

Best Practices – Window Repair and Replacement

Date: 1 May 2011

Subject: Window Repair and Replacement

Problem or Question: Our Agency used to replace windows on nearly half of the houses that we ran audits on, now NEAT generally allows us to replace only about 15% on the houses we are working on. Why is that?

Discussion:

Considerable advancements in weatherization science and application techniques have occurred over the last 6 years. Home insulation and house-sealing against air infiltration is universally acknowledged as the best, lowest cost way of achieving energy savings and building efficiency. In the majority of homes to be weatherized in Texas, replacing single-pane windows with double-pane low-e windows is simply not cost effective. Payback (based on savings-to-investment ratio [SIR]) for this measure stretches well past the objective set by Department of Energy (in other words, payback for windows is often 19 or more years vs. 15 years or less, an objective adopted by DOE and TDHCA in most cases). Therefore, if a window replacement measure does not have an SIR ranking with a 1.0 or greater then we should not and cannot replace the window, unless the window is unserviceable and/or there are other extenuating circumstances outlined in this best practice (BP).

The scientific and engineering evidence supporting the statement in the above paragraph was determined during the “Texas Field Experiment: Performance of the Weatherization Assistance Program in Hot-Climates, Low-Income Homes,” April 2008. In this study 14 of 31 houses studied in Texas had window replacements recommended by the legacy audit software (EZ2 audit used by Texas in years past). The NEAT audit did not recommend window replacement on any of 31 houses evaluated. The Texas Field Experiment observed, “In the demonstration group, NEAT/MHEA did not recommend the installation of replacement windows and doors, or the installation of replacement air conditioners except in one house. . . . Such a change would require a change in the expectations for weatherization providers.”

Subsequent experience with the NEAT audit in Texas has demonstrated that properly evaluated and correctly entered windows can and do rank in NEAT, but these are generally older, single pane windows with metal pane-framing that are also exposed to sunshine from the west, east, or south. Compared to older Texas audits, which called for window replacements in nearly 50% of evaluated homes, we are seeing correctly entered windows rank in only 8% to 15% of evaluated homes that qualify for the weatherization program. Of course, this percentage varies from region to region across Texas, but if your audits are typically recommending windows replacement on more than 15% of the home you weatherize, then it is recommended your team take a close look at how the window data is entered into NEAT by using this best practice. Your program officer and TDHCA Training Academy Team remain available to assist and guide your efforts to properly enter windows data into NEAT.

When assessing the windows of a dwelling unit, Subrecipients shall consider the following:

- Windows may be evaluated under the NEAT and MHEA audits under the “Shell” page. Windows that rank with an SIR of one (1) or greater on the “Shell” page of the energy audits may be replaced with the recommend type of window suggested by NEAT.

<http://www.tdhca.state.tx.us/ea/wap.htm>

- Windows that do not rank with an SIR of one (1) or greater on the “Shell” page may not be entered into the NEAT and MHEA audits as an infiltration measure under the “Ducts and Infiltration” page for consideration of replacement.
- Components of the window which clearly allow for air infiltration, such as sash locks, stops, broken window pane, and glazing, may be entered as infiltration measures under the “Ducts and Infiltration” page.
- Should the window which did not rank for replacement on the NEAT audit with a SIR of one (1) or greater be deteriorated to a point at which the building envelope is compromised, the window may be considered as a repair measure to ensure the protection of the building envelope. In order for the window to be considered for replacement as a repair measure, Subrecipients must clearly document the deterioration of the window with a narrative description and photographic documentation indicating that the window is broken or deteriorated beyond repair. If you have any questions as to what type of window situations should be addressed by repair or replacement measures, then it is recommended that you consult your program officer and provide him or her the documentation and photos of the windows in question.
- Clear photographic documentation of the defective items or aspects of the window must be placed in the client file.
- The visual appearance (aesthetics) and existing R- value of the window are not valid reasons to authorize window replacement as a repair measure.

Additional important points about window entries in NEAT:

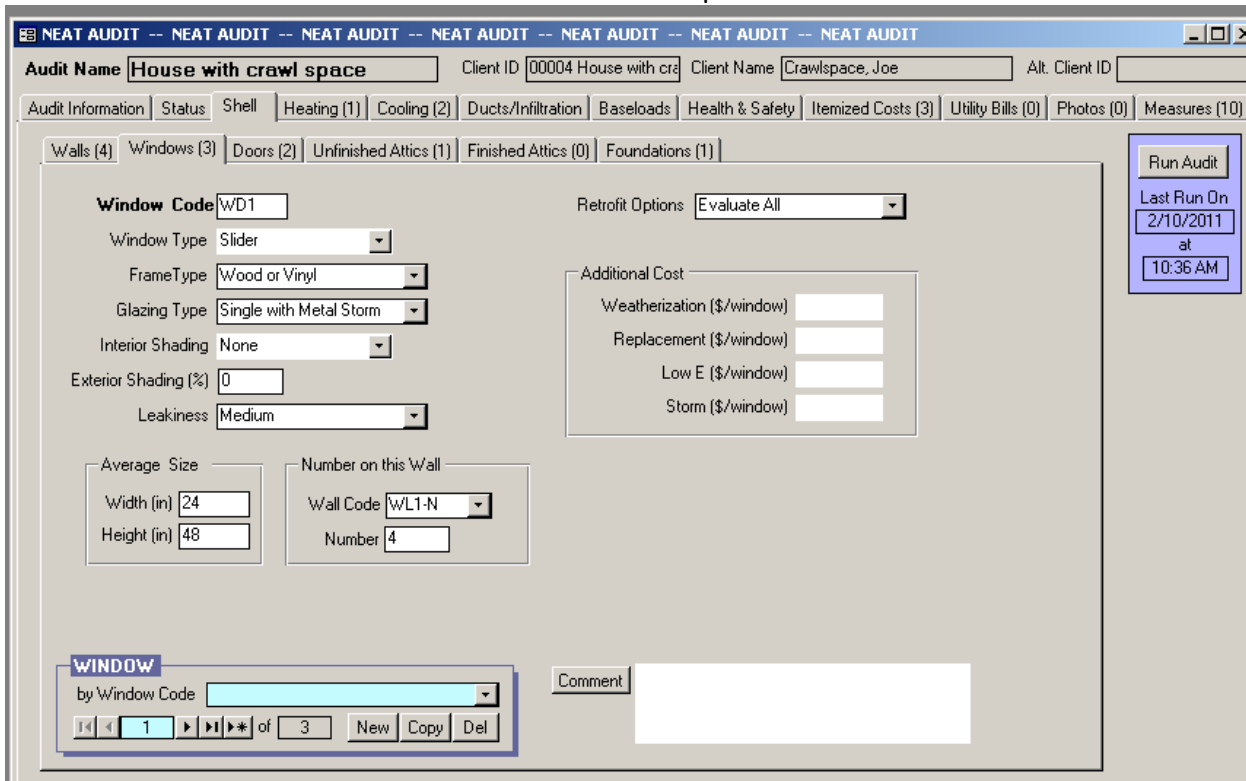
- 1) Glass panes can be entered as air infiltration or repair measures depending on the situation. (Examples: A crack between glass and pane-framing window can be addressed with clear caulk and, consequently, would be an air infiltration measure and entered in this area of NEAT. On the other hand, a totally broken glass pane would be a repair measure and entered into NEAT as a repair). A detailed house assessment with annotations about the window condition would be proper documentation of this, to include photos.
- 2) As discussed in detail in question number 1 below, when entering windows into NEAT, “Evaluate all” should be used in order to achieve the greatest amount of savings for the home.
- 3) The category “very loose windows” is an assessment of the actual infiltration within the window frame itself, and the window components inside the frame. See Appendix A at the end of this Best Practice for guidance on how to categorize looseness and tightness of windows. It is not meant to mean a window that has air-infiltration between the window frame and the house wall aperture (that problem should be addressed by typical counter-infiltration techniques, not by replacing the window). If an auditor selects “very loose windows” then the audit/file needs to have documentation including photographic documentation. In general you can tell if a window is “very loose” by placing your hand near it when the blower door is running or by using a smoke-puffer to see the stream of air entering the home when the blower door is on. In general, if you feel air coming from inside (probably about 5-20 Cfms or more) the frame then it is “loose” or “very loose.” If, on the other hand, you feel air coming from between the frame and the house, then you have an infiltration issue and should be recorded in NEAT under “Ducts/Infiltration” in the building shell section of NEAT. See Appendix A below for more details on all types of windows

Recommendation Summary: Properly enter windows data into NEAT in accordance with this best practice and following FAQs. NEAT will only “rank” windows when the savings generated by the new windows exceeds the cost, i.e. installed windows measures have SIRs of 1 or greater.

FAQ’s

1) Question: When we are inside the audit and are selecting what type of measures (options) we want NEAT to consider, should we only select the type of options we want to install based on the situation or should we select the “evaluate all” selection? For example, should we only select the type of windows we want to install, such as low-e, or should we run the audit with all window-types being eligible?

Discussion: The only way to ensure NEAT considers all measures is to make sure that all measures are eligible when you run NEAT. Select “evaluate all” whenever it is an option so that NEAT will evaluate and select the most economical and effective package of measures for the dwelling unit. See the below screenshot for an “evaluate all” selection example.



There is an exception, however, to the general rule of “Evaluate all.” Generally you should not be making window replacements mandatory unless there is something physically wrong with them requiring repair (following your state’s guidance on all this). Normally you should choose “Evaluate All” in the Retrofit Option field on the Window form. This allows NEAT or MHEA to decide if a window retrofit is cost effective (Measure SIR > 1.0), and if it is it will be recommended. However, in the case of a window that must be replaced because it is no longer serviceable (rotted wood, significantly warped frame, functionality problems, significant damage, etc.), then we need to first decide if that specific window can rank with an SIR greater than 1 **or** if we must replace the window as a repair measure.

We need to first allow the NEAT audit to determine if the window will rank on its own merit (this is accomplished by selecting evaluate all and running the audit). NEAT may select another measure, not recommend any measure, or it may recommend (rank) the window replacement on its own merit.

If the non-serviceable window does not rank on its own merit, and you still need to replace it because it is non-serviceable, you can specify (mandate) a window replacement. If you specify the measure to be considered, (for example if you select “replace with low-e”) then this user-defined action “triggers” the exception (to the SIR-based ordering of measures) and “mandates” that NEAT to consider this particular measure first. Now, for example, the mandated “Replace with low-e” window measure will be considered before any other measures. This action will affect the SIR of other measures. In this case some measures that would have ranked, may now not rank because of the effect of mandated change on all the NEAT logarithmic permutations and calculations.

Some auditors ask, “if I am only replacing existing windows with low-e windows why can’t I just check low-e windows instead of “Evaluate all”?” The primary reason that you should check “Evaluate all” is to enable NEAT to make the most cost-effective and most energy-saving recommendations for weatherization measures. The secondary reason you should check “Evaluate all” versus “Replace with low-e” is based on how the NEAT program evaluates, determines interactions, and prioritizes measures in the software. It does this to provide the auditor with a list of authorized measures in order of their priority of installation. The second order effect of “mandating” a measure, such as when you select “Replace with low-e,” is that you pull that measure to the top of the measures list and reshuffle all the ones below. Because you introduced different variables by mandating a measure, NEAT must now re-compare all the measures to each other (and reevaluate each measure) to recalculate how effective that measure is at saving energy at this point in time. Selecting “Evaluate all” enables NEAT to do its job, which is finding the most cost-effective and energy-saving weatherization measures to install in a given home.

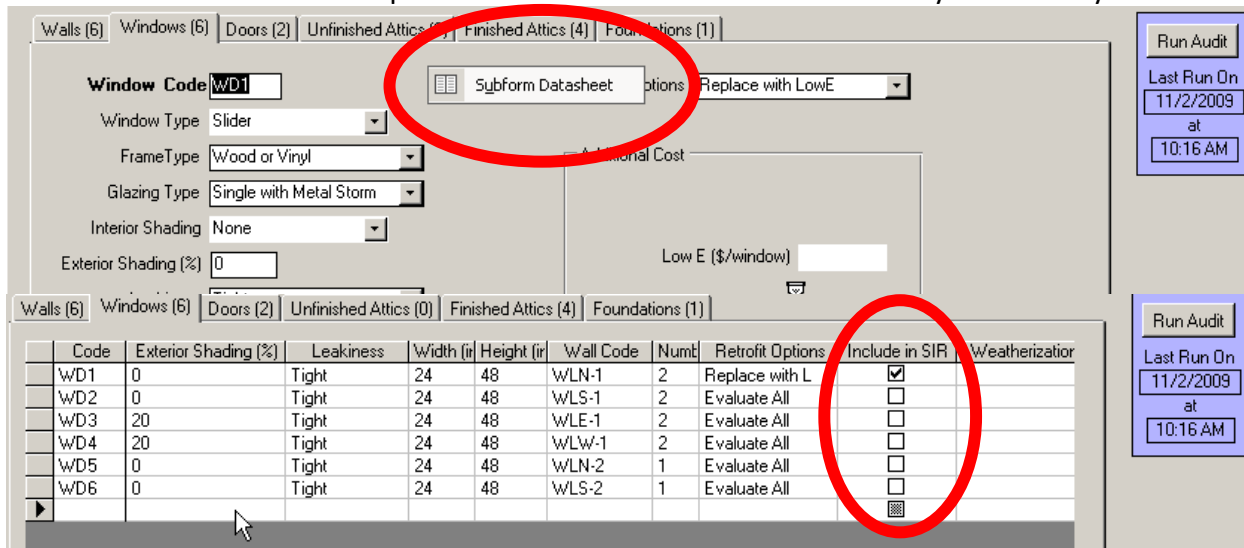


Photo:

Weather damaged window in need of replacement.

<http://www.tdhca.state.tx.us/ea/wap.htm>

IMPORTANT: To “mandate” a non-serviceable window to be treated as repair and be included in the whole house SIR, then, in the audit, check “replace” or “replace with low-e” instead of “evaluate all” in the retrofit options. NOTE: there is a minor glitch in the NEAT program which causes the SIR box to disappear when one of the “replace” options are chosen. Despite the fact the SIR box disappears, it is nonetheless very important to include the measure in the whole-house SIR. Therefore you should go into the “subform datasheet” by right-clicking in the gray area background near the measure box. Clicking in the gray background will result in a small “subform datasheet” option button popping up (as seen in the below screenshot of NEAT). After you select this button, a larger spreadsheet subform datasheet will pop up. On the spreadsheet you should find all the windows including the non-serviceable window measure you are working on; check the “include in SIR” by that measure so that the measure is treated as a repair and not treated as a Health and Safety measure by NEAT.



Recommendation Summary: Select “evaluate all” whenever it is an option in NEAT and there are no overriding considerations calling for a “mandated” window replacement, as discussed above.

2) **Question:** Some city codes require tempered glass; in that case is it permissible to put in tempered glass windows into a home if it “ranks” in NEAT with an SIR greater than or equal to 1? Our city requires tempered glass in some circumstances.

Answer: Tempered glass is allowable, as long as it ranks with the required SIR of 1 and the value includes the total installed cost. It is not permissible to rank the window without the tempered glass price and then put the difference in as a “repair” or a health and safety cost. Tempered glass does not apply to either of those cost categories in NEAT.

3) **Question:** How should we deal with “burglar bars”? The bars often have to be removed to install windows and some of the bars we deal with have no inside quick-release safety latch to allow escape in case of fire, which is unsafe, and against the IRC 2009 code.

Answer: If you take down burglar bars with no safety latch to allow egress from inside the house to the outside in every room, then you cannot remount these bars. Instead, you should tell the client during the assessment phase of weatherization that the bars are not safe because they may not be able to escape a fire and that you will not be able to remount them. You can take down

burglar bars to install a window, but you can only re-install those bars that have a safety latch in every room. If the client has existing burglar bars (with safety latches) the cost of remounting safe burglar bars should be included in the price for the windows and the window must rank with this cost included. You may add the cost of the burglar bar re-installation in the “additional cost // weatherization (\$/window)” category of the windows section of NEAT. Make sure the “include in SIR” box is checked on the NEAT screen and/or the “subform datasheet.”

4) **Question:** How should we enter sliding glass doors in NEAT? Do we have any options available to make these energy-hogs more efficient?

Answer: The sliding glass door should be classified as a window slider in NEAT, but otherwise entered as a window in the program.

Some agencies have had success eliminating the energy-wasting sliding glass door altogether. They have replaced the glass door with a single exterior door and put in a wall where the other have of the sliding glass door was. One agency was even successful putting in a window in that new wall. All of these weatherization improvements were justified by NEAT because the additional costs for the new window/door did not outweigh the SIR benefit of energy efficiency of the new window/door. If construction/carpentry costs are high in your part of Texas, this may not be a viable option to your agency.

5) **Question:** Our solar screens are the new, advanced type with over 80% ability to defeat solar heat gain entry into the house. Installation and material is not that expensive. Why do they continue to not rank in NEAT with an SIR great than 1?

Answer: Use the louvered screen in the NEAT options to represent solar screens that can reduce solar heat gain by 75% or more. When the NEAT program was written only louvered window coverings could achieve such energy savings. The NEAT update, due to be released in 2012, will adjust for this advancement in weatherization materials. Note: in your agency files have actual documentation from the solar screen manufacturing detailing the ability of their product to defeat solar heat gain. If this is not at least 75% or greater you cannot select louvered screen in the NEAT audit to represent lower-grade solar screens.

Appendix A attached:

Guidelines on how to determine the degree of leakiness associated with windows based on the type of window. The degree of leakiness must be inputted on all windows in the "Leakiness" field found under the Windows tab of NEAT and MHEA.

NOTE: This document is on the WAPTAC.ORG website which is maintained by Department of Energy at <http://www.waptac.org/Weatherization-Assistant/Weatherization-Assistant-Support-Material.aspx>

In the Weatherization Assistant, there is a data field under the “Windows” tab of both NEAT and MHEA called “Leakiness” that allows the user to describe the air leakage characteristics of each window entered. NEAT and MHEA use this input to calculate the energy savings due to reduced air infiltration for window replacements, storm windows, and window weatherization (NEAT only). For each window retrofit measure, NEAT and MHEA add the energy savings due to reduced air infiltration to other energy savings associated with the measure to obtain the total energy savings.

Five options are allowed under the “Leakiness” data field: very tight, tight, medium, loose, and very loose. Guidance on the applicability of these options to various window types is described below. In addition, the leakiness of a typical window that is frequently encountered in homes served by the Weatherization Assistance Program across the country is identified.

Fixed windows — Fixed windows are sealed in their frames and cannot be opened. Fixed windows can include most skylights (windows in the ceiling), decorative windows in doors, and large picture windows. *The leakiness of a typical fixed window is **very tight**.*

Casement windows — Casement windows have one or two sashes that are hinged at the side and almost always project outwards. They usually have a cranking mechanism to open and close the sashes, and the sashes close by pressing against the frame. They also usually have a locking/latching mechanism that seals the window by forcing the sash against the frame and any installed weatherstripping. On casement windows with two sashes, a vertical framing bar is often present in the middle of the window that houses the locking mechanism. The leakiness of a typical casement window is tight.

- **Very tight** (typical) — Weatherstripping is present and in good condition. The locking mechanism is operable and securely presses the sash into the weatherstripping and window frame.
- **Tight** (typical) — *A good seal is visually achieved between the sash and frame with the aid of a functional locking mechanism even though weatherstripping is absent or deteriorated.*
- **Medium** — A reasonable seal is visually achieved between the sash and frame when the window is closed as far as the cranking mechanism allows even though weatherstripping is absent. The locking mechanism is inoperative or does not help press the sash into the weatherstripping or frame.
- **Loose** — A gap 1/8 inch or smaller exists between the sash and window frame when the sash is closed as far as the cranking/locking mechanism allows.
- **Very loose** — A gap 1/8 inch or larger exists between the sash and window frame when the sash is closed as far as the cranking/locking mechanism allows.

Single- or double-hung (vertical slider) windows — Windows with sashes that move up and down are vertical slider windows. In double-hung units, both sashes can slide vertically past one another. Only the bottom sash slides up and down in a single-hung window. *The leakiness of a typical new vertical slider window is tight and the leakiness of a typical older window found in older homes is **medium**.*

- **Very tight** — Each moveable sash is secure in its track and weatherstripping is present and must be in excellent condition (especially the brush-type weatherstripping at the sash to sash interface and the

<http://www.tdhca.state.tx.us/ea/wap.htm>

compression weatherstripping at the head (i.e., top) or sill (i.e., bottom)). A locking mechanism presses the two sashes together at their interface and presses each moveable sash into the head and/or sill.

- **Tight** (typical of newer windows) — Each moveable sash is secure in its track although some slight play may be present. Weatherstripping is present and in good to fair condition (especially the brush-type weatherstripping at the sash to sash interface and the compression weatherstripping at the head or sill). A locking mechanism presses the two sashes together at their interface and presses each moveable sash into the head and/or sill.
- **Medium** (typical of older windows found in older homes) — Each moveable sash is still operable in its track although play may be present and the sash may not sit perfectly horizontal when closed. Weatherstripping is absent or deteriorated (especially the brush-type weatherstripping at the sash to sash interface), but there are no visible gaps. A locking mechanism helps press each moveable sash into the head and/or sill but is not effective at pressing the two sashes together at their interface.
- **Loose** — One (or both) moveable sash is loose in its track and the sash cannot be closed without leaving a gap 1/8 inch or smaller at the head or sill. There is some play (rattling) between sashes. Weatherstripping is absent or deteriorated (especially the brush-type weatherstripping at the sash to sash interface). The locking mechanism does not hold the two sashes together at their interface nor does it press each moveable sash into the head and/or sill.
- **Very loose** — One (or both) moveable sash no longer fits in its track and the sash cannot be closed without leaving a gap 1/8 inch or greater at the head or sill. There is considerable movement (rattling) between sashes. Weatherstripping is absent (especially the brush-type weatherstripping at the sash to sash interface). The locking mechanism is inoperative.

Horizontal slider windows — Windows with sashes that move sideways are horizontal slider windows. Both sashes can slide horizontally past one another in a double-sliding window, and only one sash slides in a single-sliding window. Sliding glass doors are included in this window type. Horizontal slider windows are usually a little more leaky than comparable vertical slider windows. *The leakiness of a typical horizontal slider window is medium.*

- **Very tight** — Each moveable sash is secure in its track and weatherstripping is present and must be in excellent condition (especially the brush-type weatherstripping at the sash to sash interface and the compression weatherstripping at the end jamb (i.e., side)). A locking mechanism presses the two sashes together at their interface and presses each moveable sash into the end jamb .
- **Tight** — Each moveable sash is secure in its track although some slight play may be present. Weatherstripping is present and in good to fair condition (especially the brush-type weatherstripping at the sash to sash interface and the compression weatherstripping at the end jamb). A locking mechanism presses the two sashes together at their interface and presses each moveable sash into the end jamb.
- **Medium (typical)** — Each moveable sash is still operable in its track although play may be present and the sash may not sit perfectly vertical when closed. Weatherstripping is absent or deteriorated (especially the brush-type weatherstripping at the sash to sash interface), but there are no visible gaps. A locking mechanism helps press each moveable sash into the end jamb but is not effective at pressing the two sashes together at their interface.
- **Loose** — One (or both) moveable sash is loose in its track and the sash cannot be closed without leaving a gap 1/8 inch or smaller at the end jamb. There is some play (rattling) between sashes. Weatherstripping is absent or deteriorated (especially the brush-type weatherstripping at the sash to sash interface). The locking mechanism does not hold the two sashes together at their interface nor does it press each moveable sash into the end jamb.

- Very loose — One (or both) moveable sash no longer fits in its track and the sash cannot be closed without leaving a gap 1/8 inch or larger at the end jamb. There is considerable movement (rattling) between sashes. Weatherstripping is absent (especially the brush-type weatherstripping at the sash to sash interface). The locking mechanism is inoperative.

Awning and hopper windows — One type of awning window and most hopper windows are like casement windows. Both usually have just one sash, with the awning window being hinged at the top and opening outward and the hopper window being hinged at the bottom and opening inward. Like casement windows, the sash closes by pressing against the frame and a locking/latching mechanism is usually present that seals the window by forcing the sash against the frame and any installed weatherstripping. They may or may not have a cranking mechanism to open and close the sashes. The leakiness guidelines for casement windows should be followed to determine the leakiness of these types of awning and hopper windows. *The leakiness of a typical awning and hopper window that are like casement windows is **tight**.*

Another type of awning window is like a jalousie window in that several window sashes are connected to a common crank so that the sashes open and close together at the same angle. Compared to jalousie windows, awning windows of this type have fewer sashes (just two to four sashes per window versus multiple window panes in jalousie windows), larger sashes (10 to 18 inches wide rather than 3 to 8 inches), and framed sashes (a lightweight frame supports each pane in the awning window) as apposed to the use of just window panes in jalousie windows. Awning windows of this type may have a locking mechanism that helps ensure complete window closure, whereas jalousie windows close and seal only as well as the cranking mechanism allows. *The leakiness of a typical awning window that is like a jalousie window is **medium**.*

- Very tight — Generally not applicable to awning windows that are like jalousie windows.
- **Tight** (*typical of awning windows that are like casement windows*) — *The cranking mechanism is in good working order and all window sashes are securely attached to the cranking mechanism. Weatherstripping is present and must be in excellent condition. A locking mechanism presses the separate sashes to one another and to the window frame so that a tight seal is visually evident.*
- **Medium** (*typical of awning windows that are like jalousie windows*) — *The cranking mechanism is in good working order and all window sashes are securely attached to the cranking mechanism. Weatherstripping is present but is only in fair condition. A locking mechanism helps to put the separate sashes in contact with one another and to the window frame, but the seals are not tight.*
- Loose — One or two window sashes are not securely attached to the cranking mechanism. Weatherstripping is absent or deteriorated. One or more of the interfaces where the window sashes overlap or the sash meets the window frame are not tight (1/8 inch gap or smaller) when the window is closed as far as the cranking/locking mechanism allows.
- Very loose — Multiple window sashes are not securely attached to the cranking mechanism. Weatherstripping is absent. Visible gaps (1/8 inch or larger) are evident at several of the interfaces where the window sashes overlap or the sash meets the window frame when the window is closed as far as the cranking mechanism allows. The locking mechanism is inoperative or does not help press the sashes together or into the frame.

Jalousie windows — Jalousie windows are louvered windows, typically constructed of multiple horizontal panes (usually about 3 to 8 inches wide) that all open at the same angle when a crank near the bottom of the window is turned. The leakiness of a typical jalousie window is loose.

- Very tight — Generally not applicable to jalousie windows.
- Tight — Generally not applicable to jalousie windows.

- Medium — The cranking mechanism is in good working order, all window panes are securely attached to the cranking mechanism, and a tight glass to glass seal is visually obtained at the overlap of all windows panes.
- *Loose (typical)* — *One or two window panes are not securely attached to the cranking mechanism, or one or more of the glass to glass interfaces where the window panes overlap are not tight when the window is closed as far as the cranking mechanism allows.*
- Very loose — Multiple window panes are not securely attached to the cranking mechanism, or visible gaps are evident at several of the glass to glass interfaces where the window panes overlap when the window is closed as far as the cranking mechanism allows.

The guidance provided above based on window type should be modified as follows to take into account the condition of the window panes and the presence of storm windows:

- **Window panes tightness** — Degrade the leakiness description one level if the window panes themselves have become significantly loose in their mounting and/or a small (i.e., half-dollar-sized) piece of window is broken out. Degrade the leakiness two levels if there is a larger hole in a window pane and/or an entire pane is missing.
- **Storm window presence** — Upgrade the leakiness description one level if a storm window in average or better condition is installed.