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Knowledge-Based Condition Assessment Reference Manual for Building Component-Sections

For Use with BUILDER™ and BuilderRED™ (v. 3 series)

Donald R. Uzarski, Michael N. Grussing, and Brenda B. Mehnert

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Construction Engineering Research Laboratory
U.S. Army Engineer Research and Development Center
2902 Newmark Drive
Champaign, IL 61822

Final report

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Under P2 Project #468106, "Study for Sustainment Management System (SMS) Real Property Asset Inspection Applications"

Abstract

The BUILDER™ Sustainment Management System (SMS) is a life-cycle asset management software application developed by the Engineer Research and Development Center-Construction Engineering Research Laboratory. The Department of Defense (DoD) uses BUILDER SMS to conduct facility condition assessments, identify work requirements, and report on facility conditions. In this way, it provides a consistent baseline for condition assessment across all DoD services and locations. The BUILDER system generates a multi-year work plan with recommendations for component-level repair/replacement activities that not only assists current year tactical-level facility planning, but it also aids long-range facility investment strategic planning.

To accurately and consistently measure facility conditions, a standardized inspection process is necessary. This manual describes the procedures for performing Condition Survey Inspections for building-related component infrastructure when using the BUILDER SMS. The resulting condition surveys, while they are not detailed engineering assessments or specialized inspections, do satisfy the requirements necessary for routine building management activities including the long-range budgeting and the sustainment, restoration, and modernization (SRM) program planning needed to keep DoD facilities in good working order.

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Preface

This work was conducted for the Office of the Assistant Secretary of Defense for Energy, Installations and Environment, Facilities Investment and Management (OASD EI&E-FIM) under P2 Project #468106, "Study for Sustainment Management System (SMS) Real Property Asset Inspection Applications." The technical monitor was Robert Lange, OASD (EI&E FIM).

The work was performed by the Engineering Processes Branch of the Facilities Division (CEERD-CFN) at the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Charles G. Schroeder was Chief, CEERD-CFN; Donald K. Hicks was Chief, CEERD-CF; and Kurt Kinnevan, CEERD-CZT, was the associated technical director. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti, and the Director was Dr. Lance D. Hansen.

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In addition to the authors, CERL researchers who have contributed to the BUILDER assessment methodology include: Lance Marrano, Dave Bailey, Sam Hunter, Steve Sweeney, Doug Ellsworth, Don Kermath, Mike McInerney, Orange Marshall, Richard Harris, Bruce Rives, Buddy Bartels, Matthew Walters, Bil Hawkins, Sam Vance, Clint Wilson, and Jackie Mathis. CERL research assistants for this effort include: Laurence Burley, John Borland, Makesha Bradford, Robert Butler, Na'ilah Kituku, Heather Lawson, Ryan Smith, Jason Schneider, Nicholas Byrnes, Virgean Jenkens, Steven Kibbler, Elizabeth Rutherford, Philip Weightman, Charles Wittleder, James Field, Richard Drodz, Teresa Pin, William Murphy, and Richard Humphries.

External contributors include the following: Don Brotherson, consulting architect; Audrey Fisher, Pertan Consulting; David Wickersheimer and Dr.

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The Commander of ERDC was COL Ivan P. Beckman, and the Director was Dr. David W. Pittman.

Unit Conversion Factors

Multiply	By	To Obtain
feet	0.3048	meters
inches	0.0254	meters
square feet	0.09290304	square meters

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1 Introduction

The BUILDER™ Sustainment Management System (SMS) is a web-based software application developed by the Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) to help building technicians, facility managers, and decision makers decide when, where, and how to best maintain and repair building facilities. BUILDER employs a condition-based approach to facility management, meaning that work activities for buildings are recommended based on the actual observed or expected condition state of the assets, instead of discrete deficiencies or age-based models. Central to the condition-based approach is a Condition Index (CI) metric, which measures the accumulated damage and deterioration of a building, system, or component on a 0–100 scale. In BUILDER, the CI is ultimately based on the observations from a standardized inspection process. In order to ensure consistency and repeatability, inspection guidelines have been established. This report contains the procedures, best practices, and condition-based inspection considerations to be used when conducting a BUILDER condition assessment.

1.1 Background

The Department of Defense (DoD) and many other federal agencies use BUILDER SMS to conduct facility condition assessments, identify work requirements, and report on the condition of their facilities. The primary reason for its use is to provide a consistent baseline for condition assessment across all facilities and locations in an organization's real property portfolio. The SMS methodology is a structured process for collecting, synthesizing, and organizing information about civil infrastructure and facility assets to support decisions pertaining to their sustainment over their life cycle. For each building in a real property portfolio, BUILDER supports the creation and management of a component-level asset register, which breaks down the building into its primary elements of constructed and installed assemblies. Each component element is categorized using a standardized classification system which organizes the wide array of components in a building into major systems, subsystems, and other classes based on similar behaviors.

The current observed condition of each component is then assessed by a trained inspector using a structured assessment methodology which identifies any adverse effects causing condition loss and results in a CI metric that measures each component's condition loss. The goal is to consistently and objectively translate defects and distress mechanisms observed during the inspection into a quantitative CI score, which can be tracked over the life cycle of each component.

The BUILDER system uses this information to help communicate the condition of the components, systems, and buildings in a large portfolio of real property facilities, as well as to forecast changes in that condition over time. The BUILDER system generates a multi-year work plan with recommendations for component-level repair/replacement looking several years into the future; the work plan not only assists current year tactical-level facility planning, but also it aids long-range facility investment strategic planning. In addition, the system can evaluate a wide range of scenarios by using different condition standards, organizational priorities, and budgetary levels; those evaluations can help decision makers understand the consequence of different facility-related policies.

1.2 Objective

To accurately and consistently measure condition, a standardized inspection process is necessary. This manual describes the procedures for performing Condition Survey Inspections for building-related component infrastructure using the BUILDER SMS. By employing these procedures, organizations should expect consistent and repeatable CI values reflective of the current physical condition of the components of their building facilities.

1.3 Approach

The concept of condition is not easily quantifiable in the same way that explicit physical properties such as length, area, and volume are measured. In order to measure condition, the quantitative CI scale is broken into numerical ranges, with each range defined by qualitative descriptors that relate to levels of accumulated condition loss. The science and considerable research in the CI approach is in creating the link from the physical observations that can be made during an inspection process to this condition scale.

BUILDER uses two types of observations when assessing the condition of a building component. The first type of observation is a direct condition rating, which relates the general observed condition to the closest descriptor on the CI scale. The other type of observation is called a distress, which is a mode of deterioration that adversely affects condition and can indicate potential failure modes for an asset. Each distress has a specific definition and visual cues that must exist. In addition, each distress has one of more levels of severity, which indicates how it affects an assets operational, mission, and life safety capabilities.

To support the consistent and repeatable assessment of condition, the direct condition rating guidelines and distresses need to be defined as precisely as possible. Those detailed guidelines and definitions are provided in this report, thus allowing a trained building technician who is using these procedures to accurately observe and record the conditions present when the technician is inspecting a component.

1.4 Scope

These condition surveys are not detailed engineering assessments or specialized inspections, but they do satisfy the requirements necessary for routine building management activities including long-range budgeting and sustainment, restoration, and modernization (SRM) planning. This building assessment process provides an objective and generalized framework to help identify problem areas that will require more investigation through details or specialized assessments. There may be times when detailed engineering assessments may be required to diagnose specific problems.

2 Overview

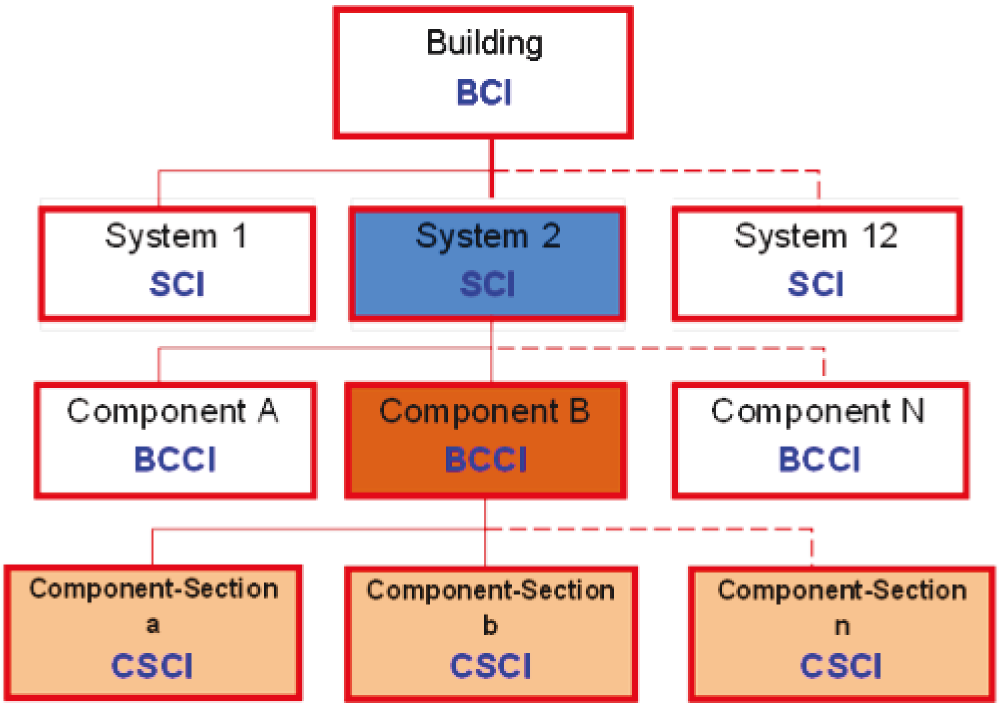
2.1 Introduction

Facility Condition Assessment (FCA) is one of the primary processes of a facility life-cycle asset management program. The FCA process results in a better understanding of the physical condition and readiness of an organization's facilities, along with the reliability of their systems and components. It also helps to identify candidates for facility SRM repair projects, a capability which represents a critical shift toward a proactive versus reactive facility management strategy. Instead of keeping facilities operational by relying primarily on corrective repairs (after a system or component has failed due to significant loss of function), the FCA process focuses on condition-based repairs which can be planned prior to failure. A condition-based approach can result in higher performing facilities at lower life-cycle costs.

This manual describes the procedures for performing FCA inspections for building-related components by using the SMS methodology. The SMS assessment process provides an objective and generalized framework to better identify problem areas that will require a more thorough investigation to diagnose specific problems through detailed or specialized assessments.

In the SMS, a Condition Survey Inspection is performed against the individual components that make up a building. When compared to a system-level or building-level assessment, the component-level assessment provides more fidelity of condition information and links problems that are identified to the specific building elements where those problems exist. This better supports a condition-based building repair strategy. It also means that an inventory of building components is necessary prior to performing an FCA. This information about the components that make up a building is called the *BUILDER inventory*. BUILDER software has a vast library of predefined component types that an assessor will select from when creating this inventory, and the inventory collection process involves identifying the type, quantity, and year installed for all pertinent components that make up a building. These components are organized into systems and subsystems that follow the ASTM UNIFORMAT II classification hierarchy (Charette and Marshall 1999; Figure 1). When a specific instance of a component is recorded, it is called a *Component-Section* in BUILDER and represents a single component assembly or collection of like components to be managed as a single unit. In this manual, the term “component” may be used interchangeably to mean a Component-Section. The BUILDER FCA process discussed in this manual directly supports computation of a CI for building Component-Sections, known as the Component-Section Condition Index (CSCI), which is the fundamental metric used in BUILDER. The CSCI is aggregated to compute a CI metric at the Building Component type level (BCCI), System type level (SCI), Building level (BCI), and even above that to sites and organizational levels.

Figure 1. Condition index hierarchy.



A condition-based building repair strategy requires that condition information be collected at the component level, and that this condition information relates to accumulated degradation and eventual loss of component function. Every component of a building has a primary function that it performs. This function is the reason that the component was constructed or installed in the building. It may also serve a number of secondary or tertiary functions. For example, for a door component, the primary function is to provide safe entry and egress of authorized movements while limiting unwanted movements of people (security), or other objects (water or moisture). The secondary functions would relate to aesthetics, and thermal and air control, among others.

Over the course of a building component's life in service, it will likely experience a deterioration of its physical condition due to general aging, use in service, and exposure to a number of external or environmental factors. This condition deterioration is manifested in *distress*(*es*) that adversely affect a component's current and future ability to perform its primary and/or secondary functions. These distresses include cracks, leaks, holes, corrosion, overheating, excessive vibration, animal/insect damage, and general deterioration or damage. These distresses can be observed during a condition assessment process. As a result, the fundamental purpose of a condition assessment process is to measure (qualitatively and/or quantitatively) a component's ability to perform its required functions, considering the presence of accumulated distress(es).

There are effectively two types of condition assessment approaches available in BUILDER. The more detailed approach, the *distress survey*, involves the individual identification and recording of the type and nature of distresses observed for a component. The presence of the recorded distresses, in addition to their severity and density, results in a CI metric that relates directly to the level of condition deterioration and indirectly to the loss of function due to this deterioration.

A less data-intensive approach (but not necessarily less in terms of observation time), is the *direct rating* method, where a single qualitative rating is assigned to the component based on condition observations (taking all distresses into account). This rating also results in a CI metric that relates to the level of deterioration and the loss of function. This abbreviated direct rating approach is often better suited to initial baseline assessments where the components are inventoried and data is initially loaded into BUILDER.

Both condition assessment methods discussed above require accurate and thorough physical observations during the assessment process. This sometimes may require an invasive (but nondestructive) look at the internal subcomponents of a component, if it can be done safely. It also typically requires interviewing building occupants or maintainers to capture variations in component performance (versus what can currently be observed during an inspection).

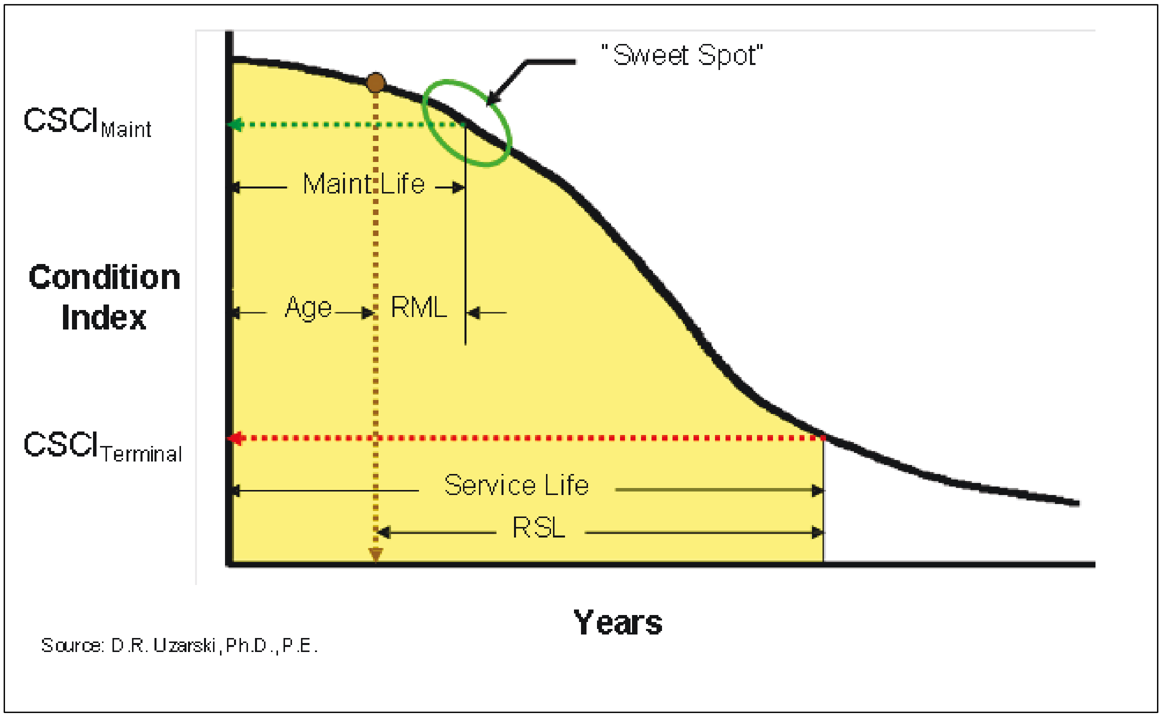
The procedures for conducting each assessment approach, as well as hybrid assessment approaches, are discussed in more detail in later chapters of this manual. A general understanding of each of the assessment types is important for the Knowledge-Based inspection discussion in Section 2.3.

2.2 Constructing the Life-Cycle Profile of a Building Component

Since physical condition deterioration is a nearly universal phenomenon, practically all building components eventually reach a point where they require extensive overhaul or replacement. The time from initial construction or installation until a building component no longer serves its intended functions and needs to be replaced is referred to as the service life. BUILDER stores default expected service life values for a range of items in its component catalog. These values are a compilation derived from several sources, and serve as an initial gross estimate. In reality, the actual values can have a wide range due to the multitude of variables that affect how long something will last. One of the reasons for performing a condition assessment is to establish and calibrate the predicted CI vs. age curve, as illustrated in Figure 2. From this, the remaining maintenance life (RML) and the remaining service life (RSL) can be more accurately estimated. In BUILDER, the default service life value serves as an initial "seeding" of the prediction model and gives a reasonable estimate of life. As condition data are added over time, the service life (and more importantly, the RSL) is automatically adjusted in BUILDER to give a better estimate of when a specific Component-Section is expected to fail and therefore must be replaced or rehabilitated.

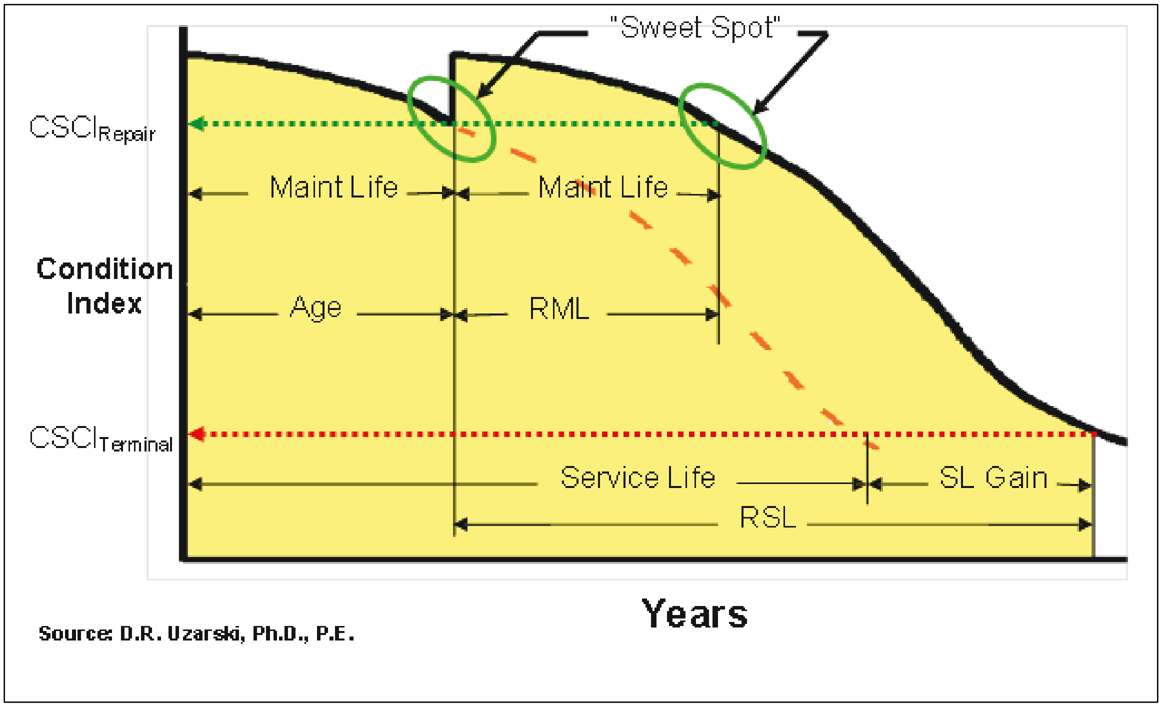
The most efficient point in the life cycle to perform corrective action is rarely near or after the failure state has occurred. In this context, corrective action is used as a broad term that encompasses maintenance and/or repair work associated with reducing or eliminating the distresses (cracks, deterioration, damage, etc.) that are negatively affecting a Component-Section. As these distresses accumulate, the Component-Section approaches what is referred to as the "sweet spot" for maintenance and repair (see Figure 2). The theoretical sweet spot is a narrow range of CSCI values that represent the economically optimum condition where maintenance/repair work should be performed. Performing maintenance work when the Component-Section's condition is in this range minimizes the penalty costs incurred from deferring maintenance and results in life-cycle cost savings. In general, the theoretical sweet spot is a CSCI range of 70 to 80, based on the associated CI scale. The practicable sweet spot represents a user-defined condition standard for triggering work. The standard, which can be different for different Component-Sections, is a minimum-desired condition level. Variables corresponding to this include building use, building importance (represented by the Mission Dependency Index [MDI]), component importance, and other factors. (Note that in this context, maintenance is used as a broad term that encompasses all work associated with reducing or eliminating the distresses found in a Component-Section. It does not mean preventive maintenance.)

Figure 2. Component-section life-cycle condition curve.



When a component-section is replaced, the life-cycle curve essentially resets, using condition and service life information measured over the previous component's life cycle to predict future deterioration rates and life. Performing maintenance and/or repair does not reset the life-cycle curve. Instead, the CSCI experiences a step increase, and RSL is consequently extended. The service life extension (measured in terms of years) is a function of the extent of the work performed (as represented by CSCI gain) and the age of the component-section when the work was completed. In theory, maximum CSCI gain from repair is to a value of 100, but the post-work CSCI will be less than this maximum if not all of the distresses are eliminated, which is usually the case. A new maintenance life is also set. Figure 3 displays these concepts.

Figure 3. Component-section life-cycle condition curve after maintenance.



2.3 Knowledge-based inspection types

As discussed above, BUILDER offers different assessment types. The procedures for performing each is described in detail in subsequent chapters of this manual. The purpose here is to address what they are and their suggested application. Sampling (discussed in detail in Section 2.9) is permitted for all of the approaches and even desired if the Component-Section is large, complex, and/or discontinuous.

Building Component-Section condition survey inspections encompass the following types:

- Distress surveys (with distress quantities or distress densities)
- Direct condition ratings
- Hybrid (distress survey of some subcomponents, direct rating of others)
- Paint ratings

2.3.1 Distress survey with distress quantities

The distress survey procedure with distress quantities is the most accurate and reproducible approach to inspections. The distress survey also provides a record of the type of distresses present (e.g., Cracked), their severity levels (e.g., High), and their quantity (e.g., 20 linear feet [LF]) for the Component-Section. It also provides for an accurate computation of density. This survey type can be accomplished at any time as it provides the most complete picture of the Component-Section and thus, it provides information of maximum value for a range of managerial decision support needs. However, this survey is also the most time consuming and expensive to accomplish.

2.3.2 Distress survey with density estimation

The distress survey procedure is similar to that with distress quantities except the quantities are not normally recorded. Since quantities are not recorded, density cannot be computed. Instead, the density (distress quantity divided by subcomponent amount) is estimated within a predefined range. The utility value of the information is less than if the quantities were recorded, but the process is faster and more economical. However, the error rate is higher. Distress quantities may be collected for the basis of computing density on those occasions when estimating is difficult or uncertain.

2.3.3 Direct condition ratings

The direct condition rating procedure is a less accurate but faster method for performing a condition survey. It involves visually inspecting each Component-Section, evaluating that item against a set of rating criteria, and selecting the appropriate rating. No information is collected regarding distresses.

2.3.4 Paint ratings

Paint ratings are used to evaluate painted surfaces. Based on the original work of Marshall (1994) from ERDC-CERL, the paint rating is similar to a direct rating. Normally, when sampling is applied to Component-Sections, sampling is applied to the paint (if painted) as well.

2.4 Pairing inspection types with inspection objectives

2.4.1 Knowledge-based inspection objectives

Several objectives result from performing condition surveys, including those listed below:

- Determine quantitative condition of the Component-Section using the CSCI.
- Determine the aggregate (rolled-up) CIs for the levels of building component (BCCI)—SCI, BCI, and higher.
- Provide a measurable condition history trend.
- Compute measurable condition deterioration rates.
- Calibrate life-cycle condition prediction model curve (refine the CSCI, shown in Figure 2).
- Compute (or recompute) the RML from condition model trends, based on the established sweet spot.
- Determine the broad scope of work for planning purposes, including a cost estimate for future maintenance or Component-Section replacement.
- Determine at what point replacement becomes a more viable option than repair.
- Compute (or re-compute) the RSL.
- Provide quality control for completed work (post-work assessment).

Every time a condition survey inspection is performed on a Component-Section, the CSCI will be computed for it. Additionally, all of the rolled-up CIs will be updated as well. The rate of deterioration, RSL, and RML are also re-computed. BUILDER always displays the CSCI as of the last inspection, the estimated CSCI, and the remaining service and remaining paint lives (if painted) as of the current calendar day.

2.4.2 Suggested condition survey inspection type applications

Table 1 lists the condition survey inspection purpose or objective and the type of survey that can be conducted to meet that purpose. As can be seen, the distress survey with distress quantities satisfies all of the inspection purposes. However, sometimes using this type of survey constitutes an overuse of inspection resources. Inspection savings will result by matching the least costly survey type to satisfy the inspection need.

Table 1. Condition survey inspection matrix by objective.

No.	Objective	Distress with Quantities	Distress	Direct
1.	Determine condition of Component-Section (CSCI)	Best	Better	Good
2.	Determine rollup condition of system, building, etc.	Best	Better	Good
3.	Provide a condition history	Best	Better	Good
4.	Compute deterioration rates	Best	Better	Limited

No.	Objective	Distress with Quantities	Distress	Direct
5.	Calibrate CSCI prediction curves	Best	Better	Limited
6.	Compute/re-compute RML	Best	Better	Limited
7.	Determine broad scope of work for planning	Good	Limited	Limited
8.	Establish when cost effective to replace	Better	Good	No
9.	Compute/re-compute RSL	Best	Good	Limited
10.	Quality control (post-work assessment)	Better	Good	No

Although different condition survey inspection approaches can be used for the same objective, there are various factors to be considered when selecting the appropriate approach. The first factor relates to where on the life-cycle curve the Component-Section is estimated to reside at the time of inspection. Figure 4 displays (in a general sense) the type of sustainment/restoration (i.e., work) needs, based on condition. Figure 5 matches a suggested condition survey inspection type to a condition in support of those work needs. For example, if the RML is believed to be years away, a direct rating may suffice. However, if the RML is believed to be a year or less, and it is desired to do the work to correct the deficiencies, the distress survey with quantities is needed.

Figure 4 General sustainment/restoration needs based on condition.

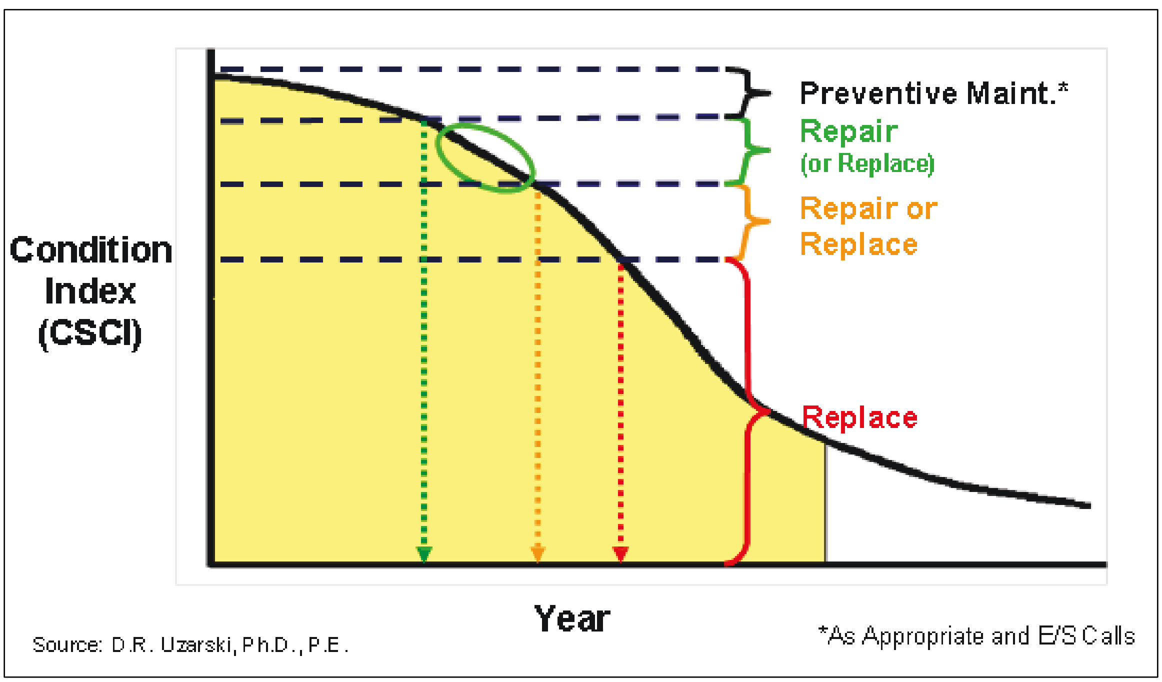
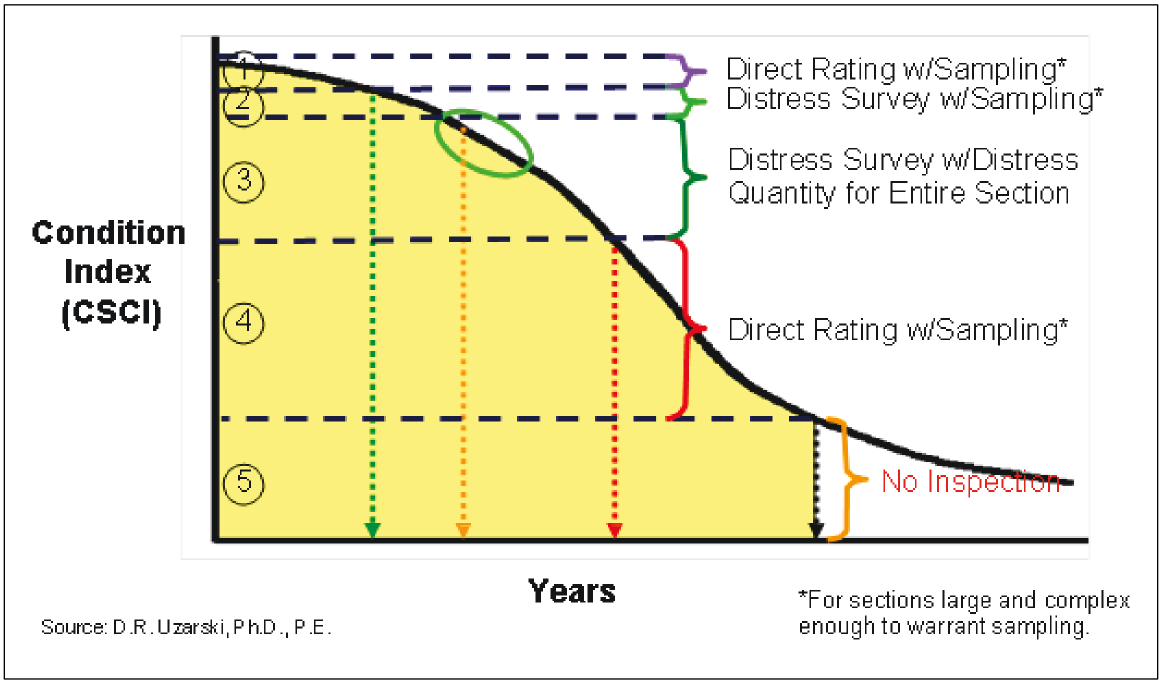


Figure 5. Suggested condition survey inspection types for specific condition ranges (zones).



2.5 Condition zones

In general, each condition zone numbered in Figure 5 will have its own condition survey inspection requirements. These requirements are addressed by zone number in the subsections below.

2.5.1 Zone 1 – Preventive Maintenance Sustainment zone

Zone 1 is the Preventive Maintenance (PM) Sustainment zone. However, although no work is planned for this zone (other than preventive maintenance and/or emergency service calls, if needed), condition surveys are needed to satisfy Objectives 1–6 (see Table 1). Direct ratings and paint ratings satisfy this requirement. (Note: computing the RSL is not of prime consideration here, since it will typically be well into the future.) Also, although future work requirements (Objective 7) are generated from these surveys, those requirements will occur most often past the normal planning horizon.

Objective 10, quality control (post-work assessment), is also accomplished in this zone because of the increase in CSCI from the work performed. If the post-work assessment of the Component-Section reveals a "Defect Free" condition, either the distress survey or the direct rating approach may be used. If the intent was not to attain a Defect Free condition, the distress survey (with quantities or density estimation) should be done to document the remaining distresses. This survey should be done as soon as practicable after the work is completed. (Note: Unless overridden by a condition survey, BUILDER assumes a post-work CSCI of 95, unless the Component-Section is replaced; replacement gives a CSCI of 100.)

2.5.2 Zone 2 - Corrective Maintenance Approach zone

Zone 2 is the Corrective Maintenance (CM) Approach zone. Although no work (other than preventive maintenance and/or emergency/service calls, if needed) is usually planned for this zone, condition assessment surveys are needed to satisfy Objectives 1–7 (see Table 1). However, since the corrective maintenance sweet spot is being approached, a greater precision to the condition assessment is needed. Thus, the distress survey with density estimation is suggested.

The CSCI boundary between Zone 1 and Zone 2 is a function of the beginning of the zone containing the sweet spot (Zone 3, discussed next). That CSCI value, rate of deterioration, and the desired long-range work plan horizon (e.g., 5 years) are used to compute the boundary between Zone 1 and Zone 2. For example, if the sweet spot's CSCI lower value is 70, the rate of deterioration is 2 points per year, and the long-range work plan horizon is 5 years (5-year plan), then the sweet spot approach zone begins at a CSCI of 80.

2.5.3 Zone 3 – Corrective Work zone

Zone 3 is termed the Corrective Work zone. Its top boundary is defined by the upper edge of the sweet spot. Meeting the objective of quantifying distresses for work accomplishment (Objective 8) is most important. This quantification is needed to refine the scope of the work and to accurately estimate the cost in preparation of funding and work accomplishment. This creates a job for the "job jar." To do this, a distress survey type (not a direct survey) with distress quantities is recommended. Objectives 1–6 will also be met, but they are of secondary importance at this point. Sampling can be used for this, but if sampling is accomplished, 100% of the component-section should be assessed. Paint ratings, if the component is painted, will normally be accomplished at the same time. If it is determined that not all of the Component-Section requires work, splitting the existing Component-Section into two or more parts should be considered.

Figure 5 shows that Zone 3 extends beyond the sweet spot. Due to competing priorities, budget constraints, and other factors, not all work will be executed as planned, or the plan may require that some work be deferred. With deferment comes continued degradation that must be documented through a distress survey with distress quantities. Also, continued degradation may progress to the point where replacement becomes the preferred alternative. Objective 9 calls for that analysis and is met here. The key here is the timing of these surveys. Timing will be discussed below, under Section 2.6, "Knowledge-based inspection timing and frequency."

The CSCI boundary between Zone 2 and Zone 3 (hitting the sweet spot) is set by the facility manager. It is based on two factors. One factor is economic criteria for minimizing the penalty cost that accrues from deferring work. The second is the condition standard level below which the Component-Section should not drop. Often the economic criterion is rolled into the process of setting the standard. Technically, the boundary should be the sweet spot minus 1 year to allow for quantification of scope and the addition of the work to the job jar "just in time" for the next annual, well defined, and well-scoped work plan. This boundary is set in BUILDER, and it serves as the "trigger point" for executing work (or at least identifying the Component-Section candidates from which to prioritize work).

The sweet spot need not be the same for all buildings or building Component-Sections. Building importance (as measured by the MDI or other means) and component importance are criteria to use. The idea is that the most important or critical inventory will be maintained to a higher level than less important inventory.

2.5.4 Zone 4 – Missed Opportunity zone

Often the condition of a Component-Section will degrade well past the sweet spot before work on it is accomplished. In the Missed Opportunity zone, life remains for the Component-Section, but the degradation is such that replacement or major rehabilitation is now the best option from an economic perspective. The replacement or rehabilitation may be either sustainment or restoration, respectively depending on whether the degradation is more or less normal or is clearly premature. Once in this zone, the primary objective is to determine how much life remains (Objective 10). The direct rating satisfies this goal. Since replacement is warranted, there is no longer a need to document distresses. And since painting will be included in the replacement or rehabilitation (if the Component-Section is painted), there is no longer a need to do paint ratings. The estimated coating condition index (CCI) will be used in the condition index rollups, as that will provide sufficient accuracy. Objectives 1–5 and also Objective 7 are met.

2.5.5 Zone 5 – Dead zone

At this point, the Component-Section is past its service life. For all practical purposes, it is dead, and immediate replacement or major restoration is the only viable option (assuming the Component-Section is still needed). No further condition surveys are needed. The estimated CSCI value satisfies Objectives 1–3. All other objectives either cannot be met, or they are meaningless with a CSCI so low. If the Component-Section is past its normally expected service life, the work would be considered sustainment. If the "death" is premature, the work would be considered restoration.

2.5.6 Exceptions

The generalized discussions above apply to a great many Component-Sections. However, there will be situations and/or Component-Sections that dictate a different condition survey inspection strategy. Five such situations are described below. Other specific, situation-based possibilities may occur in practice.

2.5.6.1 Nonmaintainable

Occasionally, a Component-Section is not maintainable (other than applicable preventive maintenance). In these cases, it simply will be replaced when needed. This situation generally involves two cases. The first is a run-to-failure option with minimal disruption due to the failure. An example would be an inexpensive bathroom exhaust fan. This is a low-risk situation. Condition surveys are not really needed in this situation. High risk situations, however, require that replacement be accomplished prior to failure because of the magnitude of the resulting disruption. An example would be a sump pump in a high water-table area. In this case, the sweet spot is set at a point in time that is prior to the end of service life. The number of years ahead is based on the tolerable risk. (The determination of service life is NOT an exact science.)

2.5.6.2 Subcomponent accessibility

Distress surveys require the viewing and recording of distress data for each subcomponent of the parent Component-Section. Direct ratings, on the other hand, are focused on the entire Component-Section (or sample thereof). Unfortunately, sometimes not all of the subcomponents are readily visible during a routine condition survey. This situation is likely for certain heating, ventilation, and air-conditioning (HVAC) components, especially when in operation. Thus even though a distress survey may be warranted, it may not be possible, necessitating a direct rating.

2.5.6.3 Catastrophic event

A catastrophic event, (such as storm damage, fire, etc.), will alter the life-cycle curve for a Component-Section. Often after a catastrophic event, some type of condition survey inspection will be required. The type of inspection will depend of the nature and extent of the damage and the urgency for repair.

2.5.6.4 Rapid rate of deterioration or short service life

These exceptions are related in that Zone 1 and possibly Zone 2 may be skipped because the sweet spot is rapidly approaching.

2.5.6.5 Previous higher level of condition assessment

In some instances, a more detailed level of condition assessment may be warranted regardless of the assessment type guidelines shown in Figure 5. If a more detailed assessment was previously performed on a Component-Section while its condition was still in the same zone, that same method will be recommended again for zones 1-3. For example, if the Component-Section is still in Zone 1 and the previous condition assessment method performed was a distress survey, the knowledge-based inspection (KBI) program would recommend a distress survey be performed instead of a direct rating.

2.6 Knowledge-based inspection timing and frequency

Thus far, discussion has focused on the type of condition survey inspection to perform. Nothing has been said about when or how often the inspections should be accomplished. Traditionally, the frequency of condition survey inspections is set on some sort of a fixed schedule. The inspections may occur at intervals of 2 years, 3 years, or something else based on facility importance, available funding, policy and doctrine, and other factors. Unfortunately, some Component-Sections will be inspected too often, and others will not be inspected often enough.

2.6.1 Knowledge-based inspection scheduling concept

A knowledge-based condition survey inspection (KBCSI) framework and procedure (Uzarski and Grussing 2006, US Patent 7,058,544) abandons the fixed schedule approach in favor of a flexible one based on supporting the objectives described above. The KBCSI approach looks at the expected CSCIs of all of the Component-Sections and uses that information to compute values for RSL, RML, condition zone location, and rate of deterioration and then uses those criteria plus others to recommend certain Component-Sections for condition survey inspection in a given year. Implementing flexibility requires an understanding of the criteria involved and setting the applicable values to the variables used in the criteria.

2.6.2 Scheduling criteria

The scheduling criteria are listed below, followed by explanations in subsections 2.6.2.1–2.6.2.10.

- Facility (building) importance
- Component-Section importance
- Service life
- Remaining service life
- Maintenance life
- Remaining maintenance life
- Rate of deterioration
- Condition zone
- Condition standards
- Maximum time frame between condition surveys

In the future, other criteria can be used to help schedule a condition survey. Specific additional criteria may include, but are not limited to: specific distress tracking, service-call history, and preventive maintenance history.

2.6.2.1 Building importance

Logically, the buildings that are most important should demand more attention than the buildings that are least important. Importance is measured by the Mission Dependency Index. If an MDI analysis has not been performed, building use can be used as a surrogate metric.

2.6.2.2 Component-section importance

Also, logically the Component-Sections that are most important or critical to building usefulness should demand more attention than the Component-Sections that are least important. As an alternative, building importance could be used as a variable.

2.6.2.3 Service life

All other factors being equal, Component-Sections with shorter service lives need to be inspected more often than those with longer lives because more change is expected from year to year.

2.6.2.4 Remaining service life

The RSL is important when the component resides in condition Zone 1 or Zone 5. In Zone 1, if the RSL is long, inspection is needed less often than if the component has a short service life. Also, in Zone 4, condition survey inspections should be scheduled at specific points prior to the RSL going to zero.

2.6.2.5 Maintenance life

Component-Sections with shorter maintenance lives need to be inspected more often than those with longer lives because more change is expected from year to year. If the frequency is too far apart, it is possible to slip by the sweet spot between condition surveys.

2.6.2.6 Remaining maintenance life

The RML will set the timing for condition surveys. RML minus one year is a key time for performing a condition survey inspection. Also, BUILDER's "Scenarios" feature will recommend work needed in future years, and the result can then be imported into BUILDER. This information forms the basis for the long-range work plan. Scheduled year minus one year should be time to conduct a condition survey inspection with distress quantities.

2.6.2.7 Rate of deterioration

Component-Sections that are rapidly deteriorating need to be inspected more often, especially if the deterioration rate is greater than expected.

2.6.2.8 Condition zone

As discussed above, the condition zone serves to determine the type of condition survey to perform. The zone also affects survey frequency when viewed with RML and RSL.

2.6.2.9 Condition standards

Standards affect condition zone range, building importance, and Component-Section importance, which in turn all affect condition assessment frequency.

2.6.2.10 Maximum time frame between condition surveys

Applying the above criteria may result in specific Component-Sections not getting a condition survey inspection for several years. However, this criteria assures that no more than a specified number of years transpire between condition surveys.

2.6.3 User-defined parameters

When evaluating the scheduling criteria listed above, the KBCSI feature compares knowledge about the Component-Section with user-defined parameters to determine when a condition assessment is to be performed. These user-defined parameters are input when creating a condition standard, as described in the BUILDER user documentation.[1] The parameters must be input for each of the five condition zones.

The user-defined parameters for the KBCSI feature include:

[1] https://www.sms.erdc.dren.mil/Products/BUILDER/Downloads.

- **CI Lower Bound.** The lower bound of the CI range of the condition zone.
- **Maximum Inspection Interval.** The maximum amount of time, in years, between condition assessments in each condition zone.
- **Number of Inspections in Zone.** The targeted number of condition assessments that should be performed in each condition zone.
- **Degradation Factor.** The ratio of the maximum relative rate of deterioration to the expected rate of deterioration when a condition assessment is triggered. That is, if the deterioration rate were set to 2, any measured deterioration rate greater than twice the expected rate would trigger another inspection.

Based on the projected CI of the Component-Section, the KBCSI feature determines which range the Component-Section is in, and how many inspections to perform in that range. It then calculates the time between inspections to accomplish this. This interval is compared to the maximum inspection interval, and the lesser of the two becomes the allowable inspection interval.

When the time since the last inspection becomes greater than the allowable interval between condition assessments, the Component-Section is flagged for inclusion into the next round of condition assessments. In addition, Or, if the rate of deterioration of the CI seen by the last condition assessment is greater than the allowable rate of deterioration determined by the degradation factor discussed in the list above, the Component-Section will be flagged for inclusion into the next round of assessments.

2.7 Creating knowledge-based inspection plans

BUILDER Version 3.0 was the first version with a feature for creating condition survey inspection plans. Version 3.3 continues to provide users with this feature. Users may use any or all of the scheduling criteria described above in in Section 2.6.2 for establishing the timing and frequencies for Component-Section inspections in a given year. Users can set the desired parameters for these criteria.

Implementing BUILDER requires creating and populating the BUILDER database that includes the collection of system inventory data. Usually an initial condition survey inspection is also conducted of all Component-Sections. The KBCSI approach is recommended here, too. Not only will the appropriate condition survey type be selected, but also some Component-

Sections may not require a condition survey at that time. Likely candidates for needing no condition survey are those that have a long RSL and are relatively new, and those that are past their service life. However, the user is cautioned that in order for KBI to properly plan, the inventory must be first collected and accurate, especially as to the material/equipment type, component type, and age. The use of rapid data modeling approaches for inventory may result in considerable error. (Refer to the *BUILDER™ Inventory Guide*, downloadable from the SMS support site, or to the online documentation for the SMS with BUILDER). This error may result in KBCSI assigning an incorrect condition survey type and year.

2.8 Preventive maintenance inspections and condition surveys

When implemented, preventive maintenance inspections (PMIs) are conducted periodically to inspect, clean, adjust, replace filters, or to otherwise maintain certain building components, particularly equipment. These PMIs provide an opportunity for PM inspectors to perform distress surveys of all the subcomponents associated with a specific component, due to the subcomponent access afforded by the PMI. Having PM inspectors do these surveys will overcome the difficulty (and sometime impossibility) of performing distress surveys by other building inspectors during the course of a routine building inspection. As discussed earlier, a lack of subcomponent accessibility limits condition surveys to direct ratings.

2.9 Inspecting through sampling

Sampling is a way of breaking up the assessment of large or spatially dispersed components into more manageable parts, with each part being assessed individually. The use of sampling can also potentially provide some efficiencies in the assessment process, because the sum of the individual sample quantities need not equal the overall quantity of the component.

Performing a condition survey inspection by sampling should be done when the component is large, complex, and/or discontinuous. In a practical sense, this means that the entire component is not readily viewable. Depending on organizational policies or guidance given to the inspector, sampling may not always be allowed but if it is, the decision to sample or not will be a judgment call made by the inspector based on building size and component quantities. Sampling rates (above the minimum addressed in Section 2.9.1) are up to the discretion of the inspector and/or organizational policy. Both sampling and non-sampling approaches can be used in the same building for different components.

Samples may be representative or nonrepresentative. Representative samples are those that *are* in a typical condition for the Component-Section as a whole. This does not mean that they are in exactly the same condition; some variation is expected. Nonrepresentative samples are those that are *not* in typical condition for the Component-Section as a whole. This can be either significantly better or worse condition. The designation as "representative" or not will affect the CI. Nonrepresentative samples are considered isolated, and thus they have less of an influence on the CI than do representative samples.

2.9.1 Representative sample creation and selection

Representative sample locations and sample sizes are determined by the layout of a given building. There are a few simple rules to follow, as listed below.

- A general walkthrough of the building is recommended prior to selecting samples to ensure that the samples are representative.
- Use discrete building discontinuities (e.g., entire rooms, wall corners) to help delineate sample boundaries, especially when the quantity has a unit of measure of square feet (square meters) or linear feet (meters).
- When an area of the building (e.g., specific room) is selected for sampling, it is recommended but not required that all of the Component-Sections at that location be inspected as part of the sample (e.g., all Component-Sections for all systems found in a room).
- Specific Component-Sections with a unit of measure of “each” should most often be sampled individually, (e.g., sample 5 of 25 interior doors as 5 separate samples).
- Sample sizes for Component-Sections with a unit of measure of “each” need not be restricted to one (see discussion below on “The Importance of Sample Locations”).
- Sample sizes are often situation specific. Try to have them be of approximately equal size, but be practical. There will be situations when equal size is not possible or practical.
- Ensure that all samples are properly identified as to location, including room number or name, if applicable. (Think of the next person or inspector – can he/she easily find this location?)

- When sampling is used for a given condition survey inspection cycle, either the distress survey or the direct condition rating approach may be used for a given Component-Section. However, do *not* combine the methods for any given Component-Section (i.e., do not use distress survey for one sample and direct condition rating for another sample).

2.9.2 Minimum representative sample quantities

The number of representative (as to condition) samples to be taken of a specific Component-Section with the unit of measure of "each" are listed below:

- One (1) sample when the Component-Section quantity is 1–4.
- Two (2) samples when the Component-Section quantity is 5–9.
- At least three (3) samples or a minimum of 10% of quantity when the Component-Section quantity is 10 or more.

The number of representative (as to condition) samples to be taken of a specific Component-Section with the unit of measure of square feet (square meters) or linear feet (meters) are listed below:

- One (1) sample when the Component-Section quantity is 1–4.
- Two (2) samples when the Component-Section quantity is 5–9.
- At least three (3) samples or a minimum of 10% of quantity when the Component-Section quantity is 10 or more.

2.9.3 Sampling suggestions

- Specific rooms inside of a building (e.g., Room 110), where all of the various Component-Sections in that room would be sampled (e.g., ceiling, walls, wall finish, floor, floor covering, light fixtures, etc.).
- Exterior wall locations (e.g., North Wall), where all Component-Sections included in that wall would be sampled (e.g., wall surface, doors, windows, awnings, lights).
- A Component-Section consisting of 10 roof ventilating fans (all 10 are the same) could label samples as Fan 1, Fan 2, etc.
- Interior doors denoted by room number (e.g., a hallway has many doors leading to rooms, so select the requisite number of doors with each door being a sample).
- Specific structural columns, beams, frames, trusses.

- A specific Component-Section (e.g., fireplace) with a quantity greater than one, but still a small number (such as two or three) that are geographically separated such that they cannot be inspected together. Inspect each one as a sample with a specific location. All Component-Sections will need to be inspected to be in conformance with the minimum sample quantity addressed above.
- If an entire Component-Section happens to be co-located at a defined sample location where other Component-Sections were sampled (e.g., a fireplace in a room selected for sampling of walls, ceiling, flooring), that Component-Section can either be included in the sample location or simply inspected without sampling.
- In general, do what makes sense, but ensure that the rules are followed.

2.9.4 Nonrepresentative samples

- Inspect nonrepresentative Component-Sections in addition to the required representative sample quantity amounts.
- Ensure that the nonrepresentative samples are designated as such.

2.9.5 Unusual condition situations

Recall that a primary objective for conducting condition survey inspections is to compute a CSCI for the Component-Section. This CSCI is used for a variety of purposes, including developing work plans. Also, as stated in 2.9.4, nonrepresentative samples should be inspected and classified so, when warranted. These nonrepresentative samples may be in significantly worse condition than the Component-Section as a whole, and they may merit work sooner than the Component-Section as a whole (i.e., the work cannot wait until the remainder of the Component-Section deteriorates to the point of needing work). In these cases, it is possible that BUILDER will not trigger work for the Component-Section because the overall condition does not warrant it (the CSCI may be in the Do Nothing zone). These situations offer the following managerial alternatives:

- Distresses can be flagged for early work (discussed in Chapter 4).
- The Component-Section can be split, with the portion that is significantly worse forming its own Component-Section. An example is a Component-Section of structural columns in a warehouse. In this case, the columns are in condition where no work actions are needed EXCEPT one column that was severely damaged by a forklift. Splitting

this one column into its own Component-Section with its resulting low CSCI is an option.

2.9.6 Sampling to quantify work needs

Sampling may also be used when a distress survey with distress quantity is used to quantify and/or refine work needs. However, the sampling rate must be increased to 100%. For Component-Sections with a unit of measure of square feet (square meters) or linear feet (meters) the choice to sample or not is based on convenience. It may be easier to record all on a smaller sample-by-sample basis than for an entire Component-Section. Component-Sections with a unit of measure of “each” should always be inspected individually when work needs are being quantified. For example, if a Component-Section consists of 10 roof ventilating fans, each fan would be a separate sample and each would be inspected. Thus, 10 samples would result.

2.9.7 The importance of sample locations

The importance of sample locations cannot be overemphasized. The above topics briefly touched on sample locations, but two important considerations of inspection data management (past, present, and future) and field data collection practicalities are addressed below.

First, the sample location creation possibly provides a basis for collecting condition survey data for a number of different Component-Sections. For example if a room were chosen as a location, the walls, ceiling, light fixtures, etc. could all be inspected and associated with the same location. This can be very useful for future inspections even if all of the Component-Sections are not inspected in a given cycle, because a method of sorting inspection data is by sample location.

Second, the creation of sample locations will affect sampling rates and sizes. It was stated earlier that Component-Sections with the unit of measure of “each” should be sampled individually. However, sometimes this is impractical. If a sample location has been created that covers a specific area, such as a room, the Component-Section may have a quantity of more than one in that room. A logical clustering of individual items may form a practical basis for a sample. An example would be a Component-Section quantity of 100 light fixtures in a building. A room being sampled may have 4 fixtures of that total Component-Section quantity. The intent would be to not inspect each light fixture in the sample location room. Rather, all 4 light fixtures would become a single sample. Under these circumstances, it becomes important to make all sample sizes roughly the same for a given Component-Section. That is, avoid one sample of 4 lights and another sample of 40 lights.

3 Conducting a BUILDER SMS Inspection

3.1 Safety considerations

There are potential for safety hazards when conducting a facility condition assessment. Before performing any assessments, it is important to have a safety plan and ensure that OSHA, agency, and installation safety rules are followed. In addition to these safety requirements, some general recommendations are provided below. These recommendations are not intended to supersede OSHA, agency, or installation-level safety requirements.

- Review safety plans prior to any site visit, and stress importance of safety on a daily basis.

- Coordinate with base safety representatives to review specific safety requirements, and follow up daily on any specific safety hazards.

- Ensure new assessors have been properly briefed on safety plans.

- Ensure that proper Personal Protective Equipment (PPE) is available, including hardhat, hearing protection, eye protection, safety shoes, gloves, and a reflective/colored safety vest.

- Be aware of tip hazards in and around buildings.

- Do not record data, review documents, or talk on phones when walking around the building or on steps or stairs; this can lead to trips or falls.

- Do not enter posted or suspected confined spaces such as crawl spaces, tanks, chases, or pits.

- Do not enter areas with hazardous material signs posted or that appear to contain hazardous materials (asbestos, gases, visible mold, etc.).

- Be careful when walking through vehicle maintenance or staging areas.

- Be aware of low-hanging obstacles, such as ductwork, pipes, wall- or ceiling-mounted equipment, etc.

- Be aware of loose-fitting clothing and lanyards that may get caught in tight areas or on piping such as in mechanical and electrical rooms, etc.

- Be careful of wildlife and insects when walking around a building or opening a seldom-entered mechanical or electrical rooms. Assessors may encounter snakes, spiders, stray cats/dogs, rats/mice, etc. in these areas.

- If you see a life safety problem, do not try to fix it; instead report it to the proper authority or building manager prior to leaving the building or area.

- Before the assessor team leaves a building and moves to the next, ensure that all team members are accounted for.

- Roof inspectors need to pay close attention to safety rules associated with ladders and accessing roofs, such as fall protection and leading edge requirements.

- Consult your local safety point of contact prior to accessing roofs.

- Use proper techniques to place, secure, and climb ladders. Never climb a ladder with anything in your hands.

- Roofs that are not accessible may be able to be assessed by observing from a nearby building, by using binoculars, or by using unmanned aerial systems (UASs) outfitted with one or more cameras.

- Do not operate powered equipment, weight handling equipment (WHE)/cranes, or remove access covers from powered equipment to perform assessments.

- BUILDER assessments are commonly performed without electrical test equipment. Do not use electrical test equipment to test circuits or equipment unless qualified to do so by a local authority. Only open panel box doors or enter electrical/mechanical rooms if you have proper training. Consult your local safety representative.

3.2 Inspection tools

It is always recommended to have the right tools to perform the assessment. A list of some of the tools recommended for an assessor to have on hand is given below:

- This manual (either as a pocket-size handbook or a pdf version)
- Hardhat
- Hearing protection
- Safety glasses
- Reflective safety vest
- OSHA-approved footwear
- Other required personal protection equipment (PPE)
- Digital camera and extra batteries
- Measuring tape
- Laser measuring device
- Measuring wheel
- Flashlight
- Clipboard, pens, colored pencils, and notepad or graph paper
- Cell phone and team cell phone list
- Assessment schedule
- Building floor plans
- Small magnet (to help determine material type)
- Level and plumb bob
- Binoculars and mirror to view hard-to-reach places
- Screwdriver, awl, pliers, and hammer or mallet
- Voltmeter, clip-on ammeter, and circuit and GFCI (ground fault circuit interrupter) testers
- Infrared surface thermometer

3.3 BUILDER Remote Entry Database

To facilitate the condition survey inspection process, a field data collection application called BUILDER Remote Entry Database (BuilderRED, or

BRED) is available for use with Windows-based tablets, laptops, or desktop PCs. See the latest BRED documentation for system requirements.[2] Use of BuilderRED is not necessary to perform a BUILDER condition survey, but it does offer advantages, including the following:

- Component Inventory for the building to be inspected is directly available in the application.
- New component inventory can be added, and existing inventory can be verified and updated directly in the application during the condition survey.
- Subcomponent checklists, applicable distresses, and their definitions are available directly in the application.
- Condition survey data from previous inspections are available directly in the application.
- The application keeps track of components inspected and sampling percentages, showing a real-time view of inspection progress.
- Condition survey data recorded in BuilderRED are easily uploaded into the BUILDER database.
- Data loading from paper-based notes or other recording mediums is eliminated, reducing errors and saving time.

Illustration of BRED usage will be introduced in this reference manual, but it is beyond the manual's scope to describe detailed BRED operations. Online documentation is provided with the BRED software that covers its functions and usage. This manual uses examples and screen captures from BRED to illustrate details of the SMS inspection procedures. BRED is one powerful and useful tool that is available to inspectors who are conducting a condition survey.

3.4 Inspector qualifications

To do a proper condition survey inspection, it is important that the inspector be qualified in the specific task. This qualification entails recognition of various subcomponents along with their applicable distress types and severity levels. Also, the inspector must be able to accurately estimate density and measure quantity. Technicians well versed in civil/architectural, electrical, and mechanical systems will be qualified as inspectors. A team

[2] https://www.sms.erdc.dren.mil/Products/BUILDER/Downloads.

approach will be needed if a single inspector is not well versed in one or more of these areas.

There may be components present that require inspection by certified personnel. This may include such items as elevators, boilers, fire protection equipment, etc. When present, those components must be inspected as per their prescribed procedures. The results of these specialized inspections should be translated into BUILDER for management use and condition analysis.

Prior to commencing a round of periodic condition survey inspections, it is strongly recommended that inspectors undertake refresher training on procedures, to involve the following training:

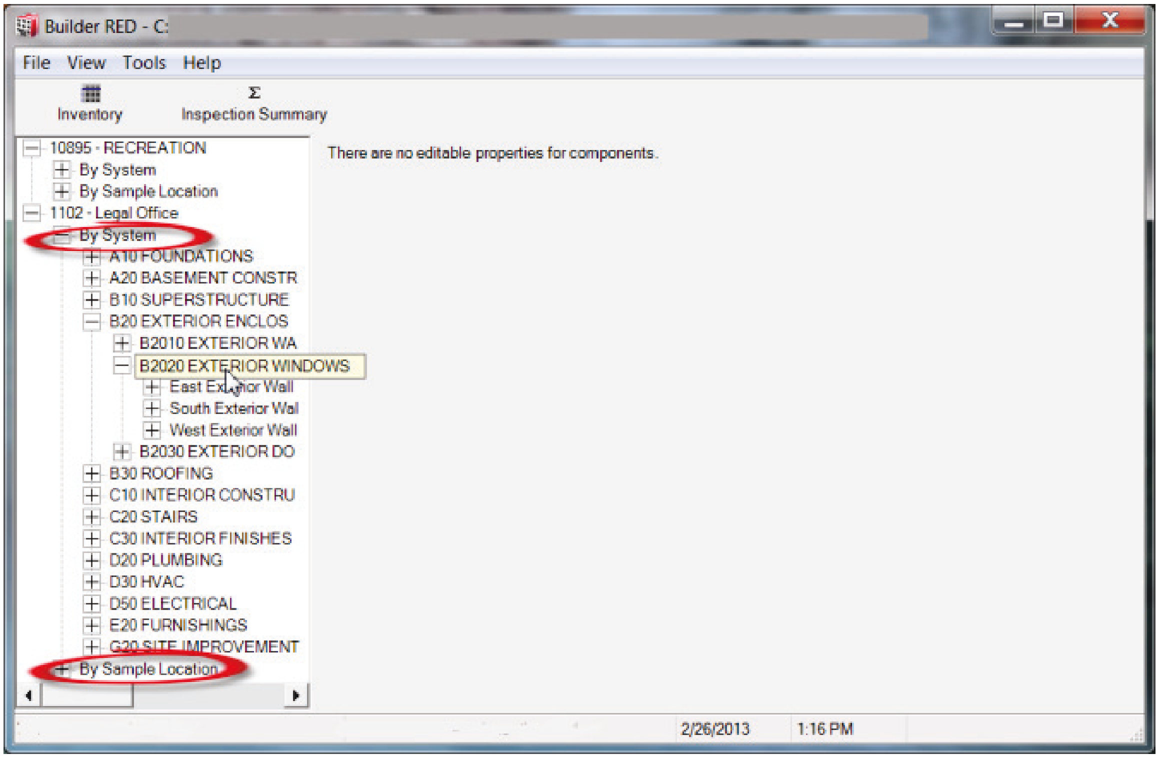
- Reviewing the distress and component rating definitions.
- Practicing estimating density.
- Practicing measuring quantity.
- Reviewing sampling procedures.
- Preparing the survey forms (if used).
- Using BRED, if used.
- Performing a practice survey at a benchmark building.

An eye trained for proper observation that is accompanied by simple diagnostic tests, where applicable, are critical to quality inspections. Know what to look for and record accurately.

3.5 Pre-assessment tasks

Prior to performing a condition survey inspection, the inspector must become familiar with the Component-Sections present, building layout, and previous inspection findings and sample locations (if any). The BUILDER database can be accessed for this information. Various reports should be run to help the inspector become familiar with the upcoming task. If BRED is to be used, the desired buildings and systems that are to be inspected will be first downloaded from BUILDER and loaded into BRED. If the survey is an initial one (no previous inspection), the decision to sample or not and the minimum amount to sample needs to have been made prior to inspecting. Inspectors should always have the discretion to increase the number of samples, if needed, to get a better representation of condition. The actual choice of samples will be made during the inspection; ensure that they are well spaced and truly representative. Reviewing sampling procedures (see section 2.9) is recommended.

Figure 6. Screenshot of BRED desktop, illustrating the component/sample location selection tree.



If the survey is a re-inspection, it is STRONGLY recommended that the same previously defined sample locations be chosen. If any of those locations are inaccessible, choose substitutes. Always be aware of situations which may demand that more representative samples or additional samples be taken. This increased need for sampling may occur where larger-than-normal variation is occurring, and the inspector feels more representative samples are needed to get an accurate CSCI. Alternatively, the need may occur where uncommon conditions arise, necessitating that nonrepresentative samples be surveyed. This latter case should be rare, however.

Once buildings are downloaded from BUILDER into BRED, all Component-Sections and previously defined sample locations are available to the inspector via the tree structure on the left of the BRED desktop (see Figure 6).

If available, a review should be made of the service call history for the building to see if any of the Component-Sections to be inspected have any history since the last condition survey. Recurring problems can translate into distress information, even if they are not apparent at the time of the condition survey. Also, even one-time calls can sometimes help explain the reason for observed stains, patches, etc.

Finally, assemble any tools and safety equipment needed for the inspection, such as per the list recommended above (see section 3.2).

3.6 Tasks during the assessment

A condition survey inspection is more than walking through a building and observing and recording problems. It also involves discussing building conditions with the building manager and occupants. Certain problems may not be obvious, or they may be intermittent. A discussion with the people who work or live in the spaces can bring these problems to the forefront.

Certain building Component-Sections are very difficult, if not impossible, to observe. These may include insulation, structural members, plumbing piping, electrical wiring, and a host of others, depending on the building. When direct observation is difficult, look for subtle clues to ascertain the condition. These clues can include uneven floors, out-of-plumb walls, water stains, sawdust, musky odors, sagging roof ridge lines, discoloration from overheating, unusual noises, etc. If a component's condition cannot be observed or inferred, do not inspect it—it is better to let BUILDER's condition models forecast condition than to enter an inaccurate guess of condition.

Additionally, certain special buildings, due to their complexity and/or use, will require extra time and attention to detail during the inspection process. Sampling rates may need to be increased or not used at all for certain Component-Sections.

If available, the equipment logs that are often kept in the mechanical rooms (or elsewhere) are an excellent source of information to review. They can provide insight to problems and a record of maintenance/work performed.

An interview with the mechanics personnel (HVAC, etc.) is recommended. Typically, certain equipment will be running and cannot be shut down for an inspection, and other equipment may not be turned on (e.g., heating units in summer). Often, too, certain subcomponents may not be visible to an inspector. Thus, the interview process can reveal problems (i.e., distresses) that may otherwise be missed. For example, is a pump not running because it is not currently needed for use or because it is inoperable?

The following are other issues related to assessment:

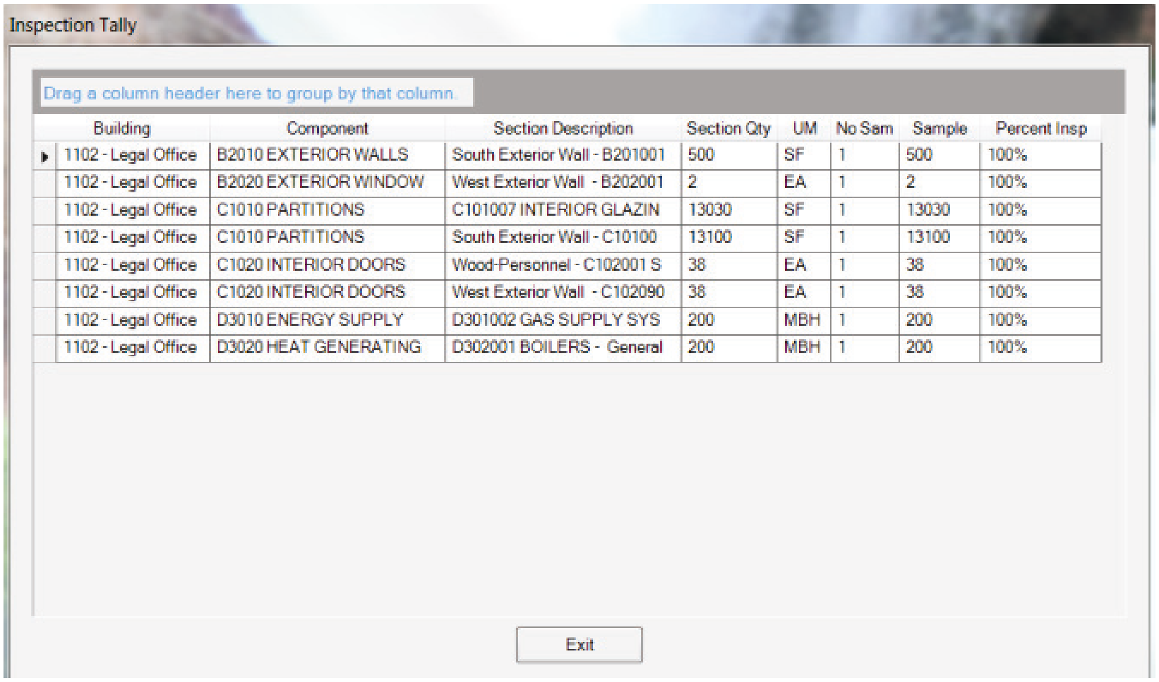
- Plan the most efficient inspection sequence and path through the building.
- Record the condition survey findings for later transfer into BUILDER.
- Refer frequently to the direct rating and distress definitions provided in this manual.
- Ensure that all assigned Component-Sections are inspected.
- Ensure that sample unit naming conventions are followed.
- Ensure that the sampling procedures, when used, are followed.
- When re-inspecting and sampling, use the previous sample unit locations, if possible.
- When sampling, be observant to "nontypical" conditions that warrant a nonrepresentative sample inspection.
- Keep track of the inspection summary (discussed in section 3.6.1 below).
- Be observant to any situation that may warrant inspection, even if the Component-Section is not on the inspection list.

Finally, for safety and efficiency, it is often best to have inspectors work in pairs or even as a larger team.

3.6.1 Keeping track of what has been inspected

The "Inspection Summary" button (see Figure 7) provides a tally of the inspection (distress surveys and direct ratings). As the condition survey continues, this summary updates to provide a current status. This update helps to ensure that Component-Sections are not missed and that the sample targets are met. Figure 7 displays an example of an inspection summary.

Figure 7. Example inspection summary.



Building	Component	Section Description	Section Qty	UM	No Sam	Sample	Percent Insp
1102 - Legal Office	B2010 EXTERIOR WALLS	South Exterior Wall - B201001	500	SF	1	500	100%
1102 - Legal Office	B2020 EXTERIOR WINDOW	West Exterior Wall - B202001	2	EA	1	2	100%
1102 - Legal Office	C1010 PARTITIONS	C101007 INTERIOR GLAZIN	13030	SF	1	13030	100%
1102 - Legal Office	C1010 PARTITIONS	South Exterior Wall - C10100	13100	SF	1	13100	100%
1102 - Legal Office	C1020 INTERIOR DOORS	Wood-Personnel - C102001 S	38	EA	1	38	100%
1102 - Legal Office	C1020 INTERIOR DOORS	West Exterior Wall - C102090	38	EA	1	38	100%
1102 - Legal Office	D3010 ENERGY SUPPLY	D301002 GAS SUPPLY SYS	200	MBH	1	200	100%
1102 - Legal Office	D3020 HEAT GENERATING	D302001 BOILERS - General	200	MBH	1	200	100%

3.7 Post-Assessment tasks

Upon completion of the FCA for a building, notify the building POC that you or your team has completed the assessment and inform the POC of any safety issues or other findings requiring immediate attention. Upon return to the office or the pre-established meeting location, notify appropriate parties concerning any safety or immediate maintenance items found. Review any notes and validate inspection data recorded in BRED to ensure accuracy and consistency. Ensure that assessments for all required components have been recorded. A data quality control process may be applied prior to uploading data into BUILDER to ensure data consistency and completeness.

3.7.1 Inspection dates of record

Each Component-Section in a given building need not be inspected on a given day. In fact, in many instances this will be impossible. However, each Component-Section must be associated with a given date for each inspection cycle. Even if inspecting the Component-Section takes more than one day, only one date shall be reported. If multiple dates are reported, BUILDER will interpret these as totally different inspections. Reasons why the inspection of a Component-Section may take more than one day are: Component-Section amount or complexity, weather interruptions, accessibility, item location, inspector sickness, emergencies, and other priorities.

To account for these reasons, BRED automatically provides for a 30-day inspection window. Once an inspection date is established for a given Component-Section condition survey inspection, inspectors have 30 days to complete the survey. The addition of more data, such as another sample, at any time within the 30 days will automatically be associated with the established inspection date.

4 Distress Survey Procedures

4.1 Introduction

The distress survey is the most accurate, reproducible, and consistent condition survey approach. It also provides a record of what's wrong with the Component-Section. The survey procedure involves visually inspecting each subcomponent present in the desired Component-Section. The distress types, their severity levels, and their quantity or density discovered for each subcomponent are recorded. The recommended distress survey applications are discussed in detail in Chapter 2.

Discussion of the procedures for conducting a distress survey inspection is provided below, using the BRED field data collection application to illustrate the process.

4.1.1 Distress definitions

Different sets of distress definitions are provided in this manual. Appendix A lists the distress set applicable to all building components except for built-up, single-ply, and asphalt shingle roofing surfaces and flashings. Those roofing distresses were developed for use with the ROOFER™ component of the SMS and are provided in Appendixes B, C, and D, respectively. They are used with BUILDER to facilitate consistency.

At the beginning of each appendix are general notes regarding application, density estimation, and other items of importance. These notes should be reviewed regularly to ensure that all inspectors apply distress ratings consistently.

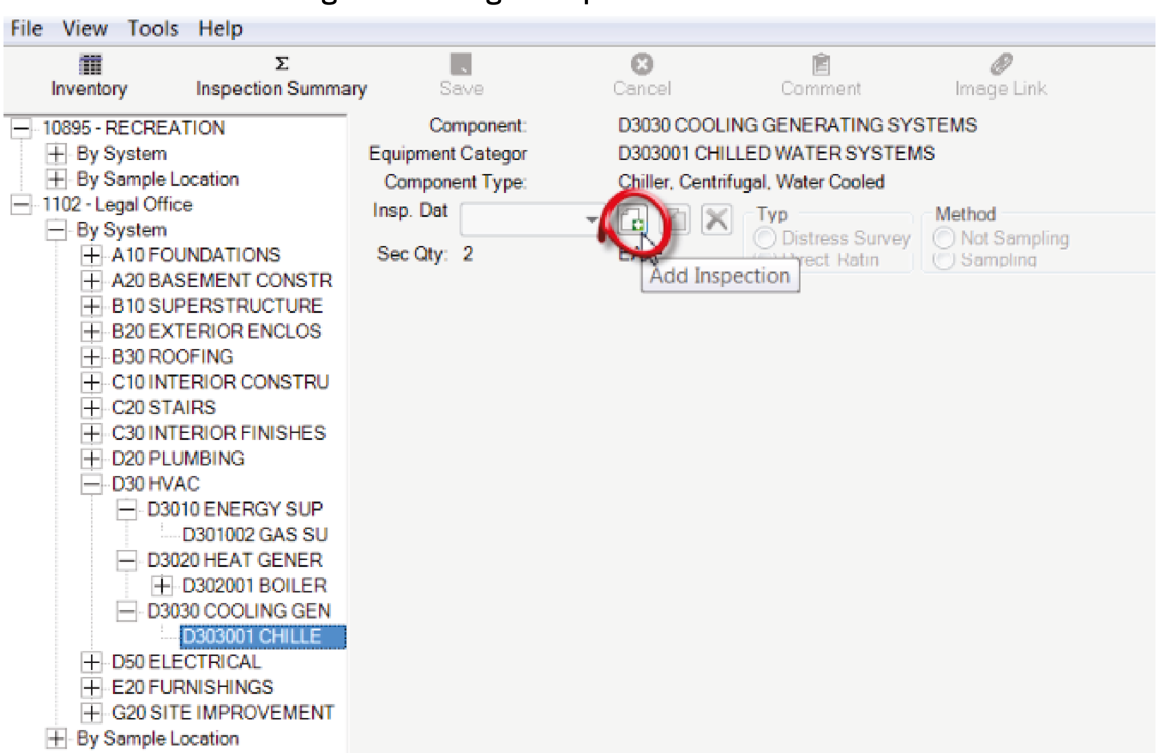
It is expected that inspectors will have the distress definitions handy for ready reference. This reference availability can be accomplished electronically through BRED, paper form, or both. Do not rely solely on memory for the definitions. Experience has shown that unnecessary error will result in certain situations, even from seasoned inspectors, if guesswork is used. If uncertain about a distress type or severity level, look it up!

4.2 Beginning the distress survey

4.2.1 Selecting the component-section, distress survey option, sample location, and quantity

Referring to Figure 8, the Component-Section to inspect will be chosen from the tree in BRED. The selection may come from the component list or the sample list, depending on whether or not sampling is being used. The most recent inspection date, quantity, and results will be shown as displayed in Figure 9 (no sampling) or Figure 10 (with sampling) if the last inspection was a distress survey. (If the last inspection was a direct rating or if the Component-Section is painted, the display will look different. Direct ratings are discussed in Chapter 5, and paint ratings are addressed in Chapter 6.) Other past inspection dates may be chosen from the date drop-down list. From here, a new inspection may be made from scratch or made from a copy of past inspection data based on the past date chosen. This is done by pressing either the **Add Inspection** button (as shown in Figure 8) or **Copy Inspection** button next to the **Add Inspection** button. The current date and current Component-Section quantity will be the default.

Figure 8. Adding an inspection to a BRED file.



If the inspection is new, the **distress survey** radio button should be selected to display the distress survey grid. For new inspections, the quantity will default to the Component-Section quantity, as stated above. The actual amount used for a given sample (if sampling is used) will need to be recorded along with the sample location.

Refer to the BRED help documentation[3] for details on specific operations using BRED, or BUILDER help documentation if the information is being manually entered directly into BUILDER.

4.2.2 Subcomponent selection

BUILDER distress surveys are conducted on a subcomponent-by-subcomponent basis for each Component-Section. However, subcomponents are not specifically inventoried in BUILDER. The number of subcomponents may vary, depending on the specific Component-Section as constructed or installed in a given building. BUILDER and BRED address this, however. When the distress survey screen is accessed, a listing of all possible subcomponents is provided, as shown in Figure 9 and Figure 10. Because BUILDER initially does not know which subcomponents are present and which ones are not, their presence is defaulted to “N/A” (not applicable). Those that are present MUST have either the “Defect Free” box checked or the applicable distresses recorded as discussed below. After the data are loaded and saved, the subcomponents will be re-sorted with those present listed at the top.

> **WARNING:** If subcomponents are present but marked “N/A,” then all of the condition indexes will be computed at lower levels than they really are. Thus, it is imperative that great care be taken with this detail.

There is one exception to the subcomponent “N/A” and “Defect Free” requirement. If ALL the subcomponents present are “Defect Free,” then a global declaration option can be made by checking the “Defect Free” checkbox (see Figure 9 and Figure 10). Selecting the global declaration of Defect Free in this case can be a time saver.

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[3] https://www.sms.erdc.dren.mil/Products/BUILDER/Downloads.

Figure 9. BRED distress survey screen (no sampling).

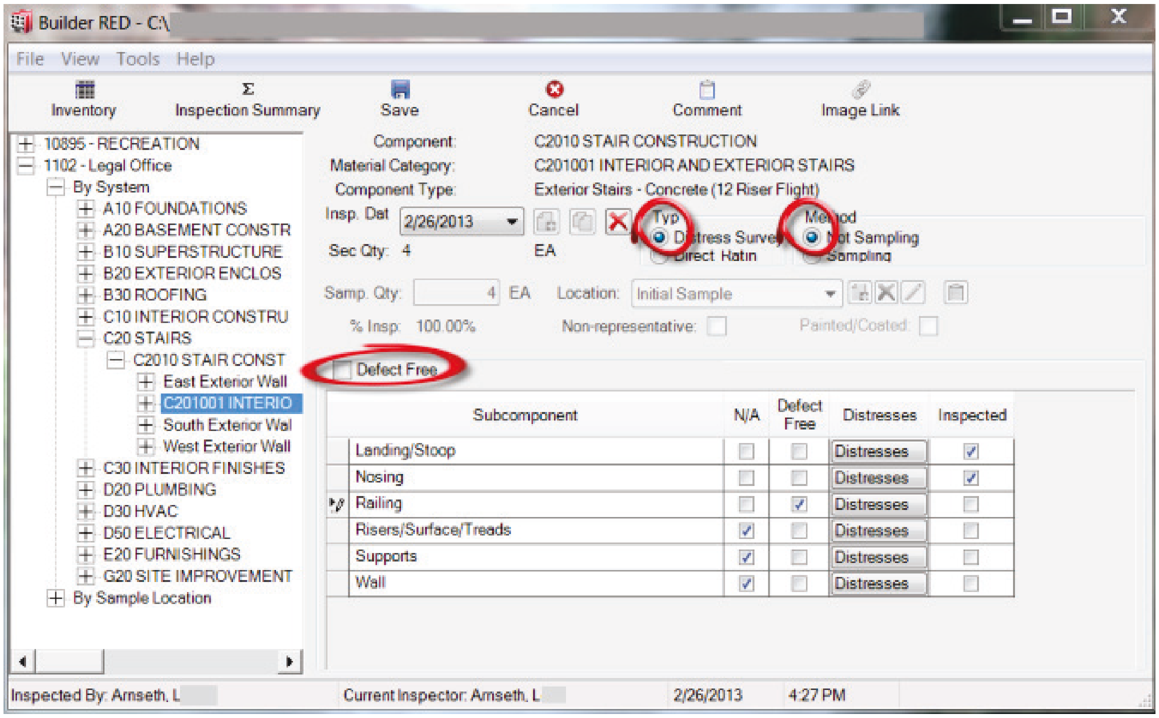
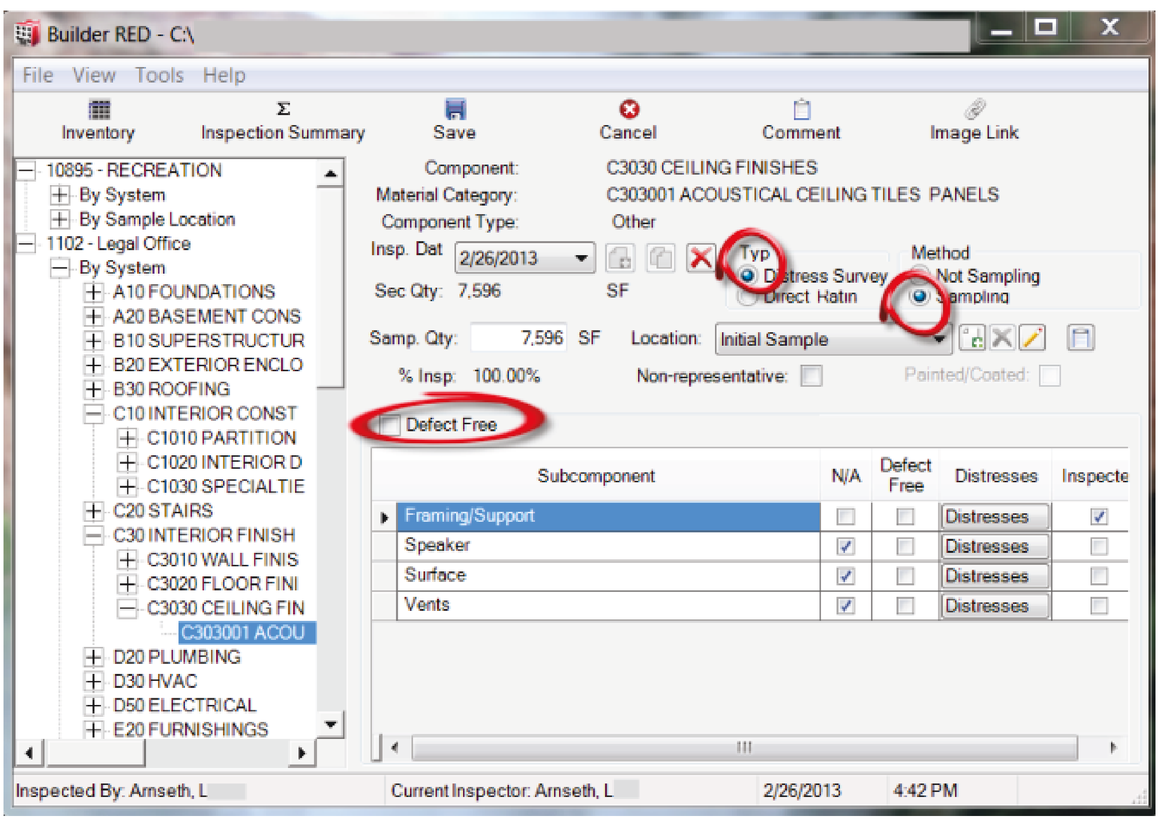


Figure 10. BRED distress survey screen (with sampling).



4.3 Distress density vs. distress quantity

There are three primary reasons for collecting distress quantity data, as listed below:

- Estimating density is not permitted or desired (business process decision).
- Computing actual density is necessary.
- Quantifying or refining work needs is desired.

A BUILDER distress survey permits the inspector to record either the measured distress quantities or an estimate of density within predefined ranges. If quantities of subcomponent and distresses are entered, then BUILDER or BRED will compute the density. The "Overview" chapter discussed the differences and intent of the two different approaches.

Simply recording an estimate of density is faster than recording quantity data, but it is also prone to error. Sometimes estimating density may be difficult or it may be found to be too inaccurate. If so, the distress quantities may be entered into BRED (or BUILDER), and the appropriate density range will be computed. This computation is illustrated in Figure 11.

If distress quantities are used, the subcomponent quantity will also need to be entered so that density can be computed. Because subcomponents are not inventoried, BUILDER will rarely know what these values are. (There are some instances when the subcomponent quantity is the same as the Component-Section or sample quantity.) The subcomponent quantity can be either estimated or measured.

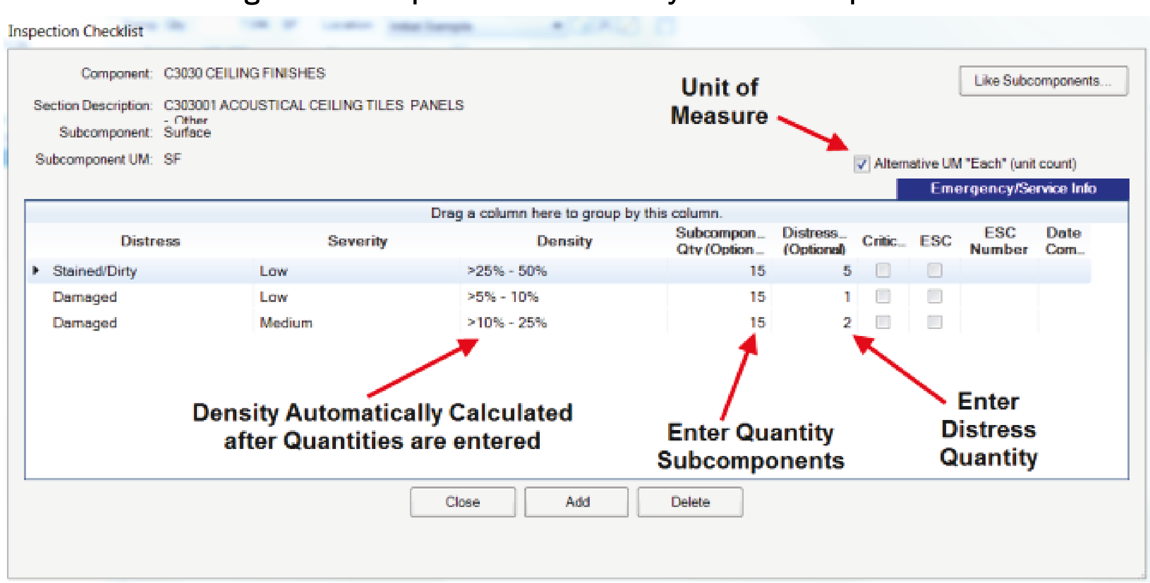
Sometimes, using a unit count instead of an area or length measurement will speed the inspection by doing the following: eliminating the need to measure and compute a subcomponent's area or length, providing the necessary density computation, and offering an advantage of giving a logical repair measurement. For example, there may be 16 sq ft of damaged ceiling tiles in a room that is 120 sq ft. This computation could also have been gathered by counting the damaged two tiles of the 15 tiles present. Plus, now the repair quantity is known (i.e., two tiles). Thus, using a unit count is an alternative unit of measure option for the subcomponent. With BRED, the subcomponent unit of measure is displayed (Figure 11). If the alternative unit count is used as the unit of measure, mark the checkbox for Alternative UM "Each" to indicate that this method was used. The example in Figure 11 used this approach.

4.4 Recording distresses

4.4.1 Recording distresses and other data with BRED

Referring to Figure 9 and Figure 10, the **Distresses** button on the subcomponents row is pressed to record all distresses. Look for the presence of distresses; for each distress found, record the applicable distress type, severity level, and density range (or distress quantity) for that subcomponent. Particular care must be taken to adhere to the definitions and notes for each distress (see Appendices A–D). When completed entering distresses for one subcomponent, inspect the next subcomponent. When all of the subcomponents have been inspected, the inspection for that Component-Section or that sample (if sampling) is completed. The process repeats for the next Component-Section or sample. Figure 11 shows a completed distress survey for a given subcomponent.

Figure 11. Completed distress survey for a subcomponent.



4.4.2 Recording distress data without BRED

Distress surveys can be accomplished without BRED. When conducting assessments in the field, data can be recorded on custom worksheets, or the information can be recorded free-form. The key is recording the proper data for later entry into BUILDER.

4.4.3 Recording distress severity

4.4.3.1 Multiple severity levels

Most distress types have more than one severity level defined. When conducting a distress survey, the inspector must be aware that more than one severity level for a given distress type may be present in the same Component-Section subcomponent. As an example, Figure 11 shows two different severity levels present for the same distress type.

4.4.3.2 Critical distresses

Figure 11 shows a checkbox labeled “Critical.” This box should be checked to trigger a repair within the first year of a work plan, even if there is still RML for the Component-Section. Thus, checking “Critical” overrides the RML for work planning. “Critical” can also be used to denote “Stop Gap” repairs prior to a future planned project.

4.4.3.3 Emergency service calls (ESC)

The “ESC” checkbox (see Figure 11) is used to flag the need for a quick and relatively inexpensive emergency/service call (ESC) to correct a problem found during the inspection. This flag is different from the “Critical” flag described in subsection 4.4.3.2 above. ESC is smaller in scope, represents unplanned work, and will be acted on in a few hours (emergency call) or days (service call).

> **Note: “Critical” and “ESC” should not be used together.**
>
> If an emergency call or service call has been issued from a previous inspection, and an ESC number and completion date (if completed) have been entered into BUILDER, the number and date will be seen in BRED. If the past inspection is copied into a current inspection, this distress will most likely be deleted since it should no longer be present.

4.4.4 Recording distress data without sampling

For each Component-Section, record the system, component name, identifying Section name if used (e.g., Roof Section A), material (or equipment) type, and/or component type. These descriptors will uniquely identify the Component-Section being inspected. Then identify and record all distress types, severity levels, and density ranges (or subcomponent quantity and distress quantity) for the subcomponents present.

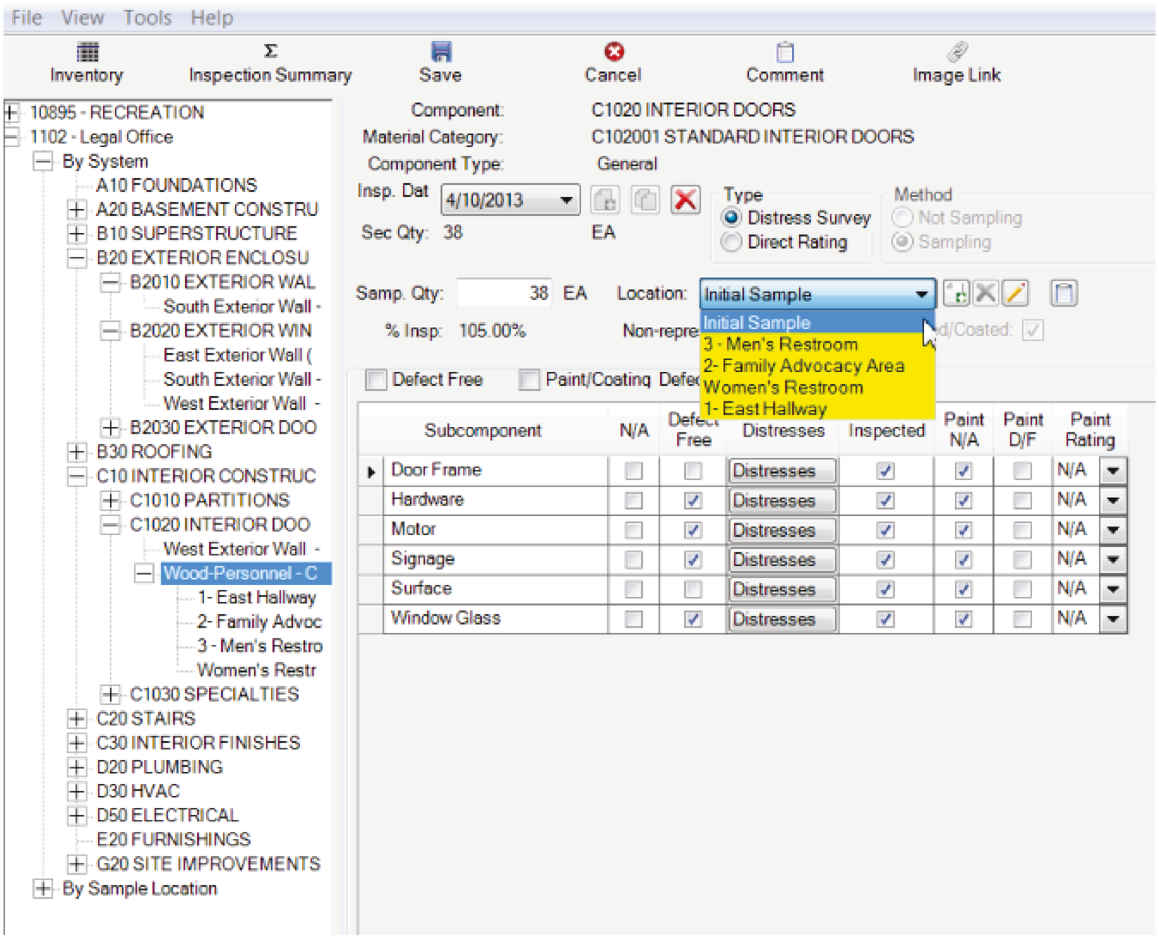
4.4.5 Recording distress data with sampling

4.4.5.1 Copying a previous distress survey

When using sampling, reinspection of previously defined Component-Section sample units is strongly recommended. Doing this permits copying the last distress survey, meaning that all distresses, severity levels, and densities for all subcomponents will be copied into the current inspection. Thus, if no work has been accomplished since the last inspection, all of the past distresses will be present. Of course the distress' severity levels may be worse, the quantity or density of distresses may be higher, and additional distresses may be present. But for those distresses that are the same, only verification is needed, thus saving time and effort plus adding to consistency and reproducibility of the survey. Any changes in distresses can be recorded through the Edit command. New distresses will be added as they would be for a new inspection.

To help track whether all copied sample locations have been inspected and the data has been saved for each one, the sample location combo box will have a yellow background until all sample locations have been saved for the current inspection. This yellow background is illustrated in Figure 12. After all sample location data are saved, the background will revert to white.

Figure 12. Distress survey copy with Component-Section sample locations in yellow.



4.4.5.2 Recording distress data

For each Component-Section included in the sample, record the system, component name, identifying Section name if used (e.g., Roof Section A), material (or equipment) type, component type, sample quantity, and whether the sample is representative. These descriptors will uniquely identify the Component-Section being inspected. Next, identify and record all distress types, severity levels, and density ranges (or subcomponent quantity and distress quantity) for the subcomponents present.

5 Direct Rating Procedures

5.1 Introduction

The direct condition rating procedure is an abbreviated method for performing a condition survey. It involves visually inspecting each Component-Section, evaluating the entire Component-Section against a set of rating criteria, and selecting the appropriate rating. The recommendation for use of direct ratings is described in section 2.4.2 in Chapter 2.

5.2 Direct rating definitions

5.2.1 Rating interpretation

The direct rating approach consists of applying three broad rating categories–Green, Amber, and Red. Green implies that the Component-Section is suffering little, if any, serviceability loss due to degradation; some sustainment (preventive maintenance or minor repairs) may be needed, but they are not significant enough to place the Component-Section on a corrective maintenance work plan. Red implies serious serviceability problems due to degradation; significant restoration or sustainment is needed in the form of major repair, rehabilitation, or replacement. Amber (or yellow) ratings represent the middle and imply a sense of caution. With an Amber rating, further analysis may be needed (e.g., a distress survey).

Each of the three broad rating categories listed above is further divided into three more-specific ratings, denoted by high (+), low (-), and middle. The (+) and (-) ratings serve as transitional ratings between Green and Amber, and between Amber and Red, and they provide more resolution to the condition rating.

Table 2 shows the direct rating definitions. The descriptive text is applicable to an entire Component-Section, or, if sampling, to a Component-Section sample. The rating *definitions* are not intended to totally or exactly describe all Component-Section situations. Rather, the rating intent described above should be adhered to in the inspection.

> **Note:** The direct condition rating definitions are repeated in Appendix E of this manual for ready reference.

It is likely that situations will arise that are not clearly defined in the rating definitions, and it may seem that either of two (or more) ratings could be appropriate. When this situation occurs, choose the rating that best fits the situation. While Table 2 is provided to help differentiate the ratings, think carefully of the intent behind the Green, Amber, and Red rating definitions, and apply them accordingly. In this context, evaluating serviceability and reliability consists of asking the question, “Because the Component-Section has one or more purposes for its existence, is it doing what it is supposed to do without disruption?” Certain subcomponent degradation may or may not prevent the Component-Section from reliably performing as desired. When rating, consider both the serviceability and the reliability of the Component-Section as well as the extent (quantity, importance, and magnitude) of subcomponent degradation.

Mechanical and electrical (e.g., HVAC) Component-Sections may require careful thought regarding serviceability loss. Total serviceability loss may occur due to minor reasons (e.g., broken wire, failed switch). However, in such situations, the overall Component-Section condition could still be Green, because perhaps only a minor fix will be needed to correct the serviceability problem.

Table 2. Direct condition rating definitions.

Rating	SRM Needs	Rating Definition
Green (+)	Sustainment consisting of possible preventive maintenance (where applicable)	Entire Component-Section or Component-Section sample is free of observable or known distress.
Green	Sustainment consisting of possible preventive maintenance (where applicable) and minor repairs (corrective maintenance) to possibly few or some subcomponents.	No Component-Section or sample serviceability or reliability reductions. Some, but not all, minor (noncritical) subcomponents may suffer from slight degradation, or a few major (critical) subcomponents may suffer from slight degradation.
Green (-)		Slight or no serviceability or reliability reduction overall to the Component-Section or sample. Some, but not all, minor (noncritical) subcomponents may suffer from minor degradation, or more than one major (critical) subcomponent may suffer from slight degradation.
Amber (+)	Sustainment or restoration to any of the following: minor repairs to several subcomponents; or significant repair, rehabilitation, or replacement of one or more subcomponents, but not enough to encompass the Component-Section as a whole or combinations thereof.	Component-Section or sample serviceability or reliability is degraded, but adequate. A very few, major (critical) subcomponents may suffer from moderate deterioration, with perhaps a few minor (noncritical) subcomponents suffering from severe deterioration.
Amber		Component-Section or sample serviceability or reliability is definitely impaired. Some, but not a majority, of major (critical) subcomponents may suffer from moderate deterioration, with perhaps many minor (noncritical) subcomponents suffering from severe deterioration.
Amber (-)		Component-Section or sample has significant serviceability or reliability loss. Most subcomponents may suffer from moderate degradation, or a few major (critical) subcomponents may suffer from severe degradation.
Red (+)	Sustainment or restoration is required consisting of major repair, rehabilitation, or replacement to the Component- Section as a whole.	Significant serviceability or reliability reduction in Component–Section or sample. A majority of subcomponents are severely degraded, and others may have varying degrees of degradation.
Red		Severe serviceability or reliability reduction to the Component-Section or sample such that it is barely able to perform. Most subcomponents are severely degraded.
Red (-)		Overall Component-Section degradation is total. Few, if any, subcomponents are salvageable. Complete loss of serviceability for Component-Section or sample.

5.2.2 Abbreviated rating approach

The abbreviated direct rating approach should accomplish the same result as the Distress Survey approach, although with slightly more CI variability due to a less rigorous data collection process and provided the following guidelines are followed:

- Consider the primary function of the component and determine the level of loss of this function (if any) due to condition deterioration. This determines the Green, Amber, or Red nominal rating.
- Consider the secondary functions of the component and determine the loss of these functions due to condition deterioration. This determination may result in a plus or minus adjustment from the nominal rating. A simplified rating matrix using this schema is shown in Table 3.

Table 3. Direct condition rating definitions, abbreviated table.

		Loss of Secondary Functions		
		Minimal	Moderate	Significant
Loss of Primary Function	None	G+	G	G-
	Partial	A+	A	A-
	Significant	R+	R	R-

In the case of an exterior door component, consider the primary and secondary functions discussed above and consider examples of primary function loss for each level, including the following:

- **None.** No loss of function; door provides a barrier to unwanted movements, while remaining fully operational.
- **Partial.** Noticeable deterioration to frame, surface, or weather stripping/seals, which may allow partial movement when closed, and/or door is less than fully operational. Safety is not an issue.
- **Significant.** Deterioration to components of door assembly allows significant potential for unwanted movement and/or significant operational issues due to damage or misalignment of frame, door, or hardware, which may present a safety issue.

Likewise, considering secondary function loss for each level based on the chart above, the following terms could apply:

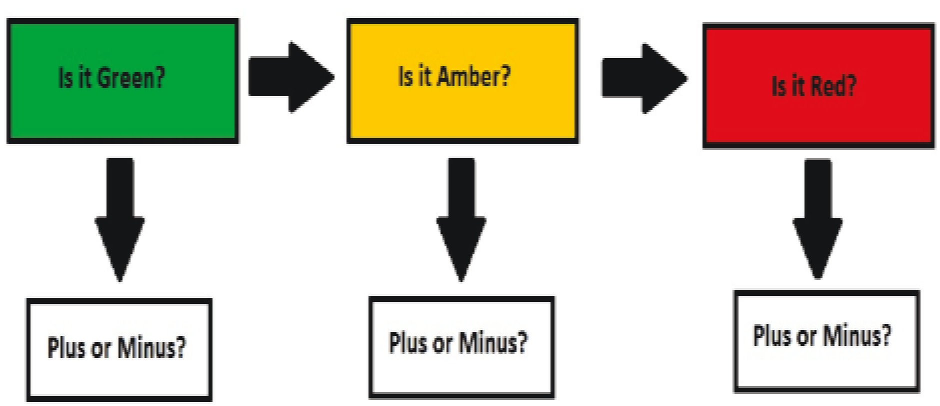
- **Minimal.** No loss or only minimal loss of aesthetics or thermal or moisture control.
- **Moderate.** Moderate loss of aesthetics due to faded paint or slight corrosion.
- **Significant.** Significant loss of aesthetics and/or inability to control thermal and air movements.

Note: These are forward-looking assessments that should consider the potential for additional loss in function. So this rating should not just consider the current loss of function, but also consider any expected loss over the next inspection and repair planning cycle (typically annual). For example, if a component is observed to be fully functional at the time of the inspection, but due to age or observed distresses it is reasonable to expect a reduction in function in the near-term, that reduction in function should be considered in the rating. It is worth noting that some systems may have components that are new but the system might still have deficiencies that could affect existing or future function.

5.2.3 Two-step rating process

The rating process should consist of two steps. The first step is the determination of the general Green, Amber, or Red rating. Fundamentally, the thought process should be, "Is it Green? – yes or no." If no, "Is it Red? – yes or no." If no to Red and Green, then it must be Amber. The second step is the possible refinement of the rating with a (+) or (-). This thought process should follow, "Is it at the high (+) end? – yes or no." If no, "Is it at the low (-) end? – yes or no." If no again, then there is no (+) or (-) to apply. Figure 13 is an illustration of this process.

Figure 13. Direct rating thought process.



5.3 Conducting a direct condition rating inspection with BRED

5.3.1 Selecting the component-section, direct rating option, sample location, and quantity

Referring to Figure 14, the Component-Section to inspect will be chosen from the tree. The selection may come from the component list or the sample list, depending on whether or not sampling is being used. The most recent inspection date, quantity, and results will be shown as displayed in Figure 14 (no sampling) or Figure 15 (with sampling) if the last inspection was a distress survey. (If the last inspection was a distress survey or if the Component-Section is painted, the display will look different. Distress surveys were discussed in Chapter 4, and paint ratings will be addressed in Chapter 6). Other past inspection dates may be chosen from the date dropdown list.

From here, a new inspection may be made from scratch or made from a copy of past inspection data based on the past date chosen. This is done by pressing either the **New Inspection** or **Copy Inspection** button next to the **Date** field. The current date and Component-Section quantity will be the default information loaded. If the inspection is new, the **direct rating** radio button should be selected to display the direct rating choices. For new inspections, the quantity will default to the Component-Section quantity. The actual amount used for a given sample (if sampling is used) will need to be recorded along with the sample location.

Refer to the online BRED help documentation for details on specific operations.

Figure 14. BRED direct rating screen (no sampling).

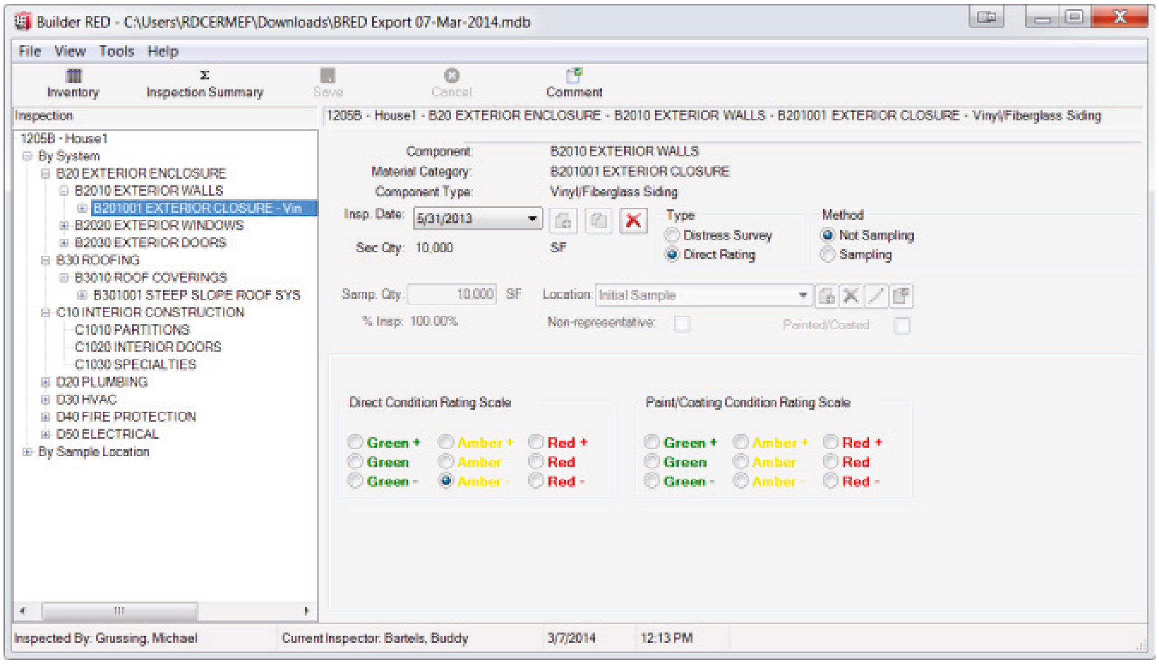
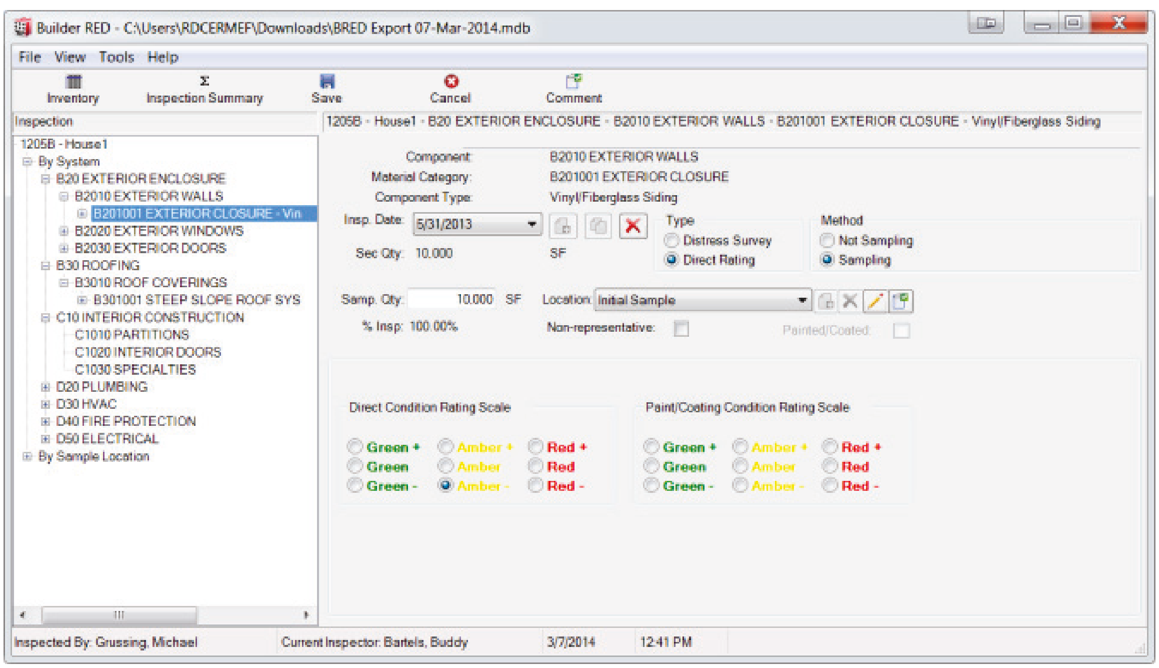


Figure 15. BRED direct rating screen (with sampling).



5.3.2 Recording direct ratings

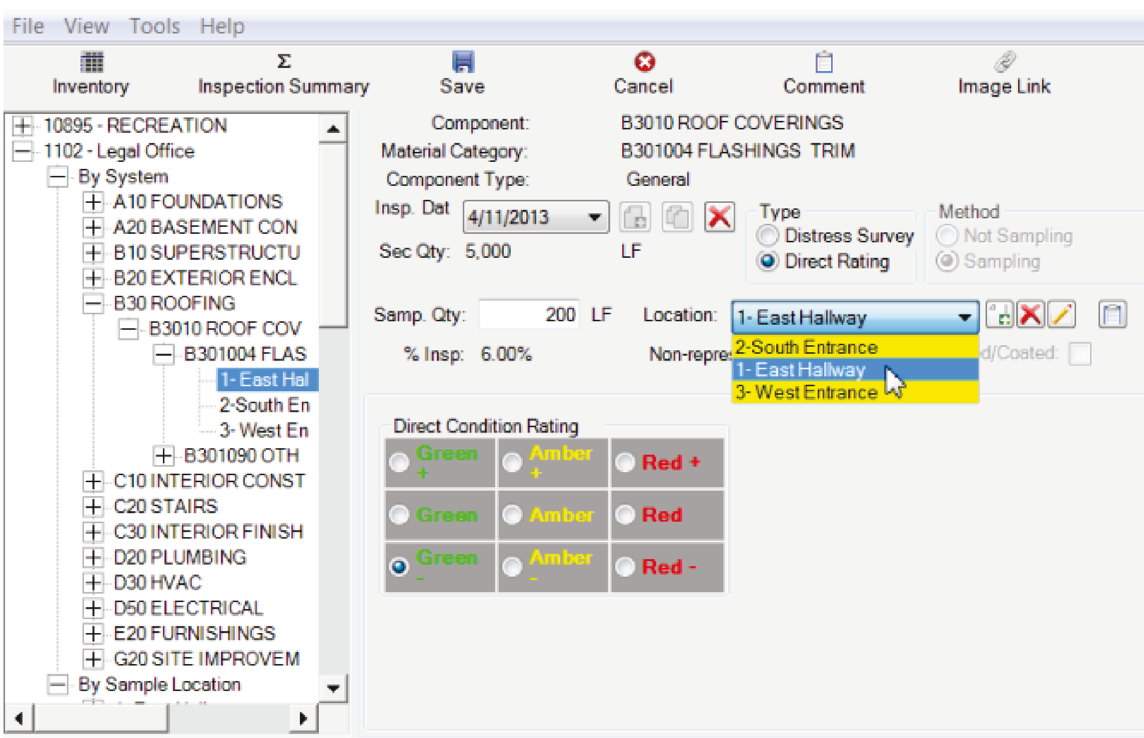
Referring to Figure 14 and Figure 15, only the appropriate rating button needs to be selected to complete the survey. Keep in mind that the rating applies to the entire Component-Section or Component-Section sample. Individual subcomponents are not rated. Particular care must be taken to adhere to the direct rating definitions given in Table 2 and Appendix E, and the rating intent described in Section 5.2 above. When completed, inspect the next sample or repeat the procedure to rate the next Component-Section.

5.3.3 Copying a previous direct rating

It was stated previously that re-inspection of previously defined Component-Section sample units is STRONGLY recommended. Re-inspecting previously defined sample units permits the inspector to copy the last direct rating into this inspection. The rating can be changed, if necessary, if the inspection findings are different.

To help track that all copied sample locations have been re-inspected, the sample location combo box will have a yellow background as illustrated in Figure 16. After all sample locations are re-inspected and saved, the background will revert to white, thus indicating that all sample locations have been re-inspected.

Figure 16. Direct rating copy component-section sample locations shown in yellow.



6 Paint Rating Procedures

6.1 Introduction

BUILDER requires that paint inspection not be done as a separate inspection from the Component-Section itself; both must be done with the same inspection date.

During an inspection, the inspector will likely find many components that have a painted or coated surface, such as varnishes, stains, and water seals, in addition to the traditional latex- and oil-based paints (note that in BUILDER, the terms painting and coating are used interchangeably). When painted or coated surfaces exist for a component, the condition of that coating is usually evaluated and rated separately from the overall condition of the component itself. This is because work activities related to repainting or re-coating can usually be performed separate from any other repairs that may occur. It is thus important to have a separate condition scale that reflects just the coating, to determine when performing these activities are most prudent.

It is important to note, however, that the condition of the paint is one of the most influential factors in the condition of the overall component, because it typically serves as a protective barrier against environmental elements and external forces of deterioration. As a result, the paint coating on a component serves a critical preservation function for the component substrate, and while the paint is typically rated separate from the overall condition, it can be a significant indicator of underlying problems with the overall component. Because of this, when a coating rating is performed, it is always done in conjunction with the overall component rating. In other words, the coating rating and overall component rating are performed by the same inspector on the same date, and are recorded on the same inspection record.

6.1.1 Do all "coated" components receive a paint rating?

Just about any component may conceivably be classified as painted, including many types of HVAC and electrical equipment. However, a paint rating might not be necessary for all these components. In general, paint and coatings will only be rated when repainting or resealing is an expected recurring work activity for that component. The activities include such items as resealing a wood deck, repainting interior walls, or re-varnishing wood stairs. In the case of factory finishes applied to the enclosure of HVAC equipment, these coatings would not typically be rated separately via a paint rating because recurring recoating is not likely for these finishes.

6.1.2 When is paint rated?

Almost any Component-Section may be painted. However, that doesn't necessarily mean that the paint on that Component-Section should be evaluated separately from the Component-Section itself.

Generally, paint and coatings will be inventoried and rated when repainting or resealing is an expected recurring work activity. These include such items as resealing a wooden deck, repainting interior walls, or re-varnishing a set of wooden stairs. Inventorying and rating will get these activities triggered and placed on the work plan. If only minor subcomponents are painted (e.g., steel handrails on a set of concrete stairs), the concrete stair Component-Section will usually not be inventoried as being painted. Any paint problems on the handrail will be considered through the inspection of that subcomponent. This is why paint problems are addressed in some of the distress definitions in Appendix A.

Paint/coatings will only be rated when the Component-Section is declared "painted/coated" in the BUILDER inventory. BUILDER inventory procedures address when a Component-Section is considered painted (or coated). Fundamentally, there are two factors to consider when deciding when paint/coatings will be inventoried. The first is the significance of the paint/coating to the Component-Section as a whole. Some Component-Sections consist of two or more subcomponents, not all of which may be painted. Those subcomponents that are painted may be only a small portion of the overall Component-Section. Second, many Component-Section subcomponents have factory-applied paint finishes. Generally, these finishes are applied to preserve the subcomponent and are rarely repainted on a periodic basis. Thus, the paint life is often equal to the Component-Section life.

6.1.3 Paint or coating rating definitions

The paint or coating on a component is performed similarly to the direct condition rating approach discussed in Chapter 5. Here, a Green, Amber, or Red condition range is first determined, and then a (+) or (–) modifier is given if the coating condition is at the upper or lower end of that range. *This same paint rating approach is performed, regardless of whether the overall component is being inspected using a distress survey or a direct rating assessment*. The one difference is that in a distress survey inspection, the direct condition paint ratings are applied at a subcomponent level, while in a direct survey inspection, one paint rating is given for the overall component. In addition, if sampling is used, a paint rating can be provided for each sample.

Paint rating guidelines for each rating are provided in Table 4 below, and are based on a combination of coating deterioration and density. As mentioned above, the direct rating approach consists of three broad categories (nine total categories defined by the % Deteriorated) described as Green, Amber, and Red. Green implies that the paint or coating is suffering little, if any, serviceability loss due to degradation, and some sustainment (touch up painting) may be needed, but not significant enough to place on a corrective maintenance work plan. This is reflected in the small % Deteriorated. Red implies serious serviceability problems due to degradation and significant repainting or recoating (usually to the entire Component-Section or Component-Section sample) is needed. As can be seen, relatively low percentages of deterioration warrant significant repainting or recoating. This is primarily due to aesthetics. Amber (or yellow) ratings represent the middle and suggest that repainting or recoating is needed soon.

Note that definitions listed in Table 4 are also in Appendix E for ready reference.

Table 4. Paint/coating rating criteria.

Rating	% Deteriorated	Relative Amount Deteriorated
Green (+)	0.00-0.03	Up to about 1" x 4" in a 8' x 10' area; 1/32" in a 10' length; or 3 in 10,000
Green	0.03 – 0.10	Between about 1" x 4" and 1" x 12" in a 8' 10' area; 1/32" and ⅛" in a 10' length; or 3 and 10 in 10,000
Green (-)	0.10 – 0.30	Between 1" x 12" and 3" x 12" in a 8' x 10' area; ⅛" and ⅜" in a 10' length, or 1 and 3 in 1000
Amber (+)	0.30 – 1.00	Between 3" x 12" and 10" x 12" in a 8' x 10' area; ⅜" and 1¼" in a 10' length; or 3 and 10 in 1000
Amber	1.00 – 3.00	Between 10" x 12" and 18" x 18" in a 8' x 10' area; 1¼" and 3¾" in a 10' length; or 1 and 3 in 100
Amber (-)	3.00 – 10.0	Between 1' x 2½' and 1' x 8' in a 8' x 10' area; 3¾" and 12" in a 10' length; or 3 and 10 in 100
Red (+)	10.0 – 17.0	Between 1' x 8' and 1¾' x 8' in a 8' x 10' area; 1' and 1¾' in a 10' length; or 10 and 17 in 100
Red	17.0 – 33.0	Between 1¾' x 8' and 3⅓' x 8' in a 8' x 10' area; 1¾' and 3⅓' in a 10' length; or 17 and 33 in 100
Red (-)	33.0 - 100	Greater than 1/3 of area, length, or amount

6.2 Paint and coating rating procedures

6.2.1 Distress survey

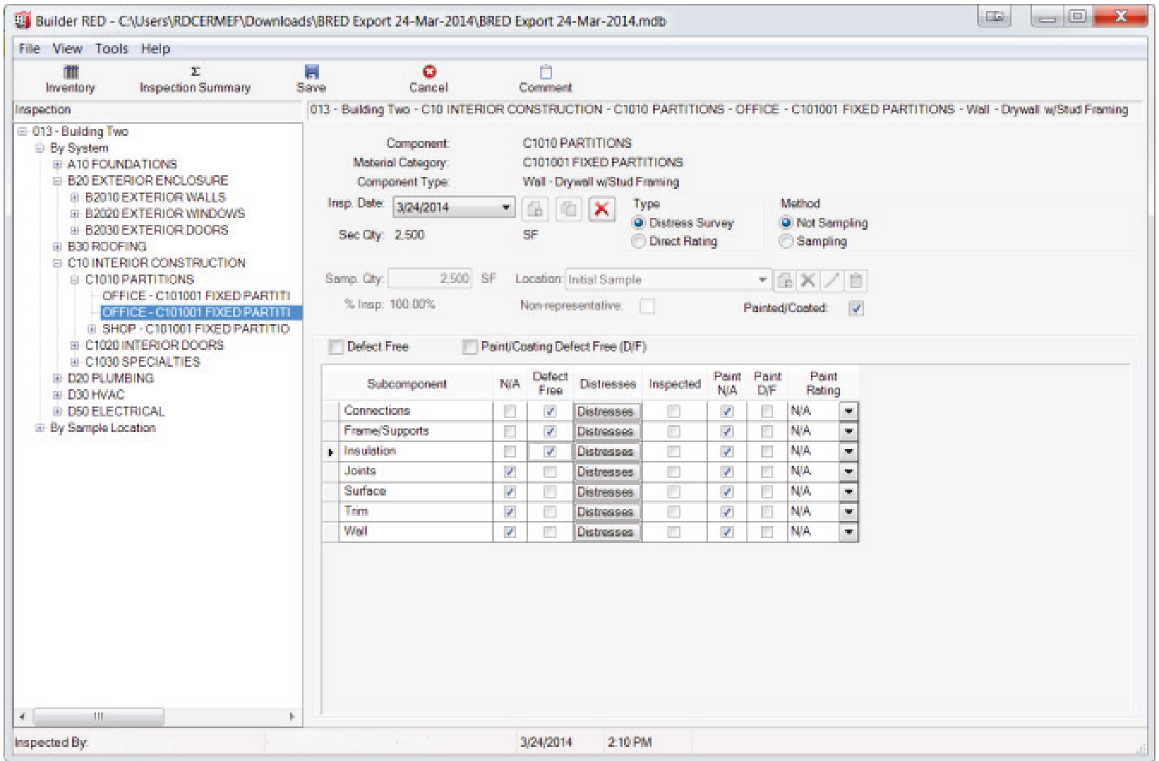
When performing a distress survey, each painted or coated subcomponent also shall be rated. This survey screen is shown in Figure 17 if BRED is being used. (Note: the screen is slightly different if sampling is used, but that screen is not shown here). The applicable rating will be chosen from the paint rating drop-down list. Any subcomponents not painted will not have a rating.

Recall from Figure 9 in Chapter 4 (Distress Survey Procedures) that if the Component-Section is not inventoried as painted/coated, the paint/coating portion of the screen is not visible. In those cases, when certain subcomponents are painted, the paint will be evaluated as part of the subcomponent distress.

If a distress survey is being copied for reinspection (see Chapter 4), the paint ratings copy over as well.

If BRED is not used, each subcomponent needs to be appropriately marked as shown in Figure 17 (no sampling).

Figure 17. Distress survey screen when component-section is painted/coated (no sampling).



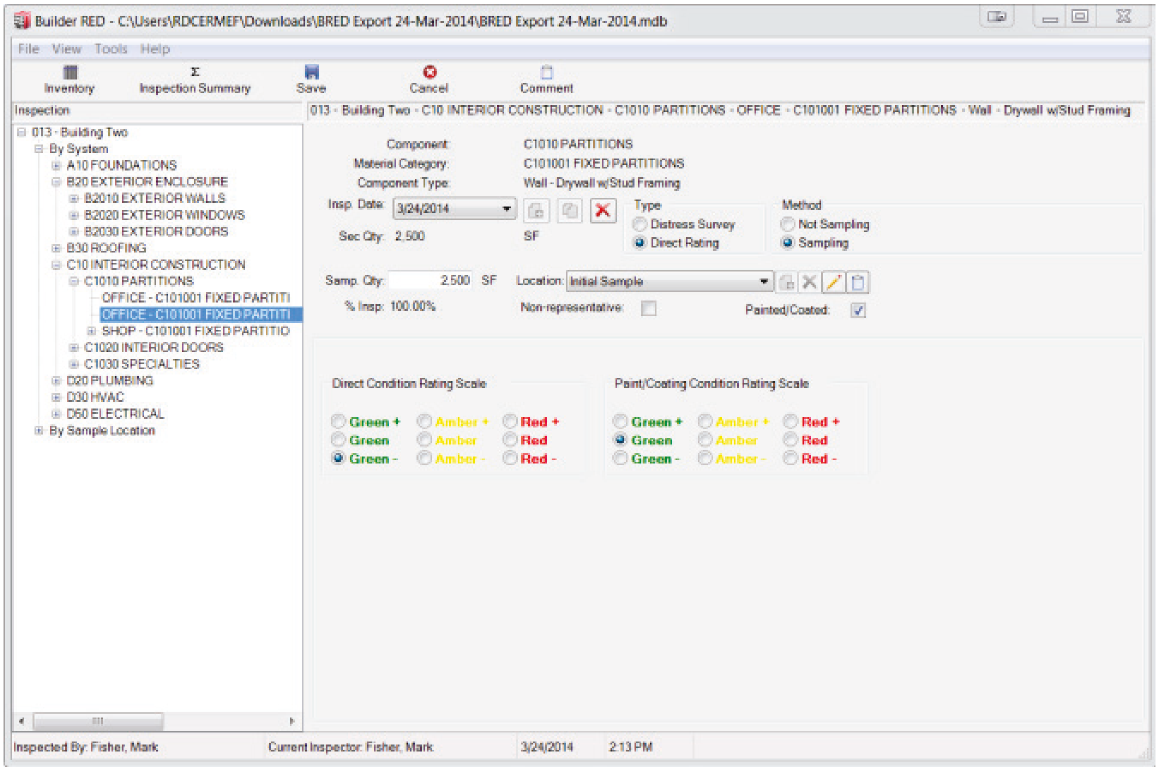
6.2.2 Direct condition rating

When performing a direct condition rating, evaluate the Component-Section paint or coating in its entirety. The “% Deteriorated” is to be based on the painted portions only. Refer to Figure 18 for marking paint ratings in BRED. (Note: the screen is slightly different if sampling is not used, but that screen is not shown here for brevity). Recall from Figure 9 that if the Component-Section is not inventoried as painted/coated, the paint/coating portion of the screen is not visible. In those cases and when certain subcomponents are painted, the paint will be evaluated as part of the overall Component-Section rating.

If a direct rating is being copied for reinspection (see Chapter 5), the paint ratings copy over as well.

If BRED is not used, the paint rating is recorded as shown in Figure 18 (with sampling).

Figure 18. Direct rating screen when component-section is painted or coated (with sampling).



Appendix A: Distress Survey Definitions

General notes

1. These distresses are intended to apply generically to all subcomponents that collectively form building Component-Sections.
2. Structural Component-Sections and subcomponents must be viewed from a loss of structural integrity perspective. A severity level of High must be recorded should the presence of any distress type compromise the structural integrity of the Component-Section or subcomponent.
3. A High rating for level of severity must be recorded for any distress type, regardless of distress density, that is resulting in an unacceptable health, life/safety, or security risks.
4. There are two general rules. One, if a certain distress type is a special case of another distress type, only record the special case. Two, if a certain distress type results from the existence of another distress, record both. Pay particular attention to the notes provided for each distress definition; they often address the application of these rules.
5. Where multiple severity levels are present for a given distress type on a given subcomponent, record each separately with the appropriate amount or density, unless stated otherwise for a given distress type. The total amount or density for all severity levels cannot exceed 100%.
6. Distress quantities or distress density may be recorded. If distress quantities are recorded, density ranges will be computed in BUILDER or BuilderRED. If distress densities are recorded, distress quantities will be blank in BUILDER or BuilderRED.
7. Some of the distress definitions described herein make note of a "replacement unit." Certain component-sections are a collection of units. Examples of this are tiles (ceiling, floor, etc.). If the logical work action for these units is to replace some or all of them (e.g., a cracked ceiling tile will be replaced), then the distress quantity and/or density should reflect the area, length, or quantity of the distressed units rather than the distress itself.
8. If during the course of the inspection, additional occurrences are found of distress-severity combinations for a given Component-Section subcomponent or subcomponent sample (if sampling), adjust the distress quantity or distress density as necessary.
9. Density ranges, when recorded instead of distress quantities, can be estimated as described in Table A1.

10. Some subcomponents have a unit of measure of “Each.” Distress densities may apply to the entire unit or a unit portion as indicated in the definitions below. Density must first be applied to an entire unit and then applied across multiple units, if present. For example, if a fan belt has been chewed by a rodent, the distress density for that unit would be 100% regardless of how much of the belt has been chewed because the belt as a whole is adversely affected. But if there are three belts present, and the other two are free of that same distress, the density will drop to 33%.
11. Distresses for built-up, single-ply, and asphalt shingle roofing (membrane, flashing, etc.) shall follow the ROOFER™ SMS definitions for roofs that are provided in Appendices B–D. Densities may be estimated or distress quantities may be recorded.

Table A1. Distress density estimation visual clues.

Density (%)	Visual Cue (when applicable)
>0%–0.1%	Difficult to notice even by careful observation, especially if spotty. (Up to about 1" x 12" in an 8' x 10' area; 1/8" in 10' length; or 1 in 1000.)
>0.1%–1%	Somewhat noticeable, but easily missed by casual observation, especially if spotty. Careful observation usually needed, if spotty. (Up to about 10" x 12" in an 8' x 10' ft area; 1¼" in 10' length; or 1 in 100.)
>1%–5%	Noticeable, even by casual observation, but still only a mere fraction of total area. (Up to about 1' x 4' in an 8' x 10' area, 6" in 10' length; or 1 in 20.)
>5%–10%	Easily noticeable even if spotty; more than a mere fraction. (Up to about 1' x 8' in an 8' x 10' area; 1' in 10' length; or 1 in 10).
>10%–25%	Readily noticeable, but less than 1/4 of area, length, or amount.
>25%–50%	Very noticeable, but less than 1/2 of area, length, or amount.
>50-<100%	Overwhelmingly noticeable; greater than 1/2 of area, length, or amount.
100%	Entire area, length, or amount.

Distress summary listing

All distresses are summarized in the list below. Details of each are given in the sections that follow below the list. (Note that the list below is formatted to jump to the related section when you click on the distress.)

General distresses: Animal/insect damaged

Definition:

Subcomponent has been gnawed, chewed, scratched, bitten, or otherwise damaged by animals, birds, and/or insects. Evidence includes holes, droppings, nests, sawdust, shavings, and particle matter indicating the presence of animals, birds, and/or insects.

Notes:

- Nests may not indicate animal or insect damage, but they indicate past or current presence of animals, birds, or insects. Nests should be recorded under “Moisture/Debris/Mold Contaminated.”
- Damage may be internal. Therefore, if clues indicate animal, bird, or insect damage, the subcomponent should be sounded with a hammer or mallet. A hollow sound may indicate internal damage.
- If damage includes staining, record “Stained” in addition to “Animal/Insect Damaged.” If the only damage is staining, only record Stained and do not record Animal/Insect Damaged.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and, as a result of the animal or insect damage, a leak has also occurred, then record the severity level as High and the distress type as “Leaks,” as well.
- If the animals, birds, or insects causing the damage are still present, record as High severity.
- If the subcomponent unit of measure is “each,” estimate the density if the subcomponent is repairable or at 100% if it must be replaced.
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and animal/insect damage has occurred to subcomponents where the logical repair would be the replacement of a unit (e.g., wood deck member, fan belt) the measurement quantity will be that entire unit even though the animal/insect damage may only encompass portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical replacement area, length, or quantity measured.

Severity levels:

- **Low.** Distress exists, but damage is superficial.
- **Medium.** Distress exists, but it is not superficial, nor is it raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.

- A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
- The passage of animals, birds, or insects is possible and/or likely, but prevention is required.
- The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
- The subcomponent is unusable.

Measurement:

Affected area, length, or quantity, as appropriate.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples:

- Termite damage
- Pet scratches
- Rodent holes
- Fecal contamination
- Carpenter bee holes
- Animal pathways in insulation
- Screen in roof ventilator displaced and holed by animal in order to gain access to attic
- Bent roof ventilator blade caused by animal gaining access to attic
- Animal hole under security fence

General distresses: Blistered

Definition:

Round or elongated raised areas of the subcomponent surface that are generally filled with air.

Note:

"Blistered" is a special case of deterioration. When present, record "Blistered" instead of "Deteriorated."

Severity levels:

- **Low.** The raised areas are noticeable by vision or touch.
- **Medium.** Blistered area has begun to show deterioration.
- **High.** Blisters are broken or worn through.

Measurement:

Affected area, length, or quantity, as appropriate.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples:

- Floor covering with raised area that is soft when walked on.
- Wall covering (wallpaper) with air pocket.

General distresses: Broken

Definition:

Subcomponent has been fractured, shattered, or otherwise separated into two or more pieces, and one or more of those pieces are missing or if the pieces are all present, the separation is resulting in the loss of operability to this or other subcomponents.

Notes:

- Care must be taken to differentiate between "Broken," "Cracked," "Damaged," "Operationally impaired," and "Missing." The differentiation between "Broken" and "Cracked" are the missing pieces or loss of operability associated with Broken. Broken provides greater problem specificity and should be used instead of Damaged, when applicable. Operationally Impaired should be recorded instead of Broken if operability is lost, but there is no true separation of pieces or if a separation is unknown. Missing pieces as a result of fracturing denotes Broken, whereas missing parts without fracturing denote Missing.

- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the fracturing a leak has occurred, record the severity level as High and record the distress type "Leaks," as well.
- If the subcomponent unit of measure is "each," estimate the density if the subcomponent is repairable or as 100% if it must be replaced. (See General Notes #10.)
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and the logical repair would be the replacement of a unit (e.g., ceiling tile, window pane, etc.), the measurement quantity will be that entire unit even though the actual broken quantity may only encompass a portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to potentially be patched. Assign only one severity level to a given logical repair or replacement area, length, or quantity measured (see General Notes #4 and #5 above).

Severity levels:

- **Medium.** Distress exists.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has occurred in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.
  - The operation of either another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement:

Affected area, length, or quantity, as appropriate.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples:

- Shattered window pane.
- Wire separated from connector, preventing lights from working.
- Ceiling tile separated into two pieces, with the one piece missing.

General distresses: Capability/capacity deficient

Definition:

Component serviceability is lacking due to insufficient capacity, technical obsolescence, or lack of compliance to applicable codes. This lack of serviceability can be due to poor original design, alterations, changes in component demand, and/or changes in building use.

Notes:

- Capability/Capacity Deficient is defined at the component level, but sometimes it is apparent at the system level (e.g., HVAC) or in a building functional area (e.g., kitchen). However, since inspection is performed on Component-Sections at the subcomponent level, Capability/Capacity Deficient should be applied to all applicable subcomponents in their parent Component-Sections. Building functional areas may need to be identified and used as the basis for creating Component-Sections to get the proper assignment of this distress.
- Consider Capability/Capacity Deficient in a broad context (e.g., meeting Americans with Disabilities Act of 1990 (ADA) requirements, building use demands, etc.)
- Only rate Component-Sections actually present in the building, not those that may be required but never installed or constructed.
- Check for problems with other components/subcomponents to ensure that other, more appropriate, distress types are not the true cause of the perceived deficiency.

- Component-Section functionality metrics are under development and when completed this distress will be superseded by those in a functionality assessment procedure.

Severity levels:

- **Low.** Distress exists, but it is superficial. Mission or quality-of-life rarely affected.
- **Medium.** Distress exists, but not superficial, nor raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Violation of law.
  - Adversely affects mission or quality-of-life for an extended period of time.

Measurement:

Affected area, length, or quantity

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity.
B = total area, length, or quantity of subcomponent.

Distress examples:

- HVAC ductwork does not extend into an office.
- HVAC unit size is too small for cooling demand.
- Furnace cannot adequately heat office in winter.
- Pipe size is too small for proper water flow.
- Wheelchair ramp is too steep.
- Room is poorly lighted.
- Door is undersized for a wheelchair.

General distresses: Clogged

Definition:

Obstruction within a subcomponent that is disrupting the intended flow of air, other gasses, or liquids.

Notes:

- “Clogged” applies to such items as pipes, drains, valves, ducts, troughs, gutters, filters, screens, heating/cooling coils, and other “enclosed (totally or partially)” subcomponents used to channel liquids and/or gasses.
- The measurement amount and density are based on the subcomponent length, area, or quantity, not on the degree of blockage for that amount. The degree of blockage is used to determine severity level.
- Sometimes, the extent of a clogged item is unknown (e.g., how much of a length of pipe is clogged?). If unknown, estimate a reasonable amount or density of the subcomponent length or area.
- If blockage is due to corrosion, debris or vegetation, or dirt, record the distress type “Corroded,” “Moisture/Debris/Mold/Contaminated, ” or “Stained/Dirty,” respectively, in addition to “Clogged.” If those distresses are present, but the flow is unaffected, do not record, “Clogged.”

Severity levels:

- **Low.** Distress exists, but blockage is superficial.
- **Medium.** Distress exists, but not superficial, nor raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, or security problems.
  - Flow is severely restricted.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement:

Affected area, length, or quantity, as appropriate.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples:

- Waste water pipe that will not drain or drains slowly.
- Downspout with little flow and water spilling over gutter.
- Low water flow from faucet (not due to low water pressure).
- Reduced air flow from duct due to presence of foreign matter.

General distresses: Corroded

Definition:

Subcomponent is wearing away, disintegrating, flaking, lensing, and/or scaling due to the effects of chemical, electrochemical, or electrolytic attack.

Notes:

- “Corroded” is a special case of deterioration. When present, record “Corroded” instead of “Deteriorated.”
- Any staining of the surrounding area (e.g., rust streaks) will also be recorded as “Stained.”
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the corroding a leak has also occurred, record the severity level as High and the distress type “Leaks,” as well.
- Record “Clogged,” in addition if corrosion is causing clogging.
- Paints and coatings that are failing to provide a protective coating, but NOT inventoried with the subcomponent, are included in the “Corroded” distress type at Low severity. Paints and coatings, inventoried with the subcomponent, that are failing to protect the subcomponent shall be given a separate paint or coating rating.
- Do not record Low severity levels for paint or coatings and higher severity levels for the subcomponent at the same locations.
- If the unit of measure of the subcomponent is “each,” estimate the density if the subcomponent is repairable or 100% if it must be replaced. (See General Notes #10.)
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and corrosion has occurred to subcomponents

where the logical repair would be the replacement of a unit (e.g., metal panel) the measurement quantity will be that entire unit even though the corrosion may only encompass portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical replacement area, length, or quantity measured as described above (see General Notes #7).
- If the corrosion is desirable (e.g., patina on copper), “Corroded” will not be recorded.

Severity levels:

- **Low.** Any of the following exists:
  - Corrosion exists, but can usually be brushed off.
  - Deterioration superficial.
  - Paint or protective coating (e.g., PVC) has failed and corrosion has begun (only when paint is not rated separately).
- **Medium.** Flaking, lensing, and/or scaling exist, but not raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement:

Affected area, length, or quantity, as appropriate.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples:

- Spotty brown rust on metal roofs.
- Brown water from internal pipe corrosion.
- Rusty pipe supports.
- Failure of the galvanized coating on a corrugated steel sheet wall.

General distresses: Cracked

Definition:

Subcomponent has been fractured. Separation into two or more pieces may or may not have occurred. Crack width may be variable and faulting may be present. There is no loss of operational ability to the subcomponent or Component-Section.

Notes:

- A hairline crack is defined as having a width so small as to be very tight.
- Care must be taken to differentiate between “Cracked,” “Broken,” “Damaged,” and “Deteriorated.” “Cracked” implies that the fractured pieces are intact, whereas “Broken” implies that some of the resulting cracked pieces are missing or a loss of operational ability. Fracturing may possibly be caused by a specific event which suggests the distress type “Damaged.” However, record as “Cracked.” Likewise, fracturing can occur as a consequence of weathering, humidity change, and sustained or repeated loading over long periods suggesting “Deteriorated.” However, record “Cracked.”
- “Cracked” and the distress types “Broken” and/or “Damaged” can occur together in the same subcomponent-Section, but only independently at different locations (e.g., different ceiling tiles in the same Component-Section).
- If the fractured pieces are faulted, record the distress type “Displaced” also.

- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the crack a leak has occurred, record the severity level as High and the distress type "Leaks," also.
- Density is determined from dividing total crack length by the subcomponent surface area or length, as appropriate.
- If the subcomponent unit of measure is "each," estimate the density if the subcomponent is repairable or 100% if it must be replaced (see General Notes #10). If multiple cracks exist at different severity levels, record at the highest level.
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and cracking has occurred in subcomponents where the logical repair would be the replacement of a unit (e.g., ceiling tile, window pane, pipe section, etc.) the measurement quantity will be that entire unit even though the actual crack may only encompass portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical replacement area, length, or quantity, measured as described above (see General Notes #7).

Severity levels

- **Low.** Hairline cracks which may or may not divide the subcomponent into pieces. If distinct pieces exist, they are held tightly together.
- **Medium.** Crack width greater than hairline and the subcomponent has been divided into pieces with clear separation, but not raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement:

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Fractured sidewalk, masonry wall, window, or ceiling tile (with all pieces present).
- Fractured pipe from frozen water.

General distresses: Damaged

Definition

Dents, chips, gouges, tears, rips, distortion, rupture, etc. resulting from impact (e.g., vehicles), fire, flood, or other means associated with specific events.

Notes

- Care must be taken to differentiate between “Damaged,” “Animal/Insect Damage,” “Broken,” “Cracked,” and “Moisture/Debris/Mold/Contaminated.” Those other distress types imply a greater specificity and should be recorded, if applicable, instead of “Damaged.”
- “Damaged,” “Animal/Insect Damage,” “Broken,” “Cracked,” and/or “Moisture/Debris/Mold/Contaminated” can occur within the same subcomponent, but only independently at different locations (e.g., different locations on the same wall.)
- If displacement has occurred along with the damage, record the distress type “Displaced” also. If the damage event has only resulted in a displacement, record “Displaced” instead of “Damaged.”

- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the specific damage event a leak has occurred, record the severity level as High and the distress type “Leaks,” also.
- If the subcomponent unit of measure is “Each” estimate the density if the subcomponent is repairable or 100% if it must be replaced (see General Notes #10).
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and damage has occurred to subcomponents where the logical repair would be the replacement of a unit (e.g., ceiling tile, window pane, pipe section, etc.) the measurement quantity will be that entire unit even though the actual damage may only encompass portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical replacement area, length, or quantity measured as described in 6) above.
- If the damage is the result of liquids other than water (e.g., oil), record “Damaged” and clarify with a comment.
- Tiny isolated dents, chips and gouges at extremely low density (difficult to see or even find) should not be recorded.

Severity levels

- **Low.** Distress exists, but superficial.
- **Medium.** Distress exists, but not superficial, nor raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Dent in metal column from collision with forklift.
- Dent and hole in metal wall from impact of a forklift tine.
- Scratches and chips in masonry wall from vehicle impact.
- Dents in gutters from ladders.
- Gouges in walls from abuse.
- Deformation of roof from flying debris or hail.
- Scratched, chipped, frayed, and/or holed ceiling tile from poor handling.
- Hole in wall from hammer.
- Carpeted wall torn from snag with passing sharp or pointed object.
- Wall corner gouged or distorted from collision with a heavy object.
- Charred wood column from fire.

General distresses: Deteriorated

Definition

The natural degradation of the subcomponent through normal usage and/or environmental exposure. This may involve disintegration, erosion, delamination, weathering, checks, warps, bumps, raveling, flaking, pitting, spalling, wear, etc. and/or a change in properties (e.g., brittle). Included are a wearing away and/or thinning of coatings (e.g., paint, varnish, polyvinyl (PVC), etc.)

Notes:

- "Corroded" and "Rotted" are special cases of "Deteriorated." When they are present, they should be recorded instead of "Deteriorated." Sometimes, "Cracked" and "Moisture/Debris/Mold /Contaminated" may be a special case of "Deteriorated." Record the distress type "Cracked" or

"Moisture/Debris/Mold /Contaminated" instead of the distress type "Deteriorated" when cracks or contamination are present, respectively.

- If displacement is occurring along with the natural degradation, record the distress type "Displaced," as well.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the degradation a leak has occurred, record the severity level as High and the distress type "Leaks," also.
- Paints and coatings that are degraded, but NOT inventoried with the subcomponent, are included in the "Deteriorated" distress type at Low severity. Paints and coatings, inventoried with the subcomponent, that are degraded shall be given a separate paint/coating rating.
- Do not record Low severity levels for paint or coatings and higher severity levels for the subcomponent at the same locations.
- If the subcomponent unit of measure is "Each" estimate the density if the subcomponent is repairable or 100% if it must be replaced (see General Notes #10).
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and deterioration has occurred to subcomponents where the logical repair would be the replacement of a unit (e.g., ceiling tile, door, wood cladding sheet, etc.) the measurement quantity will be that entire unit even though the actual deterioration may only encompass a portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical replacement area, length, or quantity measured (see General Note #7).

Severity levels

- **Low.** Either of the following exists:
  - Distress exists, but superficial.
  - Painted or coated surface worn, chipped, blistered, etc. (only when the paint is not being rated separately)
- **Medium.** Distress exists, but not superficial, nor raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.

- A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
- The undesired passage of animals or birds (and possibly insects) is possible and/or likely.
- The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
- The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Delamination of brick faces
- Splits in wood members
- Brittle and cracked caulking
- Worn or raveled carpeting
- Warped flooring
- Peeling wallpaper
- Spalled concrete
- Weathered wood deck

General distresses: Displaced

Definition

Subcomponent has been moved, deflected, shifted, bulged, rotated, faulted, or settled from its intended position. This may be due to a specific event (e.g., earthquake, collision, failure of another subcomponent, etc.), plastic deformation, or consolidation over time.

Notes

- “Displaced” is a special case of either “Damaged” or “Deteriorated.” It can be used together or separately from them. This should be used together with “Damaged” only when the subcomponent has been shifted from its normal position and the subcomponent is otherwise damaged. Distortion of the subcomponent either through being damaged or deteriorated does not, in itself, constitute being displaced. If the specific event causing the movement resulted in no other damage, record “Displaced” not “Damaged.”
- “Displaced” should be used together with “Deteriorated” if one or more subcomponent parts have moved and the distress type “Deteriorated,” is apparent also.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the displacement a leak has occurred, record the severity level as High and the distress type “Leaks,” also.
- Where displacement has resulted in cracking or vice versa, record the distress type “Cracked,” as well.
- A loose subcomponent may sag due to its weight. In these cases, record “Loose” instead of “Displaced.”
- “Displaced” may possibly occur to an entire Component-Section or to a subcomponent with other subcomponents attached to it. If so, record first to the primary subcomponent. Then, only record for other subcomponents if they have moved relative to the primary subcomponent.

Severity levels

- **Low.** Distress exists, but magnitude of movement is slight.
- **Medium.** Distress exists, but not slight, nor raised to the level of High.
- **High.** Any of the following exists:
    - Health, life/safety, security, or structural integrity problems.
    - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
    - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
    - The undesired passage of animals, birds, or insects is occurring.
    - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
    - The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Leaning chimney or flue.
- Uneven sidewalk.
- Parapet movement.
- Steps separated from building.
- Sagging roof truss.
- Dislodged door frame.
- Open seams or joints in ductwork or gutters.
- Light pole leaning after hit by truck.
- Bulge in masonry wall resulting from brick unit expansion from moisture.
- Floor with excessive deflection.
- Sagging ceiling tiles.
- Column out-of-plumb.

General distresses: Efflorescence

Definition

Soluble salts encrusted on the surface of masonry, concrete, or plaster subcomponents caused by moisture leaching free alkalis from mortar or concrete. Efflorescence is typically seen as a white powdery coating.

Severity levels

- **Low.** Coating is noticeable and easily brushed off, but the surface is visible.
- **Medium.** Either of the following exists:
  - Coating is not easily brushed off.

- o Surface is obscured.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- White powder on brick or concrete masonry.

General distresses: Electrical ground inadequate or unintentional

Definition

Unintentional connection of very low resistance causing a short circuit or a high resistance connection resulting in inadequate grounding.

Notes

- "Electrical Ground Inadequate or Unintentional" is a special case of impaired operations. When present, record "Electrical Ground Inadequate or Unintentional" instead of "Operationally Impaired."
- Record additional distress types, if known, should they be contributing to this distress. These may include "Corroded," "Loose," "Damaged," etc.

Severity levels

High - Distress exists.

Measurement

Total Sub-Component Area, Length, or Quantity, as appropriate.

Density

100% (automatic)

Distress examples

- Lightning arrester disconnected or broken.
- Connector insulated by paint.
- Open or no ground at outlet for interior wiring.

General distresses: Holes

Definition

Drilling, punching or penetration of a subcomponent for an intended purpose. Penetration depth may be partial or complete.

Notes

- Do not record “Holes” along with the distress types “Animal/Insect Damaged,” “Broken,” “Corroded,” “Damaged,” “Deteriorated,” “Missing,” or “Rotten.” The presence of holes determines the severity levels for those distress types.
- Do not record if holes are not in plain view or do not degrade the subcomponent.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the penetration a leak has occurred, record the severity level as High and the distress type as “Leaks.”
- Holes resulting from missing fasteners shall not be recorded if the fastener should be replaced. Record “Missing” for the fasteners instead.
- Do not count pinholes, unless density is sufficient to be noticeable or a leak has occurred.
- Clusters of Low severity holes within one (1) square foot (0.1 square meter) shall count as one (1) Medium severity hole.
- Weep holes shall not be recorded.

Severity levels

- **Low.** Partial depth penetration.
- **Medium.** Either of the following:
  - Clusters of Low severity holes.
  - Distress exists, but not raised to the level of High.
- **High**. Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.

- Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
- A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
- The undesired passage of animals, birds, or insects is occurring.
- The penetration is adversely affecting the operation of another subcomponent, the parent Component-Section, or another Component-Section.
- The subcomponent is unusable.

Measurement

Number of holes

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of holes
B = total area, length, or quantity of subcomponent

Distress examples

- Pipe penetration that is not sealed.
- Former anchor holes for signs since removed.
- Permanently secured door with door lock removed, but hole for lock remains.

General distresses: Leaks

Definition

The unwanted entry, passage, or escape of gas or liquid.

Notes

- If the leaking gas or liquid is a biological (e.g., herbicide, pesticide, etc.), chemical (e.g., volatile, flammable, explosive, corrosive, etc.), or radioactive hazard, High severity shall be recorded. Also, notify for immediate corrective action.

- "Leaks" may be recorded without any other distresses.
- Do not record "Leaks" in conjunction with "Animal/Insect Damaged," "Broken," "Corroded," "Cracked," "Damaged," "Deteriorated," "Displaced," "Holes," "Loose," "Missing," or "Rotten" unless the subcomponent is a tank, pipe, container, trough, pressure vessel or sealant. The loss of liquids or gas (or the gain from a vacuum loss) from those subcomponents as a result of those distresses is the trigger for "Leaks."
- Leaks from cracks, joints, etc. should be measured as the crack or joint length, etc.

Severity levels

- **Low.** Distress exists, but superficial.
- **Medium.** Distress exists, but not raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, or security problems.
  - Steady rate of flow and loss of air, gas, water, or other liquid of significant concern.
  - Pressure or vacuum loss apparent and adversely affecting usage.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the leakage.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - Overall Component-Section, component, or system usage is adversely affected by liquid or gas loss.
  - The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Water dripping from hot water heater or pipe connection.
- Air escaping from compressed air line.
- Boiler tubes dripping water into firebox.
- Water dripping from rain gutter.
- Leaky faucet.
- Loss of seal in a thermopane window causing the window to fog.
- Water entering during a storm through failed sealant joint between window and wall.

General distresses: Loose

Definition

Subcomponent or subcomponent parts are not secured tightly to one or more other subcomponents. Also, one or more fasteners (i.e., bolts, screws, pins, nails and/or rivets) are not tight (torqued to a proper tension).

Notes

- If subcomponent is loose due to being "Broken" or "Damaged" do not report "Loose."
- Fasteners are not considered subcomponents. If any fasteners are loose, record the subcomponent being fastened as "Loose" at Low severity. Estimate density based on the number of similar fasteners needed.
- If the entire subcomponent is loose, record with a density of 100% at either Medium or High severity, as applicable. Any missing fasteners should be recorded as "Missing."
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of being loose a leak has occurred, record the severity level as High and the distress type "Leaks," as well.
- Subcomponents firmly attached to a loose subcomponent are not loose.

Severity levels

- **Low.** Fasteners are loose, but subcomponent is tight.
- **Medium.** Subcomponent is loose, but not raised to the level of High.
- **High.** Any of the following exists:
  - o Health, life/safety, security, or structural integrity problems.

- Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
- A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
- The undesired passage of animals, birds, or insects is occurring.
- The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
- The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Loose bolts holding light fixture to wall.
- Roof or wall panels flapping in wind.
- Non-secured stair railing.
- Slackened guy wire.
- Squeaky floor or stair when walked or stepped on.
- Nail or screws popping out of drywall panel.
- Raised nails or screws in a deck or flooring.

General distresses: Missing

Definition

Subcomponent and/or subcomponent parts including fasteners (i.e. bolts, screws, pins, nails and/or rivets) are required, but absent due to removal, dislodgement, or deterioration.

Notes

- If a subcomponent or subcomponent parts are missing, resulting in a hole, then record “Missing.” Do not record “Holes” for this subcomponent. The distress type Holes may be valid for the subcomponent to which this subcomponent was attached. Refer to the Holes definition.
- If the entire subcomponent is missing and needed, then record “Missing” with a density of 100% at either Medium or High severity, as applicable.
- Fasteners are not considered subcomponents. If any fasteners are missing, record the subcomponent being fastened as “Missing” at Low severity. Estimate density based on the number of similar fasteners needed.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and, as a result of the missing subcomponent a leak has occurred, then record the severity level as High and the distress type as “Leaks” as well.

Severity levels

- **Low.** Fasteners are missing.
- **Medium.** Portion of or entire subcomponent absent, but severity is not raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.
  - The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
  - The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Holes where fasteners are currently required.
- Ceiling tiles removed and never replaced.
- Exhaust fan removed, but still needed.
- Missing pin in a hinge.
- Missing pop rivet from sheet metal panel.
- Handrail removed and never replaced.
- Ladder rung was loose and fell out.

General distresses: Moisture/debris contaminated

Definition

The unintended presence of foreign material, vegetation, mold, mildew, water and/or other liquid.

Notes

- The presence of moisture, debris, sand, etc. does not necessarily constitute "Moisture/Debris/Mold/Contaminated." The presence must exceed the amount normally expected through typical usage. Cleaning efforts would need to exceed those normally expected from routine housekeeping.
- "Moisture/Debris/Mold/Contaminated" is a special case of either "Damaged" or "Deteriorated." When present, use "Moisture/Debris/Mold Contaminated" instead of either "Damaged" or "Deteriorated."
- After debris, mold, mildew, etc. removal or cleaning, record "Stained/Dirty" instead of "Moisture/Debris/Mold/Contaminated," if staining remains.
- If the foreign material is dirt, record "Stained/Dirty" instead of "Moisture/Debris/Mold/Contaminated."
- The distress type "Clogged" should be used in addition to "Moisture/Debris/Mold/Contaminated" if the presence of leaves, etc. in drains, gutters, downspouts, troughs, screens, etc. is affecting water or air flow.

- If the unit of measure of the subcomponent is "Each," estimate the density if the subcomponent is repairable or 100% if it must be replaced. (See General Notes #10.)
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and moisture/debris contamination has occurred to subcomponents where the logical repair would be the replacement of a unit (e.g., room carpeting) the measurement quantity will be that entire unit even though the actual contamination may only encompass portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical repair or replacement area, length, or quantity measured (see General Note #5).

Severity levels

- **Low.** Distress exists.
- **Medium.** Subcomponent is wet or contaminated, but it is not raised to the level of High.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Cannot be cleaned, dried, or made useable.
  - Other subcomponents may be damaged.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Gutters filled with leaves.
- Trash on roof.
- The presence of leaves in air handling unit coils.
- Leaves present on insect screen to air intake vent.

- Wet insulation.
- Flood or water damage.
- Bird, animal, or insect nest.
- Grass growing in cracks in sidewalk.
- Moss growing on side of building.
- Unintended vines growing up downspout.
- Mold or mildew growing on wall.

General distresses: Noise/vibration excessive

Definition

Equipment noise and/or vibration in excess of normal or acceptable levels.

Severity levels

- **Medium.** Noise or vibration can be corrected through adjustment.
- **High.** Noise or vibration can only be corrected through replacement of one or more parts.

Measurement

Affected quantity

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected quantity
B = total quantity of subcomponent

Distress examples

- Wobbly or squeaky ceiling fan.
- HVAC compressor motor with unusual whine.
- Transformer with noisy "hum."

General distresses: Operationally impaired

Definition

Subcomponent does not operate properly or at all due to improper installation or construction, misalignment, binding, over tightening, malfunctioning, part failure, or repair/maintenance practices.

Notes

- "Operationally Impaired" only applies to subcomponents of components normally associated with "operating." These include, but are not limited to, equipment, doors, windows, light fixtures, etc.
- If impairment is caused by "Damage," "Corroded," "Animal/Insect Damage," "Rotted," or other distress types, record those distress types at the appropriate severity levels in addition to "Operationally Impaired." "Operationally Impaired" shall not be used with the distress type "Broken." "Operationally Impaired" is recorded used instead of "Broken" if operability is lost, but there is no true separation of pieces or if a separation is unknown.
- Often, it may appear that the Component-Section as a whole (e.g., air handling unit) or a Component-Section unit (e.g., one door out of two) is operationally impaired. Care must be taken to assign "Operationally Impaired" to the appropriate subcomponent(s).
- If the Component-Section is a unit that would normally be replaced if it did not operate properly (e.g., residential hot water heater, sump pump, etc.), record "Operationally Impaired" for all of the subcomponents at the appropriate severity level.

Severity levels

- **Low.** Subcomponent does not operate ideally.
- **Medium.** Impairment is significant, but not raised to the level of High.
- **High.** Either of the following exists:
  - Health, life/safety or security problem.
  - No operation of the Component-Section or a Component-Section unit.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x 100 = problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Door difficult to close due to high humidity or improperly hung.
- Door rattles in breeze.
- Window cannot be opened due to over painting.
- Window will not stay open.
- Bumper installed in incorrect location.
- Failed AC compressor.
- Improper bend (too sharp) in lightning down conductor.
- Sump pump does not work.
- No hot water from hot water heater.
- Exhaust fan blowing air in wrong direction.

General distresses: Overheated

Definition

Temperature exceeds normal or acceptable levels.

Notes

- If excessive heat has resulted in fire or other damage, the distress type, “Damaged” shall also be recorded at the applicable severity level.
- If excessive heat has resulted in discoloration, the distress type "Stained/Dirty" shall also be recorded.
- If evidence exists of overheating, but the subcomponent is not overheated at the time of the condition survey, ensure the problem that caused the overheating has been corrected. If uncertain, record “Overheated” at the appropriate severity level.
- If evidence (e.g., damage or stains) exists of past overheating, but the overheating no longer exists, do not record “Overheated.”

Severity levels

- **Medium.** Excessively warm, but otherwise poses no health, life/safety, or operating problem.
- **High.** Excessively warm or hot and poses a health, life/safety, or operating problem.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Excessively warm electrical circuit breaker.
- Evidence of heat damage around heater.
- Discolored flue.

General distresses: Patched

Definition

An obvious localized repair to the subcomponent.

Notes

- "Patched" at Medium and High severities is a special case of deterioration. When present, record "Patched" instead of "Deteriorated."
- The patch must be obvious. Patches that exist, but are virtually invisible will not be recorded.
- Patched areas may also experience other distresses unrelated to the performance of the patch itself. Record "Animal/Insect Damaged," "Cracked," "Damaged," or "Stained," as applicable and if present, as well.

- If a temporary patch has been placed to rectify any other distress type, record that distress type at one severity level lower than it would be without the temporary patch. Record in addition to "Patched."
- If a patch is recorded as High severity, also record the underlying distress type and severity level for the subcomponent.

Severity levels

- **Low.** Permanent patch exists and there is no deterioration.
- **Medium.** Any of the following exists:
  - Permanent patch is deteriorated.
  - A material mismatch was used to make the patch.
  - A temporary patch exists.
- **High.** Patch has failed.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Plaster repair of wall with poor workmanship.
- Mastic to repair roof leak.
- Pipe collar intended to repair pipe crack or hole.
- Substitute prefabricated wall panel.
- Color mismatch to replacement parts (when subcomponents are in plain sight).
- Isolated ceiling tile replacement of a different material.
- Plywood covering over door or window.
- Spackled area or holes in wall, but not painted over.

General distresses: Rotten

Definition

Fungal or bacterial decay or decomposition resulting in softness, sponginess, disintegration, loss of strength, and/or distortion of the subcomponent.

Notes

- "Rotten" is a special case of deterioration. When present, record "Rotten" instead of "Deteriorated."
- Subcomponent may or may not be accompanied by a musty odor depending on the moisture state at the time of the condition survey.
- If the unit of measure of the subcomponent is "Each," estimate the density if the subcomponent is repairable or 100% if it must be replaced (see General Note #10).
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and rotting has occurred to subcomponents where the logical repair would be the replacement of a unit (e.g., window sill, wood cladding, etc.) the measurement quantity will be that entire unit even though the actual rotting may only encompass a portion of that unit. If the subcomponent can be patched, the measurement quantity will only encompass the area to be potentially patched.
- Assign only one severity level to a given logical repair or replacement area, length, or quantity measured as described in 4) above.
- If the subcomponent is a tank, pipe, container, trough, pressure vessel, or sealant and as a result of the rot a leak has occurred, record the severity level as High and the distress type "Leaks," as well.

Severity levels

- **Medium.** Distress exists.
- **High.** Any of the following exists:
  - Health, life/safety, security, or structural integrity problems.
  - Other subcomponents, Component-Sections, equipment, furnishings, material, or other building contents may be damaged from the entry of rain, snow, wind, groundwater, etc.
  - A leak has resulted in a tank, pipe, container, trough, pressure vessel, or sealant.
  - The undesired passage of animals, birds, or insects is occurring.

- The operation of another subcomponent, the parent Component-Section, or another Component-Section is adversely affected.
- The subcomponent is unusable.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Spongy roof deck.
- Decayed soffit and fascia.
- Wood column end loss due to water immersion.

General distresses: Stained

Definition

Subcomponent discoloration resulting from liquids, graffiti, smudges, mildew, mold, moss, algae, soot, dirt, animal waste, or other sources.

Notes

- "Stained/Dirty" will not be recorded if normal housekeeping will rectify the problem. Normal housekeeping includes regular or routine vacuuming, dusting, mopping, wiping, etc.
- "Stained/Dirty" will be recorded if "special" cleaning is needed, including filter cleaning or replacement.
- If discoloration is due to excessive heat, record "Stained/Dirty" and also record "Overheated," if applicable.
- If discoloration is due to efflorescence, the record the distress type "Efflorescence" instead of "Stained/Dirty."
- If mildew, mold, moss, or algae exist, record "Moisture/Debris/Mold/Contaminated" instead of "Stained/Dirty." Only record

"Stained/Dirty" if these contaminates have been removed, but a stain remains.

- If the foreign material is other than dirt (e.g., leaves, vegetation, etc., record "Moisture/Debris/Mold/Contaminated" instead of "Stained/Dirty."
- The distress type "Clogged" should be used in addition to "Stained/Dirty" if the presence of dirt in screens, filters, coils, etc. is affecting air flow.
- If discoloration is due to corrosion, the actual corroded area will be recorded as "Corroded" at the appropriate severity level, but the remaining area will be recorded as "Stained/Dirty."
- Stains caused by animals, birds, or insects will be recorded as "Stained/Dirty" and not "Animal/Insect Damage."
- If color mismatch exists due to a subcomponent part replacement, record "Patched" instead of "Stained/Dirty."
- If surface is stained or dirty and painted (with paint inventoried as such), do not record "Stained/Dirty" for the Section itself, but rate the paint according the definitions in Appendix F.
- If the unit of measure of the subcomponent is "Each," estimate the density if the subcomponent is repairable or 100% if it must be replaced (see General Note #10).
- If the subcomponent unit of measure is square feet (square meters) or linear feet (meters) and staining has occurred to subcomponents where the logical repair is the replacement of a unit (e.g., a ceiling tile), the measurement area will be that entire unit even though the actual stain may only encompass a portion of that unit.

Severity levels

- **Low.** Distress exists.

Measurement

Affected area, length, or quantity, as appropriate.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = affected area, length, or quantity
B = total area, length, or quantity of subcomponent

Distress examples

- Graffiti spray painted on wall.
- Bird droppings.
- Rust streaks.
- Smudges on wall.
- Localized ceiling tile discoloration due to past roof leak.
- Widespread ceiling tile discoloration due to smoke, fumes, etc.
- Greasy/oily film on walls in a garage.
- Excessively dirty floors in building that has been vacant for years.
- Dirty filter reducing air flow.
- Dirty cooling coils reducing air flow in an air handling unit.

Appendix B: Built-Up Roofing Distress Survey Definitions

General notes

- These definitions are applicable to built-up roofing (BUR) surfaces and flashing components.
- Where multiple severity levels are present for a given distress record each separately.
- Distress quantities or distress density may be recorded. If distress quantities are recorded, density ranges will be computed in BUILDER/BRED. If distress densities are recorded, distress quantities will be blank in BUILDER/BRED.
- If during the course of the inspection additional occurrences are found of distress-severity combinations, adjust the quantity or density as necessary.
- To estimate density when distress quantities are not recorded, follow the density definitions for the individual distresses. However, for use in BUILDER, density may be estimated since density ranges are used, not the precise density value. Generalized visual cues are offered below in Table B-1, but may not be applicable for certain distresses.
- The distress definitions in Table B1 are from *Membrane and Flashing Condition Indexes for Built-Up Roofs, Volume II: Inspection and Distress Manual* (Shahin, Bailey, and Brotherson 1987).

Table B1. Built-up roofing distress density estimation from visual cues (Shahin, Bailey, and Brotherson 1987).

Density (%)	Visual Cue (when applicable)
>0–0.1%	Difficult to notice, even by careful observation, especially if spotty. (Up to about 1" x 12" in an 8' x 10' area; ⅛" in a 10' length.)
>0.1%–1%	Somewhat noticeable, but easily missed by casual observation, especially if spotty. Careful observation usually needed, if spotty. (Up to about 10" x 12" in a 8' x 10' area; 1¼" in a 10' length.)
>1%–5%	Noticeable, even by casual observation, but still only a mere fraction. (Up to about 1' x 4' in a 8' x 10' area; 6" in 10' length.)
>5%–10%	Easily noticeable even if spotty, more than a mere fraction. (Up to about 1' x 8' in an 8' x 10' area; 1' in a 10' length.)
>10%–25%	Readily noticeable, but less than ¼ of area or length.
>25%–50%	Very noticeable, but less than ½ of area or length.

Density (%)	Visual Cue (when applicable)
>50%–<100%	Overwhelmingly noticeable; greater than ½ of area or length.
100%	Entire area or length.

Built-up roofing: Distress summary listing

All distresses for built-up roofing (BUR) are summarized in the list below. Details of each distress are given in the sections that follow. Note that list is formatted in a way that goes directly to the particular distress.

- (BUR) Base Flashing
- (BUR) Metal Cap Flashing
- (BUR) Embedded Edge Metal
- (BUR) Flashed Penetrations
- (BUR) Pitch Pans
- (BUR) Interior Drains and Roof Level Scuppers
- (BUR) Blisters
- (BUR) Ridges
- (BUR) Splits
- (BUR) Holes
- (BUR) Surface Deterioration
- (BUR) Slippage
- (BUR) Patching
- (BUR) Debris and Vegetation
- (BUR) Improper Equipment Supports
- (BUR) Ponding

Built-up roofing: Base flashing

Definition

Base flashing is one or more piles of material extending from the roof surface up onto a vertical or inclined surface and providing a watertight termination of the membrane.

Severity levels

- **Low.** Any of the following conditions:
  - Loss of surfacing on mineral-surfaced sheets or other poor appearance (including patching), but no apparent deterioration of felts.
  - Top of base flashing is less than 6 in. above the roof surface.
  - Flashing has permanent repairs.
- **Medium.** Any of the following conditions:
  - Slippage, wrinkling, blistering, or pulling of base flashing material.
  - Loss of surfacing with some deterioration of felts but no holes, splits, or tears.
  - Grease, solvent, or oil drippings on the base flashing but no deterioration of felts.
  - Flashing has temporary repairs.
- **High.** Any of the following conditions:
  - Holes, splits, and tears in flashing caused by deterioration or physical damage.
  - Exposed gaps at the top of the base flashing which are not covered by counter-flashing, or open side laps in the flashing which allow water to channel behind them.
  - Grease, solvent, or oil drippings on the base flashing with deterioration of the felts.

Measurement

Measure lineal feet of base flashing having the above conditions. Holes, open side laps, and seams count as 1 ft each. If an area of the base flashing is at medium severity and holes are closer than 6 in., count that entire length of distressed base flashing as high severity.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of base flashing defects (ft)
B = total length of flashed perimeter of roof section being rated including flashings for penthouses, courtyards, and curbed projections (ft)

Built-up roofing: Blisters

Definition

Blisters are round or elongated, raised areas of the membrane that are filled with air.

Notes

- Blisters and ridges are difficult to differentiate at the low- and medium-severity levels. The rating error will be insignificant because of the similarity in the deduct curves. At high severity, however, it is important to distinguish between the two distresses due to their different leak potentials.

Severity levels

- **Low.** The raised areas are noticeable by vision or feel. The surfacing is still in place, and the felts are not exposed.
- **Medium.** The felts are exposed or show deterioration.
- **High.** The blisters are broken.

Measurement

Measure the length and width of the blister in lineal feet and calculate the area (length x width). If the distance between individual blisters is less than 5 ft, measure the entire affected area in square feet.

Note

When large quantities of this problem are present (especially on large roofs,), the representative sampling technique can be used.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = total area of membrane blisters (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Debris and vegetation

Definition

Foreign objects on the roof which could damage or puncture the membrane, growth of vegetation on the roof, and/or accumulation of solvent and oil drippings on the roof.

Severity levels

- **Medium.** Any of the following conditions:
  - The collection of foreign objects that are not removed from the roof during the inspection.
  - Grease, solvent, or oil drippings on the roof that are causing degradation of the roof membrane.
  - Evidence of vegetation, but it is not penetrating the felts.
- **High.** Any of the following conditions:
  - Grease, solvent, or oil drippings on the roof that are causing degradation to the roofing system.
  - Vegetation roots that have penetrated the felts.

Measurement

Measure square feet of affected area. Each isolated case of debris and vegetation of less than 1 sq ft in area should be counted as 1 sq ft.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of debris and vegetation (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Embedded edge metal

Definition

Formed strip of metal at the roof edge which continues down the vertical part of the wall to form a fascia or drip. This stripped-in flashing provides a finished termination for the roofing membrane. A formed vertical projection (gravel stop) may be incorporated to prevent loose aggregate from rolling or washing off the roof. Exterior and interior gutter in a built-in trough of metal or other material which collects water from the roof and carries it to a downspout.

Note

- A raised roof edge that is not stripped in is rated as metal cap flashing and not as embedded edge metal.

Severity levels

- **Low.** The entire length of embedded edge metal flashings is rated as low severity (at a minimum) due to the maintenance problems associated with it.
- **Medium.** Any of the following conditions:
  - The joints in embedded edge metal flashings are rated as medium severity (at a minimum) due to the maintenance problems associated with them.
  - Nails under the stripping felts are backing out.
  - Corrosion of the metal is present.
  - Loose or lifted metal flange is visible but without deterioration of the stripping felts.
  - The entire length of interior gutter is rated as medium severity (at a minimum) due to the maintenance problems and high potential for leak damage associated with its presence.
- **High.** Any of the following conditions:
  - Stripping felts are missing or loose.
  - Splits in the stripping felts occur above the metal joints.
  - Holes have occurred through the metal.
  - Loose or lifted metal flange is visible with deterioration of the stripping felts.
  - Holes or joint movement is present in the interior gutter.

Measurement

Measure lineal feet of embedded edge metal flashing having the above conditions. Each split above a joint is counted as 1 ft. As a method of sampling the joints, determine the total number of joints by dividing the total length of embedded edge metal flashing by the length of edge metal sections (normally 10 ft). Every fourth joint should be inspected for splits in the stripping felts. Count the number of inspected joints that are high severity and multiply by 4 to determine the total lineal feet of high severity joints. All other joints are rated medium severity. Multiply by 4 the number of inspected joints not rated as high severity to determine the total lineal feet of medium-severity joints.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of embedded edge metal flashing defects (ft)
B = total length of flashed perimeter of roof section being rated (including flashings for penthouses, courtyards and curbed projections [ft])

Built-up roofing: Flashed penetrations

Definition

Open pipes, plumbing vent stacks, flues, ducts, continuous pipes, guy wires, drain sumps, and other penetrations through the roof membrane (excluding pitch pans but including metal curbing for hatches and ventilators where the flange is stripped into the membrane).

Severity levels

- **Low.** Any of the following conditions:
  - Flashing sleeve is deformed.
  - Opening in the penetration, or flashing is less than 6 in. above the roof surface.
- **Medium.** Any of the following conditions:
  - Edge of stripping felts is exposed, but there is no apparent felt deterioration.

    - Top of flashing sleeve is not sealed or has not been rolled down into an existing plumbing vent stack.
    - The sleeve or umbrella is open, or no umbrella is present (where required).
    - Metal is corroded.
- **High.** Any of the following conditions:
    - Flashing sleeve or metal curb has been installed with no stripping felts.
    - Flashing sleeve or metal curb is cracked, broken, or corroded through.
    - No flashing sleeve is present.
    - Penetration is not sealed at the membrane level.

Measurement

Count each distressed flashed penetration as one linear foot at the highest severity level that exists. For metal curbs and ducts with greater than 1 ft of perimeter, count the actual length (in feet) of distressed perimeter.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = lineal feet of distressed flashed penetrations
B = total length of flashed perimeter of roof section being rated (including flashings for penthouses, courtyards and curbed projections)

Built-up roofing: Holes

Description

A membrane hole is any visible opening that extends through all membrane layers. Holes can be of various sizes and shapes, and they can be located anywhere on the roof surface.

Severity levels

- **High.** All holes in the membrane are considered high severity due to their high leak potential.

Measurement

Count the total number of holes in the membrane. If the distance between two holes is less than 1 ft, count them as one hole.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of membrane holes
B = total area of roof section being rated (sq ft)

Built-up roofing: Improper equipment supports

Definition

Improper equipment supports or pipes, conduits, and mechanical equipment supports (wood sleepers, channels, etc.) that are placed directly on the membrane below the equipment. Repairing this distress may require replacing the surrounding insulation and membrane.

Severity levels

- **Low.** All improper equipment supports are rated low severity at a minimum, due to the maintenance problems associated with them.
- **Medium.** Any of the following defects:
  - Movement of the support has displaced the membrane but has not cut or punctured it.
  - Equipment is bolted through the membrane, but the membrane is sealed and watertight.
- **High.** Any of the following defects:
  - Movement of the support has cut or punctured the roof membrane.
  - The equipment is bolted through the membrane but the membrane is not sealed, allowing water to penetrate.

Measurement

Measure square feet of each improper equipment support. The minimum dimensions for the length and the width of a support shall be 1 ft.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of improper equipment supports (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Interior drains and roof-level scuppers

Definition

A drain is a penetration at the roof membrane that allows water to flow from the roof surface into a piped drainage system. The drain fixture at the roof has a flange and/or clamping arrangement to which the roofing membrane is attached. A roof-level scupper is a channel through a parapet or raised roof edge that is designed for peripheral drainage of the roof.

Note

- Stripping felts around scuppers should be carefully inspected for holes at corners.

Severity levels

- **Low.** Bitumen has flowed into the drain leader, but the drain is not clogged.
- **Medium.** Any of the following conditions:
  - Stripping felts are exposed, but there is no apparent deterioration of felts.
  - Strainer is broken or missing.
  - Scupper shows loss of paint or protective coating or shows the start of metal corrosion.
- **High.** Any of the following conditions:
  - Stripping felts have holes or are deteriorated.
  - Clamping ring is loose or missing from drain body, or bolts are missing.
  - Drain is clogged.
  - Scupper metal is broken, or holes have occurred through the metal.

Measurement

Each distressed drain and scupper should be counted once at the highest severity level that exists.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of distressed interior drains and roof level scuppers
B = total length of flashed perimeter of roof section being rated (including flashings for penthouses, courtyards and curbed projections)

Built-up roofing: Metal cap flashing

Definition

Metal cap flashing includes counterflashing and any sheet metal coping cap which serves as part of the counterflashing or as the cover over a detail such as a roof area divider, equipment curb, raised roof edge, or an expansion joint (including the rubber bellows of an expansion joint).

Note

- Counterflashing is the material, usually sheet metal, which protects the top termination of base flashing and sheds water away from it. Counterflashing should be free to expand and contract.

Severity levels

- **Low.** Any of the following conditions:
  - Loss of paint or protective coating or the start of metal corrosion.
  - Metal coping cap is deformed and allows water to pond on the top.
  - Counterflashing is deformed but still performing its function.
  - Counterflashing has been sealed to the base flashing.
- **Medium.** Any of the following conditions:
  - Corrosion holes have occurred through the metal on a vertical surface.
  - Metal coping cap has loose fasteners, failure of soldered or sealed joints, open joints, or loss of attachment.

    - Sealant at reglet or top of counterflashing is missing or no longer functioning, allowing water to channel behind counterflashing.
    - Counterflashing is loose at the top, allowing water to channel behind it.
    - Counterflashing does not extend over top of base flashing.
- **High.** Any of the following conditions:
    - Metal coping cap or counterflashing is missing or displaced from its original position.
    - Corrosion holes have occurred through the metal on a horizontal surface.
    - Metal coping cap has mission joint covers where joint covers were originally installed.

Measurement

Measure lineal feet of metal cap flashing having the above conditions. For individual defects (e.g., joints, holes), count as 1 ft minimum.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of metal cap flashing defects (ft)
B = total length of flashed perimeter of roof section being rated (including flashings for penthouses, courtyards, and curbed projections)

Built-up roofing: Patching

Description

Patching is a localized temporary or permanent repair of the membrane using dissimilar materials to roof material. Repairs made with similar materials are not counted as patches; distresses associated with these repairs should be recorded in the appropriate category and not as patching distresses.

Severity levels

- **Low.** All patches that are not made with similar materials as that of the original construction are rated as low severity (at a minimum).
- **Medium.** All patches made with temporary materials (e.g., duct tape, caulking, and sealants) are rated medium severity (at a minimum).
- **High.** Other distresses of high severity are present within the patched area (count as patching distress only).

Measurement

- Measure square feet of each patch having the above conditions.
- When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of patching (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Pitch pans

Definition

A pitch pan is a flanged metal sleeve placed around a roof-penetrating element and filled with a sealer.

Severity levels

- **Low.** Pitch pans are rated low severity at a minimum due to the maintenance problems associated with them.
- **High.** Any of the following conditions:
  - Metal corrosion.
  - Sealing material is below metal rim.
  - Stripping felts are exposed or deteriorated.
  - Sealing material has cracked or separated from pan or roof penetration.

Measurement

Each distressed pitch pan should be counted once at the highest severity level that exists.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of distressed pitch pans
B = total length of flashed perimeter of roof section being rated (including flashings for penthouses, courtyards, and curbed projections)

Built-up roofing: Ponding

Definition

Standing water is present, or there is evidence of ponding by the presence of staining. Water which remains after 48 hr is considered ponded water.

Severity levels

Low. Ponding is rated low severity due to the maintenance problems that are associated with it.

Measurement

Measure square feet of affected area.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of ponding (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Ridges

Definition

Ridges are long, narrow (usually less than 3 in.), raised portions of the roof membrane. Their maximum height is about 2 in. Usually ridges occur directly above the insulation board joints and run perpendicular or parallel to the felts. They include all the plies and therefore, they are generally stiffer than blisters.

Notes

Blisters and ridges are difficult to differentiate at the low and medium severity levels. The rating error will be insignificant because of the similarity in the deduct curves. However at the high severity, it is important to distinguish between the two distresses due to their different leak potentials.

Severity levels

- **Low.** The ridges are noticeable, but the felts are not exposed.
- **Medium.** The ridges are raised and clearly visible. The surfacing on the ridge is gone, and the top felt is exposed.
- **High.** Either of the following conditions:
  - Open breaks have developed in the ridge.
  - Felt deterioration has progressed through the top ply, exposing underlying plies.

Measurement

Measure lineal feet of ridges running in all directions.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total length of membrane ridges (ft)
B = total area of roof section being rated (sq ft)

Built-Up Roofing: Slippage

Description

Slippage is a downslope lateral movement of felt plies. Slippage usually occurs on roofs with slopes greater than ¼ in./ft.

Severity levels

- **Low.** Less than 2 in. of slippage has occurred, evidenced by the presence of narrow bare strips perpendicular to the slope.
    - *Note: Low severity slippage requires inspection at 6 month intervals.*
- **High.** More than 2 in. of slippage has occurred. There is evidence of humping and wrinkling.

Measurement

Measure square feet of affected roof area. The affected area extends from the high point on the slope, where bare felts are noticeable, down to the low point of the slope or the area where humping and wrinkling are noticeable.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total affected area of roof (sq ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Splits

Definition

Splits are tears that extend through all membrane felts. They vary in length from a few feet to the length of the roof; they vary in width from a hair-line crack to more than 1 in. Splits generally occur directly above the joints between the long sides of insulation boards, and they run in the direction the felts were installed.

Severity levels

- **High.** An unrepaired split or a repaired split which has started to re-open.

Measurement

Measure lineal feet of split.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total length of membrane splits (ft)
B = total area of roof section being rated (sq ft)

Built-up roofing: Surface deterioration

Description

A built-up roofing membrane will generally have one of the following types of surfacing: aggregate surface, mineral surface-cap, or smooth surface-coated. The membrane surface may show any of the following distressed conditions:

- Lack of top surface or coating.
- Alligator cracking (interconnected hairline cracks that resemble alligator hide).
- Lack of adhesion between the membrane plies.

Note

Walkways are treated as part of the membrane surfacing.

Severity levels

- **Low.** Any of the following conditions:
  - On aggregate-surfaced roofs, the aggregate is not embedded or is poorly embedded, but the felts remain covered with aggregate.
  - Open edge laps or fishmouths are visible.

- On smooth-surfaced roofs, there is evidence of crazing of top surface with hairline cracks (alligatoring).
- Walkways shows loss of surfacing, loss of adhesion, cracks, blistering, or cracked coating.

- **Medium.** Any of the following conditions:
  - On aggregate-surfaced roofs, the aggregate is displaced and the top coat of bitumen is exposed.
  - On mineral-surfaced-cap sheet roofs, the mineral granules have come off the cap sheet, exposing the underlying felt.
  - On smooth-surfaced roofs, no surface coating exists or there is a loss of surface coating.
  - On smooth-surfaced roofs, alligator cracks extend down through the bitumen to the top felt.
- **High.** Any of the following conditions:
  - On aggregate-surfaced roofs, the aggregate cover has been displaced and the bitumen pour coat is deteriorated, leaving the underlying felts exposed. The felts may be deteriorated.
  - On mineral-surfaced-cap sheet roofs, the cap sheet felt is deteriorated.
  - On smooth-surfaced roofs, alligator cracks extend down through one or more plies.
  - Shrinking of the walkway has torn the membrane below it.

Measurement

Measure square feet of each affected area and rate at highest severity level which exists.

Note:

When large quantities of this problem are present (especially on large roofs), the representative sampling technique can be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of surface deterioration (sq ft)
B = total area of roof section being rated (sq ft)

Appendix C: Single Ply Roofing Distress Survey Definitions

General notes

- These definitions are applicable to single-ply (SP) roofing surfaces and flashing components.
- Where multiple severity levels are present for a given distress record each separately.
- Distress quantities or distress density may be recorded. If distress quantities are recorded, density ranges will be computed in BUILDER/BRED. If distress densities are recorded, distress quantities will be blank in BUILDER/BRED.
- If during the course of the inspection, additional occurrences are found of distress-severity combinations, then the quantity or density are adjusted, as necessary.
- To estimate density when distress quantities are not recorded, follow the density definitions for the individual distresses. However, for use in BUILDER, density may be estimated since density ranges are used and not the precise density value. Generalized visual cues are offered below in Table C1, but they may not be applicable for certain distresses.
- These distress definitions in Table C1 are from *ROOFER: Membrane and Flashing Condition Indexes for Single-Ply Membrane Roofs–Inspection and Distress Manual* (Bailey et al. 1993).

Table C1. Single-ply roofing distress density estimation from visual clues (Bailey et al. 1993).

Density (%)	Visual Cue (when applicable)
>0%–0.1%	Difficult to notice even by careful observation, especially if spotty. (Up to about 1" x 12" in an 8' x 10' area; 1/8" in 10' length)
>0.1%–1%	Somewhat noticeable, but easily missed by casual observation, especially if spotty; Careful observation usually needed, if spotty. (Up to about 10" x 12" in an 8' x 10' area; 1-1/4" in 10' length.)
>1%–5%	Noticeable, even by casual observation, but still only a mere fraction. (Up to about 1' x 4' in an 8' x 10' area; 6" in 10' length.)
>5%–10%	Easily noticeable even if spotty; more than a mere fraction. (Up to about 1' x 8' in a 8' x 10' area; 1' in 10' length.)
>10%–25%	Readily noticeable, but less than 1/4 of area or length.

Density (%)	Visual Cue (when applicable)
>25%–50%	Very noticeable, but less than 1/2 of area or length.
>50%–<100%	Overwhelmingly noticeable; greater than 1/2 of area or length.
100%	Entire area or length.

Single ply (SP) roofing distress summary listing

- (SP) Base Flashing-Membrane Material
- (SP) Base Flashing-Coated Metal
- (SP) Metal Cap Flashing
- (SP) Embedded Edge Metal
- (SP) Flashed Penetrations
- (SP) Pitch Pans
- (SP) Interior Drains and Roof Level Scuppers
- (SP) Splits
- (SP) Ridges
- (SP) Holes, Cuts, and Abrasions
- (SP) Defective Seams
- (SP) Surface Coating Deterioration
- (SP) Membrane Deterioration
- (SP) System Securement Deficiencies
- (SP) Membrane Support Deficiencies
- (SP) Patching
- (SP) Debris and Vegetation
- (SP) Improper Equipment Supports
- (SP) Ponding

Single-ply roofing: Base flashing-coated metal

Definition

Base flashing material is composed of membrane-coated metal. The metal extends from the roof surface upwards above the plane of the membrane, providing a watertight termination of the membrane.

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or light corrosion.

- Distortion of joint covers.
- Top of flashing is less than 6 in. above the roof surface.
- Exposed fasteners.

- **Medium.** Any of the following defects:
  - Joint cover is unbonded to metal base flashing, but it does not allow water to penetrate.
  - Coated metal base flashing fasteners are loose.
  - Coated metal base flashing has pulled away from the wall or curb, or it has lifted up but top termination is watertight.
  - Crazing or eroding of the joint cover material but that has not worn through and does not allow water to penetrate.
  - Coated metal base flashing has repairs made with dissimilar materials.
- **High.** Any of the following conditions:
  - Holes in metal base flashing.
  - Hole in joint cover or unbonding of joint cover from metal base flashing, allowing water to penetrate.
  - Exposed gaps at top termination of the base flashing.
  - Coated metal base flashing has pulled away from the wall or curb or has lifted up, allowing water to penetrate (rate full section of metal, which is normally a 10 ft length).

Measurement

Measure length (ft) of base flashing having the above conditions. Holes, open side laps, and seams count as 1 ft each. Each joint cover having a hole is counted as 1 ft. As a method of sampling of the joint covers for ballasted systems, determine the total number of existing joints by dividing the total length of coated metal base flashing by the length of metal sections (usually 10 ft). Every fourth joint should be inspected for defects in the cover strip. Count the number of inspected joints having a specific defect and multiply by 4 to determine the total length of the defect.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = length of base flashing defects (ft)

B = total length of flashed perimeter of roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections)

Single-ply roofing: Base flashing-membrane material

Definition

Base flashing is composed of membrane material or other flexible material. The base flashing extends from the roof surface upward to above the plane of the membrane and provides a watertight termination of the membrane.

Severity levels

- **Low.** Any of the following defects:
  - Light crazing or eroding of the base flashing.
  - Top of the base flashing is less than 6 in. above the membrane.
  - Nailing strip or flashing batten with exposed fasteners is less than 6 in. above the roof surface.
  - Seam or side lap is open less than ½ in.
  - Flashing has repairs with compatible materials.
- **Medium.** Any of the following defects:
  - Crazing or eroding of the base flashing that has worn through to a reinforcement or scrim sheet, or down to another layer of different color, or has resulted in obvious loss of sheet thickness.
  - Slippage, wrinkling, blistering, pulling, unbonding, or bridging of base flashing material that does not allow water to penetrate.
  - The presence of solvents, oil, or other chemicals with deterioration of the base flashing but does not allow water to penetrate.
  - Flashing has repairs made with dissimilar materials.
  - Seam or side lap is open more than ½ in. but does not allow water to penetrate the flashing.
  - Loose or missing termination bar where no counterflashing is used.
  - Loose or missing nailing strip.
- **High.** Any of the following defects:
  - Crazing or eroding of the base flashing that has worn through the flashing, allowing water to penetrate.
  - Holes, splits, or tears in base flashing, allowing water to penetrate.
  - Exposed gaps at top of the base flashing.
  - Seam or side lap is open through its entire width, allowing water to penetrate the flashing.

- Holes through the base flashing caused by solvent, oil, or other chemicals.

Measurement

Measure length (ft) or base flashing having the above conditions. Holes, open side laps, and seams count as 1 ft each.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of base flashing defects (ft)
B = total length of flashed perimeter of roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections)

Single-ply roofing: Debris and vegetation

Description

Debris and vegetation includes the presence of foreign objects, vegetation, fungal growth, solvents, oils, or other chemicals that could damage, puncture, or degrade the membrane.

Notes

- Accumulation of oils and grease can present a significant fire hazard and should be reported immediately.
- Do not rip out vegetation that is growing into the waterproofing systems, as that may allow water to penetrate.

Severity levels

- **Medium.** Any of the following defects:
  - Vegetation that has not penetrated the membrane.
  - Degradation of the membrane caused by solvents, oils, or other chemicals.
  - Foreign materials that are not removed from the roof during the inspection.
- **High.** Any of the following defects:

- Vegetation that has penetrated the membrane.
- Degradation of the membrane caused by solvent, oils, or other chemicals allowing water to penetrate.

Measurement

Measure square feet of debris and vegetation having the above conditions.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of debris and vegetation (sq ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Embedded edge metal

Definition

Embedded edge metal is a formed strip of metal at the edge of the roof that continues down the vertical part of the wall to form a fascia or drip edge. This stripped-in flashing provides a finished termination for the roofing membrane. On all but coated-metal flashing systems, the metal is placed on top of the membrane, and fastened to the deck through it. To make the area watertight, the metal is covered with membrane or flashing material (i.e., it is stripped in). Coated metal systems have their edge metal placed before the membrane. The membrane is adhered to the top of the coated metal, thereby eliminating the need to have it stripped in. A formed, vertical projection (gravel stop) may be incorporated to prevent ballast from rolling or washing off the roof. Exterior and interior gutters that are embedded in the membrane are considered embedded edge metal. (An interior gutter is a built-in trough of metal or other material that collects water from the roof and carries it to a drain or downspout.)

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or light corrosion.
  - Termination battens have exposed fasteners.
  - Stripping material is open less than ½ in.

  - Distortion of joint covers.
  - For coated metal edge flashings that are not stripped in, membrane is open less than ½ in.
- **Medium.** Any of the following defects:
  - Joint cover is unbonded to embedded edge metal, but it does not allow water to penetrate.
  - Nails under stripping material are backing out.
  - Stripping material is crazing, checked, or cracked.
  - Stripping material is open more than ½ in., but edge metal fasteners are not exposed.
  - Loose or lifted metal with deterioration of the stripping material.
  - Embrittled joint stripping material can be seen.
  - The entire length of interior gutter is rated medium (at a minimum) due to the potential for leak damage.
  - For coated metal edge flashing that is not stripped in, membrane is open more than ½ in., but it does not allow water to penetrate.
- **High.** Any of the following conditions:
  - The stripping material is missing or open and edge metal fasteners are exposed, or stripping material has holes, cuts or tears, allowing water to penetrate.
  - Hole in joint cover or unbonding of joint cover from embedded edge metal, allowing water to penetrate.
  - Holes through the metal are visible.
  - Holes are associated with loose or lifted embedded edge metal.
  - Holes in interior gutter are present.
  - For coated metal edge flashing that is not stripped in, the membrane is open and allowing water to penetrate.

Measurement

Each split above a joint is counted as 1 ft. As a method of sampling the embedded edge metal joints for ballasted systems, determine the number of joints by dividing the total length of embedded edge metal flashing by the length of the edge metal sections (often 10 ft). Gravel should be moved at every fourth joint, and the stripping material inspected for splits. Count the number of inspected joints having a specific defect and multiply by four to determine the total length of the defect.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of embedded edge metal flashing defects (ft).
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

Single-ply roofing: Flashed penetrations

Definition

This category includes pipes, plumbing vent stacks, flues, ducts, conduits, guy wires, drain sumps, and other penetrations through the roof membrane (excluding pitch pans but including metal curbing for hatches and ventilators where the metal flange is stripped into the membrane or, in the case of some coated metal flashing systems, the membrane is adhered to the top of the coated metal flange, thereby eliminating the need to have it stripped in).

Severity levels

- **Low.** Any of the following defects:
  - Flashing sleeve is deformed.
  - Stripping material, boot, or membrane (for coated metal flashing sleeves) is open less than ½ in.
  - Top of flashing is less than 6 in. above the membrane.
- **Medium.** Any of the following defects:
  - Stripping material is crazing, checked, or cracked.
  - Stripping material, boot, or membrane (for coated metal flashing sleeves) is open more than ½ in. but does not allow water to penetrate the flashing.
  - Top of flashing sleeve or boot is not sealed or is not rolled down into the existing plumbing vent stack.
  - Clamping band is loose or missing (where required).
  - Umbrella is open or no umbrella is present (where required).
  - Corrosion of metal or delamination of coating is visible.
- **High.** Any of the following conditions:
  - Stripping material has holes, cuts, or tears.
  - Stripping material, boot, or membrane (for coated metal flashing sleeves) is open, allowing water to penetrate.

- Holes, cuts, or tears are visible in flashing sleeve or metal curb.
- No flashing sleeve present.
- Incompatible flashing material has been used.

Measurement:

Count each small distressed flashed penetration as 1 ft at the highest severity level present. For metal curbs and ducts with more than 1 ft of perimeter, measure the length (in feet) of the distressed perimeter.

Density:

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of distressed flashed penetration (ft).
B = total length of flashed perimeter of roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections).

Single-ply roofing: Holes, cuts, and abrasions

Definition

Holes and cuts are membrane distresses caused by physical abuse from tools, traffic, debris, gravel, wind, etc., or they are manufacturing defects such as pinholes. Holes and cuts can be of various shapes and sizes. Abrasion is physical damage that has roughened or worn the membrane surface.

Severity levels

- **Low.** Surface scratches or abrasions with no significant loss of membrane thickness.
- **Medium.** Cuts, gouges, or abrasions with loss of membrane thickness but not fully penetrating the membrane.
- **High.** Any of the following defects:
  - Holes, cuts, gouges, or abrasions that penetrate the membrane.
  - Holes through the membrane that are caused by underlying mechanical fasteners.

Measurement

Count the total number of scratches, gouges, holes, and cuts in the membrane. If the distance between distresses is less than 1 ft, count the distresses as one. If the distress is longer than 1 ft, measure the length. Measure area of abrasion in square feet.

Note

When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = total number and/or length of membrane scratches, gouges, holes, and cuts (ft) or total area of abrasion (sq ft).
B = total area or roof section being rated (sq ft).

Single-ply roofing: Improper equipment supports

Definition

Improper equipment supports or pipes, conduits, and mechanical equipment supports (wood sleepers, channels, etc.) that are placed directly on the membrane below the equipment. Repairing this distress may require replacing the surrounding insulation and membrane.

Severity levels

- **Low.** All improper equipment supports are rated low severity (at a minimum) due to the maintenance problems associated with them.
- **Medium.** Any of the following defects:
  - Movement of the support has displaced the membrane, but movement has not cut or punctured the membrane.
  - Equipment is bolted through the membrane, but the membrane is sealed and watertight.
- **High.** Any of the following defects:
  - Movement of the support has cut or punctured the roof membrane.

- The equipment is bolted through the membrane, and the membrane is not sealed, allowing water to penetrate.

Measurement

Measure square feet of each improper equipment support. The minimum dimensions for the length and width of a support shall be 1 ft.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of improper equipment supports (sq ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Interior drains and roof level scuppers

Definition

A drain is a penetration of the roof membrane that allows water to flow into a piped drainage system. The drain fixture at the roof has a flange and/or clamping arrangement to which the roofing membrane is attached. A scupper is a channel through a parapet or raised roof edge that is designed to drain the roof. Roof-level scuppers are for primary drainage. Elevated (overflow) scuppers are for emergency drainage.

Note

Most SP roofing systems do not require stripping material around the drain.

Severity levels

- **Low.** Any of the following defects:
  - Field seam within 1 ft of a drain or roof-level scupper.
  - Stripping material or membrane is open less than ½ in.
- **Medium.** Any of the following defects:
  - Material is crazing, checked, or cracked.
  - Stripping material or membrane is open ½ in. or more, but the opening does not allow water to penetrate.
  - Strainer is broken or missing.

   - Scupper shows loss of protective coating or start of metal corrosion.
   - Drain has a field seam in the clamping ring.
- **High.** Any of the following conditions:
   - Stripping material has holes, cuts, or tears that allow water to penetrate.
   - Stripping material or membrane is open, allowing water to penetrate.
   - Clamping ring is loose or missing from drain or bolts are missing.
   - Drain is clogged.
   - Scupper is broken or contains holes.
   - Holes, cuts, tears, or abrasions through the membrane are within 2 ft of the drain or scupper.

Measurement

Each distressed drain and scupper should be counted once at the highest severity level present.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of distressed interior drains and scuppers (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections)

Single-ply roofing: Membrane deterioration

Definition

This category includes erosion or crazing of the membrane. Erosion is the wearing away of the membrane surface, creating a rough texture. Crazing is hairline cracking of the membrane.

Severity levels

- **Low.** Light crazing of the membrane surface.

- **Medium.** Crazing or eroding of the membrane surface that has worn through to a reinforcement or scrim sheet, or has worn down to another layer of different color, or has resulted in obvious loss of sheet thickness.
- **High.** Crazing or eroding of the membrane surface that has worn through the membrane, allowing water to penetrate.

Measurement

Measure the square feet of each affected area and rate at the highest severity level present.

Note

When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of membrane deterioration (ft)
B = total area of roof section being rated

Single-ply roofing: Defective seams

Definition

Defective seams include incomplete, damaged, or weak seams that join two sheets of a membrane.

Note

For EDPM and polyvinyl chloride (PVC) membranes, all field seams should have lap sealant at the edges. All other membranes should have lap sealant at cut edges of seams that have exposed reinforcement material.

Severity levels

- **Low.** Any of the following defects:

  - Missing lap sealant at field seam of propylene diene terpolymer (EPDM) and PVC membranes only.
  - Missing lap sealant at field seam that has exposed reinforcement material at seam edge (usually at end laps and field-cut edges of sheets).
  - Seam is open less than ½ in.
  - Wrinkling at seam that is watertight.
  - Seam intersections (e.g., T-joints) on EPDM that do not have a patch covering them.
  - Blisters within the seam.
- **Medium.** Any of the following defects:
  - Seam is open ½ in. or more, but it does not allow water to penetrate the membrane.
  - Pinched wrinkle at seam.
- **High.** Any of the following conditions:
  - Seam is open through entire depth, allowing water to penetrate.
  - Fishmouths, wrinkles, or bunches at the seam that allow water to penetrate.

Measurement

- For exposed membranes (no overlying ballast), inspect all seams visually.
- For ballasted roofs, check field seams at five different locations on the roof section. Clear ballast from 5 ft of the seam at each location and then clean the exposed seam with a whisk broom. If all checked seams are without defects, assume the remaining field seams are satisfactory. If any defects are found, use the following sampling technique.
  - For roof sections with sheet widths of 10 ft or less, inspect 2% of the total length of field seams (2 ft of every 100 ft of seam). For roof sections having sheet widths greater than 10 ft, inspect 4% of the total length of field seams (2 ft of every 50 ft of seam). Measure length of each specific seam defect found.
  - Extrapolate to determine the total length of seam defects for the entire roof section from the total length of defect found. When 2% of the seams are inspected, multiply the actual defect length by 50 to compute total length of defect. When 4% of the seams are inspected, multiply actual defect length by 25 to compute total length of defect.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total length of defective seams (ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Membrane support deficiencies

Definition

The surface on which the membrane rests may not be smooth and continuous. For fully adhered membranes, partially adhered membranes, and mechanically attached membranes, this category includes warping, bowing, or shrinking of insulation boards. For ballasted membranes, it includes displaced insulation boards. Localized absence of membrane support may be due to missing components below.

Note

Mechanical fasteners and loose insulation boards are rated as System Securement Deficiencies.

Severity levels

- **Low.** Any of the following defects:
    - Membrane tension caused by warping or bowing of substrate.
    - Uneven joints or gaps more than ½ in. wide, but less than 2 in. between insulation boards.
- **Medium.** Any of the following defects:
    - Uneven joints or gaps more than 2 in. wide between insulation boards, or absence of substrate support for width of 2 in. or more.
    - For ballasted systems, insulation boards have been displaced.
    - Lumps indicating presence of foreign material between membrane and substrate.

Measurement

Measure square feet of membrane having the above conditions.

Note

When many of these deficiencies are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of membrane support distress (ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Metal cap flashing

Definition

Metal cap flashing includes any sheet metal that serves to counter flash or cover a detail such as a parapet, firewall, roof area divider, equipment curb, raised roof edge, or an expansion joint by protecting the top termination of the base flashing and shedding water away from it. The metal cap flashing should be free to expand and contract.

Note

All single plies are installed with counterflashing to protect the top of the base flashing.

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or corrosion without holes.
  - Top of counterflashing or metal coping is deformed and allows water to pond on the top.
  - Metal cap flashing is deformed but still performing its function.
  - Metal cap flashing has been sealed to base flashing.
- **Medium.** Any of the following defects:
  - Corrosion has caused holes in the metal on a sloping or vertical surface.
  - Metal cap flashing has loose fasteners, failure of soldered or sealed joints, or loss of attachment.

  - Metal cap flashing has rough edges that are in contact with the base flashing.
- **High.** Any of the following conditions:
  - Metal cap flashing is missing or displaced from its original position.
  - Corrosion has caused holes in the metal on a horizontal surface.
  - Metal cap flashing has open joints or missing joint covers (where covers were originally installed).
  - Sealant at reglet or top of counterflashing is missing or no longer functional, allowing water to channel behind it.
  - Counterflashing is loose at the top, allowing water to channel behind it.
  - Metal cap flashing does not extend over top of the base flashing.

Measurement

Measure length (ft) or metal cap flashing having the above conditions. Individual defects (e.g., joints, holes) count as 1 ft minimum.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of metal cap flashing defects (ft)
B = total length of flashed perimeter of roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections)

Single-ply roofing: Patching

Description

Patching is a localized temporary or permanent repair of the membrane using dissimilar materials. Repairs made with similar materials are not counted as patches; distresses associated with these repairs should be recorded in the appropriate category and not as patching distresses.

Severity levels

- **Low.** All patches that are not made with similar materials as that of the original construction are rated as low severity (at a minimum).

- **Medium.** All patches made with temporary materials (e.g., duct tape, caulking, and sealants) are rated medium severity (at a minimum).
- **High.** Other distresses of high severity are present within the patched area (count as patching distress only).

Measurement

Measure square feet of each patch having the above conditions.

Note

When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of patching (sq ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Pitch pans

Definition

A pitch pan is a flanged metal sleeve placed around a roof penetration element and filled with a sealer. For pitch pans on EPDM and Hypalon roofing systems, stripping materials should cover the sides of the metal pan and terminate within the pan below the sealer.

Severity levels

- **Low.** All pitch pans are low severity at a minimum due to maintenance requirements.
- **Medium.** Any of the following defects:
  - Stripping material is crazing, checked, or cracked.
  - Stripping material or membrane (on coated metal pitch pans) is open more than ½ in., but it does not allow water to penetrate the flashing.
  - Loss of protective coating or corrosion of metal.

- For EPDM and Hypalon, stripping material is not covering the top of the metal pan or does not terminate below the sealer.

- **High.** Any of the following conditions:
  - Stripping material has holes, cuts, or tears that allow water to penetrate.
  - Edge of stripping material or membrane (on coated metal pitch pans) is open, allowing water to penetrate.
  - Sealer is below the metal rim, allowing ponding in the pan.
  - Sealer has cracked or separated from the pan or roof penetration.
  - Corrosion is visible through the metal pan.

Measurement

Each distressed pitch pan should be counted once at the highest severity level present.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of distressed pitch pans (ft)
B = total length of flashing on roof section being rated (including perimeter flashings and flashings for penthouses, courtyards, and curbed projections)

Single-ply roofing: Ponding

Definition

Ponding includes standing water or evidence of standing water by the presence of staining or accumulation of debris. Water that remains longer than 48 hr is considered to be ponded water.

Severity levels

- **Low.** General ponding is rated at low severity.
- **Medium.** Any of the following defects:
  - Ponding caused by wrinkles or folds in the membrane that blocks drainage.

- Ponding caused by warping or bowing of the substrate beneath the membrane.

Measurement

Measure square feet of affected area.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of ponding (sq ft)
B = total area of roof section being rated (sq ft)

Single-ply roofing: Ridges

Definition

Ridges are long, narrow (usually less than 3 in.), raised portions of the roof membrane. Usually ridges occur directly above the insulation board joints.

Severity levels

- **Low.** All ridges are rated low severity as a minimum.
- **High.** Open breaks have developed in the ridge, allowing water to penetrate.

Measurement

Measure length of ridges running in all directions.

Note

When many ridges are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total length of membrane ridges (ft)
B = total area or roof section being rated (sq ft)

Single-ply roofing: Splits

Definition

Splits are cracks or tears that extend through the membrane. They vary in length from a few inches to the length of the roof, and they vary in width from hair-line to more than 1 in.

Severity levels

- **High.** All splits in the membrane are considered to be high severity due to their leak potential.

Measurement

Measure length of split.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total length of membrane splits (ft)
B = total area or roof section being rated (sq ft)

Single-ply roofing: Surface coating deterioration

Definition

Surface coating deterioration includes wear, blistering, or peeling of any surface coating applied for fire protection (such as adhesive coating and sand on an EPDM membrane) or solar reflectivity, but not waterproofing.

Severity levels

- **Low.** Color of underlying membrane can be seen through the coating, or membrane has lost protection (for membrane with coating protection that does not have sand or mineral matter embedded).

- **Medium.** Membrane area has lost the sand or mineral matter portion of the coating protection (for membrane with coating protection that has sand or mineral matter embedded).

Measurement

Measure the square feet of each affected area and rate at the highest severity level present.

Note

When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of surface coating deterioration (ft)
B = total area of roof section being rated

Single-ply roofing: System securement deficiencies

Definition:

For fully adhered membranes, system securement deficiencies include membrane areas (including blisters) that are unattached to the substrate. For mechanically attached membranes, this category includes failed mechanical fasteners. For partially adhered membranes, the category includes membrane that is not adhered at points of attachment. For ballasted membranes, the membrane has areas where ballast is missing or displaced.

Notes

- Holes in the membrane caused by mechanical fasteners are rated as Holes.
- If ballast is redistributed by the inspector to cover bare areas, these areas should not be counted as defects.
- For defect definitions, “building perimeter” is area within 10 ft of a roof edge. These areas experience high wind uplift pressures.

Severity levels

- **Low.** Any of the following defects:
  - For fully adhered systems, an area of unattached membrane substrate of 2 sq ft or less.
  - For ballasted systems, a bare area of 4 sq ft or less.
- **Medium.** Any of the following defects:
  - For fully adhered systems, an area of unattached membrane substrate of greater than 2 sq ft but less than 100 sq ft (less than 25 sq ft at building perimeter).
  - For mechanically attached systems, an isolated mechanical fastener that has lost its attachment capability or has backed out, causing bridging of the membrane.
  - For partially adhered systems, an isolated point of attachment that has lost adherence.
  - For ballasted systems, a bare area of greater than 4 sq ft but less than 100 sq ft (less than 25 sq ft at building perimeter).
- **High.** Any of the following conditions:
  - For fully adhered systems, an area of unattached membrane or substrate of 100 sq ft or greater (25 sq ft at building perimeter).
  - For mechanically attached systems, adjacent mechanical fasteners that have lost their attachment capability or have backed out, causing bridging of the membrane.
  - For partially adhered systems, adjacent points of attachment that have lost adherence.
  - For ballasted systems, a bare area of 100 sq ft or greater (25 sq ft at building perimeter).

Measurement

Measure square feet of membrane having the above conditions. For mechanically fastened and partially adhered systems, count the affected area of unattached membrane.

Note

When large quantities of this problem are present, the representative sampling technique may be used.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of attachment defects (ft)
B = total area of roof section being rated (sq ft)

Appendix D: Shingle Roofing (SR) Distress Survey Definitions

General notes

- These definitions are applicable to shingled roofing (SR) surfaces and flashing components.
- Where multiple severity levels are present for a given distress record each separately.
- Distress quantities or distress density may be recorded. If distress quantities are recorded, density ranges will be computed in BUILDER/BRED. If distress densities are recorded, distress quantities will be blank in BUILDER/BRED.
- If during the course of the inspection, additional occurrences of distress-severity combinations are found, then adjust the quantity or density as necessary.
- To estimate density when distress quantities are not recorded, follow the density definitions for the individual distresses. However, for use in BUILDER, density may be estimated since density ranges are used and not the precise density value. Generalized visual cues are offered below in Table D1, but these cues may not be applicable for certain distresses.
- The distress definitions in Table D1 are reproduced from *ROOFER: Steep Roofing Inventory Procedures and Inspection and Distress Manual for Asphalt Shingle Roofs* (Bailey 1999).

Table D1. Shingle roofing (SR) distress density estimation visual clues (Bailey 1999).

Density (%)	Visual Cue (when applicable)
>0%–0.1%	Difficult to notice even by careful observation, especially if spotty. (Up to about 1" x 12" in an 8' x 10' area; 1/8" in 10' length.)
>0.1%–1%	Somewhat noticeable, but easily missed by casual observation, especially if spotty. Careful observation usually needed, if spotty. (Up to about 10" x 12" in an 8' x 10' area; 1-1/4" in 10' length.)
>1%–5%	Noticeable, even by casual observation, but still only a mere fraction. (Up to about 1' x 4' in an 8' x 10' area; 6" in 10' length.)
>5%–10%	Easily noticeable even if spotty; more than a mere fraction. (Up to about 1' x 8' in an 8' x 10' area; 1' in 10' length.)
>10%–25%	Readily noticeable, but less than 1/4 of area or length.
>25%–50%	Very noticeable, but less than 1/2 of area or length.

Density (%)	Visual Cue (when applicable)
>50%–<100%	Overwhelmingly noticeable; greater than 1/2 of area or length.
100%	Entire area or length.

Distress summary listing

All SR distresses are summarized in the list below. Details of each distress are given in the sections that follow. The list is formatted so that clicking on a distress will go directly to that section.

- (SR) Step Flashing
- (SR) Metal Cap Flashing
- (SR) Edge Metal
- (SR) Valley Flashing
- (SR) Ridge/Hip Shingles
- (SR) Metal Apron Flashing
- (SR) Flashed Penetrations
- (SR) Ridge/Hip Vents
- (SR) Pitch Pans
- (SR) Interior Gutters
- (SR) Age Deterioration
- (SR) Holes/Splits/Missing Shingles
- (SR) Unsealed/Unlocked Tabs
- (SR) Lumps/Ridges/Sags
- (SR) Exposed Fasteners
- (SR) Stains/Rust/Fungus/Mildew
- (SR) Debris and Vegetation
- (SR) Patching
- (SR) Improper Equipment Supports

Shingle roofing: Debris and vegetation

Definition

This category includes any of the following items:

- Foreign objects on the roof that could cause damage or puncture the shingles or flashing.
- Growth of vegetation on the roof.

- Accumulation of solvent or oil drippings on the roof.

Severity levels

- **Medium.** Any of the following defects:
  - Collection of foreign objects or vegetation on the field of the roof.
  - Grease, solvent, or oil drippings on the roof but no apparent degradation or the roofing system.
  - Evidence of branches making contact with the roof shingles.
- **High.** Any of the following defects:
  - Grease, solvent, or oil drippings on the roof that have caused degradation of the roofing shingles.
  - Vegetation roots that have penetrated the roof shingles.

Measurement:

Measure the exposed area (sq ft) of shingles having the above conditions.

Density:

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) debris and vegetation defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Age deterioration

Definition:

Age deterioration includes clawing and curling of the shingles, and exposure of the shingle felt or mat due to excessive loss of granules, all of which indicate shingle brittleness. Normally, such deteriorations are not localized problems but are general conditions found on large areas of the roof, such as individual roof exposures, or on the entire roof. The occurrence of these problems indicates aging and reduced service life. Clawing is the turning under of the tab corners of the shingle, and curling is the turning up of the tab corners.

Severity levels

- **Low.** Any of the following defects:
  - Loss of granular surface on shingle, but the reinforcement felt or mat is not exposed.
  - Erosion of material around the edge of a shingle, normally found less than ¼ in. from the edge.
- **Medium.** Any of the following defects:
  - Corners of the shingle are turned under or up (that is, clawing or curling).
  - Loss of granular surfacing on shingle that results in bare spots and exposes reinforcing felt or mat.
  - Loss or delamination of foil on foil-surfaced shingle.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) having age deterioration defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Edge metal

Definition

Formed edge of metal, often referred to as drip edge, placed along eaves and rakes and covered by shingles. The edge metal allows water to drip way from the vertical surfaces and protects underlying building components.

Notes

In some cases, edge metal may not have been installed. If no edge metal exists for the roof section and there is no evidence that the edge metal was originally installed, do not count its absences as a distress.

Severity levels

Medium - Missing or displaced section of edge metal (where originally installed).

Measurement

Measure length (ft) of edge metal flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of edge metal defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Exposed fasteners

Definition

Shingle fasteners are visible in the field of the roof.

Notes

If a shingle fastener has backed out, count it as a hole.

Severity levels

- **Medium.** A fastener is exposed but not backed out.

Measurement

Measure the number of exposed fasteners. Individual exposed fasteners count as 1 sq ft minimum. If more than one exposed fastener is found in an area of 1 sq ft, count the distressed area as 1 sq ft.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of exposed fasteners (sq ft) having defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Flashed penetrations

Definition

Flashing for open pipes, plumbing vent stacks, attic vents, flues, ducts, continuous pipes, guy wires, and other roof penetrations that require a deck flange integrated into the shingles.

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or corrosion.
  - Flashing sleeve is deformed.
  - Top of flue is less than 5 in. above the roof surface on the upslope side.
- **Medium.** Any of the following defects:
  - Exposed fastener in flashing.
  - The sleeve or umbrella is open, or no umbrella is present (where required).
- **High.** Any of the following defects:
  - Edge of deck flange on upslope side of penetration is exposed or visible.
  - Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.
  - Top of flashing sleeve is not sealed or has not been rolled down into existing plumbing vent stack.
  - Flashing sleeve is cracked, broken, or corroded through.
  - No flashing sleeve is present.

Measurement

Count each distressed flashed penetration as 1 ft at the highest severity level present.

Density

$$\frac{A}{B} \text{ x 100 = problem density}$$

where:

A = length of flashed penetrations defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Holes, splits, missing shingles

Definition

This category of distresses is characterized by holes, splits, cracks, or visible tears in the shingle reinforcing felt or mat, or by missing shingles or tabs.

Severity levels

- **Medium.** Any of the following defects:
  - Holes, splits, or cracks that do not extend down to the underlayment or substrate.
  - Misaligned shingle, resulting in partial loss of coverage but no exposed underlayment or substrate.
  - Missing shingle, but no exposed underlayment or substrate.
- **High.** Any of the following defects:
  - Holes or splits that extend down to the underlayment or substrate.
  - Misaligned shingle, resulting in exposed underlayment or substrate.
  - Missing shingle, resulting in exposed underlayment or substrate.
  - Exposed fastener that has backed out. (Note: if fastener has not backed out, count as exposed fastener distress, not a hole).

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \text{ x 100 = problem density}$$

where:

A = total exposed area of shingles (sq ft) having holes/splits/missing shingle defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Improper equipment supports

Definition

This distress category includes pipe, conduit, and mechanical equipment supports (wood sleepers, channels, etc.) that are placed directly on the roof surface with no protective pad or placed at an insufficient height to allow for maintaining the roofing system below the equipment. Repairing this type of distress may require replacing the surrounding roofing system.

Notes

Termination for guy wires are to be rated as Flashed Penetration distresses.

Severity levels

- **Medium.** The equipment is bolted through the shingles, and the bolts appear to be sealed.
- **High.** Any of the following defects:
  - The support has caused movement or damage to the shingles.
  - The equipment is bolted through the shingles, and the bolts do not appear to be sealed.

Measurement

Measure square feet of each improper equipment support. The minimum dimension for length and width of a support shall be 1 ft.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total area of improper equipment supports (sq ft)
B = total area of roof section being rated (sq ft)

Shingle roofing: Interior gutters

Definition

An interior gutter is a built-in trough of metal or other material that collects water from the roof and carries it to a drain or downspout.

Severity levels

- **Low.** Entire length of interior gutter is rated low severity (at a minimum), due to the maintenance problems and high potential for leak damage associated with its presence.
- **High.** Any of the following defects:
  - Clogged gutter or drain.
  - Holes or open seams in interior gutter.

Measurement

Measure entire length of gutter having the conditions described above. For clogged gutters, count lineal feet of clogging material. For clogged drain, count as 1 ft. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = length of gutter defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Lumps, ridges, sags

Definition

Lumps, ridges, or sags are present on the surface of the roof.

Notes

If other problems exist in the areas that exhibit lumping, sagging, or ridging, record them under the appropriate distresses.

Severity levels

- **Medium.** Any of the following defects:
  - Lumps or ridges that do not appear to be caused by unevenness in the supporting substrate or underlying flashing component (e.g., wrinkles in the underlying felt).
  - Lumps, ridges, or sags caused by unevenness in the supporting substrate or underlying flashing component.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) having lumps/ridges/sags defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Metal apron flashing

Definition

Roof-to-wall sheet metal flashing used at the upslope and downslope sides of chimneys, dormers, curbs, and other projections. Apron flashing should be placed at the downslope side of the projection with the edge of the deck flange exposed. The metal apron at the upslope side of the projection should have the edge of the deck flange covered by overlaying shingles. A projection that is wider than 2 ft should have a saddle-shaped cricket that diverts water around the projection.

Severity levels

- **Low.** Any of the following defects:

    - Loss of protective coating or corrosion.
    - Vertical height is less than 4 in high.
- **Medium.** Any of the following defects:
    - Absence of cricket on upslope side of penetration that is wider than 2 ft.
    - Exposed fastener in flashing.
- **High.** Any of the following defects:
    - Edge of deck flange on upslope side of penetration is exposed or visible.
    - Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.
    - Holes, splits, or cracks are present in metal flashing.
    - Metal flashing is open at vertical corner.
    - No apron flashing exists.

Measurement

Measure length (ft) of metal apron flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Metal cap flashing

Definition

Metal cap flashing includes counterflashing and any sheet metal coping cap that serves as part of the counterflashing or cover over a detail such as roof area divider, equipment curb, expansion joint, step flashing, ridge, or hip. Metal cap flashing protects the top termination of the vertical flashing (step flashing or metal apron flashing) and sheds waters away from it. It should be free to expand and contract. Properly lapped exterior siding or cladding can perform the function of metal cap flashing.

Severity levels

- **Low.** Any of the following defects:
    - Loss of protective coating or corrosion.
    - Metal coping cap is deformed, allowing water to pond on the top.
    - Counterflashing is deformed but still functioning.
    - Counterflashing has been sealed to the step flashing.
    - Exposed fasteners on horizontal surfaces of metal cap flashing.
- **Medium.** Any of the following defects:
    - Corrosion holes are present in the metal on a vertical surface.
    - Metal coping cap has loose fasteners, failure of soldered or sealed joints, open joints, or loss of attachment.
- **High.** Any of the following defects:
    - Metal coping cap or counter flashing was not installed, or is missing or displaced from its original position, allowing water to channel behind it.
    - Corrosion holes are present in the metal on a horizontal surface.
    - Metal coping cap has missing joint covers (where originally installed).
    - Sealant at reglet or top of counterflashing is missing or no longer functioning, allowing water to channel behind counterflashing.
    - Counterflashing, exterior siding, or cladding does not extend over the top of the step flashing or apron flashing.

Measurement

Measure length (ft) of metal cap flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of metal cap flashing defects (ft)

B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Patching

Definition

Roof repairs were previously made using dissimilar materials such as mastics or shingles of a different color or design.

Severity levels

- **Low.** Replacement shingle does not match appearance or composition of original adjacent shingles.
- **Medium.** Shingle replacement patch is composed of dissimilar materials such as mastic, roofing felts, or coatings.
- **High.** Shingle replacement patch composed of dissimilar materials that have other high-severity distresses (e.g., holes, splits, and cracks).

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \times 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) having patching defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Pitch pans

Definition

A pitch pan is a flanged sleeve with an open bottom that is placed around a roof penetration and filled with a bituminous, polymeric, or grout sealant to seal the area around the penetration.

Severity levels

- **Medium.** Top rim of pitch pan is not level on all sides.
- **High.** Any of the following defects:
  - Holes, splits, or cracks in metal.
  - Sealing material is below metal rim.
  - Sealing material has cracked or separated from pan or penetration.
  - Edge of deck flange on upslope side of penetration is exposed.
  - Edge of deck flange on downslope side of penetration is not overlapping shingles or is sealed to underlying shingles.

Measurement

Count each distressed pitch pan once at the highest severity level present.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = number of distressed pitch pans (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Ridge and hip shingles

Definition

Portions of shingles (usually one tab width) that are cut from a full 3-tab shingle and laid perpendicular to the hip or ridge, providing a finished water-shedding cap. Note: Ridge and Hip Shingles are treated as flashings because they provide protection of the roofing system at the termination of adjoining roof planes.

Severity levels

- **Medium.** Any of the following defects:
  - Holes, splits, or cracks not extending down to the underlayment or substrate.

  - Misaligned shingle resulting in partial loss of coverage but no exposed underlayment or substrate.
  - Missing shingle, but no exposed underlayment or substrate.
  - Exposed fasteners that have not backed out.
- **High.** Any of the following defects:
  - Holes or splits that extend down to the underlayment or substrate.
  - Misaligned shingle resulting in exposed underlayment or substrate.
  - Missing shingle resulting in exposed underlayment or substrate.
  - Exposed fastener that has backed out.

Measurement

Measure lineal feet of exposed ridge or hip shingle tabs having the conditions described above. Round total quantity to next higher whole foot. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of ridge or hip shingles having defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Ridge or hip vents

Definition

Any device installed on and along the roof ridge or hip for the purpose of ventilating the underside of the roof deck.

Severity levels

- **Medium.** Missing component of vent assembly (e.g., end caps, baffles).
- **High.** Any of the following defects:
  - Missing or loose section of ridge or hip vent.

- Holes, splits, or cracks in ridge or hip vent.
- Missing cap shingle on roof vent.

Measurement

Measure length (ft) of ridge/hip vent flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of ridge/hip vent flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Stains, rust, fungus, mildew

Definition

The shingle surface shows evidence of stains, rust, fungus, or mildew.

Notes

If the appearance is unacceptable, corrective treatments can be applied, such as cleaning with trisodium hypochlorite or installing zinc strips.

Severity levels

- **Low.** Evidence of stains, rust, fungus, or mildew.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) having stains/rust/fungus/mildew defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Step flashing

Definition

Individual pieces of metal flashing material used to flash vertical walls, chimneys, dormers, and other projections. The pieces range 7–10 in. long, and they have a 90-degree bend with a horizontal and a vertical leg. The pieces are individually placed at the end of each course of shingles where the roof meets a vertical surface. They are overlapped and stepped up the slope and then, they are fastened through the horizontal surface to the deck. Step flashing should be used only to flash a vertical surface that runs up a slope, and not across the slope.

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or corrosion of step flashing.
  - Overlay roof system shingles are not step flashed.
  - Coverages of less than one step flashing unit per shingle course exists.
- **Medium.** Any of the following defects:
  - Vertical leg of step flashing is less than 1 in. high.
  - Bent, deformed, or wide gaps in vertical leg of step flashing.
  - Loose or displaced step flashing is present.
  - Vertical joints between step flashing pieces have been sealed closed.
  - Continuous “L” flashing exists instead of incremental step flashing.
- **High.** Any of the following defects:
  - Holes exist in the step flashing.
  - No vertical flashing exists.
  - Top edge of step flashing is exposed, allowing water to penetrate behind flashing.

Measurement

Measure length (ft) of step flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of step flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Shingle roofing: Unsealed or unlocked tab

Definition

For a seal-down shingle, a lack of adhesion between the tab of a shingle and underlying shingles indicates an unsealed condition. Displacement or damage to a lock-down shingle that results in the loss of its interlocking mechanism indicates an unlocked condition.

Notes

- For seal-down shingles, use a trowel or fingers and gently try to lift tab.
- Any adherence of the shingle tab to underlying shingles should be judged as adequate.
- Test several adjacent shingles in three or four randomly selected areas of the roof.
- If any shingles are found to be unsealed, use the sampling method to determine the quantity of the affected area.

Severity levels

- **Medium.** Any of the following defects:
  - o The tab of a shingle, which is designed to be sealed down, is unsealed.
  - o A lock-down shingle is not interlocked.

Measurement

Measure the exposed area (sq ft) of shingles having the above conditions.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = total exposed area of shingles (sq ft) unsealed/unlocked defects
B = total area of roof section being rated (sq ft)

Shingle roofing: Valley flashing

Definition

Roof valley flashings are formed when two sloping sections intersect to form a V. Water from both sections of the roof runs through the valley, making the valley especially vulnerable to deterioration and leakage. Valley flashings for asphalt shingles may be of three types: (1) open valleys lined with sheet metal or mineral-surfaced asphalt roll (composition) material, (2) closed cut valleys having shingles on one side of the valley cut on an angle parallel with the valley, and (3) woven valleys lined with interwoven asphalt shingles form the adjoining roof sections. All three types of valley flashings should have underlying asphalt roll material.

Severity levels

- **Low.** Any of the following defects:
  - Loss of protective coating or corrosion on metal open valley flashing.
  - No fabricated V-shaped crimp (vertical ridge) in center of metal open valley flashing.
- **Medium.** Any of the following defects:
  - Loss of surfacing with exposure of felts in valley flashing.
  - Unsealed laps in open composition valley flashing.
  - Holes, splits, or cracks in valley flashing, but they are not extending down to the underlay.
  - Loose or missing valley shingles, with no underlay or substrate exposed.
  - Edges of valley shingles are sealed (in open or closed valleys).

  - Exposed fasteners within 12 in. of centerline of closed or woven valley.
- **High.** Any of the following defects:
  - Holes or splits in valley flashing, with underlay or substrate exposed.
  - Loose or missing valley shingles, with underlay or substrate exposed.
  - Exposed fastener within 12 in. of centerline of open valley.

Measurement

Measure length (ft) of valley flashing having the conditions described above. Individual defects count as 1 ft minimum. If the distance between distresses is less than 1 ft, count the distresses as one.

Density

$$\frac{A}{B} \text{ x } 100 = \text{problem density}$$

where:

A = length of valley flashing defects (ft)
B = total length of flashing on roof section being rated (including perimeter flashings such as flashing, edge metal, ridge and hip shingles, and valley flashings; and curb flashings around large penetrations such as dormers and skylights)

Appendix E: Direct Condition Rating Definitions

Table E1. Direct condition rating definitions.

Rating	SRM Needs	Rating Definition
Green (+)	Sustainment consisting of possible preventive maintenance (where applicable).	Entire Component-Section or Component-Section sample is free of observable or known distress.
Green	Sustainment consisting of possible preventive maintenance (where applicable) and minor repairs (corrective maintenance) to possibly few or some subcomponents.	No Component-Section or sample with serviceability or reliability reduction. Some, but not all, minor (noncritical) subcomponents may suffer from slight degradation, or few major (critical) subcomponents may suffer from slight degradation.
Green (-)		Slight or no serviceability or reliability reduction overall to the Component-Section or sample. Some, but not all, minor (noncritical) subcomponents may suffer from minor degradation, or more than one major (critical) subcomponent may suffer from slight degradation.
Amber (+)	Sustainment or restoration to any of the following: minor repairs to several subcomponents; or significant repair, rehabilitation, or replacement of one or more subcomponents, but not enough to encompass the Component-Section as a whole; or combinations thereof.	Component-Section or sample serviceability or reliability is degraded, but adequate. A very few major (critical) subcomponents may suffer from moderate deterioration, with perhaps a few minor (noncritical) subcomponents suffering from severe deterioration.
Amber		Component-Section or sample serviceability or reliability is definitely impaired. Some, but not a majority, of major (critical) subcomponents may suffer from moderate deterioration, with perhaps many minor (non-critical) subcomponents suffering from severe deterioration.
Amber (-)		Component-Section or sample has significant serviceability or reliability loss. Most subcomponents may suffer from moderate degradation, or a few major (critical) subcomponents may suffer from severe degradation.
Red (+)	Sustainment or restoration required consisting of major repair, rehabilitation, or replacement to the Component- Section as a whole.	Significant serviceability or reliability reduction in Component–Section or sample. A majority of subcomponents are severely degraded, and others may have varying degrees of degradation.
Red		Severe serviceability or reliability reduction to the Component-Section or sample, such that it is barely able to perform. Most subcomponents are severely degraded.
Red (-)		Overall Component-Section degradation is total. Few, if any, subcomponents are salvageable. Complete loss of Component-Section or sample serviceability.

Appendix F: Paint Rating Definitions

Table F1. Paint and coating rating definitions (Marshall 1994).

Rating	Percentage Deteriorated (%)	Relative Amount Deteriorated
Green (+)	0—.03	Up to about 1" x 4" in an 8' x 10' area; 1/32" in a 10' length; or 3 in 10,000.
Green	.03—.10	Between about 1" x 4" and 1" x 12" in an 8' x 10' area; 1/32" and ⅛" in a 10' length; or 3 and 10 in 10,000.
Green (-)	.10—.30	Between 1" x 12" and 3" x 12" in an 8' x 10' area; ⅛" and ⅜" in a 10' length, or 1 and 3 in 1,000.
Amber (+)	.30—1.00	Between 3" x 12" and 10" x 12" in an 8' x 10' area; ⅜" and 1¼" in a 10' length; or 3 and 10 in 1,000.
Amber	1.00—3.00	Between 10" x 12" and 18" x 18" in an 8' x 10' area; 1¼" and 3¾" in a 10' length; or 1 and 3 in 100.
Amber (-)	3.00—10.00	Between 1' x 2½' and 1' x 8' in an 8' x 10' area; 3¾" and 12" in a 10' length; or 3 and 10 in 100.
Red (+)	10.00—17.00	Between 1' x 8' and 1¾' x 8' in an 8' x 10' area; 1' and 1¾' in a 10' length; or 10 and 17 in 100.
Red	17.00—33.00	Between 1¾' x 8' and 3⅓' x 8' in an 8' x 10' area; 1¾' and 3⅓' in a 10' length; or 17 and 33 in 100.
Red (-)	33.00—100.00	Greater than 1/3 of area, length, or amount.

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Glossary

The following list provides definitions of terms used in this manual.

ADA
Americans with Disabilities Act of 1990.

Administrator
A user with Administrator Role can administer users, assign users to Roles, and change ROOFER configuration settings.

Area Cost Factor
A multiplier that adjusts national average labor/material/equipment costs to local costs. For example, in a remote area with high shipping costs and a tight labor market, the Area Cost Factor might be 1.3. The Area Cost Factor is generally a number between 0.8 and 1.2 for continental U.S. locations, but it can even be greater than 2.0 in high-cost geographic locations.

BCCI
Building Component Condition Index - a condition rating for the target Building Component. For each Component, the BCCI is computed by taking the average of its Sections' CIs, weighted by replacement cost.

BCI
Building Condition Index - a condition rating for the overall Building. For each Building, the BCI is computed by taking the average of its Systems' CIs, weighted by replacement cost.

BFI
Building Functionality Index - computed from the results of a functionality assessment.

BPI
Building Performance Index - a measure of a Building's overall performance, derived from a weighted combination of the BCI and BFI, where the lower of the two values is given two-thirds of the weight and the higher of the two values is given one-third of the weight. If no functional assessment has been performed, the BFI is assigned a value of 100.

BRED
BUILDER Remote Entry Database (also abbreviated as BuilderRED)

BUR
Built-up Roofing

CCI
Coating Condition Index

CI
Condition Index

CII
Component Importance Index

CM
Corrective Maintenance

CMC
Component material category

Complex CI
Complex Condition Index - a condition rating for the target complex. The Complex CI is computed by taking the average of the BCIs of each building in the complex, weighted by replacement cost.

CSCCI
Component-Section Coating Condition Index

CSCI
Component-Section Condition Index - a condition rating for the target Component-Section. For both condition assessment types—distress survey and direct rating—the CSCI is computed by first using the assessment data to calculate a deduct value, and then subtracting that deduct value from the maximum possible rating of 100. The deduct value computation differs for each condition assessment method.

Equipment Make
The series, collection, or line that the equipment is included in, if applicable. For example, a Trane gas furnace might be designated as S9V2, XC95, or XV95.

ERDC-CERL
U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory

ESC
Emergency/Service Call

FAFI
Functional Area Functionality Index

FCA
Facility Condition Assessment

FCI
Facility Condition Index

FI
Functionality Index

HPSB
High Performance and Sustainable Building

HVAC
Heating, ventilation, and air conditioning

ICI
Insulation Condition Index

Icon Color
Icon color designates the condition of an SMS element, or whether it has yet been inspected at all. If the icon is gray, no inspection has been performed. Red, amber, and green icons indicate a red-, amber-, or green-level average condition of all sublevels below the designated icon, assuming that a rollup has been performed.

Inspection Supervisor
A user with Inspection Supervisor Role has all the rights of an Inspector, and can also create roof inspection schedules.

Inspector
Person who performs inspections to be input into BUILDER or ROOFER. As a permissions Role, Inspectors can input and edit inventory information in Inventory mode, and can input and edit inspection information from the Condition Assessment screen.

Inventorior
A user with Inventorior Role can add and edit records below the Building level.

KBI
Knowledge-Based Inspection

M&R
Maintenance and Rehabilitation

Master Planner
A user with Master Planner Role has all the rights of a Work Planners, and can also generate multi-year work plan scenarios, and edit any and all data saved by other users of the program. Master Planner is the highest level of user privileges.

MCI
Membrane Condition Index

MDI
Mission Dependency Index - measures the relative importance of a Building

N/A
Not Applicable

PI
Performance Index. See also: BPI. The Performance Index is a weighted combination of the CI and the FI values, with the lower of the two being given two-thirds of the weight and the higher of the two values being given one-third of the weight.

PM
Preventive Maintenance

PMI
Preventative Maintenance Inspection

PRV
Plant Replacement Value. For an inventory item above the Building level, this number will be the aggregate of the PRV of all Buildings included in that item.

RCI
Roof Condition Index

RML
Remaining Maintenance Life

RPIE
Real property installed equipment

RSL
Remaining Service Life

SCCI
System Component Condition Index – a condition rating for the System Component.

SCI
System Condition Index - a condition rating for a Building System. For each System, the SCI is computed by taking the average of its Components' CIs, weighted by replacement cost.

Site CI
Site Condition Index – a condition rating for the target Site. The Site CI is computed by taking the average of the BCIs of each Building at the Site, weighted by replacement cost.

SMS
Sustainment Management System

SOW
Statement of Work

SP
Single Ply

SR
Shingle Roofing

SRM
Sustainment, Restoration, Modernization

STIG
Security Technical Implementation Guide (DoD)

SUCI
Sample Unit Condition Index

UM
Unit of Measure. Examples: Each; English; Metric.

Work Planner
A user with Work Planner role has all the rights of an Inspection Supervisors, and can also create and edit work plans, standards, policies, prioritization schemes, and RSL and cost books.

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Donald R. Uzarski, Michael N. Grussing, and Brenda B. Mehnert

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Construction Engineering Research Laboratory (CERL)
PO Box 9005
Champaign, IL 61826-9005

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14. ABSTRACT

The BUILDER™ Sustainment Management System (SMS) is a life-cycle asset management software application developed by the Engineer Re-search and Development-Construction Engineering Research Laboratory. The Department of Defense (DoD) uses BUILDER SMS to conduct facility condition assessments, identify work requirements, and report on facility conditions. In this way, it provides a consistent baseline for condition assessment across all DoD services and locations. The BUILDER system generates a multi-year work plan with recommendations for component-level repair/replacement activities that not only assists current year tactical-level facility planning, but it also aids long-range facility investment strategic planning.

To accurately and consistently measure facility conditions, a standardized inspection process is necessary. This manual describes the procedures for performing Condition Survey Inspections for building-related component infrastructure when using the BUILDER SMS. The resulting condition surveys, while they are not detailed engineering assessments or specialized inspections, do satisfy the requirements necessary for routine building management activities including long-range budgeting and the sustainment and restoration/modernization (SRM) program planning needed to keep DoD facilities in good working order.

15. SUBJECT TERMS
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