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STAFF REPORT

Alternative Procedure to Home Energy Rating System (HERS) Rater Nonresidential Duct Leakage Test Verification

California Energy Commission

Edmund G. Brown Jr., Governor

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ABSTRACT

The California Energy Commission established the Home Energy Rating System Program on June 17, 1999. As part of that effort, the Energy Commission established the requirements for field verification and diagnostic testing services performed by Home Energy Rating System Raters to show compliance with the *Building Energy Efficiency Standards.* Generally, a Home Energy Rating System Rater is limited to residential buildings, but there are several instances where the Home Energy Rating System Rater must perform verifications on nonresidential system installations.

The *Building Energy Efficiency Standards* require that air ducts installed in nonresidential buildings be tested to determine if they leak into spaces that are not intended to be occupied by people. This testing is required only for smaller nonresidential installations that are generally similar in size and design to residential installations.

The Nonresidential Appendix to the *Building Energy Efficiency Standards* further requires that these air duct leakage tests be first performed by the technician that installed the heating, ventilation, and air-conditioning system, and then verified, using the same test procedures, by a Home Energy Rating System Rater.

Staff hereby proposes an alternative procedure under Section 10-109(h) of the *Building Energy Efficiency Standards* that, if adopted by the Energy Commission, would allow a certified acceptance test technician to perform the appropriate air duct leakage test in lieu of a Home Energy Rating System Rater.

Keywords: Home Energy Rating System Rater, Acceptance Test Technician Certification Provider

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EXECUTIVE SUMMARY

The California Energy Commission established the Home Energy Rating System Program in June of 1999 with Home Energy Rating System Raters being required to perform field verification and diagnostic testing. Home Energy Rating System Raters must also submit their results to a Home Energy Rating System Provider. While the Home Energy Rating System Rater is limited to residential buildings in most cases, they are also required to perform verification tests in nonresidential buildings under certain circumstances.

The *Building Energy Efficiency Standards* require that air ducts installed in nonresidential buildings be tested to determine if they leak into spaces that are not intended to be occupied by people. Air ducts are commonly used in most buildings to conduct conditioned air to spaces within the building that are intended to be occupied by people. Significant energy can be saved if leaks into spaces that are not intended to be occupied by people such as attics are minimized. The Energy Commission established an allowable maximum leakage rates for air ducts in the *2005 Building Energy Efficiency Standards* for residential installations. These allowable leakage rates were also extended to nonresidential installations where the installations are similar in size and design to the home counterparts.

Thus, Sections 140.4(l), 141.0(b)2D, and 141.0(b)2E of the *Building Energy Efficiency Standards* require an air duct leakage test for smaller nonresidential spaces (5,000 square feet or less) that are served by simple space-conditioning equipment (similar to what is used in homes). This air duct leakage test is required when the air ducts have at least 25 percent of the ducting in spaces that are not intended to be occupied by people. These requirements apply to both newly constructed buildings and addition or alterations (including equipment change-outs) for existing buildings.

Furthermore, the Functional Testing requirements in Section NA7.5.3.2 of the Nonresidential Appendix to the *Building Energy Efficiency Standards* require that the duct leakage tests for nonresidential installations be performed by the technician that installed the heating, ventilation, and air-conditioning equipment (or the air ducts themselves) and then verified using the same test procedures by a Home Energy Rating System Rater. The intent of this duplicative test and verification requirement was to ensure that the installing technician performed the correct air duct leakage testing procedure. This was necessary because the Energy Commission could not control the training and certification of the installing technicians as was done for the Home Energy Rating System Raters.

This changed, however, with the adoption of the *2013 Building Energy Efficiency Standards*, which added Title 24, Part 1, Section 10-103-A and 10-103-B, establishing formal requirement for training and certifying of acceptance test technicians by Acceptance Test Technician Certification Providers. Acceptance Test Technician

Certification Providers perform a function similar in practice to the Home Energy Rating System Provider program for nonresidential buildings. The acceptance test technicians are required to follow specific acceptance test procedures, which are very similar to the Home Energy Rating System procedures. The acceptance test technicians are also required to record the results of the acceptance tests with their Acceptance Test Technician Certification Providers.

With the establishment of the Acceptance Test Technician Certification Provider Program, Energy Commission staff has reconsidered the need for the duplicative test and verification requirements for air duct leakage in nonresidential installations, and determined that duplicative testing and verification is not necessary in all circumstances.

Therefore, staff hereby proposes pursuant to Section 10-109(h) of the *Building Efficiency Standards* an alternative procedure to step 2 of the Functional Testing requirements in NA7.5.3.2. The alternative procedure is set forth in Appendix A to this document. If adopted by the Energy Commission, this alternative procedure would create a process through which an acceptance test technician working under an Acceptance Test Technician Certification Provider that has been specifically approved by the Energy Commission for this purpose, may perform the duct leakage test verification required by Sections 140.4(l), 141.0(b) 2D, and 141.0(b) 2E of *the Building Energy Efficiency Standards.*

CHAPTER 1:
Background and Recommendation

Background

Public Resources Code Sections 25402 and 25402.1 were enacted in 1975 as part of the enabling legislation establishing the Energy California Commission and its basic mandates. These sections require the Commission to adopt, implement, and periodically update energy efficiency standards for both residential and nonresidential buildings.

The Home Energy Rating System (HERS) Program was established by the Energy Commission on June 17, 1999. As part of that effort, the Energy Commission established the requirements for field verification and diagnostic testing services performed by HERS Raters to show compliance with the standards. HERS Raters are required to follow these procedures when conducting these tests and submit the results to their HERS provider. Generally, the HERS Rater is limited to residential buildings, but there are several instances where the HERS Rater must perform verifications on nonresidential installations.

On November 5, 2003, the Energy Commission adopted the *2005 Standards* that included a leakage restriction for specific ducts installed in nonresidential buildings to be verified by HERS Raters.

The nonresidential duct leakage tests applied to those installations when the duct (1) connects to constant-volume, single-zone air conditioners, heat pumps, or furnaces; (2) serves less than 5,000 square feet of floor area; and (3) has more than 25 percent of the duct surface area in unconditioned space. These limitations represent a very small portion of all the nonresidential buildings in California.

The air duct leakage measurement must be used by installation technicians and HERS Raters to verify that duct leakage meets the compliance criteria for sealed duct systems for which field verification and diagnostic testing is required. **Table 1** (below) summarizes the leakage criteria and the diagnostic test procedures that must be used to demonstrate compliance.

Table 1: Duct Leakage Verification and Diagnostic Test Protocols and Compliance Criteria

CASE	User and Application	Leakage Compliance Criteria, (Percent of Nominal Air Handler Airflow)	Procedures 2013 Nonresidential Appendix
New duct systems	Installation Technician Testing	6 Percent	NA2.1.4.2.1

CASE	User and Application	Leakage Compliance Criteria, (Percent of Nominal Air Handler Airflow)	Procedures 2013 Nonresidential Appendix
	HERS Rater Testing		
Altered existing duct systems	Installation Technician Testing HERS Rater Testing	15 Percent	NA2.1.4.2.1
Altered existing duct systems (that cannot be tested as described above)	Installation Technician Testing and Inspection HERS Rater Testing and Verification	Fails leakage test but all accessible ducts are sealed. Inspection and smoke test with 100 percent verification.	NA2.1.4.2.2 NA2.1.4.2.3 NA2.1.4.2.4

Source: 2016 Building Energy Efficiency Standards, Appendix NA2, Table NA2.1-1

When the Energy Commission approved the 2005 Standards, nonresidential testing and balancing (T&B) contractors (who would normally have done this testing) were traditionally trained to use traverse measurements (either the equal area method or Log-Tchebycheff method) as the primary air-flow measuring process. These methods are suitable for typical hard duct[1] installations that are common for nonresidential buildings. However, these specific installations (as described above) would typically use flexible ducting. Transverse measurement methods are not suitable for flexible ducting applications. For flexible ducting, the duct pressurization and flow measurement procedures[2] established for HERS raters by the Energy Commission are more suitable. Furthermore, the Energy Commission determined that traverse measurements produced results that were less reliable than the pressurization measurement method overall. Because the Energy Commission could not regulate the training of T&B Contractors as it could for HERS Raters, the 2005 Standards required that the duct installation contractor use the pressurization measurement method to demonstrate compliance with the duct leakage limitations and that a HERS Rater verify the results. Thus, the 2005 Standards essentially required repeating the same test for each installation, performed once by the installer and once by the HERS rater.

1 *Air ducting* is typically either "hard ducting" for "flexible ducting." *Hard ducting* is typical for nonresidential installations especially where the ducting shares the conditioned space with people. Flexible ducting is typical for residential installations where the ducting is located out of sight in unconditioned space.

2 The duct pressurization and flow measurement procedures are suitable for flexible and hard ducting installations.

On May 31, 2012, the Energy Commission adopted the 2013 Standards, which included the addition of Title 24, Part 1, Sections 10-103-A and 10-103-B establishing the formal requirement for training and certifying of acceptance test technicians (ATTs) by Acceptance Test Technician Certification Providers (ATTCPs). These were recodified as Sections 10-103.1 and 10-103.2 by the 2016 Standards.

The ATTCP program provides training, certification, and oversight of ATTs that perform the acceptance tests required by the 2013 Standards (codified in Title 24, Part 6, of the California Code of Regulations) as well as acceptance test employers. The ATTCP programs are made available by professional organizations that are required to provide training curricula for acceptance test technicians and employers, certification procedures, complaint resolution (including disciplinary procedures), quality assurance, and accountability measures. Acceptance testing ensures that installed equipment, controls, and systems in nonresidential buildings operate as required by the energy standards. The ATTCP programs require the specifications for performing all acceptance tests including the air distribution system leakage test consistent with the pressurization measurement method.

The California State Pipe Trades Council (CSPTC), a labor union representing plumbers, pipefitters, and heating, ventilation, air conditioning, and refrigeration service technicians, submitted its application to the Energy Commission for approval as a nonresidential mechanical ATTCP on January 13, 2016. The CSPTC requested in its initial ATTCP application that ATTs be considered equivalent to HERS Raters for conducting duct leakage test verifications in nonresidential buildings. This request was later redacted so as not to delay approval of the entire ATTCP application.

Recommendation

Staff proposed to address this request and reduce costs and complexity for the marketplace with a more streamlined compliance strategy by proposing an alternative procedure.

With this alternative procedure, the acceptance test performed by any ATTs certified by an approved ATTCP can stand for the required duct leakage test verification normally performed by a HERS Rater of Sections 140.4(l), 141.0(b)2D, and 141.0(b)2E of the standards.

Therefore, staff proposes under to Section 10-109(h) of the *Building Energy Efficiency Standards* an alternative procedure to step 2 of the Functional Testing requirements in NA7.5.3.2. The alternative procedure is set forth in Appendix A of this document. By providing an alternative procedure that allows the acceptance test performed by an ATT to stand in place of the verification test provided by the HERS Rater, the Energy Commission provides a potential reduction in cost and complexity for the marketplace with a more streamlined compliance strategy.

CHAPTER 2: Equivalency

There is no expected change in the actual energy efficiency for the limited number of nonresidential buildings that would be affected by the alternative procedure. This chapter discusses the intent of the relevant sections of the 2013 and 2016 Standards, the distinctions between the ATTCP and HERS programs, and the relevant equivalency of the proposed alternative procedure.

The Intent of the Standards

In the 2013 and 2016 Standards, there are three sections that reference the duct leakage testing requirements: Sections 140.4(l), 141.0(b)2D, and 141.0(b)2E. The intent of these sections is to require air ducts[3] to be sealed[4] to a leakage rate[5] of 6 percent or less of the nominal air handler airflow rate[6] as confirmed through field diagnostic testing. For new ducts that are an extension of an existing duct system, the combined new and existing duct system must limit the leakage rate to no more than 15 percent of the nominal air handler airflow rate, or if the test cannot be performed, a visual inspection of all repairs is acceptable. Moreover, Section 140.4(l) intends for the verification testing to be recorded by the HERS Rater in a registry managed by the HERS Provider[7] (typically referred to as registering the forms).

Sections 141.0(b)2D, and 141.0(b)2E generally refer to Section 140.4(l) in accordance with the associated limitations. Section 140.4(l) limits the nonresidential duct leakage

3 *Air ducts* are a common means of conveying air that is either cooled or heated by mechanical means (typically air conditioning or furnace) to a space within a building that is intended to be occupied by people.

4 Sealing an air duct entails using mastic, ducting tape (not duct-tape), and mechanical fasteners and anchors to prevent air within the duct from escaping to areas (or space) outside the duct that are not intended to be occupied by people.

5 *Leakage rate* is the rate at which air within a duct escapes the duct to areas (or spaces) not intended to be occupied by people. It is measured as a percentage of air passing through the duct.

6 *Nominal air handler airflow rate* is a general value of the total air being moved through the air duct system connected to the air handler. The nominal airflow rate is based on the reliable operational level of the air handlers at the highest capacity. An *air handler* is a device used to regulate and circulate air as part of a heating, ventilating, and air-conditioning system.

7 A *data registry* is a Web service with a user interface and database maintained by a registration provider that provides for registration of residential or nonresidential compliance documentation used for demonstrating compliance with the standards.

tests to those installations when the duct (1) connects to a constant volume[8], single zone[9], air conditioners, heat pumps[10] or furnaces, and (2) serves less than 5,000 square feet of floor area and (3) the combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:

1. Outdoors; or
2. In a space directly under a roof that:
    a. Has a U-factor[11] greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 140.3(a)1B, or
    b. Has fixed vents or openings to the outside or unconditioned spaces[12]; or
3. In an unconditioned crawl space; or
4. In other unconditioned spaces.

Reference Nonresidential Appendix NA1 (*Nonresidential HERS Verification, Testing, and Documentation Procedures*) provides direction for communication and documentation processes that must be completed for compliance with the requirements for duct sealing of HVAC systems covered by Sections 140.4(l), 141.0(b)2D, and 141.0(b)2E. All field diagnostic and testing results completed by a HERS Rater are transferred by electronic form to the HERS Provider, who in turn verifies and records the results for later reference by local jurisdictions or other authorized persons.

Reference Nonresidential Appendix NA2 (*Nonresidential Field Verification and Diagnostic Test Procedures*) contains the step-by-step procedures for field verification and diagnostic testing for air leakage testing required by standards Sections 140.4(l), 141.0(b)2D, and 141.0(b)2E. Field verification and diagnostic testing generally refer to

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8 *Constant volume* is a type of heating, ventilating, and air-conditioning (HVAC) system. In a simple system, the supply air flow rate is constant, but the supply air temperature is varied to meet the heating/cooling demands of a space. Most constant volume systems are small and serve a single zone.

9 *Single zone* refers to a (HVAC) system that serves a single space within a building.

10 Heat pumps are designed to move thermal energy opposite to the direction of natural heat flow by absorbing heat from a cold space and releasing it to a warmer one. Heat pumps can provide either heating or cooling for (HVAC) systems or domestic hot water systems (or both).

11 The *U-factor* gives a value to the insulating quality of a building element (including walls, windows and doors) in relation to standard testing conditions (the lower the U-factor, the better the insulation value). In this instance, a space under a roof that has a U-factor greater than the U-factor for the ceiling will result in heat from the ceiling being transferred to the space. (Heat transfers along the path of least resistance.) Such a space would be considered unconditioned space, and any air leaking from a duct would be a source of wasted energy.

12 An *unconditioned space* is a space within a building that is not thermally conditioned (by heating, cooling, or controlling humidity) by mechanical means (for example, a warehouse is typically unconditioned). Unconditioned spaces can also refer to areas that are not thermally conditioned AND not intended to be occupied by people (for example an attic or crawl space).

any set of instructions for any technician to follow to verify the proper operation of any installed device or system.

Reference Nonresidential Appendix NA7.5.3 ("Air Distribution Systems") requires the installation technician to perform a construction inspection and a two-step functional test. The first step is to perform the same test required in *Reference Nonresidential Appendix NA2* (above) as a direct reference. The second step is to obtain a HERS Rater field verification as specified in *Reference Nonresidential Appendix NA1*.

ATTCP and HERS Program Distinctions

There are significant distinctions between the ATT and HERS Rater certifications that result in incongruities. These differences are beyond the obvious distinction that the HERS Rater verifications are intended for residential construction, while the ATTCP Program is intended for nonresidential construction.

Most importantly, a HERS Rater must be financially independent of the general contractor, building owner and installing technician (or HVAC contractor, in this instance). In contrast, the intent of an ATT certification is to allow the installing technician (HVAC contractor) to provide the proof that the installed system is operating to specification. The alternative procedure would not require the ATT to be an independent third-party inspector.

The requirement for a HERS Provider to register compliance forms completed by HERS Rater is substantial (Joint Appendix JA7) and significantly regulated by the Energy Commission. Joint Appendix JA7 of the 2013 Standards includes the roles and responsibilities of authorized users, the compliance documentation registration process that must be followed, requirements for digital signatures, the Energy Commission approval process of the data registry, and the approval of software used for the input of data into the registry.

In comparison, the ATTCP regulations (Title 24, Part 1, §10-103.1 and §10-103.2) do not require that any ATTCP provide electronic registration of any compliance forms. ATTCP applicants are providing electronic acceptance testing forms as a means to provide the required quality assurance of ATTs in the field. The Commission does not regulate the ATTCP electronic data base to any significant degree.

Alternative Procedure Equivalency

While a parallel cannot be drawn between the ATTCP electronic acceptance test forms database and the HERS data registry, the ATTCPs maintain a record of the acceptance test forms. The alternative procedure requires an ATTCP to record, track, and report the duct leakage acceptance test form (Appendix A). This, coupled with the training approval that the Energy Commission conducts for the ATTCP, will ensure that the ATT and the HERS Rater duct leakage tests are equivalent.

CHAPTER 3:
Potential Effects of Alternative Procedure

Potential Effects on the Regulated Community

Allowing the ATT to avoid the duct leakage test verification by the HERS Rater could streamline the compliance process for nonresidential builders by eliminating duplicative testing by an independent third party. This streamlining could lower costs and encourage voluntary compliance.

Based on staff investigations, the cost to industry between using a HERS Rater or an ATT for duct leakage testing is small and depends on details of each construction project. Staff estimates that there were nearly 1,500 nonresidential duct leakage test verification forms registered in 2015. While staff is not able to estimate the total number of all registered compliance forms in 2015 (not just the duct leakage verification forms, but all forms submitted to HERS Providers), staff thinks that nonresidential duct leakage test verification forms represents fewer than 10 percent of the overall business (possibly fewer than 5 percent). HERS Providers charge $30 for each project and $1 for each compliance form submitted. Comparatively, the union-based ATTCPs are expected to charge $40 per compliance form, while the nonunion ATTCPs are expected to charge $100 per compliance form. These charges are based on business decisions that each HERS Provider and ATTCP must make to sustain operations and, in some cases, maintain a profit level. So an ATT performing the duct leakage testing could possibly increase costs for a construction project from $9 to $68 per compliance form. This cost difference is very small, however, and would be difficult to predict with any reasonable accuracy. Therefore, while there are clearly differences in cost, the overall effect is indiscernible and subject to the specific details of each construction project.

The hourly rates of lighting controls ATTs (as a proxy for mechanical ATTs) and HERS Raters are very similar (between $50 and $200 per hour). Most ATTs charge $75/per hour, while the majority of HERS Raters charge $100/per hour. The construction inspection and functional testing for the duct leakage acceptance test can take between 2 and 10 hours, depending on system size, site conditions, and physical constraints. Therefore, it is possible that allowing ATTs to perform the duct leakage testing may result in labor cost savings ranging between $75 and $250, but these savings may not be realized because there is a substantial amount of overlap in the range of hourly rates between ATTs and HERS Raters.

The ATTs may reduce their hourly rate for duct leakage acceptance testing when they submit a bid on the installation portion of the job. In effect, the ATTs can even opt to waive their hourly rate and perform the duct leakage acceptance testing at cost. This is an opportunity that the HERS Rater does not have under the 2013 Standards, which require the HERS Rater to be a third-party agent that is independent from the builder.

As long as the enforcement circumstances do not change, it is likely that some builders would continue using the HERS Raters rather than ATTs due to filing costs in some situations, while others will use the ATT option to avoid a third-party evaluation and streamline their compliance.

The estimated 1,500 nonresidential duct leakage test verifications that were registered with the HERS Providers do not represent all the projects that should have been registered. Many projects go unreported by not pulling construction permits. Therefore, one possible benefit of streamlining the compliance process by allowing ATTs to serve as HERS raters in this capacity may be a higher rate of compliance with no discernable loss of regulatory control or undue leniency. If it is easier to comply with the regulations, then it is more likely that builders will choose to comply.

Potential Effects on Local Jurisdictions

Local jurisdictions (typically through building and planning departments) would need to contend with two paths toward duct leakage testing compliance; however, the resulting process would be relatively the same for both HERS Raters and ATT compliance paths. The local inspector would verify that the prepared acceptance test form has a watermark on it from an approved ATTCP and, when appropriate, verify that the form is registered by the ATTCP online. Staff is reasonably confident that local jurisdictions can be adequately educated to avoid any undue stress.

A notice of availability emailed to all building departments and posted online could perform this education. This education would describe the alternative approval process, including:

- A list of the authorized ATTCPs that provide training to ATTs.
- A description of the required circumstances under which the testing is to be performed.
- A depiction of the appropriate forms and watermarks.
- The effective date (if appropriate).
- A script for the hotline staff to help answer questions.

This notice could be followed up with a fact sheet and *Blueprint* articles, as well as additional training as needed for one or more building departments.

Energy Commission staff is committed to providing all necessary educational materials regarding the enforcement of this alternative procedure and makes these materials available to all jurisdictions.

APPENDIX A:
Alternative Procedure to NA 7.5.3.2 Functional Testing (Step 2)

(a) ATT Performance of Duct Leakage Test in Lieu of HERS Rater.

(1) An ATT may perform the duct leakage verification required by NA 7.5.3.2 step 2 in lieu of a HERS Rater, provided that he or she is certified to do so by an ATTCP that has been in accordance with the process set forth in Subdivision (b) below.

(2) In lieu of NA7.5.3.2 step 2, the ATT must:

(A) Submit all required field verification data to an approved Acceptance Test Technician Certification Provider (ATTCP).

(B) Produce and submit signed Form NRCA-MCH-04-A to the jurisdiction having authority in the manner directed by the jurisdiction.

(b) Energy Commission Approval of ATTCP for Verification of Duct Leakage Test.

The ATT must be certified by an approved ATTCP to perform the required duct leakage acceptance test as required under the 2013 and 2016 Standards (Sections 140.4[l], 141.0[b]2D, and 141.0[b]2E) in accordance with this alternative procedure. To be approved by the Energy Commission, an ATTCP must submit an additional application demonstrating all of the following in addition to all of the requirements of Title 24, Part 1, and Section 10-103.2 (c):

- The ATTCP shall be approved and in good standing with the Energy Commission as provided under 2016 Title 24, Part 1, Chapter 10, Section 10-103.2.
- The ATTCP shall maintain an electronic database system approved by the Energy Commission that can record and hold for no less than five years all documentation of a duct leakage acceptance test as performed by its own certified ATTs.
- The ATTCP shall be capable of providing a print copy of each completed duct leakage acceptance test to the ATT that performed the test.
    - The copy shall bear the logo or other identifying insignia as approved by the Energy Commission on all pages of each duct leakage acceptance test.
    - The ATTCP shall provide a means of electronic verification of any duct leakage acceptance test for any requesting jurisdiction having authority.
- The ATTCP shall allow the Energy Commission access to its electronic system with the authority to visually inspect all records.
- The ATTCP shall provide all summary reports regarding the duct leakage acceptance tests as requested by the Energy Commission.

- The ATTCP shall provide all training, testing, and oversight necessary to certify ATTs to perform the acceptance test as required in Reference Nonresidential Appendix NA7.5.3 (“Air Distribution Systems”) and Reference Nonresidential Appendix NA2 (“Nonresidential Field Verification and Diagnostic Test Procedures”) in conjunction with this alternative procedure.
    - All training and testing materials must comply with the applicable requirements in Title 24, Part 1, Section 10-103.2 and must be approved by the Energy Commission.

APPENDIX B:
2013 and 2016 Title 24, Part 6 Excerpts

Title 24, Part 1, Section 10-109(h)

In addition to the procedures and protocols identified in the Alternative Calculation Method Approval Manuals and the Reference Appendices, the Energy Commission may authorize alternative procedures or protocols that demonstrate compliance with Part 6.

Title 24, Part 6, Section 140.4(l)

Air Distribution System Duct Leakage Sealing: Duct systems shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in *Reference Nonresidential Appendices NA1 and NA2* if the criteria in Subsections 1, 2 and 3 below are met:

1. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and
2. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and
3. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:
    - A. Outdoors; or
    - B. In a space directly under a roof that
        - a. Has a U-factor greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 140.3(a)1B, or
        - b. Has fixed vents or openings to the outside or unconditioned spaces; or
    - C. In an unconditioned crawl space; or
    - D. In other unconditioned spaces.

Title 24, Part 6, Section 141.0(b)2D

Altered Duct Systems. When new or replacement space-conditioning system ducts are installed to serve an existing building, the new ducts shall meet the requirements of Section 120.4. If the space conditioning system meets the criteria of Sections 140.4(l)1,

2, and 3, the duct system shall be sealed as confirmed through field verification and diagnostic testing in accordance with the procedures for duct sealing of an existing duct system as specified in *Reference Nonresidential Appendix NA2* to meet one of the following requirements:

1. If the new ducts form an entirely new or replacement duct system directly connected to the air handler, the measured duct leakage shall be equal to or less than 6 percent of the system air handler airflow as confirmed by field verification and diagnostic testing using the procedures in *Reference Nonresidential Appendix* Section NA2.1.4.2.1. Entirely new or replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the existing duct system of the building, including registers, grilles, boots, air handlers, coils, plenums, and ducts, if the reused parts are accessible and can be sealed to prevent leakage.

2. If the new ducts are an extension of an existing duct system, the combined new and existing duct system shall meet one of the following requirements:

    a. The measured duct leakage shall be equal to or less than 15 percent of the system air handler airflow as confirmed by field verification and diagnostic testing using the procedures in *Reference Nonresidential Appendix* Section NA2.1.4.2.1; or

    b. If it is not possible to comply with the duct leakage criterion in Subsection 141.0(b)2Diia, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified HERS Rater using the methods specified in *Reference Nonresidential Appendix* NA2.1.4.2.2.

EXCEPTION to Section 141.0(b)2Dii: Duct Sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos are exempt from the requirements of subsection 141.0(b)2Dii.

Title 24, Part 6, Section 141.0(b)2E

Altered Space-Conditioning Systems. When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

1. For all altered units where the existing thermostat does not comply with *Reference Joint Appendix JA5*, the existing thermostat shall be replaced with a thermostat that complies with *Reference Joint Appendix JA5*. All newly installed space-conditioning systems requiring a thermostat shall be equipped with a thermostat that complies with *Reference Joint Appendix JA5*; and

2. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed, if the duct system meets the criteria of Sections 140.4(l)1, 2 and 3, as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in *Reference Nonresidential Appendix NA2*, and conforming to the applicable leakage compliance criteria in Section 141.0(b)2D.

EXCEPTION 1 to Section 141.0(b)2Eii: Duct Sealing. Buildings altered so that the duct system no longer meets the criteria of Sections 144 (l)1, 2, and 3 are exempt from the requirements of Subsection 141.0(b)2Eii.

EXCEPTION 2 to Section 141.0(b)2Eii: Duct Sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the *Reference Nonresidential Appendix NA2* are exempt from the requirements of Subsection 141.0(b)2Eii.

EXCEPTION 3 to Section 141.0(b)2Eii: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos are exempt from the requirements of Subsection 141.0(b)2Eii.