as designed and if not, then determine how they are supported. A facade component not supported as intended may or may not be the cause of distress. Further investigation will be required. If distress is not present, then investigation into unintended support mechanisms should still be performed to understand how the component is supported.

9.4 *Determine Current Conditions* —The physical condition of facade components, including cracks, spalls, component dislocation, visible and concealed evidence of corrosion, expansion/contraction, unanticipated movement, and water penetration, should be documented during the inspection process. This information is later correlated with information from the service history of the wall in formulating a hypothesis on the cause(s) of observed distress. Examples of information which should be documented include:

9.4.1 Placement, condition, and resilience of sealants and gaskets.

9.4.2 Functional aspects of water control systems: such as end dams, weeps, lap and splice configurations, placement of the flashing relative to other components, and obstructions.

9.4.3 Interfaces between wall components. Critical interfaces include the integration of walls and windows; locations where facade materials or support conditions change, and where prefabricated units of the facade are joined.

9.4.4 Interface with other building components, such as copings, penetrations by mechanical equipment or structural supports, expansion control joints, and foundations.

9.4.5 Facade attachments and appurtenances such as signs and canopies, balconies, and handrails.

9.4.6 Possible mechanisms for water entry into a facade or migration within a facade.

9.4.7 Material conditions, including symptoms of deterioration, freeze-thaw damage, prolonged saturation, delaminations, adhesive or cohesive material failures, efflorescence and water-related damage to finishes.

9.4.8 Indications of displacement of facade materials or components, wear and tear, maintenance, attempted repairs, damage from non-weather-related causes such as impacts, un-accommodated volume changes, or structural movements.

9.4.9 Possible mechanisms contributing to unanticipated/uncontrolled condensation within the wall, such as air infiltration and inadequate or improperly located thermal breaks, or both.

9.5 *Determine Water Movement Paths*—Inspection may produce information on water paths resulting from the service conditions of the building.

9.6 *Performing Inspections*—Conducting inspections in a planned and orderly fashion is the most efficient and effective way to produce useful results. Planning is also necessary when concurrent sampling and testing are incorporated in the inspection program. The inspection plan should addresses the following issues:

9.6.1 *Scope*—Both typical and atypical conditions should be included. It is particularly important to include the terminations and interfaces of the components being inspected, such as corners, ends, tops, bottoms, joints, transitions to other materials, or changes in geometry. The inspection should also include both non-performing and properly performing locations, if they exist. The differences between non-performing and properly performing locations can provide useful information about the cause(s) of distress. The objective of the inspection program is to acquire information about the intrinsic properties of the facade so that conclusions reached are applicable to all similar locations in the facade. A sufficient number of inspection locations must be selected to accomplish this objective. If constraints on the inspection program preclude a sufficient number of locations, the results should be so qualified.

9.6.2 *Selection*—It may not be necessary to inspect an entire facade. The scope should be established with particular consideration for the system type, and exposure. The selection of specific inspection areas should include consideration of the service history, and review of project documents. Limitations of resources will often require the selection of inspection areas from seemingly equal choices. A preliminary inspection using rapid methods of limited detail can help in the rational selection of areas where more detailed methods are warranted.

9.6.3 *Access*—Both interior and exterior access for close-up inspection should be prearranged with the building Owner. Interior access is generally required, and may necessitate moving furniture, removing interior finish materials, or relocating or suspending the use of a space, and might have a significant temporary impact on use of the space. Exterior access will usually require the assistance of a contractor to erect scaffolding and walkway protection, provide an aerial lift, rig a swing stage, or provide industrial rope access pursuant to Practice E2505. Possible damage to the building resulting from the access equipment should also be considered, and either avoided or corrected. Safety issues relating to providing appropriate fall protection during the performance of the inspection and protecting the public way must be considered and the necessary precautions taken.

9.6.4 *Organizing Information*—A comprehensive inspection program will generate a large amount of data. Determining how the information will be recorded and organized is part of the planning process. Building drawings can be made beforehand and used to record observations, thereby making the location of the information self-evident. Symbols and shorthand notations can be developed and tabulated beforehand. It is sometimes useful to establish a numbering system based on column lines, swing stage drops, floor number, wall component within a typical module, etc., rather than repeating lengthy location identifications using words.

9.7 *Methods*—Inspection methods range from visual inspections using a binocular or a telescope, to close-up observations and inspection openings. The method used depends on the information required. Visual inspections via binoculars are particularly useful for preliminary inspections and to narrow the scope of more detailed inspections. A comprehensive inspection program will include some method for observing or evaluating concealed conditions, such as inspection openings, borescope probes, moisture meters, and sounding. Inspectors should be mindful of knowledge gained from review of the project documents, evaluation of design concept, and determination of service history when performing inspections.

9.7.1 Inspection openings involve the progressive removal of wall materials to reveal underlying, concealed conditions. Each layer may be changed or destroyed during the process, so it is desirable for the investigator to be present during the operation and to document each step. Safety issues such as the presence of asbestos, lead paint and toxins should be considered and the necessary precautions taken.

9.7.2 An inspection mirror with an adjustable head and a flashlight are useful tools for viewing concealed conditions through confined openings in much the same way that a dentist uses a mirror.

9.7.3 A fiber-optic borescope makes it possible to observe and photograph concealed conditions while making only a small diameter hole in the outer layers of a wall. It is most useful where there is an empty cavity space in the facade so the light from the scope can disperse, and the field of view can be targeted to items of interest.

9.7.4 Commercially available moisture detectors make it possible to estimate the moisture content of concealed facade materials. High moisture content can indicate proximity to a water entry point or location along a water migration path. Plotting the meter's readings on a grid superimposed on a building drawing can provide a diagram of moisture migration. Care must be taken in interpreting the absolute diagram of moisture migration resulting from leaks or condensation, or both, and in interpreting the absolute values of readings reported by these instruments, since calibration and operating technique can affect the readings.

9.7.5 Indentation resistance provides an indication of the extent of deterioration caused by prolonged exposure to water, for materials such as wood or gypsum board products. The resistance to penetration decreases as deterioration of these materials increase. Any sharp object, such as a awl, ice pick or nail can be used. Some commercially available devices have a calibrated spring that produces a consistent force at the tip of the penetrator.

9.7.6 Infrared thermography produces an image that, with proper interpretation, can indicate conditions such as air movements through a facade, concealed water within the wall, missing thermal insulation, and saturated facade materials. Infrared thermography should be performed and interpreted with the assistance of a specialist knowledgeable in the technology.

9.7.7 Sounding existing surfaces by lightly tapping with acrylic hammers provide audible feedback that can inform a listener to potential problems below the surface of the material.

9.8 *Documentation*—Inspection findings should be recorded in writing, with clarifying sketches where appropriate. The documentation should be supplemented with photographs or video, or both, and notes, but these should not normally be relied upon as the sole record of the inspection process because of the risk of deletion, equipment malfunction, or processing errors.

9.8.1 Written documentation should be complete enough for the evaluation process to be repeated, as well as for the information gathered to be interpreted in determining the cause(s) of distress. In addition to carefully recording observations, the following should be considered in making the written documentation:

9.8.1.1 The location of the observation should be clearly defined. References to column lines and floors (or stories) can be used.

9.8.1.2 Preliminary opinions formed and interpretations made during the inspection should be recorded separately from the inspection notes, and be distinct from observations of fact and measurements.

9.8.1.3 Keys for codified shorthand notations and symbols should be given. Undefined cryptic shorthand should be avoided.

9.8.1.4 If the procedure used is not self-evident, it should be described in detail.

9.8.1.5 The sequence of the inspection process should be clear from the written documentation.

9.8.1.6 The date and name of the person(s) making the observation, should be recorded for each data sheet.

9.8.2 Supplementary photographs and video are useful for informing others of the inspection procedures and observations. They provide an opportunity to evaluate and compare multiple physical observations of the facade inspection. They can be most useful in defining systemic issues that appear isolated. They may also assist in the repair detailing for specific locations and issues. In making photographs or video recordings, the following should be considered:

9.8.2.1 It should be possible to orient the pictures. This may require a progression of photos from wide to narrow view, or zooming from wide to narrow view with a video camera. Including something of known size in a photograph will help viewers determine the size of the object of interest. For example, a person or a piece of equipment such as a pocketknife can be used. For a more accurate reference, a ruler or an extended length of a carpenter's tape can be included in the picture.

9.8.2.2 The location of a picture should be identified. Labels in the picture, or markings directly on the wall, are useful for this purpose.

9.8.2.3 If the object of interest in a photograph is a crack or a split, it is helpful to add a pointer to focus attention, or to insert a tool in the crack. Cracks with low contrast do not photograph well, and enhancing the path of a crack by drawing a line next to it in a contrasting color can also be helpful. It is also sometimes helpful to intentionally cast a shadow over a small or faint object of interest to adjust the contrast of a photograph to show planar displacements.

9.8.2.4 Automatically recording a sequential number or the time and date on the film, or including the time and date in the photo label, may be helpful in organizing the pictures.

10. Analysis

10.1 The information accumulated in a condition assessment is analyzed as it is acquired. The information may motivate a change in approach or focus for subsequent steps in the evaluation process.

10.2 The evaluator should establish a cause-and-effect relationship between facade characteristics and observed distress. This requires an appropriate selection of activities and a logical analysis and interpretation of the acquired information. The analysis will address issues such as:

10.2.1 Reduction of quantitative data.

10.2.2 Resolution of conflicting data and observations.

10.2.3 Patterns and commonalities in the data and observations.

10.2.4 Identification and explanation of anomalies.

10.2.5 Correlation with known wall performance.

10.2.6 Significance of an observation or measurement, and its relevance to the behavior of the entire facade.

10.2.7 Corroboration between various procedures used.

10.3 The conclusions and findings from an evaluation should be based on the activities and procedures undertaken and the information acquired, if they are to be considered legitimate and substantiated.

10.4 The record should be sufficiently complete so that any interested party can duplicate the evaluation program, acquire similar information, and reach similar conclusions. Notes on the analysis and interpretation of the acquired information should be clear and complete enough to be understood by any other building professional skilled in condition assessment.

ANNEX

(Mandatory Information)

A1. BACKGROUND

A1.1 Consequences of Unsafe Conditions

A1.1.1 A distressed condition on a building facade that appears ready to fall (imminent failure) is what is generally identified as an Unsafe Condition. Unsafe conditions are potential hazards that can result in loss of property, injury, and possibly death. Their consequences are self-evident to the building professional most of the time. However, such conditions are not always unsafe, in the general sense of the word. For example, if the landing zone of falling debris can be made inaccessible, then potential damage from falling debris is minimal. This also assumes that the loss of facade material does not undermine the stability of the facade. In essence, the risk of Unsafe Conditions needs to be assessed to consider the consequences of a possible failure (that is, a falling component or material) and to realize appropriate mitigation.

A1.2 Mitigation of Unsafe Conditions

A1.2.1 Mitigation is the act of temporarily repairing or addressing an Unsafe Condition. The purpose of a mitigation measure is limited to changing an Unsafe Condition into a condition that is temporarily safe. The temporary repair will not necessarily meet other desirable goals, such as aesthetics or durability.

A1.2.2 Such "emergency" (short-term) measures are meant to address safety deficiencies in a building facade. These deficiencies generally consist of a facade component being unable to reliably resist its own gravity loading (weight, which is in a vertical direction) or wind loading (often in a horizontal direction), or both. Other loadings (for example, ice, thermal movement) may also apply. In the absence of a specific Code-requirement for a temporary condition, judgments will typically be needed about what magnitude of reduction in load capacity (reduced safety factor against falling) constitutes a basis to classify a condition as safe or unsafe.

A1.2.3 A value of wind pressure (both for determining if a condition is unsafe and for design of temporary repairs) may be needed. SEI/ASCE 7 may be used for determining wind speed for a shorter recurrence interval (for example, 5 years, or other longer period deemed appropriate). SEI/ASCE 37 is a useful reference for determining design wind speed for a temporary condition with a duration of months, versus years.

A1.2.4 The concepts presented herein are meant as a starting point for consideration by persons that may be involved in the process of implementing temporary repairs. Other concepts may also be appropriate.

A1.2.5 Many of the concepts require selection of member materials, sizes, shapes and thicknesses in order to determine a complete design of a temporary repair for a particular situation. Local experience in repair activities may also be needed to finalize details of a particular temporary repair.

NOTE A1.1—Most local jurisdictions require a registered architect or professional engineer to perform the services listed below.

A1.2.6 Temporary repair measures for "Unsafe Conditions" include (but are not restricted to):

A1.2.6.1 *Removal of a "Loose" Item*—An insecure portion or element of a facade may be removed, temporarily or permanently, to eliminate a falling hazard. In some cases, it may be worthwhile to store the item so as to retain the option of re-installation if appropriate permanent repairs are made at a later time. After removal of such a facade component, a temporary closure (for example, reinforced plastic, plywood, etc.) may be required to reduce or eliminate penetration of rain water.

A1.2.6.2 *Sidewalk Shed*—Sidewalk sheds consist of posts, beams, horizontal panels and vertical retainer panels (to prevent falling items from bouncing off the horizontal panels after impact) to form a "roof" over a sidewalk or other area where people may pass or congregate. The shed is intended to allow safe passage in the event of falling pieces from a facade. Shed strength and energy absorption ability should be appropriate for the situation. A light-duty shed could be acceptable for a relatively low building with a glass-and-metal facade. A heavy-duty shed would likely be needed if the unsafe portion of a glass-and-metal facade was relatively high above the surface to be protected, or if any masonry portion of a facade (high-rise or low-rise) is in an Unsafe Condition. Energy absorbing features that may be considered include: aluminum or wood beams (versus steel beams); longer-than-usual spans; layer(s) of foam insulation board together with plywood layer(s); safety netting (coarse or fine, or both, depending on the nature of the deficient facade component). Sidewalk sheds are typically regulated by local authorities or may be prescribed in the local building code.

A1.2.6.3 *Closely-Placed Netting (Mesh)*—Where feasible, to avoid the need to resist large forces due to large falling distances, consideration may be given to installing a net close to and below the deficient area. This requires some means to hold the net (for example, stand-offs or cables, or both, to higher supports).

A1.2.6.4 *Cables or Straps to Secure Deficient Panels, Projecting Features or Parapets, or Both*—It may be feasible to run steel cables, or nylon straps, across a panel or projection. The cables/straps may then be routed through adjacent windows and secured behind sound portions of wall framing. Alternatively, it may be practical to attach the cables/straps to an exterior, secure part of the facade or building frame. In some situations, cables/straps may be used together with vertical flexural members (for example, wood timbers) to secure deficient panels.

A1.2.6.5 *Special Anchors (Proprietary Types) For Repair of Masonry Panels or Stone Units*—Anchor installation requires drilling through the exterior face of a panel and then into the back-up panel or framing. The anchors can be used to secure portions of a cracked panel or unit. This category of anchors may also be useful if panel/unit is intact but existing anchors are deficient. In some cases, this type of repair may also be part of a permanent repair.

A1.2.6.6 *Exterior Framing, Plus Anchors, to Secure Deficient Panels, Projecting Elements or Parapets, or Both*—Wood, steel or aluminum framing plus anchoring devices may be used to attach to sound, adequate structure (behind, above, below, left, or right, or a combination thereof, of deficient facade item).

A1.2.6.7 *Straps or Cables, or Both, Plus Netting or Fiber-Reinforced Plastic Sheet, or Both, to Secure a Projection With "Small" Loose Pieces*—Attach netting/sheet and straps/cables to adequate structure or sound facade, or both, to restrain distressed material or components.