Nonresidential Appendix NA1

Appendix NA1 – Nonresidential HERS Verification, Testing, and Documentation Procedures

NA1.1 Purpose and Scope

~~California Home Energy Rating Systems~~

~~Compliance for~~ Appendix NA1 provides direction for communication and documentation processes that must be completed for compliance with the requirements for duct sealing of HVAC systems covered by §140.4(~~k~~l), §~~149~~141.0(b)1D, and §~~149~~141.0(b)1E that requires field verification and diagnostic testing of as-constructed duct systems by a certified Home Energy Rating System (HERS) ~~rater~~Rater, using the testing procedures in Reference Nonresidential Appendix NA2. The Commission approves HERS providers, subject to the Commission's HERS Program regulations, which appear in the California Code of Regulations, Title 20, Chapter 4, Article 8, Sections 1670-~~1676~~1675. Approved HERS providers are authorized to certify HERS ~~rater~~Raters and maintain quality control over field verification and diagnostic testing.

When the Certificate of Compliance indicates that field verification and diagnostic testing of specific energy efficiency ~~improvements~~ measures are required as a condition for ~~those improvements to qualify for~~ compliance with Title 24, Part 6, ~~compliance credit,~~ an approved HERS provider and certified HERS ~~rater~~Rater shall be used to conduct the field verification and diagnostic testing according to the applicable procedures in Reference Nonresidential Appendix NA2. HERS providers and HERS Raters~~raters~~ shall be considered special inspectors by enforcement agencies, and shall demonstrate competence to the satisfaction of the enforcement agency, for field verifications and diagnostic testing. Per California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8, Section 1673(j)(2), ~~The~~ HERS ~~provider~~ Providers and HERS ~~rater~~Raters shall be independent entities from the builder or subcontractor installer of the energy efficiency improvements being ~~tested and~~ field verified or diagnostically tested. An "Independent Entity means having no financial interest in, and not advocating or recommending the use of any product or service as a means of gaining increased business with, firms or persons specified in CCR Title 20, Division 2, Chapter 4, Article 8, Sections 1671 and 1673(j)."~~and shall have no financial interest in the installation of the improvements~~. ~~Third-party quality control programs~~Third Party Quality Control Programs approved by the Commission may serve some of the functions of HERS ~~rater~~Raters for field verification and diagnostic testing purposes as specified in NA1.6.

The remainder of this ~~chapter~~Reference Nonresidential Appendix NA1 describes the:

1. Requirements for ~~Required~~ documentation and communication for HERS verification compliance processes;~~steps.~~
2. Responsibilities assigned to each of the parties involved in the field verification and diagnostic testing process;

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~~2.~~3. Requirements for procedures for installing contractors and Certificate of Installation documentation~~installation certification by the installer~~;~~.~~

~~3.~~4. Requirements for HERS ~~rater~~Rater field verification and diagnostic testing and documentation procedures;~~.~~

~~4.~~5. Requirements for sampling procedures for HERS verification compliance;~~.~~

~~5.~~6. Requirements for Third Party Quality Control Programs;~~.~~

7. Requirements for HERS verification compliance ~~when performing~~for alterations to existing buildings.

NA1.2 Documentation and Communication Requirements for HERS Verification Compliance

The required building energy compliance features and the required field verification and diagnostic testing procedures shall be identified on a Certificate of Compliance completed in accordance with the requirements in Standards Sections 10-103(a)1 and 10-103(a)2. The builder or subcontractor shall complete all applicable Certificate of Installation documentation in accordance with the requirements in Standards Section 10-103(a)3 and the procedures described in NA1, and shall provide certification that the construction or installation complies with the applicable requirements on the Certificate of Compliance. The person responsible for the acceptance testing shall perform the required field verification and diagnostic testing and report the results on the Certificate of Acceptance documentation submitted in accordance with the requirements in Standards Section 10-103(a)4 and the procedures described in NA1, and shall provide certification that the construction or installation information reported on the Certificates of Installation is consistent with applicable requirements on the Certificate of Compliance. A certified HERS Rater shall perform all applicable HERS field verification and diagnostic testing and report the results on the applicable Certificate of Verification documentation submitted in accordance with the requirements of Standards Section 10-103(a)5 and the procedures in NA1, and shall provide certification that the construction or installation information reported on the Certificates of Installation, and the results of the Acceptance testing reported on the Certificate of Acceptance is consistent with applicable requirements on the Certificate of Compliance.

NA1.2.1 Compliance Document Registration and Validation

Document registration requirements are introduced in Section NA1.2.1.1 and further described in the procedures in subsequent sections of NA1. Validation of electronic documentation is introduced in Section NA1.2.1.2 and is applicable to many aspects of the documentation procedures described in subsequent sections of Nonresidential Appendix NA1.

NA1.2.1.1 Document Registration Terminology and Effective Dates for Registration Requirements

When submittal of documentation to a data registry is required by applicable sections of Standards Section 10-103(a), the completed documents are referred to as registered documents, and the process of completing these documents by submitting information and certification signatures to the data registry is called registration. Refer to Reference Joint Appendix JA1 for additional terminology for data registries, registered documents and registration providers.

NA1.2.1.1.1 Document registration requirements prior to January 1, 2015,

For all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6:

1. All Certificate of Verification compliance documents are required to be submitted for registration and retention to a HERS provider data registry, and
2. Certificate of Compliance, Certificate of Installation, and Certificate of Acceptance compliance documents are not required to be registered.

NA1.2.1.1.2 Document registration requirements effective on January 1, 2015,

Contingent upon the approval of Nonresidential data registry(s) by the Executive Director, for all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6:

1. All energy compliance documents (Certificate of Compliance, Certificate of Installation, Certificate of Acceptance, and Certificate of Verification) shall be submitted for registration and retention to an approved data registry. The submittals to the data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7 and the procedures in Reference Nonresidential Appendix NA10.

NA1.2.1.2 Document Validation

When document registration is required, printed paper copies or electronic copies of the applicable completed, signed, registered compliance documentation shall be allowed for use for required submittals to enforcement agencies, subject to verification that the information shown on the submitted document(s) conforms to the information shown on the current revision of the registered document(s) on file in the data registry for the building.

The document registration provider shall make document validation services available via phone, internet, or utilization of digital technologies, to enable enforcement agency officials, builders, installation contractors, HERS raters, and other authorized users of the HERS provider data registry to verify that the information shown on submitted documentation is consistent with the information shown on the current revision of the registered document on file in the HERS provider data registry for the applicable dwelling unit.

NA1.2.2 Summary of Documentation and Communication Procedures

The documentation and communication process for duct sealing field verification and diagnostic testing is summarized below. The subsequent sections of this chapter contain additional information and requirements that apply to all situations; however the section on alterations, NA1.7, applies specifically to the differences in the requirements for alterations. NA1.6 applies specifically to the differences in the requirements for Third Party Quality Control Programs.

1. The documentation author and the principal mechanical designer shall complete the compliance documents for the building.
2. The documentation author or the principal mechanical designer shall provide a signed Certificate of Compliance to the builder that indicates duct sealing with HERS ~~rater~~Rater diagnostic testing and field verification is required for compliance. The Certificate of Compliance shall be approved/signed by the principal designer/owner prior to submittal to the enforcement agency for filing with the building plans.
3. The builder or principal mechanical designer shall make arrangements for transmittal of a signed copy of the Certificate of Compliance, for units that have features requiring HERS verification, to a HERS provider. The builder shall also arrange for the services of a certified HERS ~~rater~~Rater prior to installation of the duct system, so that once the installation is complete the HERS ~~rater~~Rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy by the enforcement agency. The builder or principal mechanical designer shall make available to the HERS ~~rater~~Rater a copy of the Certificate of Compliance that was approved/signed by the principal designer/owner and submitted to the enforcement agency.
4. The builder or subcontractor shall install the duct system(s) that requires field verification and diagnostic testing. The builder or the installing subcontractor shall perform diagnostic testing according to the procedures specified in Reference Nonresidential Appendix NA1.4 and NA2.
5. When the installation is complete, the builder or the installing subcontractor shall complete and sign the ~~Installation~~ Certificate of Installation and post a copy of the completed signed ~~Installation~~ Certificate of Installation at the building site for review by the enforcement agency in conjunction with requests for final inspection. The builder or subcontractor shall also provide a signed copy of the ~~Installation~~ Certificate of Installation to the HERS ~~rater~~Rater.
6. The HERS ~~rater~~Rater shall confirm that the ~~Installation~~ Certificate of Installation has been completed as required, and that the installer's diagnostic test results and all other ~~Installation~~ Certificate of Installation information shows compliance consistent with the requirements given in the plans and specifications and Certificate of Compliance approved by the local enforcement agency for the building.
7. The HERS ~~rater~~Rater shall complete the field verification and diagnostic testing as specified in NA1.5 and shall enter the test results into the HERS provider data registry.

8. The HERS provider shall make available copies of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ to the HERS ~~rater~~Rater, builder, and the HERS ~~rater~~Rater shall arrange to have a copy of the completed signed Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ posted at the building site for review by the enforcement agency in conjunction with requests for final inspection.
9. The enforcement agency shall not approve a building with individual single zone package space conditioning equipment for occupancy until the enforcement agency has received a completed signed copy of the ~~Installation~~ Certificate of Installation, and a completed signed copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ at the building site in conjunction with requests for final inspection.
10. The HERS provider shall make document verification services available, via phone or internet communications interface, to the enforcement agency, builders and contractors, HERS ~~rater~~Raters, the Energy Commission, and other authorized users of the HERS provider data registry. The HERS provider shall insure that the Certificate of Compliance, ~~Installation~~ Certificate of Installation, and Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ information and approval signatures are retained per Title 20 Section 1673(d).

NA1.3 Summary of Responsibilities

This section summarizes responsibilities set forth in this chapter and organizes them by the responsible party. **This section is not, however, a complete accounting of the responsibilities of the respective parties.**

NA1.3.1 Builder

The builder shall make arrangements for transmittal of the Certificate of Compliance, for features requiring HERS verification, to the HERS provider. The builder shall make arrangements for the services of a certified HERS ~~rater~~Rater prior to installation of the duct systems, so that once the installation is complete the HERS ~~rater~~Rater has ample time to complete the field verification and diagnostic testing without delaying final approval of occupancy building permit by the enforcement agency. The builder shall provide to the HERS ~~Rater~~Rater a copy of the Certificate of Compliance that was approved/signed by the principal designer/owner and submitted to the enforcement agency.

The builder's employees or subcontractors responsible for the installation shall perform diagnostic testing, as specified in Reference Nonresidential Appendix NA1.4 and NA2, and shall complete and sign the ~~Installation~~ Certificate of Installation to certify the diagnostic testing results and that the installation work meets the requirements for compliance credit shown on the Certificate of Compliance. The builder or subcontractor shall post a copy of the ~~Installation~~ Certificate of Installation at the construction site for review by the enforcement agency, in conjunction with requests for final inspection. The builder or subcontractor shall also provide a completed signed copy of the ~~Installation~~ Certificate of Installation to the HERS ~~rater~~Rater.

If the builder chooses to utilize group sampling for HERS compliance, the builder or the HERS ~~rater~~Rater shall identify the units to be included in the sample group for field verification and diagnostic testing. The builder or the HERS ~~rater~~Rater shall arrange for the submittal of a completed signed copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ to the enforcement agency in conjunction with requests for final inspection for each individual single zone package space conditioning equipment unit.

NA1.3.2 HERS Provider and Rater

The HERS provider shall maintain a data registry with the capability to receive and store data information provided by authorized users of the data registry sufficient to facilitate administration the of HERS compliance verification procedures and documentation procedures as described in Reference Residential Appendix RA2. Data registry capabilities shall include a secure web-based interface accessible by authorized users, and the ability to receive data transfer files as specified by Residential ACM Manual Appendix D. The HERS provider shall maintain a list of the space conditioning units in the group from which sampling is drawn, the units selected for sampling, the units sampled and the results of the sampling, the units selected for re-sampling, the units that have been tested and verified as a result of re-sampling, and the corrective action taken. The provider shall retain records of all information content and approval signatures for completed Certificate of

Compliance forms, completed ~~Installation~~ Certificate of Installation forms, and completed registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ forms for a period of five years per Title 20 section 1673(d).

The HERS ~~rater~~Rater providing the diagnostic testing and verification shall transmit the test results to the HERS provider data registry. A registered copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ from the provider, signed by the ~~rater~~Rater, shall be provided for the "tested" unit and each of the remaining "not tested" units from a designated sample group for which compliance is verified based on the results of a sample. The HERS provider's registered copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall be made available to the HERS ~~rater~~Rater, the builder, the enforcement agency, and other authorized users of the HERS provider data registry, and a copy of the completed signed Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall be posted at the building site for review by the enforcement agency in conjunction with requests for final inspection.

The HERS ~~rater~~Rater shall produce a separate Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for each unit that meets the diagnostic requirements for compliance. The registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall have unique HERS provider-designated identifiers for registration number, and sample group number, and shall include the lot location, building permit number, time and date stamp of issuance of the certificate, provider logo or seal, and indicate if the space conditioning unit has been "tested"or if it was a "not tested" unit approved as part of sample group. The HERS ~~rater~~Rater shall not provide a Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for a building with a space conditioning unit that does not have a completed signed ~~Installation~~ Certificate of Installation as specified in NA1.4.

If field verification and diagnostic testing on a sampled space conditioning unit identifies a failure to meet the requirements for compliance credit, the HERS ~~rater~~Rater shall report to the HERS provider, the builder, and the enforcement agency that re-sampling will be required.

If re-sampling identifies another failure, the HERS ~~rater~~Rater shall report to the HERS provider, the builder, and the enforcement agency that corrective action, diagnostic testing, and field verification will be required for all the untested space conditioning units in the group. The report shall identify each space conditioning unit that shall be fully tested and corrected.

The HERS provider shall also report to the builder when diagnostic testing and field verification has shown that the failures have been corrected for all of the space conditioning units.

When individual space conditioning unit testing and verification confirms that the requirements for compliance have been met, the HERS provider shall make available to the builder and the enforcement agency a registered copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for each space conditioning unit in the group.

The HERS provider shall file a report with the enforcement agency if there has been a sample group failure, explaining all actions taken (including field verification, testing, and corrective actions) to bring into compliance space conditioning units for which full testing has been required.

NA1.3.3 Third-Party Quality Control Program

An approved third-party quality control program shall:

1. Provide training to participating program installing contractors, installing technicians, and specialty third party quality control program subcontractors regarding compliance requirements for measures for which diagnostic testing and field verification are required,
2. Collect data from participating installers for each installation completed for compliance credit,
3. Complete data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved,
4. Provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved,
5. Require resubmission of data when retesting and correction is directed, and

6. Maintain a database of all data submitted in a format that is acceptable to the Commission and available to the Commission upon request.

The third-party quality control program provider shall arrange for the services of an independent HERS ~~rater~~Rater to conduct independent field verifications of the installation work performed by the participating installing contractor and the Third Party Quality Control Program, completing all of the responsibilities of a HERS ~~rater~~Rater as specified in this Chapter with the exception that sampling shall be completed for a group of up to 30 space conditioning units, and sampling and re-sampling shall be completed for a minimum of one out of every 30 sequentially completed units from the group.

NA1.3.4 Enforcement Agency

The enforcement agency, at its discretion, may require independent testing and field verification to be scheduled so that it can be completed in conjunction with the enforcement agency's required inspections. The enforcement agency may also require that it observe the diagnostic testing and field verification performed by builders or subcontractors and the certified HERS ~~rater~~Rater in conjunction with the enforcement agency's required inspections to corroborate the results documented on the ~~Installation~~ Certificate of Installation and the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~.

For space conditioning units that have used a compliance alternative that requires field verification and diagnostic testing, the enforcement agency shall not approve a building with individual single zone package space conditioning equipment for occupancy until the enforcement agency has received a completed ~~Installation~~ Certificate of Installation that has been signed by the builder/owner or installing subcontractor, and a completed registered copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ that has been made available by the HERS provider, signed and dated by the HERS ~~rater~~Rater, and posted at the building site for review by the enforcement agency in conjunction with requests for final inspection.

NA1.4 Installer ~~Requirements~~ Procedures – ~~Installation~~ Certificate of Installation ~~Form~~ Documentation

~~Installation~~ Certificates of Installation are required for ~~each and every~~all buildings and ~~for every~~ shall include the applicable information for all of the installed ~~single zone package~~ space conditioning ~~equipment unit~~ systems in the building. ~~that requires duct sealing with~~ HERS ~~rater~~Rater field verification and diagnostic testing. When compliance requires duct sealing, builder employees or subcontractors shall perform diagnostic testing according to the procedures specified in Reference Nonresidential Appendix NA2, and verify that the work meets the requirements for compliance credit as shown on the Certificate of Compliance. The owner/installer shall complete a~~n~~ ~~Installation~~ Certificate of Installation and sign the certificate to certify that the installation work meets the requirements for compliance credit.

A signed copy of the ~~Installation~~ Certificate of Installation shall be posted at the job site for review by the enforcement agency, in conjunction with requests for final inspection, and a copy shall be provided to the HERS ~~rater~~Rater.

When the Standards do not require the Certificate of Installation to be registered, the Certificates of Installation that are posted in the field for review by the enforcement agency at final inspection are not required to be registered certificates from a HERS provider data registry, but shall conform to all other applicable requirements of 10-103(a)3.

NA1.5 Acceptance Procedures - Certificate of Acceptance Documentation

Certificates of Acceptance for duct testing are required for all applicable single zone package space conditioning systems in the building. When compliance requires duct sealing, the acceptance test Field Technician shall perform the required field verification and diagnostic testing according to the procedures specified in Reference Nonresidential Appendix NA2, and verify that the work meets the requirements for compliance credit as shown on the Certificate of Compliance. The owner/installer shall complete a Certificate of Installation and sign the certificate to certify that the installation work meets the requirements for compliance credit.

A signed copy of the Certificate of Acceptance shall be posted at the job site for review by the enforcement agency, in conjunction with requests for final inspection, and a copy shall be provided to the HERS Rater.

When the Standards do not require the Certificate of Acceptance to be registered, the Certificates of Acceptance that are posted in the field for review by the enforcement agency at final inspection are not required to be registered certificates from a data registry, but shall conform to all other applicable requirements of 10-103(a)4.

~~NA1.5~~NA1.6 HERS Rater Procedures – Verification, Testing, and Sampling

At the builder's option, HERS field verification and diagnostic testing shall be completed either for each single zone package space conditioning equipment unit in the building or for a sample from a designated group of units. Field verification and diagnostic testing for compliance credit for duct sealing shall use the diagnostic duct leakage from fan pressurization of ducts procedure in Reference Nonresidential Appendix NA2.

The builder or subcontractor shall provide to the HERS ~~rater~~Rater a copy of the Certificate of Compliance approved/signed by the principal designer/owner and a registered copy of the ~~Installation~~ Certificate of Installation as required in NA1.4. Prior to completing field verification and diagnostic testing, the HERS ~~rater~~Rater shall confirm that the ~~Installation~~ Certificate(s) of Installation has been completed as required, and that the installer's diagnostic test results and all other ~~Installation~~ Certificate of Installation information shows compliance consistent with the Certificate of Compliance.

If field verification and diagnostic testing determines that the requirements for compliance are met, the HERS ~~rater~~Rater shall transmit the test results to the HERS provider data registry, whereupon the provider shall make available a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ to the HERS ~~rater~~Rater, the builder, the enforcement agency, and other authorized users of the HERS provider data registry. Printed copies, electronic or scanned copies, and photocopies of the completed signed registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall be allowed for document submittals, subject to verification that the information contained on the copy conforms to the registered document information currently on file in the provider data registry for the space conditioning unit.

The HERS ~~rater~~Rater shall provide copies of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ to the builder, and post a completed signed registered copy of the Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ at the building site for review by the enforcement agency in conjunction with requests for final inspection.

The HERS provider shall make available via phone or internet communications interface a way for enforcement agencies, builders, and HERS ~~rater~~Raters to verify that the information displayed on copies of the submitted Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ conforms to the registered document information currently on file in the provider data registry for the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~.

If the builder chooses the sampling option, the applicable procedures described in NA1.5.1, NA1.5.2 and NA1.5.3 shall be followed.

~~NA1.5.1~~NA1.6.1 HERS Procedures - Initial Field Verification and Diagnostic Testing

The HERS ~~rater~~Rater shall diagnostically test and field verify the first single zone package space conditioning equipment unit of each building. This initial testing allows the builder to identify and correct any potential duct installation and sealing flaws or practices before other units are installed. If field verification and diagnostic testing determines that the requirements for compliance are met, the HERS ~~rater~~Rater shall transmit the test results to the HERS provider registry, whereupon the provider shall make available a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ to the HERS ~~rater~~Rater, the builder, and the enforcement agency.

~~NA1.5.2~~NA1.6.2 HERS Procedures – Group Sample Field Verification and Diagnostic Testing

After the initial field verification and diagnostic testing is completed, the builder or the HERS ~~rater~~Rater shall identify a group of up to seven individual single zone package space conditioning equipment units in the building from which a sample will be selected and identify the names and license numbers of the subcontractors responsible for the installations requiring field verification and diagnostic testing. The HERS ~~rater~~Rater shall verify that a Certificate of Compliance and a~~n~~ ~~Installation~~ Certificate of Installation has been completed for each unit having features requiring HERS verification. The HERS ~~rater~~Rater shall also confirm that the ~~Installation~~ Certificates of Installation have been completed as required, and that the installer's diagnostic test results, and all other ~~Installation~~ Certificate of Installation information shows compliance consistent with the Certificate of Compliance. The group shall be closed prior to selection of the sample that will be field verified and diagnostically tested.

The builder or the HERS ~~Rater~~Rater may request removal of units from the group by notifying the HERS provider prior to selection of the sample that will be tested and shall provide justification for the change. Removed units which are installed shall either be field verified and diagnostically tested individually or shall be included in a subsequent group for sampling.

The HERS ~~rater~~Rater, with no direction from the installer or builder, shall randomly select one unit out of the closed group for field verification and diagnostic testing. The HERS ~~rater~~Rater shall enter the test and/or field verification results into the HERS provider data registry regardless of whether the results indicate a pass or fail. If the test fails then the failure must be entered into the provider's data registry even if the installer immediately corrects the problem. In addition, the procedures in NA1.5.3 shall be followed.

If field verification and diagnostic testing determines that the requirements for compliance are met, the HERS ~~rater~~Rater shall enter the test results into the HERS provider data registry. Whereupon, the provider shall make available to the HERS ~~rater~~Rater, the builder, the enforcement agency and other approved users of the HERS provider data registry, a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for the "tested" unit and a Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall also be provided for each "not tested" conditioning unit in the sample group. The Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall report the successful diagnostic testing results and conclusions regarding compliance for the"tested" conditioning unit. The Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall also provide:

1. Building permit number for the unit.
2. Registration Number – a HERS provider-designated identification number unique to the unit.
3. Group Number – a HERS provider-designated identification number unique to the sample group.
4. Time and date stamp of the provider's issuance of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~.
5. Provider's logo or official seal.
6. Indication that the conditioning unit was a "tested" unit, or was a "not tested" unit from the sample group.

The registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ shall not be provided for units that have not yet been installed and sealed.

Whenever the builder changes subcontractors who are responsible for installation of the space conditioning equipment units, the builder shall notify the HERS ~~rater~~Rater of any subcontractors who have changed, and terminate sampling for the associated group. All units requiring HERS ~~rater~~Rater field verification and diagnostic testing for compliance that were installed by previous subcontractors or were subject to field verification and diagnostic testing under the supervision of a previous HERS provider, for which the builder does not have a completed Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~, shall either be individually tested or included in a separate group for sampling. Individual single zone package space conditioning equipment units that are subject to the requirements of §144(k) with installations completed by new subcontractors shall either be individually tested or shall be included in a new sampling group following a new *Initial Field Verification and Testing*, per NA1.5.1.

The HERS ~~rater~~Rater shall not notify the builder when sample testing will occur prior to the completion of the work that is to be tested, or prior to entry of the data from the ~~Installation~~ Certificate of Installation into the provider data registry. After the HERS ~~rater~~Rater selects the sample unit to test, and notifies the builder when testing will occur, the builder shall not do additional work on the features being tested.

The HERS provider shall close a group within 6 months after the signature date shown on any ~~Installation~~ Certificate of Installation in the group. When such group closure occurs, the HERS provider shall notify the builder or contractor and HERS ~~rater~~Rater that the group has been closed, and a sample shall be selected for field verification and diagnostic testing.

~~NA1.5.3~~NA1.6.3 HERS Procedures - Re-sampling, Full Testing and Corrective Action

"Re-sampling" refers to the procedure that requires testing of additional dwellings within a group when the selected sample dwelling from a group fails to comply with the HERS verification requirements.

When a failure is encountered during sample testing, the failure shall be entered into the provider's data registry. Corrective action shall be taken and the unit shall be retested to verify that corrective action was successful. Corrective action and retesting on the unit shall be repeated until the testing indicates compliance and the results have been entered into the HERS provider data registry. Whereupon, a registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for the dwelling shall made available to the HERS ~~rater~~Rater, the builder, the enforcement agency, and other authorized users of the HERS provider data registry. In addition, the HERS ~~rater~~Rater shall conduct re-sampling to assess whether the first failure in the group is unique or if the rest of the units in the group are likely to have similar failings. The HERS ~~rater~~Rater shall randomly select for re-sampling one of the remaining untested units in the group for testing of the feature that failed.

If testing in the re-sample confirms that the requirements for compliance credit are met, then the unit with the failure shall not be considered an indication of failure in the other units in the group. The HERS ~~rater~~Rater shall transmit the re-sample test results to the HERS provider data registry, whereupon the provider shall make available to the HERS ~~rater~~Rater, the builder, the enforcement agency, and other authorized users of the HERS provider data registry, a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for each of the remaining units in the group including the dwelling unit in the re-sample.

If field verification and diagnostic testing in the re-sample results in a second failure, the HERS ~~rater~~Rater shall report the second failure to the HERS provider, the builder, and the enforcement agency. All dwelling units in the group must thereafter be individually field verified and diagnostically tested. The builder shall take corrective action in all space conditioning units in the group that have not been tested. In cases where corrective action would require destruction of building components, the builder may choose to reanalyze compliance and choose different measures that will achieve compliance. In this case a new Certificate of Compliance shall be completed and submitted to the HERS provider, the HERS ~~rater~~Rater and the enforcement agency. The HERS ~~rater~~Rater shall conduct field verification and diagnostic testing for each of these space conditioning units to verify that problems have been corrected and that the requirements for compliance have been met. Upon verification of compliance, the HERS ~~rater~~Rater shall enter the test results into the HERS provider data registry. Whereupon the provider shall make available to the HERS ~~rater~~Rater, the builder, the enforcement agency, and other authorized users of the HERS provider data registry a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ for each individual unit in the group.

The HERS provider shall file a report with the enforcement agency explaining all action taken (including field verification, diagnostic testing, and corrective action,) to bring into compliance units for which full testing has been required. If corrective action requires work not specifically exempted by the CMC or the CBC, the builder shall obtain a permit from the enforcement agency prior to commencement of any of the work.

Corrections to avoid reporting a failure to the HERS provider data registry shall not be made to a sampled or re-sampled unit after the HERS ~~rater~~Rater selects the sample unit, or during the course of HERS testing of the unit. If it becomes evident that such corrections have been made to a sampled or re-sampled unit to avoid reporting a failure, field verification and diagnostic testing shall be required to be performed on 100 percent of the individual single zone package space conditioning equipment units in the group.

~~NA1.6~~NA1.7 Third Party Quality Control Programs

The Commission may approve third-party quality control programs that serve some of the function of HERS ~~rater~~Raters for diagnostic testing and field verification purposes but do not have the authority to sign compliance documentation as a HERS ~~rater~~Rater. The third-party quality control program shall provide training to installers regarding compliance requirements for duct sealing. The third-party quality control program shall collect data from participating installers for each installation completed for compliance credit, provide data checking analysis to evaluate the validity and accuracy of the data to independently determine whether compliance has been achieved, provide direction to the installer to retest and correct problems when data checking determines that compliance has not been achieved, require resubmission of data when retesting and correction is directed, and maintain a database of all data submitted by installers in a format that is acceptable to the Commission and available to the Commission upon request. The data that is collected by the third-party quality control program shall be more detailed than the data required for showing compliance with the Standards, shall provide an independent check on the validity and accuracy of the installer's claim that compliance has been achieved, and shall not be alterable by the installer to indicate that compliance has been achieved when in fact compliance has not been achieved.

The HERS provider shall arrange for the services of a HERS ~~rater~~Rater to conduct independent field verifications of the installation work performed by the participating installing contractor and Third Party Quality Control Program, completing all of the responsibilities of a HERS ~~rater~~Rater as specified in this chapter with the exception that sampling shall be completed for a group of up to thirty space conditioning units with a minimum sample of one out of every 30 sequentially completed units from the group. The HERS ~~rater~~Rater shall be an independent entity from the third-party quality control program. Re-sampling, full testing and corrective action shall be completed as specified in NA1.5.3 with the exception that the group size can be up to 30 units. The third party quality control program shall not impose restrictions on the HERS ~~rater~~Rater or the HERS provider that limit their independence, or the ability of the HERS ~~rater~~Rater or the HERS provider to properly perform their functions. For example, the third party quality control program shall not impose restrictions on a HERS ~~rater~~Rater's use of equipment beyond that required by the Energy Commission.

The third-party quality control program shall meet all of the requirements imposed on of a HERS ~~rater~~Rater specified in the Commission's HERS Program regulations (California Code of Regulations, Title 20, Division 2, Chapter 4, Article 8, Sections 1670 -1675), including the requirement that they be an independent entity from the builder the HERS ~~rater~~Rater for the units, and the subcontractor installer as specified by Section 1673(i). However, a third-party quality control program may have business relationships with installers participating in the program to advocate or promote the program and an installer's participation in the program and to advocate or promote products that the third-party quality control program sells to installers as part of the program.

Prior to approval by the Commission, the third party quality control program shall provide a detailed explanation to the Commission of 1) the data that is to be collected from the installers, 2) the data checking process that will be used to evaluate the validity and accuracy of the data, 3) the justification for why this data checking process will provide strong assurance that the installation actually complies, and 4) the format for the database that will be maintained and provided to the Commission upon request. The third-party quality control program may apply for a confidential designation of this information as specified in the Commission's Administrative Regulations (California Code of Regulations, Title 20, Division 2, Chapter 7, Article 2, Section 2505). The third-party quality control program shall also provide a detailed explanation of the training that will be provided to installers and the procedures that it will follow to complete independent field verifications.

The third party quality control program licensed/certified installing contractor and the installing contractor's responsible installing technicians shall be required to be trained in quality installation procedures, the requirements of this Appendix NA1, and any other applicable specialized third party quality control program-specific procedures as a condition for participation in the program. The training requirements also apply to the installing contractor's specialty subcontractors who provide Third Party Quality Control Program services. All installation verification and diagnostic work performed in the program shall be subject to the same quality assurance procedures as required by the Energy Commission's HERS program regulations.

The third-party quality control program shall be considered for approval as part of the rating system of a HERS provider, which is certified as specified in the Commission's HERS Program regulations, Title 20,Division 2, Chapter 4, Article 8, Section 1674. A third-party quality control program can be added to the rating system through the re-certification of a certified HERS provider as specified by Title 20, Division 2, Chapter 4, Article 8, Section 1674(d).

~~NA1.7~~NA1.8 Installer ~~Requirements~~ Procedures and HERS Rater Procedures for Alterations

This section on alterations is intended to describe the differences that apply to alterations. Otherwise the procedures and requirements detailed in previous sections shall also apply to procedures and requirements for alterations. For alterations, building owners or their agents may carry out the actions that are assigned to builders in previous sections ~~of this document.~~of Reference Nonresidential Appendix NA1.

Applicable procedures for registration of compliance documents described in Appendix NA1shall also apply to alterations.

When compliance for an alteration requires diagnostic testing and field verification, the building permit applicant may choose for the testing and field verification to be completed for the permitted space conditioning unit alone, or alternatively as part of a designated sample group of space conditioning units for which the same installing company has completed work that requires ~~diagnostic testing and~~ field verification and diagnostic testing for compliance.

When sampling is utilized for HERS verification compliance for alterations, the buildings in a designated sample group are not required to be located within the same enforcement agency jurisdiction. However, to enable the enforcement agency to schedule testing to accomplish the corroboration of field verification and diagnostic testing procedures performed by the building owner, subcontractors, or certified HERS rater as described in Section NA1.x.x., the enforcement agency may require that a separate dwelling unit from the sample group that is located within its jurisdiction be tested.

The building permit applicant shall make arrangements for transmittal of the Certificate of Compliance to the HERS provider identifying the building features and measures requiring HERS verification.

When the enforcement agency does not require building design plans to be submitted with the application for a building permit for an alteration, the applicable registered Certificate of Compliance documentation specified in 10-103(a)1 is not required to be approved by the enforcement agency prior to issuance of a building permit, but shall be approved by the enforcement agency prior to final inspection of the dwelling unit, and shall be made available to the enforcement agency for all applicable inspections as specified in Standards Section 10-103(a)2A.

HERS raters or other authorized users of the HERS provider data registry may provide *documentation author* support to facilitate the submittal of the required Certificate of Compliance information to the HERS provider data registry on behalf of the building owner or agent of the building owner, when such facilitation has been authorized by the building owner or agent of the building owner. *Documentation authors* shall provide an electronic signature to certify the documentation is accurate and complete. The building owner or agent of the building owner who is eligible under Division 3 of the Business and Professions Code to take responsibility for the design specification for the alteration shall provide an electronic signature to register the Certificate of Compliance, to certify the information provided on the Certificate is true and correct, to certify conformance with Part 6, and shall submit the registered Certificate of Compliance to the enforcement agency for approval.

The building permit applicant shall also submit a copy of the approved/signed Certificate of Compliance to the HERS ~~rater~~Rater.

The installer shall perform diagnostic testing and the procedures specified in Reference nonresidential Appendix NA1.4 and NA2. When the installation is complete, the person responsible for the performance of the installation shall complete and sign the ~~Installation~~ Certificate of Installation, and post a copy at the building site for review by the enforcement agency in conjunction with requests for final inspection. The owner or subcontractor shall also provide a completed signed copy of the ~~Installation~~ Certificate of Installation to the HERS ~~rater~~Rater.

The HERS ~~rater~~Rater shall verify that the Certificate of Compliance and the ~~Installation~~ Certificate of Installation have been completed for each unit having features requiring HERS verification, and that the installer's diagnostic test results and all other ~~Installation~~ Certificate of Installation information shows compliance consistent with the Certificate of Compliance for the unit.

If group sampling is utilized for compliance, the HERS ~~rater~~Rater shall define a group of up to seven units for sampling purposes, requiring that all units within the group have been serviced by the same installing company. The installing company may request a group for sampling that is smaller than seven units. Whenever the HERS ~~rater~~Rater for an installing company is changed, a new group shall be established.

Re-sampling, full testing and corrective action shall be completed if necessary as specified in NA1.5.3. For alterations, the installing company shall offer to complete field verification and diagnostic testing and any necessary corrective action at no charge to building owners in the group.

The enforcement agency shall not approve the alteration until the enforcement agency has received a completed ~~Installation~~ Certificate of Installation as specified in NA1.4, and a copy of the registered Certificate of ~~Field~~ Verification ~~and Diagnostic Testing~~ as specified in NA1.5.

Third Party Quality Control Programs, as specified in NA1.6, may also be used with alterations. When a Third Party Quality Control Program is used, the enforcement agency may approve compliance based on the ~~Installation~~ Certificate of Installation, where data checking has indicated that the unit complies, on the condition that if HERS compliance verification procedures indicate that re-sampling, full testing or corrective action is necessary, such work shall be completed.

Nonresidential Appendix NA2

Appendix NA2 – Nonresidential Field Verification and Diagnostic Test Procedures

Table of Contents

NA2.1 Air Distribution Diagnostic Measurement and Procedures for Field Verification and Diagnostic Testing of Air Distribution Systems

Diagnostic inputs are used for the calculation of improved duct efficiency. The diagnostics include observation of various duct characteristics and measurement of duct leakage and system fan flows as described below in NA2.3.3 through NA2.3.8. These observations and measurements replace those assumed as default values.

The diagnostic procedures include:

- Measurement of duct surface area if ducts are located outdoors or in multiple spaces as described in Section NA2.3.3.
- Observation of the insulation level for the supply (R_s) and return (R_r) ducts outside the conditioned space as described in Section NA2.3.5.
- Observation of the presence of a cool roofing product.
- Observation of the presence of an outdoor air economizer.
- Measurement of total duct system leakage as described in Section NA2.3.8.

Using default values instead of measured values will produce conservative (low) estimates of duct efficiency.

NA2.1.1 Purpose and Scope

- NA2.1 contains procedures for measuring field verification and diagnostic testing the for air leakage in single zone, constant volume, nonresidential air distribution systems. The methods described here apply to single zone, constant volume heating and air conditioning systems serving zones with 5000 ft² of conditioned floor area or less, with duct systems located in unconditioned or semi-conditioned buffer spaces or outdoors as required by Standards section 140.4(l). Field measurement and verification procedures must be performed if a reduced duct leakage credit is claimed.
- These NA2.1 procedures apply are applicable to new space conditioning systems in newly constructed buildings or and to new or altered air space conditioning systems applied in to existing buildings.
- NA2.1 procedures shall be used by installers, HERS Raters, and others who perform field verification of air distribution systems as required by Standards Section 140.4(l).
- Table NA2.1-1 provides a summary of the duct leakage verification and diagnostic test protocols included in Section NA2.1, and the compliance criteria.

The Nonresidential ACM Manual contains calculation procedures for determining distribution efficiency of single-zone nonresidential air distribution systems serving 5,000 ft² or less. By default, duct leakage is assumed to be untested.

NA2.1.2 Instrumentation Specifications

The instrumentation for the air distribution diagnostic measurements shall conform to the following specifications:

NA2.1.2.1 Pressure Measurements

All pressure measurements shall be measured with measurement systems (i.e. sensor plus data acquisition system) having an accuracy of plus or minus± 0.2 Pa. All pressure measurements within the duct system shall be made with static pressure probes, Dwyer A303 or equivalent.

NA2.1.2.2 Duct Leakage Measurements

~~The~~ All measurements of duct leakage airflow ~~air flows during duct leakage testing~~ shall have an accuracy of ~~±~~ plus or minus 3 percent~~-~~ of measured airflow or better using digital gauges.

NA2.1.2.3 Calibration

All instrumentation used for duct leakage diagnostic measurements shall be calibrated according to the manufacturer's calibration procedure to conform to the ~~above~~ accuracy requirement specified in Section NA2.1.2. ~~All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.~~

NA2.1.3 ~~Duct Pressurization~~ Diagnostic Apparatus

NA2.1.3.1 Apparatus for Duct Pressurization and Leakage Flow Measurement

The apparatus for duct system ~~fan~~ pressurization and duct system leakage measurements shall consist of a duct system pressurization and leakage airflow measurement device meeting the specifications in Section NA2.1.2.

NA2.1.3.2 Apparatus for Smoke-Test of Accessible-Duct Sealing (Existing Duct Systems)

The apparatus for determining leakage in and verifying sealing of all accessible leaks in existing duct systems provide means for introducing controllable amounts of non-toxic visual or theatrical smoke into the duct pressurization apparatus for identifying leaks in accessible portions of the duct system. The means for generating smoke shall have sufficient capacity to ensure that any accessible leaks will emit visibly identifiable smoke.

NA2.1.4 Verification and Diagnostic Procedures

~~The following sections identify input values for building and HVAC system (including ducts) using either default or diagnostic information.~~

~~NA2.1.5 Building Information and Defaults~~

~~The calculation procedure for determining air distribution efficiencies requires the following building information:~~

1. ~~climate zone for the building,~~
2. ~~conditioned floor area,~~
3. ~~number of stories,~~
4. ~~areas and U-values of surfaces enclosing space between the roof and a ceiling, and~~
5. ~~surface area of ductwork if ducts are located outdoors or in multiple spaces.~~

~~Using default values rather than diagnostic procedures produce relatively low air distribution-system efficiencies. Default values shall be obtained from following sections:~~

1. ~~the location of the duct system in Section NA2.3.4,~~
2. ~~the surface area and insulation level of the ducts in Section NA2.3.3.1 and Section NA2.3.5.1,~~
3. ~~the system fan flow in Section NA2.3.6, and~~
4. ~~the leakage of the duct system in Section NA2.3.8~~

NA2.1.6 Diagnostic Input

Diagnostic inputs are used for the calculation of improved duct efficiency. The diagnostics include observation of various duct characteristics and measurement of duct leakage and system fan flows as described in Sections NA2.3.3 through NA2.3.8. These observations and measurements replace those assumed as default values.

The diagnostic procedures include:

- Measurement of total duct system leakage as described in Section NA2.3.8.
- Measurement of duct surface area if ducts are located outdoors or in multiple spaces as described in Section NA2.3.3.2.
- Observation of the insulation level for the supply (R_s) and return (R_r) ducts outside the conditioned space as described in Section NA2.3.5.2.
- Observation of the presence of a cool roof.
- Observation of the presence of an outdoor air economizer.

NA2.1.7 Duct Surface Area

The supply-side and return-side duct surface areas shall be calculated separately. If the supply or return duct is located in more than one space, the area of that duct in each space shall be calculated separately. The duct surface area shall be determined using one of the following methods.

NA2.1.7.1 Default Duct Surface Area

The default duct surface area for supply and return shall be calculated as follows:

For supplies:

Equation NA2-1

$$A_{s,total} = K_s A_{floor}$$

Where K_s (supply duct surface area coefficient) shall be 0.25 for systems serving the top story only, 0.125 for systems serving the top story plus one other, and 0.08 for systems serving three or more stories.

For returns:

Equation NA2-2

$$A_{r,total} = K_r \ A_{floor}$$

Where K_r (return duct surface area coefficient) shall be 0.15 for systems serving the top story only, 0.125 for systems serving the top story plus one other, and 0.08 for systems servings three or more stories.

If ducts are located outdoors, the outdoor duct surface area shall be calculated from the duct layout on the plans using measured duct lengths and nominal inside diameters (for round ducts) or inside perimeters (for rectangular ducts) of each outdoor duct run in the building that is within the scope of the calculation procedure. When using the default duct area, outdoor supply duct surface area shall be less than or equal to the default supply duct surface area; outdoor return duct surface area shall be less than or equal to the default return duct surface area.

The surface area of ducts located in the buffer space between ceilings and roofs shall be calculated from:

Equation NA2-3

$$A_{s,buffer} = A_{s,total} - A_{s,outdoors}$$

Equation NA2-4

$$A_{r,buffer} = A_{r,total} - A_{r,outdoors}$$

NA2.1.7.2 Measured Duct Surface Area

Measured duct surface areas shall be used when the outdoor duct surface area measured from the plans is greater than default duct surface area for either supply ducts or return ducts. If a duct system passes through multiple spaces that have different ambient temperature conditions as specified in Section NA2, the duct surface area shall be measured for each space individually. The duct surface area shall be calculated from measured duct lengths and nominal inside diameters (for round ducts) or inside perimeters (for rectangular ducts) of each duct run located in buffer spaces or outdoors.

NA2.1.8 Duct Location

Duct systems covered by this procedure are those specified in the §144(k)3.

NA2.1.9 Duct Wall Thermal Resistance

NA2.1.9.1 Default Duct Insulation R value

Default duct wall thermal resistance for new buildings is R-8.0, the mandatory requirement for ducts installed in newly constructed buildings, additions and new or replacement ducts installed in existing buildings. Default duct wall thermal resistance for existing ducts in existing buildings is R-4.2. An air film resistance of 0.7 (hr-ft²-°F/BTU] shall be added to the duct insulation R value to account for external and internal film resistance.

NA2.1.9.2 Diagnostic Duct Wall Thermal Resistance

Duct wall thermal resistance shall be determined from the manufacturer's specification observed during diagnostic inspection. If ducts with multiple R values are installed, the lowest duct R value shall be used. If a duct with a higher R value than 8.0 is installed, the R-value shall be clearly stated on the building plans and a visual inspection of the ducts must be performed to verify the insulation values.

NA2.1.9.3NA2.1.4.1 Total Fan FlowNominal Air Handler Airflow

The nominal air handler airflow used to determine the target leakage rate for compliancetotal fan flow for an air conditioner or a heat pump for all climate zones shall be equal to 400 cfm per /rated ton of cooling capacity with rated tons defined by unit scheduled capacity at the conditions the unit's ARI rating standard from §112. Airflow throughNominal air handler airflow for heating--only system furnaces shall be based on 21.7 cfm per /kBtu/hr of rated heating output capacity.

NA2.1.10 Duct Leakage Factor for Delivery Effectiveness Calculations

Default duct leakage factors for the Proposed Design shall be obtained from Table NA2-1, using the "Untested" values.

Duct leakage factors for the Standard Design shall be obtained from Table NA2-2, using the appropriate "Tested" value.

Duct leakage factors shown in Table NA2-1 shall be used in calculations of delivery effectiveness contained in the Nonresidential ACM Manual.

~~*Table NA2-1 – Duct Leakage Factors*~~

	~~as = ar =~~
~~Untested duct systems~~	~~0.82~~
~~Sealed and tested duct systems in existing buildings, -System tested after HVAC equipment and/or duct -installation~~	~~0.915~~
~~Sealed and tested new duct systems. -System tested after HVAC system installation~~	~~0.96~~

~~*NA2.1.10.1*~~*NA2.1.4.2 Diagnostic Duct Leakage*

Diagnostic duct leakage measurement ~~is~~ shall be used by installers and ~~raters~~ HERS Raters to verify that ~~total~~ duct leakage meets the compliance criteria for ~~any~~ sealed duct systems ~~specified in the compliance documents~~for which field verification and diagnostic testing is required. ~~Table NA2-2~~Table NA2.1-1 ~~shows~~ summarizes the leakage criteria and ~~and~~ the diagnostic test procedures that ~~may~~ shall be used to demonstrate compliance. ~~In addition to the minimum tests shown, existing duct systems may be tested to show they comply with the criteria for new duct systems.~~

Table NA2.1-1 ~~NA2-2 –~~ Duct Leakage ~~Tests~~ Verification and Diagnostic Test Protocols and Compliance Criteria

Case	User and Application	Leakage Compliance ~~c~~Criteria, (% of Nominal Air Handler Airflow)~~total fan flow~~	Procedure(s)
Sealed and tested new- duct systems	Installer Testing HERS Rater Testing	6%	~~NA2.3.8.1~~NA2.1.4.2.1
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	15% ~~Total Duct Leakage~~	NA2.1.4.2.1~~NA2.3.8.1~~
	~~Installer Testing and Inspection~~ ~~HERS Rater Testing and Verification~~	~~60% Reduction in Leakage and Visual Inspection~~	~~NA2.3.8.2~~ ~~NA2.3.8.4~~
Sealed and tested altered existing duct systems	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Test but All Accessible Ducts are Sealed ~~And Visual~~ Inspection and Smoke Test with 100% Verification	~~NA2.3.8.3~~NA2.1.4.2.2 ~~NA2.3.8.4~~NA2.1.4.2.3 NA2.1.4.2.4

~~NA2.1.10.1.1~~NA2.1.4.2.1 Diagnostic ~~Total~~ Duct Leakage ~~Test~~ from Fan Pressurization of Ducts

The objective of this procedure is for an installer to determine ~~or~~ and a ~~rater~~ HERS Rater to verify the ~~total~~ leakage of a new or altered duct system. The ~~total~~ duct leakage shall be determined by pressurizing the entire duct system~~both the supply and return~~ ducts to 25 Pa~~scals~~ (0.1 inches water) with respect to outside~~with all ceiling diffusers/grilles and HVAC equipment installed~~. ~~When existing ducts are to be altered, this test shall be performed prior to and after duct sealing.~~ The following procedure shall be used for the fan pressurization tests:

1. Verify that the air handler, supply and return plenums and all the connectors, transition pieces, duct boots, and registers are installed, and ensure the following locations have been sealed:~~.~~
   - Connections to plenums and other connections to the air-handling unit.
   - Refrigerant line and other penetrations into the air-handling unit.

- Air handler access door or panel (do not use permanent sealing material, metal tape is acceptable).

The entire duct system including the air- handler shall be included in the test.

1.2. For newly installed or altered ducts, verify that cloth backed rubber adhesive duct tape has not been used.

2.3. Temporarily Sseal all the supply registers and return registersgrilles, except for one large centrally located return register grille or the system fanair handler cabinet access door or panel. Verify that all outside air dampers and/or economizers are sealed prior to pressurizing the system.

3.4. Attach the fan flowmeter device to the duct system at the unsealed register return grille or the air handler cabinet access door or doorpanel.

4.5. Install a static pressure probe at a supply register located close to the air handler, or at the supply plenum.

5.6. Adjust the fan flowmeter to produce a positive 25 Pascal (0.1 inches water) pressure difference between the supply duct and the outside or at the supply register or the supply plenum with respect to the outside or with respect to the building space with the entry door open to the outside.

6.7. Record the flow through the flowmeter, ($Q_{total,25}$) - this is the total duct leakage flow at 25 Pa (0.1 inches water)seals.

7. Divide the duct leakage flow by the total fan nominal air handler airflow determined by the procedure in Section NA2.1.4.1 and convert to a percentage. If the duct leakage flow percentage is equal to or less than 6 percent for new duct systems or less than 15 percent for altered duct systems,the target compliance criterion from Table NA2.1-1, the system passes.

8. Duct systems that have passed this total leakage test will be tested by a HERS rater to show compliance.

NA2.1.10.2 Leakage Improvement from Fan Pressurization of Ducts

For altered existing duct systems which have a higher leakage percentage than the Total Duct leakage criteria in Section NA2.3.8.1, the objective of this test is to show that the original leakage is reduced through duct sealing as specified in Table NA2-2. The following procedure shall be used:

1. Use the procedure in NA2.3.8.1 to measure the leakage before commencing duct sealing.

2. After sealing is complete use the same procedure to measure the leakage after duct sealing.

3. Subtract the sealed leakage from the original leakage and divide the remainder by the original leakage. If the leakage reduction is 60 percent or greater of the original leakage, the system passes.

4. Complete the Visual Inspection specified in NA2.3.8.4.

Duct systems that have passed this leakage reduction test and the visual inspection test will be tested by a HERS rater to show compliance.

NA2.1.10.2.1NA2.1.4.2.2 Sealing of All Accessible Leaks

For altered existing duct systems that do not are unable to pass the total leakage test in Section (NA2.3.8.1NA2.1.4.2.1), the objective of this test is to show verify that all accessible leaks are sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

1. Complete each of the leakage test specified in Section NA2.1.4.2.1.

2. Seal all accessible ducts

3. After sealing is complete, again use the procedure in NA2.1.4.2.1 to measure the leakage after duct sealing.s

1. Complete the Smoke Test as specified in NA2.1.4.2.3.

4.

2.5. Complete the Visual Inspection as specified in NA2.3.8.4NA2.1.4.2.4.

All duct systems that could notfail to pass either the total leakage test or the leakage improvement test specified in Section NA2.1.4.2.1 will shall be tested and inspected by a HERS rater Rater to show verify that all accessible ducts have been sealed and excessively damaged ducts have been replaced. Compliance with HERS verification requirements shall not utilize group sampling procedures when the installer used the Sealing of All Accessible Leaks procedure in Section NA2.1.4.2.2This requires a sampling rate of 100 percent.

NA2.1.4.2.3 Smoke-Test of Accessible-Duct Sealing

For altered existing ducts that fail the leakage tests, the objective of the smoke test is to confirm that all accessible leaks have been sealed. The following procedure shall be used:

1. Inject either theatrical or other non-toxic smoke into a fan pressurization device that is maintaining a duct pressure difference of 25 Pa (0.1 inches water) relative to the duct surroundings, with all grilles and registers in the duct system sealed.
2. Visually inspect all accessible portions of the duct system during smoke injection.
3. The system shall pass the test if one of the following conditions is met:
   - No visible smoke exits the accessible portions of the duct system.
   - Smoke only emanates from the furnace cabinet which is gasketed and sealed by the manufacturer and no visible smoke exits from the accessible portions of the duct system.

NA2.1.10.2.2NA2.1.4.2.4 Visual Inspection of Accessible Duct Sealing

For altered existing duct systems that are unable to pass the leakage test in Section NA2.1.4.2.1fail to be sealed to 15 percent of total fan flow, the objective of this inspection is to confirm that all accessible leaks have been sealed and that excessively damaged ducts have been replaced. The following procedure shall be used:

Visually inspect to verify that the following locations have been sealed:

1. Connections to plenums and other connections to the forced air--handling unit.
2. Refrigerant line and other penetrations into the forced air-handling unit.
3. Air handler access door or panel (do not use permanent sealing material, metal tape is acceptable).
4. Register boots sealed to surrounding material.
5. Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes.

Visually inspect to verify that portions of the duct system that are excessively damaged have been replaced. Ducts that are considered to be excessively damaged are:

Flex ducts with the vapor barrier split or cracked with a total linear split or crack length greater than 12 inches

Crushed ducts where cross-sectional area is reduced by 30 percent or more

Metal ducts with rust or corrosion resulting in leaks greater than 2 inches in any dimension

Ducts that have been subject to animal infestation resulting in leaks greater than 2 inches in any dimension

Labeling requirements for tested systems

A sticker shall be affixed to the exterior surface of the air handler access door with the following text in 14 point font:

"The leakage of the air distribution ducts was found to be CFM @ 25 Pascals or percent of total fan flow.

This system (check one):

□ Has a leakage rate that is equal to or lower than the prescriptive requirement of 6 percent leakage for new duct systems or 15 percent leakage for alterations to existing systems. It meets the prescriptive requirements of California Energy Efficiency Standards.

~~☐ Has a leakage rate higher than 6 percent leakage for new duct systems or 15 percent leakage for altered existing systems. It does NOT meet the meet or exceed the prescriptive requirements of the Standards. However, all accessible ducts were sealed.~~

~~Signed: ____________________~~

~~Print name: ______________________~~

~~Print Company Name: _____________________~~

~~Print Contractor License No: __________________~~

~~Print Contractor Phone No: ___________________~~

~~Do not remove sticker"~~

~~Definitions~~

~~aerosol sealant closure system: A method of sealing leaks by blowing aerosolized sealant particles into the duct system which must include minute by minute documentation of the sealing process.~~

~~buffer space: an unconditioned or indirectly conditioned space located between a ceiling and the roof.~~

~~delivery effectiveness: The ratio of the thermal energy delivered to the conditioned space and the thermal energy entering the distribution system at the equipment heat exchanger.~~

~~distribution system efficiency: The ratio of the thermal energy consumed by the equipment with the distribution system to the energy consumed if the distribution system had no losses or impact on the equipment or building loads.~~

~~equipment efficiency: The ratio between the thermal energy entering the distribution system at the equipment heat exchanger and the energy being consumed by the equipment.~~

~~equipment factor: Fequip is the ratio of the equipment efficiency including the effects of the distribution system to the equipment efficiency of the equipment in isolation.~~

~~fan flowmeter device: A device used to measure air flow rates under a range of test pressure differences.~~

~~flow capture hood: A device used to capture and measure the airflow at a register.~~

~~load factor: Fload is the ratio of the building energy load without including distribution effects to the load including distribution system effects.~~

~~pressure pan: a device used to seal individual forced air system registers and to measure the static pressure from the register.~~

~~recovery factor: Frecov is the fraction of energy lost from the distribution system that enters the conditioned space.~~

~~thermal regain: The fraction of delivery system losses that are returned to the building.~~

Nonresidential Appendix NA3

Appendix NA3 – Fan Motor Efficiencies

Table NA3-1 – Fan Motor Efficiencies (< 1 HP)

Nameplate or Brake Horsepower	Standard Fan Motor Efficiency	NEMA* High Efficiency	Premium Efficiency
1/20	40%	...	...
1/12	49%	...	...
1/8	55%	...	...
1/6	60%	...	...
1/4	64%	...	...
1/3	66%	...	...
1/2	70%	76.0%	80.0%
3/4	72%	77.0%	84.0%
NOTE: For default drive efficiencies, see NONRESIDENTIAL ACM Manual Table N2-17.			
*NEMA - Proposed standard using test procedures.			
Minimum NEMA efficiency per test IEEE 112b Rating Method.			

Table NA3-2 – Fan Motor Efficiencies (1 HP and over)

	Open Motors				Enclosed Motors			
Motor Horsepower	2 pole 3600 rpm	4 pole 1800 rpm	6 pole 1200 rpm	8 pole 900 rpm	2 pole 3600 rpm	4 pole 1800 rpm	6 pole 1200 rpm	8 pole 900 rpm
1	77.0 ~~—~~	85.5 ~~82.5~~	82.5 ~~80.0~~	74.0 ~~74.0~~	77.0 ~~75.5~~	85.5 ~~82.5~~	82.5 ~~80.0~~	74.0 ~~74.0~~
1.5	84.0 ~~82.5~~	86.5 ~~84.0~~	86.5 ~~84.0~~	75.5 ~~75.5~~	84.0 ~~82.5~~	86.5 ~~84.0~~	87.5 ~~85.5~~	77.0 ~~77.0~~
2	85.5 ~~84.0~~	86.5 ~~84.0~~	87.5 ~~85.5~~	85.5 ~~85.5~~	85.5 ~~84.0~~	86.5 ~~84.0~~	88.5 ~~86.5~~	82.5 ~~82.5~~
3	85.5 ~~84.0~~	89.5 ~~86.5~~	88.5 ~~86.5~~	86.5 ~~86.5~~	86.5 ~~85.5~~	89.5 ~~87.5~~	89.5 ~~87.5~~	84.0 ~~84.0~~
5	86.5 ~~85.5~~	89.5 ~~87.5~~	89.5 ~~87.5~~	87.5 ~~87.5~~	88.5 ~~87.5~~	89.5 ~~87.5~~	89.5 ~~87.5~~	85.5 ~~85.5~~
7.5	88.5 ~~87.5~~	91.0 ~~88.5~~	90.2 ~~88.5~~	88.5 ~~88.5~~	89.5 ~~88.5~~	91.7 ~~89.5~~	91.0 ~~89.5~~	85.5 ~~85.5~~
10	89.5 ~~88.5~~	91.7 ~~89.5~~	91.7 ~~90.2~~	89.5 ~~89.5~~	90.2 ~~89.5~~	91.7 ~~89.5~~	91.0 ~~89.5~~	88.5 ~~88.5~~
15	90.2 ~~89.5~~	93.0 ~~91.0~~	91.7 ~~92.0~~	89.5 ~~89.5~~	91.0 ~~90.2~~	92.4 ~~91.0~~	91.7 ~~90.2~~	88.5 ~~88.5~~
20	91.0 ~~90.2~~	93.0 ~~91.0~~	92.4 ~~91.0~~	90.2 ~~90.2~~	91.0 ~~90.2~~	93.0 ~~91.0~~	91.7 ~~90.2~~	89.5 ~~89.5~~
25	91.7 ~~91.0~~	93.6 ~~91.7~~	93.0 ~~91.7~~	90.2 ~~90.2~~	91.7 ~~91.0~~	93.6 ~~92.4~~	93.0 ~~91.7~~	89.5 ~~89.5~~
30	91.7 ~~91.0~~	94.1 ~~92.4~~	93.6 ~~92.4~~	91.0 ~~91.0~~	91.7 ~~91.0~~	93.6 ~~92.4~~	93.0 ~~91.7~~	91.0 ~~91.0~~
40	92.4 ~~91.7~~	94.1 ~~93.0~~	94.1 ~~93.0~~	91.0 ~~91.0~~	92.4 ~~91.7~~	94.1 ~~93.0~~	94.1 ~~93.0~~	91.0 ~~91.0~~
50	93.0 ~~92.4~~	94.5 ~~93.0~~	94.1 ~~93.0~~	91.7 ~~91.7~~	93.0 ~~92.4~~	94.5 ~~93.0~~	94.1 ~~93.0~~	91.7 ~~91.7~~
60	93.6 ~~93.0~~	95.0 ~~93.6~~	94.5 ~~93.6~~	92.4 ~~92.4~~	93.6 ~~93.0~~	95.0 ~~93.6~~	94.5 ~~93.6~~	91.7 ~~91.7~~
75	93.6 ~~93.0~~	95.0 ~~94.1~~	94.5 ~~93.6~~	93.6 ~~93.6~~	93.6 ~~93.0~~	95.4 ~~94.1~~	94.5 ~~93.6~~	93.0 ~~93.0~~
100	93.6 ~~93.0~~	95.4 ~~94.1~~	95.0 ~~94.1~~	93.6 ~~93.6~~	94.1 ~~93.6~~	95.4 ~~94.5~~	95.0 ~~94.1~~	93.0 ~~93.0~~
125	94.1 ~~93.6~~	95.4 ~~94.5~~	95.0 ~~94.1~~	93.6 ~~93.6~~	95.0 ~~94.5~~	95.4 ~~94.5~~	95.0 ~~94.1~~	93.6 ~~93.6~~
150	94.1 ~~93.6~~	95.8 ~~95.0~~	95.4 ~~94.5~~	93.6 ~~93.6~~	95.0 ~~94.5~~	95.8 ~~95.0~~	95.8 ~~95.0~~	93.6 ~~93.6~~
200	95.0 ~~94.5~~	95.8 ~~95.0~~	95.4 ~~94.5~~	93.6 ~~93.6~~	95.4 ~~95.0~~	96.2 ~~95.0~~	95.8 ~~95.0~~	94.1 ~~94.1~~
250	95.0 ~~94.5~~	95.8 ~~95.0~~	95.4 ~~95.4~~	94.5 ~~94.5~~	95.8 ~~95.4~~	96.2 ~~95.0~~	95.8 ~~95.0~~	94.5 ~~94.5~~
300	95.4 ~~95.0~~	95.8 ~~95.4~~	95.4 ~~95.4~~	—	95.8 ~~95.4~~	96.2 ~~95.4~~	95.8 ~~95.0~~	—
350	95.4 ~~95.0~~	95.8 ~~95.4~~	95.4 ~~95.4~~	—	95.8 ~~95.4~~	96.2 ~~95.4~~	95.8 ~~95.0~~	—
400	95.8 ~~95.4~~	95.8 ~~95.4~~	95.8 ~~—~~	—	95.8 ~~95.4~~	96.2 ~~95.4~~	95.8 ~~—~~	—
450	95.8 ~~95.8~~	96.2 ~~95.8~~	96.2 ~~—~~	—	95.8 ~~95.4~~	96.2 ~~95.4~~	95.8 ~~—~~	—
500	95.8 ~~95.8~~	96.2 ~~95.8~~	96.2 ~~—~~	—	95.8 ~~95.4~~	96.2 ~~95.8~~	95.8 ~~—~~	—

Nonresidential Appendix NA4

Appendix NA4 – Compliance Procedures for Relocatable Public School Buildings

NA4.1 Purpose and Scope

This document describes the compliance procedures that shall be followed when the whole building performance approach is used for relocatable public school buildings. Relocatable public school buildings are constructed (manufactured) at a central location and could be shipped and installed in any California climate zone. Furthermore, once they arrive at the school site, they could be positioned so that the windows face in any direction. The portable nature of relocatable classrooms requires that a special procedure be followed for showing compliance when the whole building performance method is used. Compliance documentation for relocatable public school buildings will be reviewed by the Division of the State Architect (DSA).

NA4.2 The Plan Check Process

The Division of the State Architect is the enforcement agency for relocatable public school buildings. Since relocatables are manufactured in batches, like cars or other manufactured products, the plan check and approval process occurs in two phases. The first phase is when the relocatable manufacturer completes design of a model or modifies a model. At this point, complete plans and specifications are submitted to the DSA; DSA reviews the plans for compliance with the energy standards and other California Building Code (CBC) requirements; and a "pre-check" (PC) design approval is granted. Once the PC design is approved, a school district or the manufacturer may file an "over-the-counter" application with DSA to construct one or more relocatables. The over-the-counter application is intended to be reviewed quickly, since the PC design has already been pre-checked. The over-the-counter application is the building permit application for construction and installation of a relocatable at a specific site, and includes the approved PC design drawings as well as site development plans for the proposed site where the relocatable will be installed. An over-the-counter application also is required for the construction of a stockpile of one or more relocatables based on the approved PC design drawings. Stockpiled relocatables are stored typically at the manufacturer's yard until the actual school site is determined where the relocatable will be installed. Another over-the-counter application is required to install a previously stockpiled relocatable at which time site development plans for the proposed site are checked.

The effective date for all buildings subject to the energy standards is the date of permit application. If a building permit application is submitted on or after the effective date, then the new energy standards apply. For relocatable classrooms, the date of the permit application is the date of the over-the-counter application, not the date of the application for PC design approval. The PC design is only valid until the code changes.

NA4.3 The Compliance Process

Like other nonresidential buildings, the standard design for relocatable public school buildings is defined by the prescriptive requirements. In the case of relocatables, there are two choices of prescriptive criteria:

- Table 143-C in the Standards may be used for relocatable school buildings that can be installed in any climate zone in the state. In this case, the compliance is demonstrated in climates 14, 15, and 16 and this is accepted as evidence that the classroom will comply in all climate zones. These relocatables will have a permanent label that allows it to be used anywhere in the state.
- Table 143-A in the Standards may be used for relocatable school buildings that are to be installed in only specific climate zones. In this case, compliance is demonstrated in each climate zone for which the

relocatable has been designed to comply. These relocatables will have a permanent label that identifies in which climate zones it may be installed. It is not lawful to install the relocatable in other climate zones.

The building envelope of the standard design has the same geometry as the proposed design, including window area and position of windows on the exterior walls, and meets the prescriptive requirements specified in §143. Lighting power for the standard design meets the prescriptive requirements specified in §146. The HVAC system for the standard design meets the prescriptive requirements specified in §144. The system typically installed in relocatables is a single-zone packaged heat pump or furnace. Most relocatable school buildings do not have water heating systems, so this component is neutral in the analysis. Other modeling assumptions such as equipment loads are the same for both the proposed design and the standard design and are specified in the Nonresidential ACM Manual.

Manufacturers shall certify compliance with the standards and all compliance documentation shall be provided. If the manufacturer chooses to comply using Table 143-A in the Standards for compliance in only specific climate zones, then the manufacturers shall indicate the climates zones for which the classroom will be allowed to be located.

Since relocatable public school buildings could be positioned in any orientation, it is necessary to perform compliance calculations for multiple orientations. Each model with the same proposed design energy features shall be rotated through ~~12~~ 8 different orientations either in climate zones 14, 15 and 16 for relocatables showing statewide compliance or in the specific climate zones that the manufacturer proposes for the relocatable to be allowed to be installed, i.e., the building with the same proposed design energy features is rotated in 30 degree increments and shall comply in each case. Approved compliance programs shall automate the rotation of the building and reporting of the compliance results to insure it is done correctly and uniformly and to avoid unnecessary documentation.

NA4.4 Documentation

The program shall present the results of the compliance calculations in a format similar to Table NA4-3. For each of the cases (~~12~~ 8orientations times number of climates), the Time Dependent Valuation (TDV) energy for the *Standard Design* and the *Proposed Design* are shown (the energy features of the *Proposed Design* shall be the same for all orientations). The final column shows the compliance margin, which is the difference between the TDV energy for the *Proposed Design* and the *Standard Design*. Approved compliance programs shall scan the data presented in the Table NA4-3 format and prominently highlight the case that has the smallest compliance margin. Complete compliance documentation shall be submitted for the building and energy features that achieve compliance in all of the climate zones and orientations as represented by the case with the smallest margin. DSA may require that compliance documentation for other cases also be submitted; showing that the *Proposed Design* building and energy features are identical to the case submitted, in each orientation and climate zone. Table NA4-3 shows rows for climate zones 14, 15, and 16, which are the ones used when the criteria of Table 143-C in the Standards is used to show compliance throughout the state. If the criteria of Table 143-A in the Standards is used, then rows shall be added to the table for each climate zone for which the manufacturer wants the relocatable to be allowed to be installed.

Table NA4-3 – Summary of Compliance Calculations Needed for Relocatable Classrooms

			TDV Energy	
Climate Zone	Azimuth	Proposed Design	Standard Design	Compliance Margin
14	30			
	75			
	120			
	165			
	210			
	255			
	300			
	345			
15	30			
	75			
	120			
	165			
	210			
	255			
	300			
	345			
16	30			
	75			
	120			
	165			
	210			
	255			
	300			
	345			

NA4.5 Optional Features

Relocatable classrooms may come with a variety of optional features, like cars. A school district can buy the “basic model” or it can pay for options. Many of the optional features do not affect energy efficiency and are not significant from the perspective of energy code compliance. Examples include floor finishes (various grades of carpet or tiles), casework, and ceiling and wall finishes. Other optional features do affect energy performance such as window construction, insulation, lighting systems, lighting controls, HVAC ductwork, HVAC equipment, and HVAC controls.

When a manufacturer offers a relocatable classroom model with a variety of options, it is necessary to identify those options that affect energy performance and to show that the model complies with any combination of the optional features. Most of the time, optional energy features are upgrades that clearly improve performance. If the basic model complies with the Standards, then adding any or all of the optional features would improve performance. The following are examples of optional features that are clear upgrades in terms of energy performance:

- HVAC equipment that has both a higher SEER and higher EER than the equipment in the basic model.

- Lighting systems that result in less power than the basic model.
- Lighting controls, such as occupancy sensors, that are recognized by the standards and for which power adjustment factors in Table 146-C are published in §146.
- Windows that have both a lower SHGC and lower U-factor (limited to relocatables that do not take credit for daylighting).
- Wall, roof or floor construction options that result in a lower U-factor than the basic model.

For energy code compliance purposes, it is necessary to show that every variation of the relocatable classroom that is offered to customers will comply with the Standards. There are two approaches for achieving this, as defined below:

1) Basic Model Plus Energy Upgrades Approach. The simplest approach is to show that the basic model complies with the Standards and that all of the options that are offered to customers are clear energy upgrades that would only improve performance. As long as each and every measure in the basic model is met or exceeded by the energy upgrades, the relocatable classroom will comply with the Standards.

While clear upgrades are obvious in most cases, the following are some examples of options that are not energy upgrades, for which additional analysis would be needed to show compliance that every combination of options comply.

- HVAC equipment that has a higher SEER, but a lower EER.
- Windows that lower SHGC but increase U-factor, or vice versa.
- Insulation options that reduce the U-factor for say walls, but increase it for the roof.
- Any other combination of measures that results in the performance of anyone measure being reduced in comparison to a complying basic model.

2) Modeling of Every Combination Approach. A more complex whole building performance approach is required when a model is available with options which in combination may or may not comply. In this case every combination of options shall be modeled, and the specific combinations that comply shall be determined and only those combinations shall be allowed. This approach, while possible, requires considerably more effort on the part of the relocatable manufacturer and its energy consultant. It also places a greater burden on DSA when they issue the over-the-counter building permit for the PC design that only allows specific combinations of energy options. DSA would have to examine the specific optional features that are proposed with the over-the-counter application and make sure that the proposed combination of measures achieves compliance.

The manufacturer or its energy consultant would need to prepare a table or chart that shows all of the acceptable combinations that achieve compliance. This chart could be quite complex, depending on the number of optional features that are offered.

Table NA4-4 is intended to illustrate the complexity that could be involved in modeling of every combination of energy features. It shows a list of typical optional features that would affect energy performance. In this example, there are two possible for each of the eight options, e.g. the feature is either there or not (in an actual case there could be a different number of options and a different number of states for any option). In the example any one of the features could be combined with any of the others. The number of possible combinations in this example is two (the number of states) to the eighth power (the number of measures that have two states). The number of possible options is then 2^8 or 256. This is the number of combinations that would need to be modeled in order to determine which combination of optional features achieves compliance.

Table NA4-4 – Examples of Optional Features for Relocatable Classrooms

	Options Offered	States
1	Efficient lighting option	Yes/No
2	High efficiency heat pump	Yes/No
3	Improved wall insulation	Yes/No
4	Improved roof insulation	Yes/No
5	Occupancy sensor for lighting	Yes/No
6	Low-e windows	Yes/No
7	Skylights	Yes/No
8	Daylighting Controls	Yes/No

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~~– Overall Envelope TDV Energy Approach (Envelope Tradeoff Procedure)~~

~~NA5.1 Scope~~

~~This reference appendix describes the calculations that shall be used for making building envelope tradeoffs which are referenced in §143(b). The methodology in this reference appendix yields estimates of TDV energy for both the standard design and the proposed design building envelope. Compliance is achieved with §143(b) when the total TDV energy of the proposed design is no greater than the TDV energy of the standard design, as determined by the methods described in this appendix. In making the calculations, it shall be assumed that the orientation and area of each envelope component of the standard design are the same as in the proposed design. In most cases, the window area and skylight area of the standard design shall be the same as the proposed design, however, in some instances, the window and/or skylight area of the standard design may be reduced to limits established by the prescriptive standards. This is addressed in more detail below.~~

~~The requirements of §143(c) may not be traded off through this procedure.~~

~~NA5.2 TDV Energy of the Standard Design~~

~~Equation NA5-1 shall be used to calculate the TDV energy of the standard design. Values for wall, floor, roof, door and glazing U-factors shall be taken from the prescriptive requirements for the relevant climate zone and occupancy from the Standards Table 143-A, Table 143-B or Table 143-C as appropriate. Values for window solar heat gain coefficients shall be taken from the prescriptive relative solar heat gain requirement from the Standards Table 143-A, Table 143-B or Table 143-C as appropriate. For roof replacements that trigger insulation upgrades and cool roof requirements, the criteria are specified in §149. The value for visible transmittance (VT) of each window component shall be 1.2 times the solar heat gain coefficient (SHGC) of the window.~~

~~Equation NA5-1~~

$$TDV_{std} = \sum_{i=1}^{nW} c_{Wu,i} \times \left(A_{W,i}^{Std} \times U_{W,i}^{Std}\right) + \sum_{i=1}^{nG} A_{G,i}^{Std} \times \left[\left(c_{Gu,i} \times U_{G,i}^{Std}\right) + \left(c_{Gs,i} \times SHGC_{G,i}^{Std}\right) + \left(c_{Gt,i} \times VT_{G,i}^{Std}\right)\right]$$
$$+ \sum_{i=1}^{nR} c_{Ru,i} \times \left(A_{R,i}^{Std} \times U_{R,i}^{Std}\right) + \sum_{i=1}^{nS} A_{S,i}^{Std} \times \left[\left(c_{Su,i} \times U_{S,i}^{Std}\right) + \left(c_{Ss,i} \times SHGC_{S,i}^{Std}\right) + \left(c_{St,i} \times VT_{S,i}^{Std}\right)\right]$$
$$+ \sum_{i=1}^{nF} c_{Fu,i} \times \left(A_{F,i} \times U_{F,i}^{Std}\right) + \sum_{i=1}^{nD} c_{Du,i} \times \left(A_{D,i} \times U_{D,i}^{Std}\right)$$

Where:

TDV_{std}	=	TDV energy of the standard design, for space cooling and heating only
W, F, R, G, S, D	=	Index for the building envelope component type (wall, floor, roof, glazing/window, skylight, and door, respectively)
i	=	Index representing each unique combination of occupancy type (nonresidential, 24-hour, and retail); orientation (applicable only for walls, doors and windows); and coefficient category. For roofs, the categories are attic, light (HC<7) and mass (HC>=7). For floors the categories are light and mass. For walls, the categories are light, medium mass (7≤HC<15) and heavy mass (HC≥15).
nW, nF, nR, nG, nS, nD	=	Number of components of the applicable envelope feature of the standard design (wall, floor, roof, glazing/window, skylight, door)
$A^{Std}_{W,i}, A_{F,i}, A^{Std}_{R,i}$ / $A^{Std}_{G,i}, A^{Std}_{S,i}, A_{D,i}$	=	Exterior surface area of each building envelope component (in ft²). The index "i" shall indicate each unique combination of construction class and orientation (when appropriate). The window and skylight areas in the standard design may be smaller than the proposed design when adjustments are necessary. When window and/or skylight area is reduced, the area of the parent wall/roof is increased so that the gross area of wall/roof for the standard design is the same as the proposed design.
$U^{Std}_{W,i}, U^{Std}_{F,i}, U^{Std}_{R,i}$ / $U^{Std}_{G,i}, U^{Std}_{S,i}, U^{Std}_{D,i}$	=	The standard design U-factor in Btu/hr- ft²-°F for the wall , floor, roof, window, skylight and door from the Standards TABLE 143-A, TABLE 143-B or TABLE 143-C as appropriate. When the prescriptive requirements varies with class of construction or orientation, the class of construction or orientation used to determine the criteria shall be the same as the proposed design.
$SHGC^{Std}_{G,i}, SHGC^{Std}_{S,i}$	=	The relative solar heat gain coefficient for windows and skylights from the Standards TABLE 143-A, TABLE 143-B or TABLE 143-C, as applicable.
$VT^{Std}_{G,i}, VT^{Std}_{S,i}$	=	The visible transmittance for the corresponding A_G and A_S. The VT for the standard design shall be calculated as 1.2 times the standard design SHGC.
$c_{Wu,i}$, $c_{Fu,i}$, $c_{Ru,i}$, $c_{Gu,i}$, $c_{Su,i}$	=	U-factor coefficients for the wall, floor, roof, windows, skylights and doors, respectively. The index "i" represents a unique combination of occupancy, orientation, and coefficient type. The coefficient type is determined based on Table NA5-1.
$c_{Gs,i}$, $c_{Ss,i}$	=	Solar heat gain coefficients for the windows and skylights, respectively. The coefficient "i" is a unique combination of occupancy type and orientation.
$c_{Gt,i}$, $c_{St,i}$	=	Visible transmission coefficients for the windows and skylights, respectively. The coefficient "i" is a unique combination of occupancy type and orientation.

Table NA5-1 – Coefficient Categories to Use with Construction Types

Table from Reference Joint Appendix JA4 where Proposed Design is Selected	Coefficient Category
Table 4.2.1 – U-factors of Wood Framed Attic Roofs	Roof, Attic
Table 4.2.2 – U-factors of Wood Framed Rafter Roofs	Roof, Light
Table 4.2.3 – U-factors of Structurally Insulated Panels (SIPS) Roof/Ceilings	Roof, Light
Table 4.2.4 – U-factors of Metal Framed Attic Roofs	Roof, Attic
Table 4.2.5 – U-factors of Metal Framed Rafter Roofs	Roof, Light
Table 4.2.6 – U-factors for Span Deck and Concrete Roofs	Roof, Mass
Table 4.2.7 – U-factors for Metal Building Roofs	Roof, Light
Table 4.2.8 – U-factors for Insulated Ceiling with Removable Panels	Roof, Light
Table 4.2.9 – U-factors for Insulated Metal Panel Roofs and Ceilings (Metal SIPS)	Roof, Light
Table 4.3.1 – U-factors of Wood Framed Walls	Wall, Light
Table 4.3.2 – U-factors of Structurally Insulated Wall Panels (SIPS)	Wall, Light
Table 4.3.3 – U-factors of Metal Framed Walls for Nonresidential Construction	Wall, Light
Table 4.3.4 – U-factors for Metal Framed Walls for Low - Rise Residential Construction	Wall, Light
Table 4.3.5 – Properties of Hollow Unit Masonry Walls	Either wall, light; medium; or heavy depending on HC of selected assembly
Table 4.3.6 – Properties of Solid Unit Masonry and Solid Concrete Walls	
Table 4.3.7 – Properties of Concrete Sandwich Panels	
Table 4.3.11 – Thermal Properties of Log Home Walls	
Table 4.3.8 – U-factors for Spandrel Panels and Glass Curtain Walls	Wall, Light
Table 4.3. 9– U-factors for Metal Building Walls	Wall, Light
Table 4.3.10 – U-factors for Insulated Metal Panel Walls (Metal SIPS)	Wall, Light
Table 4.3.12 – Thermal and Mass Properties of Straw Bale Walls	Wall, Light
Table 4.4.1 – Standard U-factors for Wood-Framed Floors with a Crawl Space	Floor, Light
Table 4.4.2 – Standard U-factors for Wood Framed Floors without a Crawl Space	Floor, Mass
Table 4.4.3 – Standard U-factors for Wood Foam Panel (SIP) Floors	Floor, Light
Table 4.4.4 – Standard U-factors for Metal-Framed Floors with a Crawl Space	Floor, Light
Table 4.4.5 – Standard U-factors for Metal-Framed Floors without a Crawl Space	Floor, Light
Table 4.4.6 – Standard U-factors for Concrete Raised Floors	Floor, Mass
Table 4.5.1 – Opaque Doors	Wall, Light

NA5.2.1 Window Area Limits for the Standard Design

The gross wall area of the standard design is the same as the corresponding component of the proposed design. However, it may be necessary to reduce the window area of the standard design and increase the opaque wall area of the standard design when the window-wall-ratio of the proposed design (WWR_{prop}) is more than the prescriptive limit. This is accomplished by the following procedures:

NA5.2.1.1 Adjust Total Window Area

Step 1 Calculate the maximum allowed total window area ($A_{WndwTotal,sd}$) for the standard design. This is the greater of 6 ft times the display perimeter or 40 percent of the gross wall area.

Step 2 Calculate the maximum allowed window-wall-ratio ($WWR_{Total,sd}$) for the standard design by dividing the maximum allowed window area ($A_{WndwTotal,sd}$) determined in the previous step by the gross wall exterior area.

Step 3 Calculate the proposed window-wall-ratio ($WWR_{Total, pd}$) by dividing the proposed total window area by the gross exterior wall area.

Step 4 If $WWR_{Total,pd}$ is less than or equal to $WWR_{Total,sd}$, then set the window area of the standard design equal to the window area of the proposed design. If $WWR_{Total,pd}$ is greater than $WWR_{Total, sd}$, then the area of each window in the standard design shall be reduced from the proposed design by multiplying each window area by the ratio of $WWR_{Total,sd}$ / $WWR_{Total,pd}$.

NA5.2.1.2 Adjust West Window Area

After adjusting the total window area (if necessary), a separate test shall be made for the west facing windows.

Step 1 Calculate the maximum allowed window area ($A_{WndwWest,sd}$) for the standard design on the west facades. This is the greater of 6 ft times the display perimeter of the west facades or 40 percent of the west-facing gross wall area.

Step 2 Calculate the maximum allowed window-wall-ratio ($WWR_{West,sd}$) for the standard design on the west façade by dividing the maximum allowed window area ($A_{West,sd}$) determined in the previous step by the west facing gross exterior wall area.

Step 3 Calculate the proposed adjusted window-wall-ratio ($WWR_{West, pd}$) by dividing the standard design west facing window area determined in the total window area adjustments by the west-facing gross exterior wall area.

Step 4 If $WWR_{West,pd}$ is less than or equal to $WWR_{West,sd}$, then no additional adjustments are made to west facing windows. If $WWR_{West,pd}$ is greater than $WWR_{West, sd}$, then the area of each west facing window in the standard design shall be further reduced by multiplying each west facing adjusted window area by the ratio of $WWR_{West,sd}$ / $WWR_{West,pd}$.

NA5.2.2 Skylight Area Limits for the Standard Design

The gross roof area of the standard design is the same as the proposed design. However, it may be necessary to reduce the skylight area of the standard design and increase the opaque roof area of the standard design when the skylight-roof-ratio of the proposed design (SRR_{prop}) is more than the prescriptive maximum allowed. This is accomplished by the following procedure:

Step 1 Calculate the maximum allowed skylight area ($A_{Skyl,sd}$) for the standard design. This is the sum of 10 percent of the roof area over atria and 5 percent of other roof areas.

Step 2 Calculate the maximum allowed skylight-roof-ratio (SRR_{sd}) for the standard design by dividing the maximum allowed skylight area ($A_{Skyl,sd}$) determined in the previous step by the gross exterior roof area.

Step 3 Calculate the proposed skylight-roof-ratio (SRR_{pd}) by dividing the proposed design skylight area by the gross exterior roof area.

Step 4 If SSR_{pd} is less than or equal to SSR_{sd}, then no adjustments are made to skylight area of the standard design. If SSR_{pd} is greater than SSR_{sd}, then the area of each skylight in the standard design shall be reduced by multiplying the area of each skylight by ratio of SRR_{sd} / SRR_{pd}.

NA5.3 TDV Energy of the Proposed Design

Equation NA5-2 shall be used to calculate the TDV energy of the proposed design. The proposed design equation includes two multipliers for cool roofs and overhangs that are explained in subsequent sections.

Equation NA5-2

$$TDV_{prop} = \sum_{i=1}^{nW} c_{Wu,i} \times \left(A_{W,i} \times U_{W,i}^{Prop}\right) + \sum_{i=1}^{nG} A_{G,i} \times \left[\left(c_{Gu,i} \times U_{G,i}^{Prop}\right) + \left(c_{Gs,i} \times SHGC_{G,i}^{Prop} \times M_{OH,i}\right) + \left(c_{Gt,i} \times VT_{G,i}^{Prop}\right)\right]$$

$$+ \sum_{i=1}^{nR} c_{Ru,i} \times \left(A_{R,i} \times U_{W,i}^{Prop} \times M_{CR,i}\right) + \sum_{i=1}^{nS} A_{S,i} \times \left[\left(c_{Su,i} \times U_{S,i}^{Prop}\right) + \left(c_{Ss}, i \times SHGC_{S,i}^{Prop}\right) + \left(c_{St}, i \times VT_{S,i}^{Prop}\right)\right]$$

$$+ \sum_{i=1}^{nF} c_{Fu,i} \times \left(A_{F,i} \times U_{W,i}^{Prop}\right) + \sum_{i=1}^{nD} c_{W} \times \left(A_{D,i} \times U_{D,i}^{Prop}\right)$$

Where:

TDVprop	=	TDV energy of the proposed design, for space cooling and heating only.
W,F,R,G,S,D	=	Index for the building envelope component type (wall, floor, roof, window, skylight, door)
i	=	Index for each unique occupancy type, orientation, and coefficient category.
nW, nF, nR, nG, nS, nD	=	Number of components of the applicable envelope feature of the proposed design (wall, floor, roof, window, skylight, door).
$A_{W,i}, A_{F,i}, A_{R,i}$ $A_{G,i}, A_{S,i}, A_{D,i}$	=	Exterior surface area of each building envelope component (in ft²) of the proposed building. The index "i" shall indicate each unique combination of construction class and orientation (when appropriate).
$U_{W,i}^{Prop}, U_{F,i}^{Prop}, U_{R,i}^{Prop}$ $U_{G,i}^{Prop}, U_{S,i}^{Prop}, U_{D,i}^{Prop}$	=	The proposed design U-factor in Btu/h- ft²-°F for the wall , floor, roof, window, skylight and door component indicated by index i.
$SHGC_{G,i}^{Prop}, SHGC_{S,i}^{Prop}$	=	The solar heat gain coefficient of windows and skylights based on NFRC certified ratings or CEC defaults.
$VT_{G,i}^{Prop}, VT_{S,i}^{Prop}$	=	The window visible transmittance of windows and skylights from NFRC optic data or 1.2 times CEC defaults for SHGC.
$SHGC_{G,i}^{Prop}$	=	The solar heat gain coefficient for the window of the proposed building corresponding to index i. Note that overhangs are treated by the overhang multiplier, $M_{OH,i}$.
$SHGC_{S,i}^{Prop}$	=	The skylight SHGC for the corresponding AS.
$VT_{G,i}^{Prop}$	=	The window visible transmittance for the corresponding A_G. The VT for the standard design shall be calculated as 1.2 x $SHGC_{G,std}$.
$VT_{S,i}^{Prop}$	=	The skylight visible transmittance for the corresponding AS. The VT for the standard design shall be calculated as 1.2 x $SHGC_{S,std}$.
$c_{Wu,i}$, $c_{Fu,i}$, $c_{Ru,i}$, $c_{Gu,i}$, $c_{Su,i}$	=	U-factor coefficient for the wall, floor, roof, windows, skylights and doors, respectively. Coefficients match those used in the standard design.
$c_{Gs,i}$, $c_{Ss,i}$	=	Solar heat gain weighting coefficients for the windows and skylights, respectively.
$c_{Gt,i}$, $c_{St,i}$	=	Visible transmittance coefficients for the windows and skylights, respectively.
$M_{CR,i}$	=	Cool roof multiplier, as defined below.
$M_{OH,i}$	=	Overhang multiplier as defined below.

NA5.3.1 Cool Roof Multiplier (MCR)

The cool roof multiplier is an adjustment to the roof component of TDV energy. It is calculated from the following equation:

Equation NA5-3

$$M_{CR,i} = 1 + c_{Ref} \times (\rho_{aged,prop} - \rho_{aged,std}) + c_{Emit} \times (\varepsilon_{prop} - \varepsilon_{std})$$

Where:

$M_{CR,i}$	=	A multiplier that accounts for differences between the prescriptive cool roof requirement and the reflectance and emittance of the proposed design.
C_{Ref}	=	Coefficient for the reflectance of the roof. This depends on occupancy type and climate zone. The coefficients are listed in Tables NA5-3, NA5-4, and NA5-5.
C_{Emit}	=	Coefficient for the emittance of the roof. This depends on occupancy type and climate zone. The coefficients are listed in Tables NA5-3, NA5-4, and NA5-5.
$\rho_{aged,prop}$	=	Proposed aged design reflectance of the roof outside surface. This data is from the three-year aged reflectance from CRRC. If aged reflectance is not available from CRRC, then an estimate of the aged reflectance shall be used based on the CRRC initial reflectance. Use the following equation to estimate the aged reflectance: $\rho_{aged,prop} = 0.7 \times (\rho_{init,prop} + 0.06)$ If neither initial nor aged reflectance data is available from CRRC for the proposed roof, then a default aged reflectance of 0.1 shall be used.
$\rho_{aged,std}$	=	Standard design aged solar reflectance, as required by the prescriptive requirements of §143(a) and summarized in Table NA5-2.
ε_{prop}	=	Proposed design thermal emittance of the roof outside surface from CRRC data. If CRRC data is not available, then a default value of 0.75 shall be used.
ε_{std}	=	Thermal emittance of the roof outside surface of the standard design, as defined in Table NA5-2

Table NA5-2 – Standard design values for solar reflectance and thermal emittance

	Aged Solar Reflectance	Thermal Emittance
Low-Rise, Low-Sloped, CZ2 through CZ15	0.55	0.75
Low-Rise, Low-Sloped, CZ1 and CZ16	0.1	0.75
High-Rise, Low Sloped, CZ10 through CZ15	0.55	0.75
High-Rise, Low Sloped, CZ1-9 and CZ16	0.1	0.75
Steep-sloped, CZ2 through CZ15	0.25	0.75
Steep-sloped, all other	0.1	0.75

NA5.3.2 Overhang Multiplier (M_{OH})

The solar gains component of window TDV energy is adjusted when overhangs provide shading. The size and configuration of the overhang is approximated by a projection factor (PF), which is defined below.

Equation NA5-4

$$M_{OH,i} = 1 + a_i \times PF_i + b_i \times PF_i^2$$

Where

a_i	=	First coefficient for the projection factor. Varies by orientation and climate
b_i	=	Second coefficient for the projection factor. Varies by orientation and climate.
PF_i	=	Projection Factor. $PF = \frac{H}{V}$.
H	=	Horizontal projection of the overhang from the surface of the window in feet, but no greater than V
V	=	Vertical distance from the window sill to the bottom of the overhang, in feet.

~~NA5.4 Coefficients~~

~~Table NA5-3 – Nonresidential Coefficients~~

Coefficient/CLZ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	271.87	242.47	195.46	175.15	192.00	111.38	90.07	111.94	124.22	153.72	225.65	212.82	195.34	247.84	193.39	346.76
c_F (mass)	265.55	190.18	176.41	130.67	161.91	94.94	72.35	77.35	77.35	109.94	183.94	161.28	157.65	203.10	131.40	296.44
a (east)	-0.90	-0.45	-2.33	-0.62	-0.61	-1.26	-0.73	-0.74	-0.68	-0.68	-0.51	-0.54	-0.59	-0.61	-0.67	0.33
b (east)	0.25	0.36	0.77	0.39	1.58	0.85	0.39	0.35	0.29	0.29	0.21	0.26	0.22	0.26	0.27	0.12
a (north)	-1.55	-0.06	1.61	-0.15	0.52	-0.17	-0.34	-0.31	-0.31	-0.31	-0.13	-0.14	-0.17	-0.19	-0.28	0.11
b (north)	0.70	0.04	-0.72	0.08	-0.18	0.09	0.17	0.15	0.15	0.15	0.07	0.08	0.09	0.10	0.13	-0.03
a (south)	-0.96	-1.14	-2.18	-1.31	-1.49	-0.84	6.68	-0.74	-0.94	-1.07	-1.04	-0.92	-1.07	-0.96	-0.77	-1.51
b (south)	0.20	0.91	7.87	0.95	1.49	0.71	-4.08	0.25	0.54	0.57	0.65	0.62	0.64	0.61	0.33	1.66
a (west)	-0.88	-0.70	-0.73	-0.91	0.12	-0.43	-0.80	-0.46	-0.72	-0.59	-0.70	-0.65	-0.65	-0.63	-0.44	-0.51
b (west)	0.15	0.48	1.51	0.54	1.91	0.22	0.35	0.12	0.27	0.20	0.22	0.21	0.24	0.24	0.03	0.31
c_R (attic)	218.71	267.29	191.99	215.08	181.95	140.70	132.27	163.28	175.64	217.56	270.93	258.22	246.21	300.35	256.90	345.32
c_R (light)	241.17	315.45	218.07	257.77	222.35	181.96	171.95	199.83	213.39	263.87	288.29	286.43	268.75	324.85	282.17	371.78
c_R (mass)	213.10	190.51	167.97	153.94	148.23	113.99	96.47	109.89	107.07	134.27	205.92	186.46	184.10	229.38	175.33	287.74
c_{Emit}	0.52	0.15	0.29	0.01	0.27	0.15	-0.10	-0.20	-0.27	-0.26	-0.11	-0.04	-0.17	-0.05	-0.61	0.10
c_{Ref}	0.95	-0.12	0.28	-0.54	0.20	-0.50	-1.24	-1.15	-1.13	-1.04	-0.67	-0.56	-0.84	-0.56	-1.38	-0.07
c_{Ss}	-511.67	289.49	32.51	562.51	91.92	-5.02	555.73	818.12	800.55	761.50	734.20	687.40	801.77	771.69	819.20	252.00
c_{St}	-51.54	-29.37	-39.75	12.83	-60.27	162.57	7.51	-40.07	11.11	-4.27	7.76	-2.23	-8.10	-10.96	214.91	-47.41
c_{Su}	166.28	117.60	105.42	64.12	92.03	117.35	31.65	21.47	42.05	67.76	122.26	110.92	86.08	115.49	111.68	207.95
c_W (heavy mass)	144.37	85.71	89.78	66.34	60.49	40.67	42.95	32.17	37.51	58.24	138.33	102.57	118.12	131.67	137.53	196.09
c_W (light)	170.52	215.98	160.68	182.30	162.30	125.38	122.18	155.91	171.92	217.44	253.22	227.71	232.08	269.21	284.47	300.86
c_W (medium mass)	158.57	111.64	108.56	89.88	79.05	55.77	44.86	54.81	63.88	90.76	164.42	133.55	146.34	165.76	163.64	220.44

~~*Table NA5-3 – Nonresidential Coefficients (Con't)*~~

Coefficient/CLZ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_{Gs} (east)	50.79	256.16	170.33	293.91	238.39	297.25	279.82	367.47	376.81	411.91	378.11	356.38	418.51	431.91	666.01	220.11
c_{Gt} (east)	-5.10	-18.76	2.55	-11.89	-1.11	7.68	5.40	-7.11	-6.51	-24.04	-10.30	-9.85	-16.06	-21.54	-28.86	-18.99
c_{Gu} (east)	27.93	30.86	16.35	15.65	12.73	0.00	1.81	5.25	11.32	20.26	43.74	31.60	30.33	48.65	40.08	69.96
c_{Gs} (north)	60.86	131.95	94.93	147.24	115.89	138.86	151.32	173.12	183.41	207.77	188.48	172.21	194.08	206.89	303.70	137.30
c_{Gt} (north)	-8.69	-12.18	-3.30	-6.61	-6.33	4.05	0.67	-2.47	-6.51	-22.40	-16.83	-14.82	-15.45	-14.30	-20.19	-28.12
c_{Gu} (north)	30.51	47.12	20.83	18.33	16.50	0.00	4.97	9.87	19.34	20.02	53.06	43.82	42.90	62.07	54.49	81.90
c_{Gs} (south)	69.67	312.07	203.98	313.44	319.53	319.30	-20.69	367.01	493.59	520.67	406.32	356.94	403.75	395.22	586.58	247.63
c_{Gt} (south)	-5.14	-23.27	6.31	-6.32	3.85	12.57	127.19	4.61	-8.79	-30.06	-12.54	-8.10	-19.63	-26.04	-33.07	-21.99
c_{Gu} (south)	32.54	44.30	26.07	28.81	23.64	1.72	60.43	32.56	18.35	24.03	57.44	48.62	45.22	56.49	32.84	81.45
c_{Gs} (west)	85.68	340.91	206.01	364.57	239.59	340.91	348.89	483.20	468.46	492.09	555.65	473.69	544.08	560.24	713.09	292.21
c_{Gt} (west)	-7.74	-18.68	8.34	-3.20	-3.62	9.81	1.89	-10.69	-11.13	-30.03	-57.41	-17.47	-27.51	-32.01	-30.12	-33.80
c_{Gu} (west)	29.06	41.19	20.45	20.48	13.65	0.00	2.92	4.01	16.78	19.85	50.45	40.90	39.45	59.06	51.41	81.01

~~Table NA5-4 – 24-Hour Coefficients~~

Coefficient/CLZ	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	271.87	242.47	195.46	175.15	192.00	111.38	90.07	111.94	124.22	153.72	225.65	212.82	195.34	247.84	193.39	346.76
c_F (mass)	265.55	190.18	176.41	130.67	161.91	94.94	72.35	77.35	77.35	109.94	183.94	161.28	157.65	203.10	131.40	296.44
a (east)	-0.90	-0.45	-2.33	-0.62	-0.61	-1.26	-0.73	-0.74	-0.68	-0.68	-0.51	-0.54	-0.59	-0.61	-0.67	0.33
b (east)	0.25	0.36	0.77	0.39	1.58	0.85	0.39	0.35	0.29	0.29	0.21	0.26	0.22	0.26	0.27	0.12
a (north)	-1.55	-0.06	1.61	-0.15	0.52	-0.17	-0.34	-0.31	-0.31	-0.31	-0.13	-0.14	-0.17	-0.19	-0.28	0.11
b (north)	0.70	0.04	-0.72	0.08	-0.18	0.09	0.17	0.15	0.15	0.15	0.07	0.08	0.09	0.10	0.13	-0.03
a (south)	-0.96	-1.14	-2.18	-1.31	-1.49	-0.84	6.68	-0.74	-0.94	-1.07	-1.04	-0.92	-1.07	-0.96	-0.77	-1.51
b (south)	0.20	0.91	7.87	0.95	1.49	0.71	-4.08	0.25	0.54	0.57	0.65	0.62	0.64	0.61	0.33	1.66
a (west)	-0.88	-0.70	-0.73	-0.91	0.12	-0.43	-0.80	-0.46	-0.72	-0.59	-0.70	-0.65	-0.65	-0.63	-0.44	-0.51
b (west)	0.15	0.48	1.51	0.54	1.91	0.22	0.35	0.12	0.27	0.20	0.22	0.21	0.24	0.24	0.03	0.31
c_R (attic)	218.71	267.29	191.99	215.08	181.95	140.70	132.27	163.28	175.64	217.56	270.93	258.22	246.21	300.35	256.90	345.32
c_R (light)	241.17	315.45	218.07	257.77	222.35	181.96	171.95	199.83	213.39	263.87	288.29	286.43	268.75	324.85	282.17	371.78
c_R (mass)	213.10	190.51	167.97	153.94	148.23	113.99	96.47	109.89	107.07	134.27	205.92	186.46	184.10	229.38	175.33	287.74
c_{Emit}	0.52	0.15	0.29	0.01	0.27	0.15	-0.10	-0.20	-0.27	-0.26	-0.11	-0.04	-0.17	-0.05	-0.61	0.10
c_{Ref}	0.95	-0.12	0.28	-0.54	0.20	-0.50	-1.24	-1.15	-1.13	-1.04	-0.67	-0.56	-0.84	-0.56	-1.38	-0.07
c_{Ss}	-511.67	289.49	32.51	562.51	91.92	-5.02	555.73	818.12	800.55	761.50	734.20	687.40	801.77	771.69	819.20	252.00
c_{St}	-51.54	-29.37	-39.75	12.83	-60.27	162.57	7.51	-40.07	11.11	-4.27	7.76	-2.23	-8.10	-10.96	214.91	-47.41
c_{Su}	166.28	117.60	105.42	64.12	92.03	117.35	31.65	21.47	42.05	67.76	122.26	110.92	86.08	115.49	111.68	207.95
c_W (heavy mass)	144.37	85.71	89.78	66.34	60.49	40.67	42.95	32.17	37.51	58.24	138.33	102.57	118.12	131.67	137.53	196.09
c_W (light)	170.52	215.98	160.68	182.30	162.30	125.38	122.18	155.91	171.92	217.44	253.22	227.71	232.08	269.21	284.47	300.86
c_W (medium mass)	158.57	111.64	108.56	89.88	79.05	55.77	44.86	54.81	63.88	90.76	164.42	133.55	146.34	165.76	163.64	220.44

~~*Table NA5-4 – 24-Hour Coefficients (Con't)*~~

~~Coefficient~~	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	~~12~~	~~13~~	~~14~~	~~15~~	~~16~~
~~c_{Gs} (east)~~	~~-220.04~~	~~106.38~~	~~-44.31~~	~~146.32~~	~~26.74~~	~~145.21~~	~~181.28~~	~~267.11~~	~~312.11~~	~~371.67~~	~~287.84~~	~~232.53~~	~~357.10~~	~~349.93~~	~~752.41~~	~~62.81~~
~~c_{Gt} (east)~~	~~-33.13~~	~~-23.20~~	~~-25.04~~	~~-17.18~~	~~-24.28~~	~~-9.63~~	~~-8.40~~	~~-17.30~~	~~-13.55~~	~~-32.71~~	~~-23.27~~	~~-21.58~~	~~-27.25~~	~~-34.44~~	~~-41.35~~	~~-38.95~~
~~c_{Gu} (east)~~	~~123.09~~	~~94.63~~	~~88.88~~	~~75.43~~	~~79.35~~	~~50.86~~	~~38.34~~	~~47.45~~	~~49.60~~	~~61.28~~	~~107.09~~	~~97.42~~	~~83.16~~	~~103.58~~	~~76.27~~	~~167.89~~
~~c_{Gs} (north)~~	~~-58.35~~	~~97.29~~	~~20.14~~	~~108.58~~	~~22.48~~	~~65.25~~	~~106.49~~	~~140.11~~	~~167.07~~	~~193.30~~	~~180.33~~	~~149.43~~	~~188.07~~	~~194.13~~	~~335.65~~	~~116.98~~
~~c_{Gt} (north)~~	~~-42.93~~	~~-38.97~~	~~-34.72~~	~~-26.94~~	~~-33.55~~	~~-17.04~~	~~-13.36~~	~~-19.23~~	~~-19.71~~	~~-26.90~~	~~-33.99~~	~~-32.02~~	~~-30.64~~	~~-38.94~~	~~-37.50~~	~~-52.47~~
~~c_{Gu} (north)~~	~~115.96~~	~~96.83~~	~~93.03~~	~~76.91~~	~~85.01~~	~~54.01~~	~~42.62~~	~~51.95~~	~~57.11~~	~~70.12~~	~~112.00~~	~~101.93~~	~~93.13~~	~~116.61~~	~~89.97~~	~~169.17~~
~~c_{Gs} (south)~~	~~-224.68~~	~~171.07~~	~~10.18~~	~~207.71~~	~~88.05~~	~~162.72~~	~~-21.62~~	~~264.42~~	~~526.65~~	~~436.65~~	~~351.29~~	~~323.50~~	~~362.71~~	~~381.46~~	~~871.10~~	~~94.34~~
~~c_{Gt} (south)~~	~~-26.79~~	~~-26.68~~	~~-31.56~~	~~-15.73~~	~~-34.75~~	~~-7.91~~	~~69.33~~	~~-7.61~~	~~-56.84~~	~~-34.25~~	~~-24.43~~	~~-47.00~~	~~1.76~~	~~-39.62~~	~~-62.58~~	~~-47.18~~
~~c_{Gu} (south)~~	~~116.16~~	~~98.97~~	~~84.66~~	~~74.36~~	~~72.95~~	~~43.88~~	~~60.50~~	~~70.26~~	~~33.01~~	~~57.95~~	~~115.89~~	~~102.94~~	~~110.86~~	~~105.67~~	~~72.92~~	~~169.10~~
~~c_{Gs} (west)~~	~~-218.97~~	~~201.76~~	~~23.54~~	~~242.73~~	~~9.66~~	~~165.34~~	~~258.32~~	~~359.99~~	~~424.09~~	~~461.66~~	~~403.63~~	~~379.28~~	~~514.35~~	~~541.92~~	~~1259.14~~	~~146.50~~
~~c_{Gt} (west)~~	~~-30.33~~	~~-39.35~~	~~-36.99~~	~~-22.89~~	~~-35.94~~	~~-30.52~~	~~-13.15~~	~~-20.92~~	~~-24.36~~	~~-43.40~~	~~-27.87~~	~~-34.29~~	~~-38.40~~	~~-48.38~~	~~-213.11~~	~~-57.34~~
~~c_{Gu} (west)~~	~~120.45~~	~~87.80~~	~~81.97~~	~~63.44~~	~~79.44~~	~~36.04~~	~~34.27~~	~~42.83~~	~~51.84~~	~~57.71~~	~~115.34~~	~~95.23~~	~~86.55~~	~~105.27~~	~~29.63~~	~~166.61~~

~~Table NA5-5 – Retail Coefficients~~

Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_F (light)	11.80	59.12	0.00	10.77	0.00	0.00	0.00	0.00	5.02	31.07	84.21	63.89	70.65	111.25	110.58	141.89
c_F (mass)	0.00	13.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.95	11.69	13.62	43.83	51.70	86.00
a (east)	0.26	-2.16	-1.45	-2.11	-1.93	-1.74	-2.05	-2.09	-2.04	-2.07	-1.85	-2.10	-2.08	-2.21	-1.92	-1.96
b (east)	-0.25	1.05	0.71	0.99	0.89	0.74	1.05	1.00	0.99	1.00	0.83	1.00	0.96	1.00	0.91	0.87
a (north)	-1.19	-0.80	-1.01	-0.85	-1.06	-1.18	-1.05	-0.99	-0.94	-0.80	-0.63	-0.71	-0.68	-0.61	-0.72	-0.55
b (north)	0.61	0.42	0.53	0.45	0.55	0.62	0.56	0.52	0.49	0.42	0.33	0.38	0.36	0.33	0.38	0.29
a (south)	-5.20	-2.36	-2.97	-2.89	-3.01	-6.24	-2.58	-3.41	-2.31	-2.29	-2.66	-2.82	-2.80	-2.68	-2.13	-2.93
b (south)	4.45	1.25	1.88	1.75	1.74	3.93	1.49	1.37	1.22	1.13	1.56	1.64	1.61	1.57	1.04	1.79
a (west)	-2.44	-1.99	-2.03	-2.43	-2.02	-2.08	-2.10	-2.04	-1.92	-1.83	-1.94	-1.92	-2.23	-1.84	-1.85	-1.92
b (west)	1.36	0.84	0.78	1.03	0.91	4.24	0.94	0.90	0.82	0.82	0.74	0.76	1.23	0.68	0.75	0.77
c_R (attic)	107.40	194.26	108.65	145.19	100.00	70.90	87.23	116.13	137.90	167.33	201.41	186.53	192.12	235.28	219.81	250.01
c_R (light)	97.08	183.93	95.29	136.06	97.49	68.50	85.56	105.29	128.79	163.37	186.48	174.28	184.93	220.37	222.20	232.47
c_R (mass)	79.98	88.20	51.61	55.17	34.46	22.46	25.96	34.02	34.53	62.04	118.96	100.45	108.40	135.66	114.01	179.76
c_{Emit}	-0.20	-0.57	-0.55	-0.74	-0.81	-1.59	-1.05	-1.33	-1.12	-1.02	-0.64	-0.61	-0.81	-0.72	-1.00	-0.30
c_{Ref}	-0.80	-1.68	-2.08	-2.38	-2.32	-4.76	-4.05	-4.05	-3.07	-2.77	-1.93	-1.96	-2.33	-2.01	-2.48	-1.12
c_{Ss}	213.31	800.49	636.93	918.22	614.03	742.37	833.45	946.54	1011.98	1091.94	1073.16	1030.57	1207.88	1220.95	1570.86	731.66
c_{St}	11.13	13.34	6.66	50.68	34.66	57.09	50.78	118.53	46.93	20.76	41.11	39.97	-6.88	20.47	35.88	3.72
c_{Su}	-2.74	-8.65	-45.50	-39.87	-43.21	-61.17	-53.11	-30.92	-48.37	-36.13	-6.87	-19.28	-14.98	3.50	-27.31	45.99
c_W (heavy mass)	52.21	58.17	24.77	32.82	7.66	5.65	5.26	20.84	28.92	49.67	105.90	78.83	93.48	107.52	137.00	145.05
c_W (light)	73.60	159.34	76.79	117.60	90.20	60.81	60.42	112.38	136.11	172.29	192.53	166.40	189.65	213.97	253.96	202.87
c_W (medium mass)	59.37	86.25	39.15	54.95	22.71	16.45	21.76	45.19	56.46	81.75	131.91	104.67	122.30	144.65	167.49	167.59
c_{Gs} (east)	7.14	112.23	52.93	114.81	87.55	91.43	100.54	133.72	150.73	172.34	169.07	149.60	176.99	183.08	270.91	96.01
c_{Gt} (east)	3.22	-0.19	7.84	3.51	6.03	8.54	5.94	4.58	2.69	-2.66	0.19	1.73	-0.96	-4.94	-2.97	-1.17
c_{Gu} (east)	-1.16	7.49	-2.34	0.54	-2.30	-9.12	-5.98	-3.18	-1.14	4.92	12.23	7.69	9.73	14.15	18.73	19.62

~~*Table NA5-5 – Retail Coefficients (Con't)*~~

Coefficient	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c_{Gs} (north)	18.27	56.92	32.76	56.77	38.01	48.14	53.60	64.88	70.31	93.08	74.60	68.90	78.51	83.72	123.50	55.37
c_{Gt} (north)	2.87	-1.81	3.72	2.86	4.00	5.95	4.58	3.11	2.09	-5.58	-1.79	-1.19	-2.06	-3.98	-5.01	-5.02
c_{Gu} (north)	-0.40	7.05	-3.92	0.20	-4.08	-10.79	-7.25	-4.60	-0.69	4.12	13.70	9.42	11.30	16.60	17.76	22.70
c_{Gs} (south)	19.93	140.61	79.21	131.38	107.71	47.15	122.23	-105.32	197.44	219.92	186.54	163.26	182.41	183.11	311.65	115.11
c_{Gt} (south)	6.09	-1.66	8.42	4.80	6.56	40.94	7.58	102.93	4.77	-0.88	2.85	3.10	-1.13	-2.91	-7.90	-2.02
c_{Gu} (south)	1.91	10.61	-0.13	4.97	0.23	0.98	-3.24	42.55	2.83	7.53	18.99	13.23	14.80	20.02	17.55	24.93
c_{Gs} (west)	32.06	152.29	96.82	126.76	94.79	108.39	139.66	179.00	195.99	210.12	220.24	201.58	196.28	251.91	297.46	132.57
c_{Gt} (west)	4.20	-4.54	-0.42	15.93	2.83	-16.53	6.50	8.35	0.01	-1.33	-6.87	-1.22	-2.66	-7.14	-6.94	-7.95
c_{Gu} (west)	0.39	8.29	0.20	5.88	-4.68	-1.62	-5.85	-1.20	1.04	6.05	15.01	10.88	20.55	18.90	21.34	23.88

Nonresidential Appendix NA6

Appendix NA6 – Alternate Default Fenestration Procedure to Calculate Thermal Performance

NA6.1 Scope

This appendix provides other than a repair, an alternate default a procedure for non-rated NFRC certified fenestration products mostly site-built fenestration. The Center of Glass (COG) values are required to be used in Equation NA6-1, NA6-2 and NA6-3 and shall be determined by the manufacturers in accordance with NFRC procedures.

NONRESIDENTIAL

For Nonresidential up to1,000 ft² in area of new glass. To meet the Alternate Default Fenestration the manufacturer must first determine the COG for U-factor$_C$, SHGC$_C$ and Visual Transmittance (VT$_C$) by using NFRC procedures. If unable to determine center of glass values the alternative Energy Commissions Default Tables will be use as a whole fenestration product (frame, spacer and glass) values, Table 110.6-A for U-factors and Table 110.6-B for SHGC values. Since there is no default Visual Transmittance values available then a VT$_C$ equal to1.0 will be used to determine the Total Performance of the fenestration including glass and frame, VT$_T$.

For Nonresidential the altered fenestration or glass alone other than a repair shall meet the values listed in Table 141.0-A unless the altered glass area meets Exception 1 to Section 141.0(b)1Ai. If the altered fenestration or glass alone is not rated by NFRC then the Alternate Default Fenestration calculated values can be used similar to Nonresidential up to 1000 ft² as described above.

RESIDENTIAL

For Residential when only for non-rated site-built fenestration is being installed the Alternate Default Fenestration calculated values may be used. For Residential up to 250 ft² in area or 0.5% times the conditioned floor area (CFA) whichever is greater shall meet Sections §110.6(a)2 and §110.6(a)3. The Alternate Default Fenestration calculated values are typically worse than those listed in Prescriptive Approach in Table 150.1-A and alternatively the Performance Approach will have to be used. The visual Transmittance (VT) value is not required for residential energy compliance purposes. If unable to determine center of glass (COG) values for the U-factor and Solar Heat Gain Coefficient then alternatively the Energy Commissions Default Table 110.6-A for U-factors and Table 110.6-B for SHGC values will be used..

DOCUMENTATION

The Energy Commission's FC-1 Label Certificate Form shall be use to document the Alternate Default Fenestration calculated values.

STATEMENT

Additionally the manufacturer must provide documentation stating the COG U-factor$_C$, SHGC$_C$ and Visual Transmittance (VT$_C$) were determined in accordance with NFRC procedures. If unable to determine center of glass values the alternative Energy Commissions Default Tables will be use as frame and glass values, Table 110.6-A for U-factors and Table 110.6-B for SHGC values.

determining fenestration thermal performance for skylights and site–built vertical fenestration less than 10,000 ft² in area, or alterations with only replacement glass of any area, as excepted from §116(a)2 and §116(a)3. The calculated values are typically lower than those listed in Tables 140.3-A, 140.3-B, 140.3-C and Table 150.1-C

For fenestration 10,000 ft² or greater, the FC-1 Label Certificate shall be use to document the Alternate Default Fenestration calculated values. The FC-1 form will be and be filled using values set forth in Table 116-A and Table 116-B of the Standards.

as determined in Equation NA6-1, NA6-2 and NA6-3Default U-factor

The default U-factor shall be determined using the following equation.

Equation NA6-1

$$U_T = C_1 + (C_2 \times U_c)$$

Where:

U_T = The fenestration product U-factor Is the Total Performance of the fenestration including glass and frame

C_1 = Coefficient selected from Table NA6-5

C_2 = Coefficient selected from Table NA6-5

U_C = Center of glass U-factor Center of glass U-factor calculated in accordance with NFRC 100 Section 4.5.3.1 http://www.nfrc.org/software.aspx

Table NA6-5 – U-factor Coefficients

Product Type	Frame Type	C_1	C_2
Site-Built Vertical Fenestration	Metal	0.311	0.872
	Metal Thermal Break	0.202	0.867
	Non-Metal	0.202	0.867
Skylights with a Curb	Metal	0.711	1.065
	Metal Thermal Break	0.437	1.229
	Non-Metal	0.437	1.229
Skylights with no Curb	Metal	0.195	0.882
	Metal Thermal Break	0.310	0.878
	Non-Metal	0.310	0.878

NA6.3NA6.2 Default Solar Heat Gain Coefficient, SHGC

The SHGC of the fenestration product shall be calculated using the following equation:

Equation NA6-2

$$SHGC_T = 0.08 + (0.86 \times SHGC_c)$$

Where:

$SHGC_T$ .... = SHGC Is the Total Performance of the fenestration including glass and framefor the fenestration including glass and frame

$SHGC_C$ .... = -Center of glass SHGC calculated in accordance with NFRC 200 Section 4.5.1.1 http://www.nfrc.org/software.aspx

SHGC for the center of glass alone

NA6.3 Default Visual Transmittance, VT

- Equation NA6-3 - VT of Center of Glass (COG) calculation

$$VT_T = VT_F \times VT_C$$

Where:

VT_T = Is the Total Performance of the fenestration including glass and frame

VT_F = 0.53 for projecting windows, such as casement and awning windows

VT_F = 0.67 for operable or sliding windows

VT_F = 0.77 for fixed or non operable windows

VT_F= 0.88 for curtain wall/storefront, Site-built and manufactured non-curb mounted skylights

VT_FF = 1.0 for Curb Mounted manufactured Skylights

VT_C = Center of glass VT is calculated in accordance with NFRC 200 Section 4.5.1.1 http://www.nfrc.org/software.aspx or ASTM E972Is the performance value for the center of glass alone.

VTc Must be calculated in accordance to Lawrence Berkeley National Lab (LBNL) Window 6 or ASTM E972

Where:

VT_T = The Visual Transmittance of the glazing including glass and frame

0.86 = Approximate metal framing in commercial application

VT_C = The Visual Transmittance of the center of glass alone

NA6.4 Responsibilities for Compliance

This section describes the responsibilities of energy consultants, designers, architects, builders, installers, and enforcement agencies when using the procedures- of this appendix.

NA6.4.1 Energy Consultants, Designers, Architects

The person with responsibility for preparing the compliance documentation shall establish the inputs from the following:

- The center of glass U-factor, SHGC and VT shall be taken from manufacturers' literature and determined using methods consistent with NFRC 100, NFRC 200 and NFRC 202 procedures.
- The frame type (Metal, Metal Thermal Break, Non-metal) shall be verified from manufacturers' literature and through observations of frame sections provided by the manufacturer.

For the Pprescriptive Overall Ccompliance Mmethod, the $U_T$and , $SHGC_T$, U_C, $SHGC_C$ and VTc determined through this procedurecalculated- values sshall be entered on the prescriptive ENV-1-C form, Part 2 of 2. In addition the FC-1~~2~~ Label Certificate must be also filled and located at the project site~~'s~~ location in according to Reference Nonresidential Appendix NA7.

For the ~~performance~~ Performance C~~c~~ompliance Approach~~method~~, the calculated values shall be entered ~~the U_T and $SHGC_T$, U_C and $SHGC_C$ determined through this procedure shall~~and ~~be~~ documented on the Performance PERF-1 and Performance ENV-1-C forms. In addition the FC-1~~2~~ Label Certificate must be filled and located at the project site~~'s~~ location in according to Reference Nonresidential Appendix NA7.

For both the prescriptive and performance compliance method, the building plans shall contain a window schedule that lists the calculated ~~U_T and $SHGC_T$~~values in which matches the FC-1 Form or improved -thermal performance values than listed on the FC-1 Form.~~determined through this procedure above and~~ T~~t~~he specifications of the windows shall be consistent with the values used in this procedure, e.g. frame type glazing product, etc.

Permit applications must include fenestration U-factor~~ and~~, SHGC and VT values documentation for the building plan checker. This documentation must include a copy of the manufacturer's documentation showing the Glazing Type information (center of glass U-factor, center of glass SHGC, center of glass VT, number of panes~~, and~~, coatings~~)~~ and the frame type (frame material type, presence of thermal breaks, and identification of structural glazing (glazing with no frame)) that is used to determine U_T~~ and~~, $SHGC_T$, and VT_T~~.~~. If the proposed design uses multiple fenestration products, manufacturer's documentation for each fenestration product shall be attached to the plans. Manufacturer's documentation must be provided for each unique combination of glazing and frame used for compliance and~~. A copy of the manufacturer's documentation~~ shall be located at the project's location.

If mixed fenestration is included in the compliance analysis, then the compliance submittal must clearly be identified which are certified fenestration products, and which are non-certified fenestration products (site-built less than 1~~0~~,000 ft² or skylights). The manufacturer's documentation and calculations for each product must be included in the submittal, and either the ENV-1-C or PERF-1 form must be included on the building plans. All non-certified fenestration products and is less than 1~~0,000~~,000 ft² or skylights for commercial and requires a filled FC-1~~2~~ or for Residential up to 250 ft² in area or 0.5% time CFA whichever is greater.~~.~~

NA6.4.2 Builder and Installer Responsibilities

The builder must ensure that the fenestration (glass and frame) documentation showing the U factor,~~ and~~ SHGC, and VT used for determining compliance is provided to the installer. The builder is responsible for ensuring that the persons preparing compliance documentation are specifying products the builder intends to install. The builder is responsible for ensuring that the installer installs glass with thermal performance equal to or better than the thermal performance used for energy compliance and that the frame type installed is the same as that used for compliance. The builder also must ensure that the field inspector for the enforcement agency is provided with manufacturer's documentation attached to each~~, an~~ Energy Commission's FC-1~~2~~ Label Certificate showing the thermal performance and method of determining thermal performance for the actual fenestration products installed. The builder should verify that these fenestration products are clearly shown on the building plans before fenestration products are purchased and installed. A copy of the manufacturer's documentation and FC-1~~2~~ shall be located at the project location.

NA6.4.3 Enforcement Agency Responsibilities

NA6.4.3.1 Plan Checker

The enforcement agency plan checker or reviewer is responsible for ensuring that the plans identify all site-built fenestration and skylights occasionally residential site-built fenestration will be used and also identified on the FC-1 Form. The plan checker shall ensure that site-built fenestration and skylights using the alternate default procedure shall meet the following:

1. U-factors,~~ and~~ SHGC and VT (for Commercial use only) values are clearly shown on the window schedules on the plans, and
2. T~~t~~he Glazing Type and Frame Type and which are the basis of this procedure are properly documented, and

3. M~~m~~anufacturer documentation of the Glazing Type and Frame Type has been provided for the each of the fenestration products using the procedure of this appendix, and
4. T~~t~~he building has less than 1~~0~~,000 ft² of vertical site-built fenestration or skylight for commercial or for Residential up to 250 ft² in area or 0.5% time CFA whichever is greater ~~,~~ and
5. A~~a~~ completely filled out FC-1~~2~~ Label Certificate for each non-certified fenestration product and~~.~~
6. Building plans should be consistent with the energy compliance documentation.

NA6.4.3.2 Enforcement Agency Inspector

The enforcement agency field inspector is responsible for ensuring that the building using the procedure in this appendix has less than 1~~0~~,000 ft² of site-built fenestration for commercial or for Residential up to 250 ft² in area or 0.5% time CFA whichever is greater.

The enforcement agency field inspector is responsible for ensuring that manufacturer's documentation has been provided for the installed fenestration at the project location. The field inspector is responsible for ensuring that the U-factor, ~~and~~ SHGC and VT for the installed fenestration is consistent with the plans.~~,~~ T~~t~~he Prescriptive ENV-1-C ~~Part 2 of 2~~ or the Performance PERF-1~~,~~ and Performance ENV-1C and the Commission's FC-~~2~~1 Label Certificate for each fenestration product shall be~~, and~~ consistent with the~~that~~ ~~manufacturer~~manufacturer's documentation and with~~are consistent with~~ the fenestration products installed in the building.

Nonresidential Appendix NA7

Appendix NA7 – Acceptance and Installation Requirements for Nonresidential Buildings and Covered Processes

Table of Contents

NA7.1 Purpose and Scope

This appendix defines acceptance procedures that must be completed on certain controls and equipment before the installation is deemed to be in compliance with the Standards. These requirements apply to all newly installed equipment for which there are acceptance requirements in new and existing buildings. The procedures apply to nonresidential, high-rise residential, ~~and~~ hotel/motel buildings and covered processes as defined by the California Energy Commission's Energy Efficiency Standards for Nonresidential Buildings (Standards).

The purpose of the acceptance tests is to assure:

1. The presence of equipment or building components according to the specifications in the compliance documents.
2. Installation quality and proper functioning of the controls and equipment to meet the intent of the design and the Standards.

Modifications and additions to these acceptance requirements needed to improve clarity or to better ensure proper installation and functionality may be approved by the Energy Commission.

NA7.2 Introduction

Acceptance requirements are defined as implementation of targeted inspection checks and functional and performance testing to determine whether specific building components, equipment, systems, and interfaces between systems conform to the criteria set forth in the Standards and to related construction documents (plans or specifications). Acceptance requirements improve code compliance effectiveness and help meet the expected level of performance.

Acceptance testing is not intended to take the place of commissioning or test and balance procedures that a building owner might incorporate into a building project. It is an adjunct process focusing only on demonstrating compliance with the Standards.

Third-party review of the information provided on Certificate of Acceptance documentation is not required, with one exception: duct leakage diagnostic test results for some constant volume space conditioning systems serving less than 5,000 square feet of conditioned floor area are required to be verified by a certified HERS rater as specified in Standards Section 140.4(l).

~~Prior to signing a Certificate of Acceptance the installing contractor, engineer of record or owners agent shall be responsible for reviewing the plans and specifications to assure they conform to the acceptance requirements. Persons eligible to sign the Certificate of Acceptance are those responsible for its preparation; and licensed in the State of California as a civil engineer, mechanical engineer, licensed architect or a licensed contractor performing the applicable work or a person managing work on a structure or type of work described pursuant to Business and Professions Code sections 5537, 5538, and 6737.1.~~

NA7.3 ~~Responsible Party~~Roles and Responsibilities

Individuals who perform the field testing and verification work, and provide the information required for completion of the Certificate of Acceptance documentation are not required to be licensed professionals. The person who signs the Certificate of Acceptance document to certify compliance with the acceptance requirements shall be licensed as specified in Standards Section 10-103(a)4.

NA7.3.1 Responsible Person

The Certificate of Acceptance shall be signed by the person who is responsible for the work identified on the Certificate of Acceptance. The *Responsible Person* shall be a licensed professional who is eligible under Division 3 of the Business and Professions code in the applicable classification, to take responsibility for the scope of work identified on the Certificate of Acceptance document. The *Responsible Person* shall review the information on the Certificate of Acceptance document and sign the document to certify compliance with the acceptance requirements. The *Responsible Person* shall assume responsibility for the acceptance testing work performed by the *Field Technician* agent(s) or employee(s), and if necessary shall interview the person who performed the acceptance test work in order to ascertain whether the testing work reported on the Certificate of Acceptance was completed as reported and is consistent with the *Responsible Person's* expectation. The *Responsible Person* may also perform the required acceptance testing work, and in that case shall also sign as the *Field Technician* on the Certificate of Acceptance document.

NA7.3.2 Field Technician

The *Field Technician* is responsible for performing the acceptance test procedures and documenting the results of on the Certificate of Acceptance document. The *Field Technician* shall sign the Certificate of Acceptance to certify that the information provided on the Certificate of Acceptance is true and correct.

NA7.3.3 Documentation Author

Documentation Authors who provide administrative support for document preparation for Certificate of Acceptance documentation shall sign a declaration statement on the documents they prepare to certify the information provided on the documentation is accurate and complete.

NA7.3.4 Enforcement Agency

The Certificate of Acceptance shall be submitted to the enforcement agency in order to receive the final Certificate of Occupancy. The enforcement agency shall have the authority to require the *Responsible Person* and *Field Technician* to demonstrate competence, to its satisfaction.~~The installing responsible party shall certify compliance with the acceptance requirements. They shall be responsible for performing data analysis, calculation of performance indices, and crosschecking results with the requirements of the Standards. They shall be responsible for issuing a Certificate of Acceptance as well as copies of all measurement and monitoring results for individual test procedures to the enforcement agency. The enforcement agency shall not release a final Certificate of Occupancy until a Certificate of Acceptance, and all applicable acceptance requirements for code compliance forms, are approved and submitted by the responsible party. A responsible party who is licensed shall record their State of California contractor's license number or their State of California professional registration license number on each Certificate of Acceptance that they issue.~~

NA7.4 Building Envelope Acceptance Tests

NA7.4.1 Fenestration

- Each fenestration product shall ~~have either~~provide ~~an~~an NFRC Label Certificate or the Commission's Fenestration Certificate, FC-1 ~~or FC-2~~, to identify the thermal performance (e.g. U-factor, SHGC, and VT) of each fenestration product being installed. The labels shall be located at the job site for verification by the enforcement agency. In addition, the responsible party shall fill out the Fenestration Acceptance Certificate. The responsible party shall verify the thermal performance of each specified fenestration product being installed ~~and shall ensure that it~~ matches the label certificate, energy compliance documentation and building plans. A copy of the certificate shall be given to the building owner and the enforcement agency for their records.

NA7.4.1.1 Elements Requiring Verification:

The responsible party shall verify the following:

1. The thermal performance for each fenestration product matches the building plans, energy compliance documentation, and the label certificate; and~~,~~
2. The delivery receipt or purchase order matches the delivered fenestration product(s); and~~.~~

3. Verify the NFRC Label Certificate is filled out and includes an NFRC's Certified Product Directory (CPD) number andor a Certificate Number (when the Component Modeling Approach Label is submitted).

3.4. that the FC-1 or FC-2 matches the purchase order or detailed receiptFor non-rated fenestration verify FC-1 is completely filled..

4.5. The Certificate of Acceptance form is completed and signed.

NA7.4.1.2 Required Documentation

- NFRC Product Label Certificate:
  - The Component Modeling Approach (CMA) Labellabel Certificate can list a single or multiple fenestration products, each with its own -CPD number on the left columnCPD number and verified for authenticity by accessing -http://cpd.nfrc.org/cpd2/ ; or
  - -The Certificate Number CPD number for each CMA Label Certificate fenestration product" can be verified for authenticity by accessing http://cmast.nfrc.org/Project/CertificateFind.aspx ; orwww.NFRC.org,
  - Certified Product Database; or
  - Commission's Fenestration Label Certificate:
    - The FC-1 and FC-2 are used to document Fenestration products not certified or rated by NFRC by using the Commission's Default Table values in §110.6- A and Table 110.6-B or the calculated values as indicated Nonresidential Appendix NA6. or the Alternate Default Fenestration Thermal Performance method as described in Appendix NA6.
    - FC-1 is used for vertical fenestration 10,000 ft² or greater and is only limited to the Energy Commission's Default Values found in Standards Table 110.6-A and Table 110.6-B or;
    - FC-2 is used for vertical fenestration less than 10,000 ft² and may use either the Energy Commission's Default Table Values found in Standards Table 116-A and Table 116-B or may use the Alternate Default Fenestration Thermal Performance procedures described in Appendix NA6.
- Purchase Order or Receipt:
  - A copy of the purchase order or a detailed payment receipt shall be used to cross reference with the NFRC Product Label Certificate CPD number or the FC-1 or FC-2 values; and
  - The purchase order or a detailed payment receipt should match the energy compliance documentation and the building plans.
- Fenestration Building Plans:
  - The building plans shall list in a schedule for each fenestration product to be installed in the building.
- Certificate of Acceptance Form:
  - The acceptance form mustshall be filled out by the responsible party and signed; and.
  - The signed Certificate of Acceptance shall be submitted to enforcement agency or field inspector; and.
  - A copy of the Certificate of Acceptance shall be given to the building owner.

NA7.5 Mechanical Systems Acceptance Tests

NA7.5.1 Outdoor Air

NA7.5.1.1 Variable Air Volume Systems Outdoor Air Acceptance

NA7.5.1.1.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Sensor used to control outdoor air flow is either factory calibrated or field calibrated.
- Attach calibration certification or results.
- Dynamic damper control is being used to control outside air.
- Specify the type of dynamic control being utilized to control outside air.
- Specify the method of delivering outside air to the unit.
- Pre-occupancy purge has been programmed for the 1-hour period immediately before the building is normally occupied.
- F~~System controlling outside airflow was calibrated either in the field or factory.~~

NA7.5.1.1.2 Functional Testing

Step 1: If the system has an outdoor air economizer, force the economizer high limit to disable economizer control (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

Step 2: Adjust supply airflow to achieve design airflow or maximum airflow at full cooling~~either the sum of the minimum zone airflows or 30 percent of the total design airflow~~. Verify and document the following:

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.
- Outside air damper position ~~OSA controls~~ stabilizes within 5 minutes.

Step 3: Adjust supply airflow to either the sum of the minimum zone airflows, full heating, or 30 percent of the total design airflow. ~~achieve design airflow.~~ Verify and document the following:

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.
- Outside air damper position ~~OSA controls~~ stabilizes within 5 minutes.

Step 4: Restore system to “as-found” operating conditions

NA7.5.1.2 Constant Volume System Outdoor Air Acceptance

NA7.5.1.2.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- System is designed to provide a fixed minimum OSA when the unit is on.
- Specify the method of delivering outside air to the unit.
- Pre-occupancy purge has been programmed for the 1-hour period immediately before the building is normally occupied.
    - Minimum position is marked on the outside air damper.
    - The system has means of maintaining the minimum outdoor air damper position.

NA7.5.1.2.2 Functional Testing

Step 1: If the system has an outdoor air economizer, force the economizer to the minimum position and stop outside air damper modulation (e.g. for a fixed drybulb high limit, lower the setpoint below the current outdoor air temperature)

- Measured outside airflow reading is within 10 percent of the total ventilation air called for in the Certificate of Compliance.

NA7.5.2 Constant-Volume, Single-Zone, Unitary Air Conditioners and Heat Pumps

NA7.5.2.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Thermostat is located within the space-conditioning zone that is served by the HVAC system.
- Thermostat meets the temperature adjustment and dead band requirements of Standards §120.2(b).
- Occupied, unoccupied, and holiday schedules have been programmed per the facility's schedule.
- Pre-occupancy purge has been programmed to meet the requirements of Standards §120.1(c)2.

NA7.5.2.2 Functional Testing

Step 1: Disable economizer and demand control ventilation systems (if applicable).

Step 2: Simulate a heating demand during the occupied condition. Verify and document the following:

- Supply fan operates continually.
- The unit provides heating.
- No cooling is provided by the unit.
- Outside air damper is at minimum position.

Step 3: Simulate operation in the dead band during occupied condition. Verify and document the following:

- Supply fan operates continually.
- Neither heating nor cooling is provided by the unit.
- Outside air damper is at minimum position.

Step 4: Simulate cooling demand during occupied condition. Lock out economizer (if applicable). Verify and document the following:

- Supply fan operates continually.
- The unit provides cooling.
- No heating is provided by the unit.
- Outside air damper is at minimum position.

Step 5: Simulate operation in the dead band during unoccupied mode. Verify and document the following:

- Supply fan is off.
- Outside air damper is fully closed.
- Neither heating nor cooling is provided by the unit.

Step 6: Simulate heating demand during unoccupied conditions. Verify and document the following:

- Supply fan is on (either continuously or cycling).

- Heating is provided by the unit.
- No cooling is provided by the unit.
- Outside air damper is either closed or at minimum position.

Step 7: Simulate cooling demand during unoccupied condition. Lock out economizer (if applicable). Verify and document the following:

- Supply fan is on (either continuously or cycling).
- Cooling is provided by the unit.
- No heating is provided by the unit.
- Outside air damper is either closed or at minimum position.

Step 8: Simulate manual override during unoccupied condition. Verify and document the following:

- System operates in "occupied" mode.
- System reverts to "unoccupied" mode when manual override time period expires.

Step 9: Restore economizer and demand control ventilation systems (if applicable), and remove all system overrides initiated during the test.

NA7.5.3 Air Distribution Systems

NA7.5.3.1 Construction Inspection

Prior to Functional Testing on new duct systems, verify and document the following:

- Duct connections meet the requirements of Standards §120.4.
- Specify choice of drawbands.
- Flexible ducts are not ~~compressed~~constricted in any way.
- ~~Ducts are fully accessible for testing.~~
- Duct leakage tests shall be performed before access to ductwork and connections are blocked.
- Joints and seams are properly sealed according to the requirements of Standards §120.4.
- Joints and seams are not sealed with cloth back rubber adhesive tape unless used in combination with Mastic and drawbands. Cloth backed tape may be used if tape has been approved by the CEC. Ducts are fully accessible for testing.
- Insulation R-Values meet the minimum requirements of §120.4(a).
- Insulation is protected from damage and suitable for outdoor service if applicable per Standards §120.4(f).

Prior to Functional Testing on all new and existing duct systems, visually inspect to verify that the following locations have been sealed:

- Connections to plenums and other connections to the forced air unit
- Refrigerant line and other penetrations into the forced air unit
- Air handler door panel (do not use permanent sealing material, metal tape is acceptable)
- Register boots sealed to surrounding material
- Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes

NA7.5.3.2 Functional Testing

Step 1: Perform duct leakage test ~~per~~ as specified by Reference Nonresidential Appendix NA2 ~~. Certify~~to verify the ~~following:~~

~~Duct~~duct leakage conforms to the requirements of Standards §140.4(~~k~~l) and ~~Standards~~ §141.0(b)1D~~149(b)1D~~.

Step 2: Obtain HERS Rater field verification as ~~required~~ specified ~~by~~ in Reference Nonresidential Appendix NA1.

NA7.5.4 Air Economizer Controls

NA7.5.4.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Economizer lockout setpoint complies with Table 140.4(e)-C of Section§140.4(e)3.
- If the high-limit control is fixed dry-bulb, it shall have an adjustable setpoint.
- Economizer lockout control sensor is located to prevent false readings.
- Sensor performance curve is provided by factory with economizer instruction material.
- Sensor output value measured during sensor calibration is plotted on the performance curve.
- Primary damper control temperature sensor located after the cooling coil to maintain comfort.
- Economizer damper moves freely without binding.
- Unitary systems with an economizer have control systems, including two-stage or electronic thermostats, that cycle compressors off when economizers can provide partial cooling
- Economizer reliability features are present per Standards Section 140.4(e)4.
- System is designed to provide up to 100 percent outside air without over-pressurizing the building.
- For systems with DDC controls lockout sensor(s) are either factory calibrated or field calibrated.
- For systems with non-DDC controls, manufacturer's startup and testing procedures have been applied
- For direct expansion systems 65,000 Btu/hr and less, thermostats (e.g. two stage or electronic) and control system has capacity to modulate compressor or cycle compressor off during periods where economizer cooling can partially meet the cooling load as per Section 140.4(e)2.B.i.
- For direct expansion systems, equipment submittal specifies compressor capacity steps and/or compressor capacity modulation complying with the stages or modulation required in Section 140.4(e)2.B.ii.
- Provide an economizer specification sheet proving capability of at least 100,000 actuations.
- Provide a product specification sheet proving compliance with AMCA Standard 500 damper leakage at 10 cfm/sf.
- Unit has a direct drive modulating actuator with gear driven interconnections.

NA7.5.4.2 Functional Testing

Step 1: Disable demand control ventilation systems (if applicable)

Step 2: Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open. Verify and document the following:

- Economizer damper is 100 percent open and return air damper is 100 percent closed.

- For systems that meet the criteria of §140.4(e)2.B.i, verify that the economizer is 100 percent open part of the time and the compressor cycles on and off when the cooling demand can no longer be met by the economizer alone.
- For systems that meet the criteria of §140.4(e)2.b.ii1, verify that the economizer provides partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling loadremains 100 percent open when the cooling demand can no longer be met by the economizer alone.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled (if unit has heating capability).

Step 3: Disable the economizer and simulate a cooling demand. Verify and document the following:

- Economizer damper closes to its minimum position.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled (if unit has heating capability).

Step 4: If unit has heating capability, Ssimulate a heating demand and set the economizer so that it is capable of operating (i.e. actual outdoor air conditions are below lockout setpoint). Verify the following:

- The economizer is at minimum position

Return air damper opens

Step 5: Turn off the unit. Verify and document the following:

- Economizer damper closes completely.

Step 65: Restore demand control ventilation systems (if applicable) and remove all system overrides initiated during the test.

NA7.5.5 Demand Control Ventilation (DCV) Systems

NA7.5.5.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Carbon dioxide control sensor is factory calibrated or field-calibrated per §120.1(c)4.
- The sensor is located in the high density space between 3 ft and 6 ft above the floor or at the anticipated level of the occupants' heads.
- DCV control setpoint is at or below the CO_2 concentration permitted by §120.1(c)4.C.

NA7.5.5.2 Functional Testing

Step 1: Disable economizer controls

Step 2: Simulate a signal at or slightly above the CO_2 concentration setpoint required by §120.1(c)4.C. Verify and document the following:

- For single zone units, outdoor air damper modulates open to satisfy the total ventilation air called for in the Certificate of Compliance.
- For multiple zone units, either outdoor air damper or zone damper modulate open to satisfy the zone ventilation requirements.

Step 3: Simulate signal well below the CO_2 setpoint. Verify and document the following:

- For single zone units, outdoor air damper modulates to the design minimum value.

- For multiple zone units, either outdoor air damper or zone damper modulate to satisfy the reduced zone ventilation requirements.

Step 4: Restore economizer controls and remove all system overrides initiated during the test.

Step 5: With all controls restored, apply CO_2 calibration gas at a concentration slightly above the setpoint to the sensor. Verify that the outdoor air damper modulates open to satisfy the total ventilation air called for in the Certificate of Compliance.

NA7.5.6 Supply Fan Variable Flow Controls

NA7.5.6.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Supply fan includes device(s) for modulating airflow, such as variable speed drive or electrically commutated motor.
  - For multiple zone systems:
    - Discharge static pressure sensors are either factory calibrated or field-calibrated.
    - The static pressure location, setpoint, and reset control meets the requirements of §140.4(c)2.B~~C~~ and §140.4(c)2.C~~D~~.

NA7.5.6.2 Functional Testing

Step 1: Simulate demand for full design airflow. Verify and document the following:

- Supply fan controls modulate to increase capacity.
- For multiple zone systems, s~~S~~upply fan maintains discharge static pressure within +/-10 percent of the current operating set point.
- Supply fan controls stabilize within a 5 minute period.

Step 2: Simulate demand for reduced or minimum airflow. Verify and document the following:

- Supply fan controls modulate to decrease capacity.
- Current operating setpoint has decreased (for systems with DDC to the zone level).
- For multiple zone systems, ~~S~~supply fan maintains discharge static pressure within +/-10 percent of the current operating setpoint.
- Supply fan controls stabilize within a 5 minute period.

Step 3: Restore system to correct operating conditions

NA7.5.7 Valve Leakage Test

NA7.5.7.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Valve and piping arrangements were installed per the design drawings.

NA7.5.7.2 Functional Testing

Step 1: For each of the pumps serving the distribution system, dead head the pumps using the discharge isolation valves at the pumps. Document the following:

- Record the differential pressure across the pumps
- Verify that this is within 5 percent of the submittal data for the pump

Step 2: Reopen the pump discharge isolation valves. Automatically close all valves on the systems being tested. If 3-way valves are present, close off the bypass line. Verify and document the following:

- The valves automatically close.
- Record the pressure differential across the pump
- Verify that the pressure differential is within 5 percent of the reading from Step 1 for the pump that is operating during the valve test.

Step 3: Restore system to correct operating conditions

NA7.5.8 Supply Water Temperature Reset Controls

NA7.5.8.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Supply water temperature sensors have been either factory or field calibrated.

NA7.5.8.2 Functional Testing

Step 1: Change reset control variable to its maximum value. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~
- Verify that actual supply temperature changes to~~is~~ within 2 percent of the ~~control~~ new setpoint.

Step 2: Change reset control variable to its minimum value. Verify and document the following:

- Chilled or hot water temperature setpoint is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~
- Verify that actual supply temperature ~~is~~ changes to within 2 percent of the ~~control~~ new setpoint.

Step 3: Restore reset control variable to automatic control. Verify and document the following:

- Chilled or hot water temperature set-point is reset to appropriate value.
- ~~Actual supply temperature changes to meet setpoint.~~
- Verify that actual supply temperature ~~is~~ changes to within 2 percent of the ~~control~~ newl setpoint.

NA7.5.9 Hydronic System Variable Flow Controls

NA7.5.9.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- The static pressure location, setpoint, and reset control meets the requirements of the Standards Section 140.4(k)6B.
- Pressure sensors are either factory or field calibrated.

NA7.5.9.2 Functional Testing

Step 1: Modulate control valves to reduce water flow to 50 percent of the design flow or less, but not lower than the pump minimum flow. Verify and document the following:

- Pump operating speed decreases (for systems with DDC to the zone level).
- Current operating setpoint has not increased (for all other systems that are not DDC).
- System pressure is within 5 percent of current operating setpoint.
- System operation stabilizes within 5 minutes after test procedures are initiated.

Step 21: Open control valves to increase water flow to a minimum of 90 percent design flow. Verify and document the following:

- Pump speed increases
- Pumps are operating at 100 percent speed.
- System pressure is greater than the setpoint in Step 1.
- System pressure is either within ±5 percent of current operating setpoint. or the pressure is below the setpoint and the pumps are operating at 100 percent speed.
- System operation stabilizes within 5 minutes after test procedures are initiated.

Step 2: Modulate control valves to reduce water flow to 50 percent of the design flow or less, but not lower than the pump minimum flow. Verify and document the following:

- Pump speed decreases.
- Current operating setpoint has decreased (for systems with DDC to the zone level).
- Current operating setpoint has not increased (for all other systems).
- System pressure is within 5 percent of current operating setpoint.
- System operation stabilizes within 5 minutes after test procedures are initiated.

Step 3: Restore system to correct operating conditions.

NA7.5.10 Automatic Demand Shed Control Acceptance

NA7.5.10.1 Construction Inspection

Prior to Acceptance Testing, verify and document the following:

- That the EMCS interface enables activation of the central demand shed controls.

NA7.5.10.2 Functional Testing

Step 1: Engage the global demand shed system. Verify and document the following:

- That the cooling setpoint in non-critical spaces increases by the proper amount.
- That the cooling setpoint in critical spaces do not change.

Step 2: Disengage the global demand shed system. Verify and document the following:

- That the cooling setpoint in non-critical spaces return to their original values.
- That the cooling setpoint in critical spaces do not change.

NA7.5.11 Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units

NA7.5.11.1 Construction Inspection

Prior to Functional Testing, verify and document the following:

- Verify fault detection and diagnostics (FDD) hardware is installed on HVAC unit.
- Verify the FDD system matches the make and model reported on the design drawings.
- Verify the following air temperature sensors are permanently installed:
  - outside air
  - supply air
  - return air
- Verify the controller has the capability of displaying the value of the following parameters:
  - Air temperatures: outside air, supply air, return air.
  - Refrigerant pressure and temperature sensors (if present, their output should be made available).
- Verify the controller provides system status by indicating the following conditions:
  - Free cooling available
  - Economizer enabled
  - Compressor enabled
  - Heating enabled
  - Mixed air low limit cycle active

~~Verify FDD hardware is installed on equipment by the manufacturer and that equipment make and model include factory-installed FDD hardware that match the information indicated on copies of the manufacturer's cut sheets and on the plans and specifications.~~

~~**Eligibility Criteria**~~

~~A fault detection and diagnostics (FDD) system for direct-expansion packaged units shall contain the following features to be eligible for credit in the performance calculation method:~~

1. ~~The unit shall include a factory-installed economizer and shall limit the economizer deadband to no more than 2°F.~~
2. ~~The unit shall include direct-drive actuators on outside air and return air dampers.~~
3. ~~The unit shall include an integrated economizer with either differential dry-bulb or differential enthalpy control.~~
4. ~~The unit shall include a low temperature lockout on the compressor to prevent coil freeze-up or comfort problems.~~
5. ~~Outside air and return air dampers shall have maximum leakage rates conforming to ASHRAE 90.1-2004.~~
6. ~~The unit shall have an adjustable expansion control device such as a thermostatic expansion valve (TXV).~~
7. ~~To improve the ability to troubleshoot charge and compressor operation, a high-pressure refrigerant port will be located on the liquid line. A low-pressure refrigerant port will be located on the suction line.~~
8. ~~The following sensors should be permanently installed to monitor system operation and the controller should have the capability of displaying the value of each parameter:~~

- ~~Refrigerant suction pressure~~
- ~~Refrigerant suction temperature~~
- ~~Liquid line pressure~~
- ~~Liquid line temperature~~
- ~~Outside air temperature~~
- ~~Outside air relative humidity• Return air temperature~~
- ~~Return air relative humidity~~
- ~~Supply air temperature~~
- ~~Supply air relative humidity.~~

~~The controller will provide system status by indicating the following conditions:~~

- ~~Compressor enabled~~
- ~~Economizer enabled~~
- ~~Free cooling available~~
- ~~Mixed air low limit cycle active~~
- ~~Heating enabled.~~

~~The unit controller shall have the capability to manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.~~

NA7.5.11.2 Functional Testing

For each HVAC unit to be tested, complete the following:

NA7.5.11.2.1 Functional Testing for Air Temperature Sensor Failure/Fault

Step 1: Verify the FDD system indicates normal operation.

Step 2: Disconnect outside air temperature sensor from unit controller. Verify and document the following:

- FDD system reports a fault.

Step 3: Connect outside air temperature sensor to unit controller. Verify and document the following:

- FDD system indicates normal operation.

NA7.5.11.2.2 Functional Testing for Excess Outside Air

Step 1: Coordinate this test with NA7.5.1 Outdoor Air

- If NA7.5.1 Outdoor Air passes, verify FDD system indicates normal operation.

NA7.5.11.2.3 Functional Testing for Economizer Operation

Step 1: Interfere with normal unit operation so test NA7.5.4 Air Economizer Controls fails by immobilizing the outdoor air economizer damper according to manufacturer's instructions

- After NA7.5.4 Air Economizer Controls fails, verify FDD system reports a fault.

Step 2: Successfully complete and pass NA7.5.4 Air Economizer Controls

- After NA7.5.4 Air Economizer Controls passes, verify FDD system reports normal operation.

NA7.5.11.2.4 Functional Testing for Refrigerant Diagnostic Sensors

Step 1: During normal cooling operation, record refrigerant temperatures and pressures, and saturated discharge temperature and saturated suction temperature, if displayed by the unit controller.

Step 2: During same operating conditions as Step 1, install calibrated refrigerant gauge with an accuracy of plus or minus 3% shall be used to determine and record saturated discharge temperature and saturated suction temperatures. If either temperature determined is more than 5 F different than recorded in Step 1, test has failed. Otherwise, test passes.

- Refrigeration gauges shall be calibrated according to the manufacturer's calibration procedure to conform to the accuracy requirement specified. All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.

~~Test low airflow condition by replacing the existing filter with a dirty filter or appropriate obstruction.~~

1. ~~Verify that the fault detection and diagnostics system reports the fault.~~
2. ~~Verify that the system is able to verify the correct refrigerant charge.~~
3. ~~Calibrate outside air, return air, and supply air temperature sensors.~~

NA7.5.12 Automatic F~~f~~ault D~~d~~etection and D~~d~~iagnostics (FDD) for A~~a~~ir H~~h~~andling U~~u~~nits and Z~~z~~one T~~t~~erminal U~~u~~nits.

NA7.5.12.1 Functional Testing for Air Handling Units

Testing of each AHU with FDD controls shall include the following tests.

1. Sensor drift/failure:

Step 1: Disconnect outside air temperature sensor from unit controller.

Step 2: Verify that the FDD system reports a fault.

Step 3: Connect OAT sensor to the unit controller.

Step 4: Verify that FDD indicates normal system operation.

2. Damper/actuator fault:

Step 1: From the control system workstation, command the mixing box dampers to full open (100 percent outdoor air).

Step 2: Disconnect power to the actuator and verify that a fault is reported at the control workstation.

Step 3: Reconnect power to the actuator and command the mixing box dampers to full open.

Step 4: Verify that the control system does not report a fault.

Step 5: From the control system workstation, command the mixing box dampers to a full-closed position (0 percent outdoor air),

Step 6: Disconnect power to the actuator and verify that a fault is reported at the control workstation.

Step 7: Reconnect power to the actuator and command the dampers closed.

Step 8: Verify that the control system does not report a fault during normal operation.

3. Valve/actuator fault:

Step 1: From the control system workstation, command the heating and cooling coil valves to full open or closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.

4. Inappropriate simultaneous heating, mechanical cooling, and/or economizing:

Step 1: From the control system workstation, override the heating coil valve and verify that a fault is reported at the control workstation.

Step 2: From the control system workstation, override the cooling coil valve and verify that a fault is reported at the control workstation.

Step 3: From the control system workstation, override the mixing box dampers and verify that a fault is reported at the control workstation.

NA7.5.12.2 Functional Testing for Zone Terminal Units

Testing shall be performed on one of each type of terminal unit (VAV box) in the project. A minimum of 5 percent of the terminal boxes shall be tested.

1. Sensor drift/failure:

Step 1: Disconnect the tubing to the differential pressure sensor of the VAV box.

Step 2: Verify that control system detects and reports the fault.

Step 3: Reconnect the sensor and verify proper sensor operation.

Step 4: Verify that the control system does not report a fault.

2. Damper/actuator fault:

(a) Damper stuck open.

Step 1: Command the damper to be fully open (room temperature above setpoint).

Step 2: Disconnect the actuator to the damper.

Step 3: Adjust the cooling setpoint so that the room temperature is below the cooling setpoint to command the damper to the minimum position. Verify that the control system reports a fault.

Step 4: Reconnect the actuator and restore to normal operation.

(b) Damper stuck closed.

Step 1: Set the damper to the minimum position.

Step 2: Disconnect the actuator to the damper.

Step 3: Set the cooling setpoint below the room temperature to simulate a call for cooling. Verify that the control system reports a fault.

Step 4: Reconnect the actuator and restore to normal operation.

3. Valve/actuator fault (For systems with hydronic reheat):

Step 1: Command the reheat coil valve to (full) open.

Step 2: Disconnect power to the actuator. Set the heating setpoint temperature to be lower than the current space temperature, to command the valve closed. Verify that the fault is reported at the control workstation.

Step 3: Reconnect the actuator and restore normal operation.

4. Feedback loop tuning fault (unstable airflow):

Step 1: Set the integral coefficient of the box controller to a value 50 times the current value.

Step 2: The damper cycles continuously and airflow is unstable. Verify that the control system detects and reports the fault.

Step 3: Reset the integral coefficient of the controller to the original value to restore normal operation.

5. Disconnected inlet duct:

Step 1: From the control system workstation, commands the damper to full closed, then disconnect power to the actuator and verify that a fault is reported at the control workstation.

6. Discharge air temperature sensor:

Step 1: Adjust zone setpoints to drive the box from dead band to full heating.

Step 2: Verify that in heating, the supply air temperature resets up to the maximum setpoint while the airflow is maintained at the dead band flow rate.

Step 3: Verify that after the supply air temperature is reset up to the maximum setpoint, the airflow rate then increases up to the heating maximum flow rate in order to meet the heating load.

NA7.5.13 Distributed Energy Storage DX AC Systems Acceptance Tests[1]

These acceptance requirements apply only to constant or variable volume, direct expansion (DX) systems with distributed energy storage (DES/DXAC). These acceptance requirements are in addition to those for other systems or equipment such as economizers, packaged equipment, etc.

[1] From AEC, Distributed Energy Storage for Direct-Expansion Air Conditioners, January 27, 2005.

Nonresidential Appendix NA8

~~Appendix NA8 – Illuminance Categories and Luminaire Power~~

~~*NA8.1 Illuminance Categories*~~

~~Please see Chapter 10 in the IESNA Lighting Handbook, Ninth Edition.~~

~~*NA8.2 Illuminance Categories and Luminaire Power*~~

~~Luminaire power shall be taken from the following tables.~~

~~Table NA8-1 – Fluorescent Circline~~

~~Table NA8-2 – Compact Fluorescent 2D~~

~~Table NA8-3 – Compact Fluorescent~~

~~Table NA8-4 – Long Compact Fluorescent~~

~~Table NA8-5 – Fluorescent U-Tubes~~

~~Table NA8-6 – Fluorescent Linear Lamps – Preheat~~

~~Table NA8-7 – Fluorescent Linear Lamps T5~~

~~Table NA8-8 – Fluorescent Rapid Start T-8~~

~~Table NA8-9 – Fluorescent Rapid Start T-12~~

~~Table NA8-10 – Fluorescent Rapid Start High Output (HO) T8 & T12, 8 ft~~

~~Table NA8-11 – Fluorescent Instant Start (single pin base "Slimline") T12, 4 ft~~

~~Table NA8-12 – Fluorescent Instant Start (single pin base "Slimline") T8 & T12, 8 ft.~~

~~Table NA8-13 – High Intensity Discharge~~

~~Table NA8-14 – 12 Volt Tungsten Halogen Lamps Including MR16, Bi-pin, AR70, AR111, PAR36~~

~~Table NA8-1 – Fluorescent Circline~~

	Lamps		Ballasts			System	
Type	Number	Designation	Number	Designation	Description	Watts	Comment
Rapid Start (22 W)	1	FC8T9	1	MAG STAND.	Mag. Stand.	29	8" OD
T5 Program Start (22 W)	1	FC9T5	1	ELECT NO	Electronic Normal Light	28	8" OD
	2	FC9T5	1	ELECT NO	Electronic Normal Light	53	
T5 Program Start (40 W)	1	FC12T5	1	ELECT NO	Electronic Normal Light	44	12" OD
	2	FC12T5	1	ELECT NO	Electronic Normal Light	84	
T5 Rapid Start (55 W)	1	FC12T5HO	1	ELECT NO	Electronic Normal Light	61	12" OD
	2	FC12Tag5HO	1	ELECT NO	Electronic Normal Light	111	
	1	FC12T5HO	1	ELECT DIM	Electronic Dimming	8~62	
	2	FC12T5HO	1	ELECT DIM	Electronic Dimming	18~120	
T5 Rapid Start (40 + 22 W)	1+1	FC12T5/FC9T5	1	ELECT NO	Electronic Normal Light	68	8" & 12" OD

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

~~Table NA8-2 – Compact Fluorescent 2D~~

	Lamps		Ballasts			System	
Type	Number	Designation	Number	Designation	Description	Watts	Comment
10W, GR10q-4 Four Pin Base	1	CFS10W/GR10q	1	MAG STD	Mag. Stand.	16	3.6" across
	1	CFS10W/GR10q	1	ELECT	Electronic	13	
	2	CFS10W/GR10q	1	ELECT	Electronic	26	
16W, GR10q-4 Four Pin Base	1	CFS16W/GR10q	1	MAG STD	Mag. Stand.	23	5.5" across
	1	CFS16W/GR10q	1	ELECT	Electronic	15	
	2	CFS16W/GR10q	1	ELECT	Electronic	30	
21W, GR10q-4 Four Pin Base	1	CFS21W/GR10q	1	MAG STD	Mag. Stand.	31	5.5" across
	1	CFS21W/GR10q	1	ELECT	Electronic	21	
	2	CFS21W/GR10q	1	ELECT	Electronic	42	
28W, GR10q-4 Four Pin Base	1	CFS28W/GR10q	1	MAG STD	Mag. Stand.	38	8.1" across
	1	CFS28W/GR10q	1	ELECT	Electronic	28	
	2	CFS28W/GR10q	1	ELECT	Electronic	56	
(38W, GR10q-4 Four Pin Base	1	CFS38W/GR10q	1	ELECT	Electronic	37	8.1" across
	2	CFS38W/GR10q	1	ELECT	Electronic	74	

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-3 – Compact Fluorescent

Type	Lamps Number	Lamps Designation	Ballasts Number	Ballasts Designation	Ballasts Description	System Watts	Comment
Twin (5 W, G23 Two Pin Base - F5TT Lamp)	1	CFT5W/G23	1	MAG STD	Mag. Stand.	9	4.1" MOL
	2	CFT5W/G23	2	MAG STD	Mag. Stand.	18	
Twin (7 W, G23 Two Pin Base - F7TT Lamp)	1	CFT7W/G23	1	MAG STD	Mag. Stand.	11	5.3" MOL
	2	CFT7W/G23	2	MAG STD	Mag. Stand.	22	
Twin (7 W, 2G7 Four Pin Base - F7TT Lamp)	1	CFT7W/2G7	1	ELECT	Electronic	8	5.3" MOL
	2	CFT7W/2G7	2	ELECT	Electronic	16	
Twin (9 W, G23 Two Pin Base - F9TT Lamp)	1	CFT9W/G23	1	MAG STD	Mag. Stand.	13	6.5" MOL
	2	CFT9W/G23	2	MAG STD	Mag. Stand.	26	
Twin (9 W, 2G7 Four Pin Base - F9TT Lamp)	1	CFT9W/2G7	1	ELECT	Electronic	10	6.5" MOL
	2	CFT9W/2G7	2	ELECT	Electronic	20	
Twin (13 W, GX23 Two Pin Base - F13TT)	1	CFT13W/GX23	1	MAG STD	Mag. Stand.	17	7.5" MOL
	2	CFT13W/GX23	2	MAG STD	Mag. Stand.	34	
Twin (13 W, 2GX7 Four Pin Base - F13TT)	1	CFT13W/2GX7	1	ELECT	Electronic	17	7.5" MOL
	2	CFT13W/2GX7	2	ELECT	Electronic	34	
Quad (9 W, G23-2 Two Pin Base - F9DTT Lamp)	1	CFQ9W/G23-2	1	MAG STD 120	120 V Mag. Stand.	13	4.4" MOL
	2	CFQ9W/G23-2	2	MAG STD 120	120 V Mag. Stand.	26	
Quad (13 W, G24d-1 Two Pin Base - F13DTT Lamp)	1	CFQ13W/G24d -1	1	MAG STD 120	120 V Mag. Stand.	18	6.0" MOL
	2	CFQ13W/G24d -1	2	MAG STD 120	120 V Mag. Stand.	36	
	1	CFQ13W/G24d -1	1	MAG STD 277	277 V Mag. Stand.	16	
	2	CFQ13W/G24d -1	2	MAG STD 277	227 V Mag. Stand.	32	
Quad (13 W, GX23-2 Two Pin Base)	1	CFQ13W/GX23 -2	1	MAG STD	Mag. Stand.	17	4.8" MOL
	2	CFQ13W/GX23 -2	2	MAG STD	Mag. Stand.	34	
Quad (16W GX32d-1 Two Pin Base)	1	CFQ16W/GX32 d-1	1	MAG STD	Mag. Stand.	20	5.5" MOL
	2	CFQ16W/GX32 d-1	2	MAG STD	Mag. Stand.	40	
Quad (18 W, G24d-2 Two Pin Base - F18DTT Lamp)	1	CFQ18W/G24d -2	1	MAG STD 120	120 V Mag. Stand.	25	6.8" MOL
	2	CFQ18W/G24d -2	2	MAG STD 120	120 V Mag. Stand.	50	
	1	CFQ18W/G24d -2	1	MAG STD 277	227 V Mag. Stand.	22	
	2	CFQ18W/G24d -2	2	MAG STD 277	227 V Mag. Stand.	44	
	1	CFQ22W/GX32 d-2	1	MAG STD	Mag. Stand.	27	6.0" MOL
Quad (22W, GX32d Two Pin Base)	2	CFQ22W/GX32 d-2	2	MAG STD	Mag. Stand.	54	
Quad (26 W, G24d-3 Two Pin Base -	1	CFQ26W/G24d -3	1	MAG STD 120	120 V Mag. Stand.	37	7.6" MOL

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
F26DTT Lamp)	2	CFQ26W/G24d-3	2	MAG STD 120	120 V Mag. Stand.	74	
	1	CFQ26W/G24d-3	1	MAG STD 277	227 V Mag. Stand.	33	
	2	CFQ26W/G24d-3	2	MAG STD 277	227 V Mag. Stand.	66	
	1	CFQ26W/G24d-3	1	ELECT 277V	277 V Electronic	28	
	2	CFQ26W/G24d-3	2	ELECT 277V	277 V Electronic	54	
Quad (28W GX32d Two Pin Base)	1	CFQ28W/GX32d-3	1	MAG STD	Mag. Stand.	34	6.8" MOL
	2	CFQ28W/GX32d-3	2	MAG STD	Mag. Stand.	68	
Quad (10 W, G24q-1 Four Pin Base)	1	CFQ10W/G24q-1	1	MAG STD 120	120 V Mag. Stand.	16	4.6" MOL
	2	CFQ10W/G24q-1	2	MAG STD 120	120 V Mag. Stand.	32	
	1	CFQ10W/G24q-1	1	MAG STD 277	227 V Mag. Stand.	13	
	2	CFQ10W/G24q-1	2	MAG STD 277	227 V Mag. Stand.	26	
Quad (13 W, G24q-1 Four Pin Base)	1	CFQ13W/G24q-1	1	MAG STD 120	120 V Mag. Stand.	18	6.0" MOL
	2	CFQ13W/G24q-1	2	MAG STD 120	120 V Mag. Stand.	36	
	1	CFQ13W/G24q-1	1	MAG STD 277	227 V Mag. Stand.	16	
	2	CFQ13W/G24q-1	2	MAG STD 277	227 V Mag. Stand.	32	
	1	CFQ13W/G24q-1	1	ELECT	Electronic	16	
	2	CFQ13W/G24q-1	2	ELECT	Electronic	29	
Quad (13 W, GX7 Four Pin Base)	1	CFQ13W/GX7	1	MAG STD	Mag. Stand.	17	4.8" MOL
	2	CFQ13W/GX7	2	MAG STD	Mag. Stand.	34	
Quad (18 W, G24q-2 Four Pin Base)	1	CFQ18W/G24q-2	1	MAG STD 120	120 V Mag. Stand.	25	6.8" MOL
	2	CFQ18W/G24q-2	2	MAG STD 120	120 V Mag. Stand.	50	
	1	CFQ18W/G24q-2	1	MAG STD 277	227 V Mag. Stand.	22	
	2	CFQ18W/G24q-2	2	MAG STD 277	227 V Mag. Stand.	44	
	1	CFQ18W/G24q-2	1	ELECT	Electronic	21	
	2	CFQ18W/G24q-2	2	ELECT	Electronic	38	
Triple (13 W, GX24q-1 Four Pin Base)	1	CFM 13W/GX24q-1	1	MAG STD	Mag. Stand.	18	4.2" MOL
	2	CFM 13W/GX24q-1	2	MAG STD	Mag. Stand.	36	

	Lamps		Ballasts				
Type	Number	Designation	Number	Designation	Description	System Watts	Comment
	1	CFM 13W/GX24q-1	1	ELECT	Electronic	16	
	2	CFM 13W/GX24q-1	2	ELECT	Electronic	29	
Triple (18W, GX24q-2 Four Pin Base)	1	CFM 18W/GX24q-2	1	MAG STD	Mag. Stand.	25	5.0" MOL
	2	CFM 18W/GX24q-2	2	MAG STD	Mag. Stand.	50	
	1	CFM 18W/GX24q-2	1	ELECT	Electronic	21	
	2	CFM 18W/GX24q-2	2	ELECT	Electronic	38	
Triple (26W, GX24q-3 Four Pin Base)	1	CFTR 26W/GX24q-3	1	MAG STD	Mag. Stand.	37	4.9 to 5.4" MOL
	2	CFTR 26W/GX24q-3	2	MAG STD	Mag. Stand.	74	
	1	CFTR 26W/GX24q-3	1	ELECT	Electronic	28	
	2	CFTR 26W/GX24q-3	1	ELECT	Electronic	57	
	1	CFTR 26W/GX24q-3	1	ELECT DIM	Electronic DImming	8~29	BF .05~1.0
	2	CFTR 26W/GX24q-3	1	ELECT DIM	Electronic Dimming	12~57	BF .05~1.0
Triple (32 W, GX24q-3 Four Pin Base)	1	CFTR32WGX24q-3	1	ELECT	Electronic	36	
	2	CFTR32WGX24q-3	1	ELECT	Electronic	69	
	1	CFTR32WGX24q-3	1	ELECT DIM	Electronic DImming	9~38	BF .05~1.05
	2	CFTR32WGX24q-3	1	ELECT DIM	Electronic Dimming	20~76	BF .05~1.05
Triple or Quad (42W, GX24q-4 Four Pin Base)	1	CFTR42WGX24q-4	1	ELECT	Electronic	46	
	2	CFTR42WGX24q-4	1	ELECT	Electronic	94	
	1	CFTR42WGX24q-4	1	ELECT DIM	Electronic DImming	10~49	BF .05~1.05
	2	CFTR42WGX24q-4	1	ELECT DIM	Electronic Dimming	20~98	BF .05~1.05
Triple or Quad (57W, GX24q-5 Four Pin Base)	1	CFTR57WGX24q-5	1	ELECT	Electronic	62	
	1	CFTR57WGX24q-5	1	ELECT DIM	Electronic Dimming	18~66	BF .05~1.05
Triple or Quad (70W, GX24q-6 Four Pin Base)	1	CFTR70WGX24q-6	1	ELECT	Electronic	75	
	1	CFTR70WGX24q-6	1	ELECT DIM	Electronic Dimming	18~80	BF .05~1.00

~~RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%~~

Table NA8-4 – Long Compact Fluorescent

	Lamps		Ballasts			System	
Type	Number	Designation	Number	Designation	Description	Watts	Comment
T5 Twin (18W - F18TT Lamp)	1	FT18W/2G11	1	MAG.	Mag. Energy Efficient	23	BF~1.0
	2	FT18W/2G11	1	MAG.	Mag. Energy Efficient	46	BF~1.0
	3	FT18W/2G11	1	MAG.	Mag. Energy Efficient	69	
	1	FT18W/2G11	1	ELECT	Electronic	24	
	2	FT18W/2G11	1	ELECT	Electronic	35	
	3	FT18W/2G11	1	ELECT	Electronic	52	
T5 Twin (24-27W- F24TT or F27TT Lamp)	1	FT24W/2G11	1	MAG.	Mag. Energy Efficient	32	
	2	FT24W/2G11	1	MAG.	Mag. Energy Efficient	66	
	3	FT24W/2G11	1	MAG.	Mag. Energy Efficient	98	
	1	FT24W/2G11	1	ELECT	Electronic	27	BF~1.0
	2	FT24W/2G11	1	ELECT	Electronic	52	BF~1.0
T5 Twin (36-39W - F36TT or F39TT Lamp)	1	FT36W/2G11	1	MAG.	Mag. Energy Efficient	51	
	2	FT36W/2G11	1	MAG.	Mag. Energy Efficient	66	
	3	FT36W/2G11	2	MAG.	Mag. Energy Efficient	117	
	1	FT36W/2G11	1	ELECT	Electronic	37	
	2	FT36W/2G11	1	ELECT	Electronic	70	
	1	FT36W/2G11	1	ELECTHO	Electronic High Output	46	BF=1.22
	2	FT36W/2G11	1	ELECTHO	Electronic High Output	86	BF=1.20
T5 Twin (40 W - F40TT Lamp)	1	FT40W/2G11	1	MAG.	Mag. Energy Efficient	43	
	2	FT40W/2G11	1	MAG.	Mag. Energy Efficient	86	
	3	FT40W/2G11	2	MAG.	Mag. Energy Efficient	130	
Electronic Ballasts	1	FT40W/2G11	1	ELECT NO	Electronic	41	BF~.90
	2	FT40W/2G11	1	ELECT NO1	Electronic	72	BF~.88
	2	FT40W/2G11	1	ELECT NO2	Electronic	78	BF~.97
	3	FT40W/2G11	1	ELECT NO	Electronic	103 110	BF~.86 BF~.88
	1	FT40W/2G11	1	ELECT HO	Electronic High Output	50	BF ~ 1.1
	1	FT40W/2G11	1	ELECT DIM1	Electronic Dimming	10- 45	BF .05~1.0
	2	FT40W/2G11	1	ELECT DIM1	Electronic Dimming	17- 97	BF .05~1.0
	1	FT40W/2G11	1	ELECT DIM2	Electronic Dimming	11-38	BF .05~.88
	2	FT40W/2G11	1	ELECT DIM2	Electronic Dimming	16-76	BF .05~.88
T5 Twin (50 W - F50TT Lamp)	1	FT50W/2G11	1	ELECT NO	Electronic Normal Output	54	BF~.98
	2	FT50W/2G11	1	ELECT NO	Electronic Normal Output	106	BF~.98
	1	FT50W/2G11	1	ELECT HO	Electronic High Output	61	BF~1.12
	2	FT50W/2G11	1	ELECT HO	Electronic High Output	115	BF~1.10
	1	FT50W/2G11	1	ELECT DIM	Electronic Dimming	51	
	2	FT50W/2G11	1	ELECT DIM	Electronic Dimming	92	
T5 Twin (55 W - F55TT Lamp)	1	FT55W/2G11	1	ELECT NO	Electronic Normal Output	58 62	BF~.92 BF~1.0
	2	FT55W/2G11	1	ELECT NO	Electronic Normal Output	109 116	BF~.90 BF~.95
	1	FT55W/2G11	1	ELECT DIM	Electronic Dimming	8~62	BF .01~98
	2	FT55W/2G11	1	ELECT DIM	Electronic Dimming	8-120	BF .01~.98

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
T5 Twin (80 W – F80TT Lamp)	1	FT80W/2G11	1	ELECT NO	Electronic	91	BF~1.00

Table NA8-5 – Fluorescent U-Tubes

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
2 ft. Fluorescent U-Tube T8 (32W - FBO31T8 or F32T8/U/6 Lamp)	1	FB31T8/F32T8U	0.5	MAG.	Mag. Energy Efficient	35	Tandem wired
	1	FB31T8/F32T8U	1	MAG.	Mag. Energy Efficient	36	
	2	FB31T8/F32T8U	1	MAG.	Mag. Energy Efficient	69	
	3	FB31T8/F32T8U	1.5	MAG.	Mag. Energy Efficient	104	Tandem wired
	3	FB31T8/F32T8U	2	MAG.	Mag. Energy Efficient	105	
	1	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	39	
	2	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	62	
	3	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	92	
	1	FB31T8/F32T8U	1	ELECT DIM	Electronic DImming	9~33	BF .05~.88
	2	FB31T8/F32T8U	1	ELECT DIM	Electronic DImming	14~64	BF .05~.88
	3	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	18~93	BF .05~.88
	4	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	25~116	BF .05~.88
2 ft. Fluorescent U-Tube T12 (“Energy Saving” 34W)	1	FB40T12/ES	0.5	MAG.	Mag. Energy Efficient	36	Tandem wired
	1	FB40T12/ES	1	MAG.	Mag. Energy Efficient	43	
	2	FB40T12/ES	1	MAG.	Mag. Energy Efficient	87	
	3	FB40T12/ES	1	MAG.	Mag. Energy Efficient	105	
	3	FB40T12/ES	1.5	MAG.	Mag. Energy Efficient	108	Tandem wired
	3	FB40T12/ES	2	MAG.	Mag. Energy Efficient	115	
	1	FB40T12/ES	0.5	ELECT	Electronic	30	Tandem wired
	1	FB40T12/ES	1	ELECT	Electronic	31	
	2	FB40T12/ES	1	ELECT	Electronic	59	
	3	FB40T12/ES	1	ELECT	Electronic	90	
	3	FB40T12/ES	1.5	ELECT	Electronic	88	Tandem wired
	3	FB40T12/ES	2	ELECT	Electronic	90	

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-6 – Fluorescent Linear Lamps – Preheat

Type	Lamps		Ballasts			System Watts	Comment
	Nmbr	Designation	Nmbr	Designation	Description		
Fluorescent Preheat T5 (8W)	1	F8T5	1	MAG STD	Mag. Stand.	12	12" MOL
Fluorescent Preheat T8 (15W)	1	F15T8	1	MAG STD	Mag. Stand.	22	18" MOL
Fluorescent Preheat T12 (15W)	1	F15T12	1	MAG STD	Mag. Stand.	23	18" MOL
Fluorescent Preheat T12 (20W)	1	F20T12	1	MAG STD	Mag. Stand.	25	24" MOL
	2	F20T12	1	MAG STD	Mag. Stand.	50	24" MOL
Fluorescent Preheat T8 (30W)	1	F30T8	1	MAG STD	Mag. Stand.	46	30" MOL
	2	F30T8	1	MAG STD	Mag. Stand.	79	30" MOL

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-7 – Fluorescent Linear Lamps T5

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
~23" Fluorescent Program Start T5 (14W)	1	F14T5	1	ELECT	Elect. Program Start BF=1	18	
	2	F14T5	1	ELECT	Elect. Program Start BF=1	34	
~34.5" Fluorescent Program Start T5 (21W)	1	F21T5	1	ELECT	Elect. Program Start BF=1	27	
	2	F21T5	1	ELECT	Elect. Program Start BF=1	50	
~46" Fluorescent Program Start T5 (28W)	1	F28T5	1	ELECT	Elect. Program Start BF=1	30	
	2	F28T5	1	ELECT	Elect. Program Start BF=1	60	
~58.5" Fluorescent Program Start T5 (35W)	1	F35T5	1	ELECT	Elect. Program Start BF=1	40	
	2	F35T5	1	ELECT	Elect. Program Start BF=1	78	
~23" Fluorescent Program Start T5 High Output (24W)	1	F24T5HO	1	ELECT	Elect. Program Start BF=1	29	
	2	F24T5HO	1	ELECT	Elect. Program Start BF=1	55	
~34.5" Fluorescent Program Start T5 High Output(39W)	1	F39T5	1	ELECT	Elect. Program Start BF=1	43	
	2	F39T5	1	ELECT	Elect. Program Start BF=1	85	
~46" Fluorescent Program Start T5 High Output (54W)	1	F54T5	1	ELECT	Elect. Program Start BF=1	62	
	2	F54T5	1	ELECT	Elect. Program Start BF=1	121	
	1	F54T5	1	ELECT DIM	Elect. Dimming	8-63	
	2	F54T5	1	ELECT DIM	Elect. Dimming	18-125	
~57.5" Fluorescent Program Start T5 High Output (80W)	1	ºF80T5	1	ELECT	Elect. Program Start BF=1	90	

RO = ballast factor 70 to 85%   NO = ballast factor 85 to 100%   HO = ballast factor >100%

Table NA8-8 – Fluorescent Rapid Start T-8

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
2 foot Fluorescent Rapid Start T8 (17W)	1	F17T8	1	MAG.	Mag. Energy Efficient	31	
	2	F17T8	1	MAG.	Mag. Energy Efficient	45	
Electronic Ballasts	1	F17T8	1	ELECT NO	Electronic Normal Output	22	
	2	F17T8	1	ELECT NO	Electronic Normal Output	33	
	3	F17T8	1	ELECT NO	Electronic Normal Output	53	
	3	F17T8	2	ELECT NO	Electronic Normal Output	55	
	4	F17T8	1	ELECT NO	Electronic Normal Output	63	
2 foot Fluorescent Rapid	1	F17T8	1	ELECT DIM	Electronic Dimming	8~20	BF .05~.88

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
Start T8 (17W)	2	F17T8	1	ELECT DIM	Electronic Dimming	10~37	BF .05~.88
	3	F17T8	1	ELECT DIM	Electronic Dimming	12~56	BF .05~.88
	4	F17T8	1	ELECT DIM	Electronic Dimming	18~69	BF .05~.88
3 foot Fluorescent Rapid Start T8 (25W)	1	F25T8	1	MAG.	Mag. Energy Efficient	33	
	2	F25T8	1	MAG.	Mag. Energy Efficient	65	
Electronic Ballasts	1	F25T8	1	ELECT NO	Electronic Normal Output	27	
	2	F25T8	1	ELECT NO	Electronic Normal Output	48	
	3	F25T8	1	ELECT NO	Electronic Normal Output	68	
	4	F25T8	1	ELECT NO	Electronic Normal Output	89	
	1	F25T8	1	ELECT RO	Electronic Reduced Output	24	
	2	F25T8	1	ELECT RO	Electronic Reduced Output	41	
	3	F25T8	1	ELECT RO	Electronic Reduced Output	59	
	4	F25T8	1	ELECT RO	Electronic Reduced Output	76	
	1	F25T8	1	ELECT HO	Electronic High Output	29	BF~1.05
	2	F25T8	1	ELECT HO	Electronic High Output	51	BF~1.05
	3	F25T8	1	ELECT HO	Electronic High Output	74	BF~1.05
	1	F25T8	1	ELECT DIM	Electronic Dimming	8~25	BF .05~.94
	2	F25T8	1	ELECT DIM	Electronic Dimming	13~49	BF .05~.94
	3	F25T8	1	ELECT DIM	Electronic Dimming	16~76	BF .05~.94
	4	F25T8	1	ELECT DIM	Electronic Dimming	22~96	BF .05~.88
4 foot Fluorescent Rapid Start T12 for T-8 ballasts (“Energy Saving” 25W)	1	F25T12ES	1	ELECT NO	Electronic Normal Output	27	
	2	F25T12ES	1	ELECT NO	Electronic Normal Output	52	
	3	F25T12ES	1	ELECT NO	Electronic Normal Output	77	
	4	F25T12ES	1	ELECT NO	Electronic Normal Output	95	
4 foot Fluorescent Instant Start T8 (“Energy Saving” 30W)	1	F32T8/30ES	1	ELECT NO	Electronic Normal Output	29	
	2	F32T8/30ES	1	ELECT NO	Electronic Normal Output	54	
	3	F32T8/30ES	1	ELECT NO	Electronic Normal Output	79	
	4	F32T8/30ES	1	ELECT NO	Electronic Normal Output	104	
	1	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	27	
	2	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	48	
	3	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	70	

~~Type~~	~~Lamps~~		~~Ballasts~~			~~System Watts~~	~~Comment~~
	~~Number~~	~~Designation~~	~~Number~~	~~Designation~~	~~Description~~		
	~~4~~	~~F32T8/30ES~~	~~1~~	~~ELECT RO~~	~~Electronic Reduced Output~~	~~91~~	
	~~1~~	~~F32T8/30ES~~	~~1~~	~~ELECT NO EE~~	~~EE Normal Output~~	~~33~~	
	~~2~~	~~F32T8/30ES~~	~~1~~	~~ELECT NO EE~~	~~Energy efficiency Normal Output~~	~~52~~	
	~~3~~	~~F32T8/30ES~~	~~1~~	~~ELECT NO EE~~	~~Energy efficiency Normal Output~~	~~77~~	
	~~4~~	~~F32T8/30ES~~	~~1~~	~~ELECT NO EE~~	~~Energy efficiency Normal Output~~	~~101~~	
	~~1~~	~~F32T8/30ES~~	~~1~~	~~ELECT RO EE~~	~~EE Reduced Output~~	~~28~~	
	~~2~~	~~F32T8/30ES~~	~~1~~	~~ELECT RO EE~~	~~EE Reduced Output~~	~~45~~	
	~~3~~	~~F32T8/30ES~~	~~1~~	~~ELECT RO EE~~	~~EE Reduced Output~~	~~66~~	
	~~4~~	~~F32T8/30ES~~	~~1~~	~~ELECT RO EE~~	~~EE Reduced Output~~	~~88~~	
~~4 foot Fluorescent Rapid Start T8 (32W)~~	~~1~~	~~F32T8~~	~~0.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~35~~	~~Tandem wired~~
	~~1~~	~~F32T8~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~44~~	
	~~2~~	~~F32T8~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~74~~	
	~~3~~	~~F32T8~~	~~1.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~105~~	~~Tandem wired~~
	~~3~~	~~F32T8~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~109~~	
	~~4~~	~~F32T8~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~140~~	~~(2) two-lamp ballasts~~
~~4 foot Fluorescent Rapid Start T8 (32W)~~	~~1~~	~~F32T8~~	~~1~~	~~ELECT NO~~	~~Electronic Normal Output~~	~~32~~	
	~~2~~	~~F32T8~~	~~1~~	~~ELECT NO~~	~~Electronic Normal Output~~	~~62~~	
	~~3~~	~~F32T8~~	~~1~~	~~ELECT NO~~	~~Electronic Normal Output~~	~~93~~	
	~~4~~	~~F32T8~~	~~1~~	~~ELECT NO~~	~~Electronic Normal Output~~	~~114~~	
	~~1~~	~~F32T8~~	~~1~~	~~EE NO~~	~~EE Normal Output~~	~~35~~	
	~~2~~	~~F32T8~~	~~1~~	~~EE NO~~	~~EE Normal Output~~	~~55~~	
	~~3~~	~~F32T8~~	~~1~~	~~EE NO~~	~~EE Normal Output~~	~~82~~	
	~~4~~	~~F32T8~~	~~1~~	~~EE NO~~	~~EE Normal Output~~	~~107~~	
	~~1~~	~~F32T8~~	~~1~~	~~ELECT RO~~	~~Electronic Reduced Output~~	~~29~~	
	~~2~~	~~F32T8~~	~~1~~	~~ELECT RO~~	~~Electronic Reduced Output~~	~~51~~	
	~~3~~	~~F32T8~~	~~1~~	~~ELECT RO~~	~~Electronic Reduced Output~~	~~76~~	
	~~4~~	~~F32T8~~	~~1~~	~~ELECT RO~~	~~Electronic Reduced Output~~	~~98~~	
	~~2~~	~~F32T8~~	~~1~~	~~ELECT HO~~	~~Electronic High Output~~	~~77~~	~~BF~1.13~~
	~~3~~	~~F32T8~~	~~1~~	~~ELECT HO~~	~~Electronic High Output~~	~~112~~	~~BF~1.18~~
	~~1~~	~~F32T8~~	~~1~~	~~EE RO~~	~~EE Reduced Output~~	~~30~~	
	~~2~~	~~F32T8~~	~~1~~	~~EE RO~~	~~EE Reduced Output~~	~~48~~	
	~~3~~	~~F32T8~~	~~1~~	~~EE RO~~	~~EE Reduced Output~~	~~73~~	

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
	4	F32T8	1	EE RO	EE Reduced Output	96	
	2	F32T8	1	ELECT TL	Electronic Two Level (50 & 100%)	65	
	1	F32T8	1	ELECT DIM1	Electronic Dimming	9~35	BF .05~1.0
	2	F32T8	1	ELECT DIM1	Electronic Dimming	15~68	BF .05~1.0
	3	F32T8	1	ELECT DIM1	Electronic Dimming	20~102	BF .05~1.0
	1	F32T8	1	ELECT DIM2	Electronic Dimming	9~33	BF .05~.88
	2	F32T8	1	ELECT DIM2	Electronic Dimming	14~64	BF .05~.88
	3	F32T8	1	ELECT DIM2	Electronic Dimming	18~93	BF .05~.88
	4	F32T8	1	ELECT DIM2	Electronic Dimming	25~116	BF .05~.88
5 foot Fluorescent Rapid Start T8 (40W)	1	F40T8	1	MAG.	Mag. Energy Efficient	50	
	2	F40T8	1	MAG.	Mag. Energy Efficient	92	
	1	F40T8	1	ELECT	Electronic	46	
	2	F40T8	1	ELECT	Electronic	79	
	3	F40T8	1	ELECT	Electronic	112	
3 foot Fluorescent Rapid Start T12 ("Energy-Saving" 25W)	1	F30T12/ES	1	MAG STD	Mag. Stand.	42	
	2	F30T12/ES	1	MAG STD	Mag. Stand.	74	
	3	F30T12/ES	1.5	MAG STD	Mag. Stand.	111	Tandem wired
	3	F30T12/ES	2	MAG STD	Mag. Stand.	116	
	2	F30T12/ES	1	MAG.	Mag. Energy Efficient	66	
	1	F30T12/ES	1	ELECT	Electronic	26	
	2	F30T12/ES	1	ELECT	Electronic	53	
3 foot Fluorescent Rapid Start T12 ("Stand." 30W)	1	F30T12	1	MAG STD	Mag. Stand.	46	
	2	F30T12	1	MAG STD	Mag. Stand.	80	
	3	F30T12	1.5	MAG STD	Mag. Stand.	118	Tandem wired
	3	F30T12	2	MAG STD	Mag. Stand.	125	
	2	F30T12	1	MAG.	Mag. Energy Efficient	73	
	1	F30T12	1	ELECT	Electronic	30	
	2	F30T12	1	ELECT	Electronic	66	
4 foot Fluorescent Rapid Start T12 ("Energy-Saving Plus"32W)	1	F40T12/ES Plus	0.5	MAG.	Mag. Energy Efficient	34	Tandem wired
	1	F40T12/ES Plus	1	MAG.	Mag. Energy Efficient	41	
	2	F40T12/ES Plus	1	MAG.	Mag. Energy Efficient	68	
	3	F40T12/ES Plus	1	MAG.	Mag. Energy Efficient	99	
	3	F40T12/ES Plus	1.5	MAG.	Mag. Energy Efficient	102	Tandem wired
	3	F40T12/ES Plus	2	MAG.	Mag. Energy Efficient	109	
	4	F40T12/ES Plus	2	MAG.	Mag. Energy Efficient	136	(2) Two-lamp ballasts

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-9 – Fluorescent Rapid Start T-12

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
4 foot Fluorescent Rapid Start T12 ("Energy-Saving"34W)	1	F40T12/ES	0.5	MAG STD**	Mag. Stand.	42	Tandem wired
	1	F40T12/ES	1	MAG STD**	Mag. Stand.	48	
	2	F40T12/ES	1	MAG STD**	Mag. Stand.	82	

~~Type~~	~~Lamps~~		~~Ballasts~~			~~System Watts~~	~~Comment~~
	~~Number~~	~~Designation~~	~~Number~~	~~Designation~~	~~Description~~		
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~MAG STD**~~	~~Mag. Stand.~~	~~122~~	~~Tandem wired~~
	~~3~~	~~F40T12/ES~~	~~2~~	~~MAG STD**~~	~~Mag. Stand.~~	~~130~~	
	~~4~~	~~F40T12/ES~~	~~2~~	~~MAG STD**~~	~~Mag. Stand.~~	~~164~~	~~(2) Two-lamp ballasts~~
	~~1~~	~~F40T12/ES~~	~~0.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~36~~	~~Tandem wired~~
	~~1~~	~~F40T12/ES~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~43~~	
	~~2~~	~~F40T12/ES~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~72~~	
	~~3~~	~~F40T12/ES~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~105~~	
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~108~~	~~Tandem wired~~
	~~3~~	~~F40T12/ES~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~112~~	
	~~4~~	~~F40T12/ES~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~144~~	~~(2) Two-lamp ballasts~~
	~~2~~	~~F40T12/ES~~	~~1~~	~~MAG HC~~	~~Mag. Heater Cutout~~	~~58~~	
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~MAG HC~~	~~Mag. Heater Cutout~~	~~87~~	~~Tandem wired~~
	~~4~~	~~F40T12/ES~~	~~2~~	~~MAG HC~~	~~Mag. Heater Cutout~~	~~116~~	~~(2) Two-lamp ballasts~~
	~~2~~	~~F40T12/ES~~	~~1~~	~~MAG HC FO~~	~~Mag. Heater Cutout Full Light~~	~~66~~	
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~MAG HC FO~~	~~Mag. Heater Cutout Full Light~~	~~99~~	~~Tandem wired~~
	~~4~~	~~F40T12/ES~~	~~2~~	~~MAG HC FO~~	~~Mag. Heater Cutout Full Light~~	~~132~~	~~(2) Two-lamp ballasts~~
	~~1~~	~~F40T12/ES~~	~~0.5~~	~~ELECT~~	~~Electronic~~	~~30~~	~~Tandem wired~~
	~~1~~	~~F40T12/ES~~	~~1~~	~~ELECT~~	~~Electronic~~	~~31~~	
	~~2~~	~~F40T12/ES~~	~~1~~	~~ELECT~~	~~Electronic~~	~~62~~	
	~~3~~	~~F40T12/ES~~	~~1~~	~~ELECT~~	~~Electronic~~	~~90~~	
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~ELECT~~	~~Electronic~~	~~93~~	~~Tandem wired~~
	~~3~~	~~F40T12/ES~~	~~2~~	~~ELECT~~	~~Electronic~~	~~93~~	
	~~4~~	~~F40T12/ES~~	~~1~~	~~ELECT~~	~~Electronic~~	~~121~~	
	~~4~~	~~F40T12/ES~~	~~2~~	~~ELECT~~	~~Electronic~~	~~124~~	~~(2) Two-lamp ballasts~~
	~~2~~	~~F40T12/ES~~	~~1~~	~~ELECT AO~~	~~Elec. Adjustable Output (to 15%)~~	~~60~~	
	~~3~~	~~F40T12/ES~~	~~1.5~~	~~ELECT AO~~	~~Elec. Adjustable Output (to 15%)~~	~~90~~	~~Tandem wired~~
	~~4~~	~~F40T12/ES~~	~~2~~	~~ELECT AO~~	~~Elec. Adjustable Output (to 15%)~~	~~120~~	~~(2) Two-lamp ballasts~~
~~4 foot Fluorescent Rapid Start Stand. (40W)~~	~~1~~	~~F40T12~~	~~0.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~44~~	~~Tandem wired~~
	~~1~~	~~F40T12~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~46~~	
	~~2~~	~~F40T12~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~88~~	
	~~3~~	~~F40T12~~	~~1~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~127~~	
	~~3~~	~~F40T12~~	~~1.5~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~132~~	~~Tandem wired~~
	~~3~~	~~F40T12~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~134~~	
	~~4~~	~~F40T12~~	~~2~~	~~MAG.~~	~~Mag. Energy Efficient~~	~~176~~	~~(2) Two-lamp ballasts~~
	~~2~~	~~F40T12~~	~~1~~	~~MAG HC~~	~~Mag. Heater Cutout~~	~~71~~	
	~~3~~	~~F40T12~~	~~1.5~~	~~MAG HC~~	~~Mag. Heater Cutout~~	~~107~~	~~Tandem wired~~

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
	4	F40T12	2	MAG HC	Mag. Heater Cutout	142	(2) Two-lamp ballasts
4 foot Fluorescent Rapid Start Stand. (40W) *cont.*	2	ºF40T12	1	MAG ºF FO	Mag. Heater Cutout Full Light	80	
	3	ºF40T12	1.5	MAG ºF FO	Mag. Heater Cutout Full Light	120	Tandem wired
	4	ºF40T12	2	MAG ºF FO	Mag. Heater Cutout Full Light	160	(2) Two-lamp ballasts
	1	ºF40T12	0.5	ELECT	Electronic	36	Tandem wired
	1	ºF40T12	1	ELECT	Electronic	37	
	2	ºF40T12	1	ELECT	Electronic	72	
	3	ºF40T12	1	ELECT	Electronic	107	
	3	ºF40T12	1.5	ELECT	Electronic	108	Tandem wired
	3	ºF40T12	2	ELECT	Electronic	109	
	4	ºF40T12	1	ELECT	Electronic	135	
	4	ºF40T12	2	ELECT	Electronic	144	(2) Two-lamp ballasts
	2	ºF40T12	1	ELECT RO	Electronic Reduce Output (75%)	61	
	3	ºF40T12	1	ELECT RO	Electronic Reduce Output (75%)	90	
	3	ºF40T12	1.5	ELECT RO	Electronic Reduce Output (75%)	92	Tandem wired
	4	ºF40T12	2	ELECT RO	Electronic Reduce Output (75%)	122	(2) Two-lamp ballasts
	2	ºF40T12	1	ELECT TL	Elec. Two Level (50 & 100%)	69	
	3	ºF40T12	1.5	ELECT TL	Elec. Two Level (50 & 100%)	104	Tandem wired
	4	ºF40T12	2	ELECT TL	Elec. Two Level (50 & 100%)	138	(2) Two-lamp ballasts
	2	ºF40T12	1	ELECT AO	Elec. Adjustable Output (to 15%)	73	
	3	ºF40T12	1.5	ELECT AO	Elec. Adjustable Output (to 15%)	110	Tandem wired
	4	ºF40T12	2	ELECT AO	Elec. Adjustable Output (to 15%)	146	(2) Two-lamp ballasts
	2	ºF40T12	1	ELECT DIM	Electronic Dimming (to 1%)	83	
	3	ºF40T12	1.5	ELECT DIM	Electronic Dimming (to 1%)	125	Tandem wired
	4	ºF40T12	2	ELECT DIM	Electronic Dimming (to 1%)	166	(2) Two-lamp ballasts

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-10 – Fluorescent Rapid Start High Output (HO) T8 & T12, 8 ft

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
8 foot Fluorescent Rapid	1	F96T8/HO	1	ELECT	Electronic	88	

Start T8 High Output (86W)	2	F96T8/HO	1	ELECT	Electronic	160
8 foot Fluorescent Rapid Start T12 High Output ("Energy Saving" 95W)	1	F96T12/HO/ES	1	MAG STD	Mag. Stand.	125
	2	F96T12/HO/ES	1	MAG STD**	Mag. Stand.	227
	2	F96T12/HO/ES	1	MAG.	Mag. Energy Efficient	208
	2	F96T12/HO/ES	1	ELECT	Electronic	170
8 foot Fluorescent Rapid Start T12 High Output ("Stand." 110W)	1	F96T12/HO	1	MAG STD	Mag. Stand.	140
	2	F96T12/HO	1	MAG STD**	Mag. Stand.	252
	2	F96T12/HO	1	MAG.	Mag. Energy Efficient	237
	1	F96T12/HO	1	ELECT	Electronic	119
	2	F96T12/HO	1	ELECT	Electronic	205
8 foot Fluorescent Rapid Start T12 Very High Output ("Energy Saving" 195W)	1	F96T12/VHO/ES	1	MAG STD	Mag. Stand.	200
	2	F96T12/VHO/ES	1	MAG STD	Mag. Stand.	325
8 foot Fluorescent Rapid Start T12 Very High Output ("Stand." 215W)	1	Stand.96T12/VHO	1	MAG STAND.	Mag. Stand.	230
	2	Stand.96T12/VHO	1	MAG STAND.	Mag. Stand.	452

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-11 – Fluorescent Instant Start (single pin base "Slimline") T12, 4 ft

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
4 foot Fluorescent Slimline Energy-Saving T12 (32W)	1	Stand.48T12/ES	1	MAG STAND.	Mag. Stand.	51	
	2	Stand.48T12/ES	1	MAG STAND.	Mag. Stand.	82	
4 foot Fluorescent Slimline Stand. Stand. (39W)	1	Stand.48T12	1	MAG Stand.	Mag. Stand.	59	
	2	Stand.48T12	1	MAG Stand.	Mag. Stand.	98	

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-12 – Fluorescent Instant Start (single pin base "Slimline") T8 & T12, 8 ft.

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
8 foot Fluorescent T8 Slimline (59W)	1	F96T8	1	MAG.	Mag. Stand.	58	
	2	F96T8	1	MAG.	Mag. Stand.	120	
	2	F96T8	1	ELECT NO	Electronic Normal Output	110	
	1	F96T8	1	ELECT HO	Electronic High Output	72	BF~1.10
	2	F96T8	1	ELECT HO1	Electronic High Output	140	BF~1.10
	2	F96T8	1	ELECT HO2	Electronic High Output	151	BF~1.20
8 foot Fluorescent T12 Slimline ("Energy-Saving" 60W)	1	F96T12/ES	1	MAG STD	Mag. Stand.	87	
	2	F96T12/ES	1	MAG STD**	Mag. Stand.	135	

	2	F96T12/ES	1	MAG.	Mag. Energy Efficient	112
	1	F96T12/ES	1	ELECT	Electronic	70
	2	F96T12/ES	1	ELECT	Electronic	107
8 foot Fluorescent T12 Slimline ("Stand." 75W)	1	F96T12	1	MAG STD	Mag. Stand.	101
	2	F96T12	1	MAG STD**	Mag. Stand.	160
	2	F96T12	1	MAG.	Mag. Energy Efficient	144
	1	F96T12	1	ELECT	Electronic	85
	2	F96T12	1	ELECT	Electronic	132

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-13 – High Intensity Discharge

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
Mercury Vapor	1	H40	1	MAG STD	Mag. Stand.	51	
	1	H50	1	MAG STD	Mag. Stand.	68	
	1	H75	1	MAG STD	Mag. Stand.	92	
	1	H100	1	MAG STD	Mag. Stand.	120	
	1	H175	1	MAG STD	Mag. Stand.	205	
	1	H250	1	MAG STD	Mag. Stand.	285	
	1	H400	1	MAG STD	Mag. Stand.	454	
	1	H1000	1	MAG STD	Mag. Stand.	1080	
Metal Halide	1	M35/39	1	MAG STD	Mag. Stand.	58	
	1	M35/39	1	ELECT	Electronic	44	
	1	M50	1	MAG STD	Mag. Stand.	68	
	1	M50	1	ELECT	Electronic	58	
	1	M70	1	MAG STD	Mag. Stand.	95	
	1	M70	1	ELECT	Electronic	86	
	1	M100	1	MAG STD	Mag. Stand.	130	
	1	M100	1	ELECT	Electronic	110	
	1	M125	1	MAG STD	Mag. Stand.	150	
	1	M150	1	MAG STD	Mag. Stand.	189	
	1	M150	1	ELECT	Electronic	168	
	1	M175	1	MAG STD	Mag. Stand.	208	
	1	M200	1	MAG STD	Mag. Stand.	232	
	1	M225	1	MAG STD	Mag. Stand.	258	
	1	M250	1	MAG STD	Mag. Stand.	295	
	1	M320	1	MAG STD	Mag. Stand.	368	
	1	M320	1	MAG LR	277v Linear Reactor	345	
	1	M360	1	MAG STD	Mag. Stand.	422	
	1	M360	1	MAG LR	277v Linear Reactor	388	
	1	M400	1	MAG STD	Mag. Stand.	461	
	1	M400	1	MAG LR	277v Linear Reactor	426	
	1	M450	1	MAG STD	Mag. Stand.	502	
	1	M450	1	MAG LR	277v Linear Reactor	478	
	1	M750	1	MAG STD	Mag. Stand.	820	
	1	M900	1	MAG STD	Mag. Stand.	990	
	1	M1000	1	MAG STD	Mag. Stand.	1080	

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
	1	M1500	1	MAG STD	Mag. Stand.	1650	
	1	M1650	1	MAG STD	Mag. Stand.	1810	
High Pressure Sodium	1	S35	1	MAG STD	Mag. Stand.	47	
	1	S50	1	MAG STD	Mag. Stand.	66	
	1	S70	1	MAG STD	Mag. Stand.	93	
	1	S100	1	MAG STD	Mag. Stand.	128	
	1	S150	1	MAG STD	Mag. Stand.	188	
	1	S200	1	MAG STD	Mag. Stand.	240	
	1	S250	1	MAG STD	Mag. Stand.	302	
High Pressure Sodium *cont.*	1	S400	1	MAG STD	Mag. Stand.	469	
	1	S1000	1	MAG STD	Mag. Stand.	1100	
Low Pressure Sodium	1	LPS18	1	MAG STAND.	Mag. Stand.	30	
	1	LPS35	1	MAG STAND.	Mag. Stand.	60	
	1	LPS55	1	MAG STAND.	Mag. Stand.	80	
	1	LPS90	1	MAG STAND.	Mag. Stand.	125	
	1	LPS135	1	MAG STAND.	Mag. Stand.	178	
	1	LPS180	1	MAG STAND.	Mag. Stand.	220	

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-14 – 12 Volt Tungsten Halogen Lamps Including MR16, Bi-pin, AR70, AR111, PAR36

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
	1	20 watt lamp	1	ELECT	Electronic Power Supply	23	
	1	25 watt lamp	1	ELECT	Electronic Power Supply	28	
	1	35 watt lamp	1	ELECT	Electronic Power Supply	38	
	1	37 watt lamp	1	ELECT	Electronic Power Supply	41	
	1	42 watt lamp	1	ELECT	Electronic Power Supply	45	
	1	50 watt lamp	1	ELECT	Electronic Power Supply	54	
	1	65 watt lamp	1	ELECT	Electronic Power Supply	69	
	1	71 watt lamp	1	ELECT	Electronic Power Supply	75	
	1	75 watt lamp	1	ELECT	Electronic Power Supply	80	
	1	100 watt lamp	1	ELECT	Electronic Power Supply	106	
	1	20 watt lamp	1	MAG	Mag. Transformer	24	
	1	25 watt lamp	1	MAG	Mag. Transformer	29	
	1	35 watt lamp	1	MAG	Mag. Transformer	39	
	1	37 watt lamp	1	MAG	Mag. Transformer	42	
	1	42 watt lamp	1	MAG	Mag. Transformer	46	
	1	50 watt lamp	1	MAG	Mag. Transformer	55	
	1	65 watt lamp	1	MAG	Mag. Transformer	70	
	1	71 watt lamp	1	MAG	Mag. Transformer	76	
	1	75 watt lamp	1	MAG	Mag. Transformer	81	
	1	100 watt lamp	1	MAG	Mag. Transformer	108	

Appendix NA8 –Luminaire Power

NA8.1 Luminaire Power

The following tables contain a limited list of lamp and ballast combinations. These tables provide an alternate voluntary option to the provision in Section 130(c) for determining luminaire power for any lamp and ballast combination specifically listed in Appendix NA8. This appendix is not intended to list all possible lamp and ballast combinations, and shall not to be used to determine luminaire power for any lighting system not specifically listed in this appendix.

Table NA8-1 – Fluorescent U-Tubes

Type	Lamps		Ballasts			System Watts
	Number	Designation	Number	Designation	Description	
2 ft. Fluorescent U-Tube T8	1	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	39
	2	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	62
	3	FB31T8/F32T8U	1	ELECT NO	Electronic Normal Output	92
	1	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	33
	2	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	64
	3	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	93
	4	FB31T8/F32T8U	1	ELECT DIM	Electronic Dimming	116

NO = ballast factor 85 to 100%

Table NA8-2 – Fluorescent Linear Lamps T5

Type	Lamps		Ballasts			System Watts
	Number	Designation	Number	Designation	Description	
~23" Fluorescent Program Start T5 (14W)	1	F14T5	1	ELECT	Elect. Program Start BF=1	18
	2	F14T5	1	ELECT	Elect. Program Start BF=1	34
~34.5" Fluorescent Program Start T5 (21W)	1	F21T5	1	ELECT	Elect. Program Start BF=1	27
	2	F21T5	1	ELECT	Elect. Program Start BF=1	50
~46" Fluorescent Program Start T5 (28W)	1	F28T5	1	ELECT	Elect. Program Start BF=1	30
	2	F28T5	1	ELECT	Elect. Program Start BF=1	60
~58.5" Fluorescent Program Start T5 (35W)	1	F35T5	1	ELECT	Elect. Program Start BF=1	40
	2	F35T5	1	ELECT	Elect. Program Start BF=1	78
~23" Fluorescent Program Start T5 High Output (24W)	1	F24T5HO	1	ELECT	Elect. Program Start BF=1	29
	2	F24T5HO	1	ELECT	Elect. Program Start BF=1	55
~34.5" Fluorescent Program Start T5 High Output(39W)	1	F39T5	1	ELECT	Elect. Program Start BF=1	43
	2	F39T5	1	ELECT	Elect. Program Start BF=1	85
~46" Fluorescent Program Start T5 High Output (54W)	1	F54T5	1	ELECT	Elect. Program Start BF=1	62
	2	F54T5	1	ELECT	Elect. Program Start BF=1	121
	1	F54T5	1	ELECT DIM	Elect. Dimming	63
	2	F54T5	1	ELECT DIM	Elect. Dimming	125
~57.5" Fluorescent Program Start T5 High Output (80W)	1	°F80T5	1	ELECT	Elect. Program Start BF=1	90

Table NA8-3 – Fluorescent Rapid Start T-8

Type	Lamps		Ballasts			System Watts
	Number	Designation	Number	Designation	Description	
2 foot Fluorescent Rapid Start T8 (17W) Electronic Ballasts	1	F17T8	1	ELECT NO	Electronic Normal Output	22
	2	F17T8	1	ELECT NO	Electronic Normal Output	33
	3	F17T8	1	ELECT NO	Electronic Normal Output	53
	3	F17T8	2	ELECT NO	Electronic Normal Output	55
	4	F17T8	1	ELECT NO	Electronic Normal Output	63
2 foot Fluorescent Rapid Start T8 (17W)	1	F17T8	1	ELECT DIM	Electronic Dimming	20
	2	F17T8	1	ELECT DIM	Electronic Dimming	37
	3	F17T8	1	ELECT DIM	Electronic Dimming	56
	4	F17T8	1	ELECT DIM	Electronic Dimming	69
3 foot Fluorescent Rapid Start T8 (25W) Electronic Ballasts	1	F25T8	1	ELECT NO	Electronic Normal Output	27
	2	F25T8	1	ELECT NO	Electronic Normal Output	48
	3	F25T8	1	ELECT NO	Electronic Normal Output	68
	4	F25T8	1	ELECT NO	Electronic Normal Output	89
	1	F25T8	1	ELECT RO	Electronic Reduced Output	24
	2	F25T8	1	ELECT RO	Electronic Reduced Output	41
	3	F25T8	1	ELECT RO	Electronic Reduced Output	59
	4	F25T8	1	ELECT RO	Electronic Reduced Output	76
	1	F25T8	1	ELECT HO	Electronic High Output	29
	2	F25T8	1	ELECT HO	Electronic High Output	51
	3	F25T8	1	ELECT HO	Electronic High Output	74
	1	F25T8	1	ELECT DIM	Electronic Dimming	25
	2	F25T8	1	ELECT DIM	Electronic Dimming	49
	3	F25T8	1	ELECT DIM	Electronic Dimming	76
	4	F25T8	1	ELECT DIM	Electronic Dimming	96

Table NA8-3 (continued) – Fluorescent Rapid Start T-8

4 foot Fluorescent Instant Start T8 ("Energy Saving" 30W)	1	F32T8/30ES	1	ELECT NO	Electronic Normal Output	29
	2	F32T8/30ES	1	ELECT NO	Electronic Normal Output	54
	3	F32T8/30ES	1	ELECT NO	Electronic Normal Output	79
	4	F32T8/30ES	1	ELECT NO	Electronic Normal Output	104
	1	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	27
	2	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	48
	3	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	70
	4	F32T8/30ES	1	ELECT RO	Electronic Reduced Output	91
	1	F32T8/30ES	1	ELECT NO EE	EE Normal Output	33
	2	F32T8/30ES	1	ELECT NO EE	Energy efficiency Normal Output	52
	3	F32T8/30ES	1	ELECT NO EE	Energy efficiency Normal Output	77
	4	F32T8/30ES	1	ELECT NO EE	Energy efficiency Normal Output	101
	1	F32T8/30ES	1	ELECT RO EE	EE Reduced Output	28
	2	F32T8/30ES	1	ELECT RO EE	EE Reduced Output	45
	3	F32T8/30ES	1	ELECT RO EE	EE Reduced Output	66
	4	F32T8/30ES	1	ELECT RO EE	EE Reduced Output	88

Table NA8-3 (continued) – Fluorescent Rapid Start T-8

4 foot Fluorescent Rapid Start T8 (32W)	1	F32T8	1	ELECT NO	Electronic Normal Output	32
	2	F32T8	1	ELECT NO	Electronic Normal Output	62
	3	F32T8	1	ELECT NO	Electronic Normal Output	93
	4	F32T8	1	ELECT NO	Electronic Normal Output	114
	1	F32T8	1	EE NO	EE Normal Output	35
	2	F32T8	1	EE NO	EE Normal Output	55
	3	F32T8	1	EE NO	EE Normal Output	82
	4	F32T8	1	EE NO	EE Normal Output	107
	1	F32T8	1	ELECT RO	Electronic Reduced Output	29
	2	F32T8	1	ELECT RO	Electronic Reduced Output	51
	3	F32T8	1	ELECT RO	Electronic Reduced Output	76
	4	F32T8	1	ELECT RO	Electronic Reduced Output	98
	2	F32T8	1	ELECT HO	Electronic High Output	77
	3	F32T8	1	ELECT HO	Electronic High Output	112
	1	F32T8	1	EE RO	EE Reduced Output	30
	2	F32T8	1	EE RO	EE Reduced Output	48
	3	F32T8	1	EE RO	EE Reduced Output	73
	4	F32T8	1	EE RO	EE Reduced Output	96
	2	F32T8	1	ELECT TL	Electronic Two Level (50 & 100%)	65
	1	F32T8	1	ELECT DIM1	Electronic Dimming	35
	2	F32T8	1	ELECT DIM1	Electronic Dimming	68
	3	F32T8	1	ELECT DIM1	Electronic Dimming	102
	1	F32T8	1	ELECT DIM2	Electronic Dimming	33
	2	F32T8	1	ELECT DIM2	Electronic Dimming	64
	3	F32T8	1	ELECT DIM2	Electronic Dimming	93
	4	F32T8	1	ELECT DIM2	Electronic Dimming	116
5 foot Fluorescent Rapid Start T8 (40W)	1	F40T8	1	ELECT	Electronic	46
	2	F40T8	1	ELECT	Electronic	79
	3	F40T8	1	ELECT	Electronic	112

RO = ballast factor 70 to 85% NO = ballast factor 85 to 100% HO = ballast factor >100%

Table NA8-4 – Fluorescent Rapid Start High Output (HO) T8, 8 ft

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
8 foot Fluorescent Rapid Start T8 High Output (86W)	1	F96T8/HO	1	ELECT	Electronic	88	
	2	F96T8/HO	1	ELECT	Electronic	160	

HO = ballast factor >100%

Table NA8-5 – High Intensity Discharge

Type	Lamps		Ballasts			System Watts	Comment
	Number	Designation	Number	Designation	Description		
Metal Halide	1	M35/39	1	MAG STD	Mag. Stand.	58	
	1	M35/39	1	ELECT	Electronic	44	
	1	M50	1	MAG STD	Mag. Stand.	67	
	1	M50	1	ELECT	Electronic	58	
	1	M70	1	MAG STD	Mag. Stand.	95	
	1	M70	1	ELECT	Electronic	86	
	1	M100	1	MAG STD	Mag. Stand.	130	
	1	M100	1	ELECT	Electronic	110	
	1	M150	1	MAG STD	Mag. Stand.	185	
	1	M150	1	ELECT	Electronic	168	
	1	M175	1	MAG STD	Mag. Stand.	208	
	1	M175	1	ELECT	Electronic	194	
	1	M200	1	MAG STD	Mag. Stand.	232	
	1	M250	1	MAG STD	Mag. Stand.	295	
	1	M250	1	ELECT	Electronic	269	
	1	M320	1	MAG STD	Mag. Stand.	368	
	1	M320	1	ELECT	Electronic	343	
	1	M360	1	MAG STD	Mag. Stand.	422	
	1	M400	1	MAG STD	Mag. Stand.	452	
	1	M400	1	ELECT	Electronic	430	
	1	M450	1	MAG STD	Mag. Stand.	508	
	1	M750	1	MAG STD	Mag. Stand.	818	
	1	M1000	1	MAG STD	Mag. Stand.	1080	
	1	M1500	1	MAG STD	Mag. Stand.	1605	
High Pressure Sodium	1	S35	1	MAG STD	Mag. Stand.	47	
	1	S50	1	MAG STD	Mag. Stand.	66	
	1	S70	1	MAG STD	Mag. Stand.	91	
	1	S100	1	MAG STD	Mag. Stand.	128	
	1	S150	1	MAG STD	Mag. Stand.	188	
	1	S200	1	MAG STD	Mag. Stand.	230	
	1	S250	1	MAG STD	Mag. Stand.	295	
	1	S400	1	MAG STD	Mag. Stand.	464	
	1	S1000	1	MAG STD	Mag. Stand.	1100	

Nonresidential Appendix NA9

Appendix NA9 – Nonresidential Fault Detection and Diagnostics

NA9.1 System Requirements

1. The following temperature sensors should be permanently installed to monitor system operation: outside air, supply air, return air

2. Temperature sensors shall have an accuracy of plus or minus 1.3°F.

3. Refrigerant pressure sensor, if used, shall have an accuracy of plus or minus 3% of full scale.

4. The controller shall have the capability of displaying the value of each sensor.

5. The controller shall provide system status by indicating the following conditions:

- Free cooling available
- Economizer enabled
- Compressor enabled
- Heating enabled
- Mixed air low limit cycle active

6. The unit controller shall manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.

7. Faults shall be reported to a fault management application accessible by day-to-day operating or service personnel, or annunciated locally on zone thermostats.

8. The FDD System shall be certified by the CEC and verified to be correctly installed.

NA9.2 Faults to be Detected

The FDD system shall detect the following faults:

- Air temperature sensor failure/fault
- Not economizing when it should
- Economizing when it should not
- Damper not modulating
- Excess outdoor air

~~NA8.2.1.1~~NA9.2.1.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

- The water tank is filled to the proper level.
- The water tank is sitting on a foundation with adequate structural strength.
- The water tank is insulated and the top cover is in place.
- The DES/DXAC is installed correctly (refrigerant piping, etc.).
- Verify that the correct model number is installed and configured.

~~NA8.2.1.2~~NA9.2.1.2 Equipment Testing

Step 1: Simulate cooling load during daytime period (e.g. by setting time schedule to include actual time and placing thermostat cooling set-point below actual temperature). Verify and document the following:

- Supply fan operates continually.
- If the DES/DXAC has cooling capacity, DES/DXAC runs to meet the cooling demand (in ice melt mode).
- If the DES/DXAC has no ice and there is a call for cooling, the DES/DXAC runs in direct cooling mode.

Step 2: Simulate no cooling load during daytime condition. Verify and document the following:

- Supply fan operates as per the facility thermostat or control system.
- The DES/DXAC and the condensing unit do not run.

Step 3: Simulate no cooling load during morning shoulder time period. Verify and document the following:

- The DES/DXAC is idle.

Step 4: Simulate a cooling load during morning shoulder time period. Verify and document the following:

- The DES/DXAC runs in direct cooling mode.

~~NA8.2.1.3~~NA9.2.1.3 Calibrating Controls

Set the proper time and date, as per manufacturer's installation manual for approved installers.

~~NA8.2.2~~NA9.2.2 Thermal Energy Storage (TES) Systems

The following acceptance tests apply to thermal energy storage systems that are used in conjunction with chilled water air conditioning systems.

~~NA8.2.2.1~~NA9.2.2.1 Eligibility Criteria

The following types of TES systems are eligible for compliance credit:

- Chilled Water Storage
- Ice-on-Coil
- Ice Harvester
- Brine
- Ice-Slurry

- Eutectic Salt
- Clathrate Hydrate Slurry (CHS)

The following Certificate of Compliance information for both the chiller and the storage tank shall be provided on the plans to document the key TES System parameters and allow plan check comparison to the inputs used in the DOE-2 simulation. DOE-2 keywords are shown in ALL CAPITALS in parentheses.

Chiller:

- Brand and Model
- Type (Centrifugal, Reciprocating, Other)
- Capacity (tons) (SIZE)
- Starting Efficiency (kW/ton) at beginning of ice production (COMP - KW/TON - START)
- Ending Efficiency (kW/ton) at end of ice production (COMP - KW/TON/END)
- Capacity Reduction (% / °F) (PER – COMP - REDUCT/F)

Storage Tank:

- Storage Type (TES-TYPE)
- Number of Tanks (SIZE)
- Storage Capacity per Tank (ton-hours) (SIZE)
- Storage Rate (tons) (COOL – STORE - RATE)
- Discharge Rate (tons) (COOL – SUPPLY - RATE)
- Auxiliary Power (watts) (PUMPS + AUX - KW)
- Tank Area (CTANK – LOSS - COEFF)
- Tank Insulation (R - Value) (CTANK – LOSS - COEFF)

~~NA8.2.2.2~~NA9.2.2.2 Functional Testing

Acceptance testing also shall be conducted and documented on the Certificate of Acceptance in two parts:

In the TES System Design Verification part, the installing contractor shall certify the following information, which verifies proper installation of the TES System consistent with system design expectations:

- The TES system is one of the above eligible systems.
- Initial charge rate of the storage tanks (tons).
- Final charge rate of the storage tank (tons).
- Initial discharge rate of the storage tanks (tons).
- Final discharge rate of the storage tank (tons).
- Charge test time (hrs).
- Discharge test time (hrs).
- Tank storage capacity after charge (ton-hrs).
- Tank storage capacity after discharge (ton-hrs).
- Tank standby storage losses (UA).
- Initial chiller efficiency (kW/ton) during charging.

- Final chiller efficiency (kW/ton) during charging.

In the TES System Controls and Operation Verification part, the installing contractor also shall complete the following acceptance testing to ensure the TES System is controlled and operates consistent with the compliance simulation. The installing contractor shall convey the results of the testing to the enforcement agency using the Certificate of Acceptance.

1. Verify that the TES system and the chilled water plant is controlled and monitored by an energy management system (EMS).
2. Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a partial or no charge of the tank and simulate no cooling load by setting the indoor temperature set point higher than the ambient temperature. Verify that the TES system starts charging (storing energy).
3. Force the time to be between 6:00 p.m. and 9:00 p.m. and simulate a partial charge on the tank and simulate a cooling load by setting the indoor temperature set point lower than the ambient temperature. Verify that the TES system starts discharging.
4. Force the time to be between noon and 6:00 p.m. and simulate a cooling load by lowering the indoor air temperature set point below the ambient temperature. Verify that the tank starts discharging and the compressor is off.
5. Force the time to be between 9:00 a.m. to noon, and simulate a cooling load by lowering the indoor air temperature set point below the ambient temperature. Verify that the tank does not discharge and the cooling load is met by the compressor only.
6. Force the time to be between 9:00 p.m. and 9:00 a.m. and simulate a full tank charge by changing the sensor that indicates tank capacity to the Energy Management System so that it indicates a full tank capacity. Verify that the tank charging is stopped.
7. Force the time to be between noon and 6:00 p.m. and simulate no cooling load by setting the indoor temperature set point above the ambient temperature. Verify that the tank does not discharge and the compressor is off.

NA9.2.3 Supply Air Temperature Reset Controls

The following acceptance tests apply to supply air temperature reset controls.

NA9.2.3.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Reset controls have been installed per Standards §144(f)(2).
- Reset schedule, including high and low setpoint limits and equipment lockout temperatures, is available and documented in the building plans. Reset schedule resets temperature by at least 25% of the difference between the design supply air temperature and design room air temperature.
- Sensors used to control supply air temperature have been calibrated, or read accurately against a calibrated temperature standard. Attach a copy of the calibration certificate or field verification results.
- If applicable, duct static pressure reset controls are disabled during testing to prevent any unwanted interaction.
- Controls for outside air damper or economizer operation are disabled during testing to prevent any unwanted interaction.
- Document current supply air temperature.

NA9.2.3.2 Functional Testing

- If system is single-duct, or has zone-level reheat, Steps 1-3 are performed once at the main supply fan. If system is dual-duct, Steps 1-3 are performed for each duct or "deck" downstream of the main supply fan.
- Check to make sure that chilled/hot water coils, if used, are not already fully open and calling for maximum cooling/heating. If this is the case, reverse Steps 1 and 2 as necessary to allow system to operate within its bounds of operation and not be forced to meet an impossible setpoint.
- If zone feedback is used to reset, identify any zones with unusually high loads ("rogue zones") prior to and during performing the test. If possible, exclude those zones from the reset sequence.

Step 1: Override reset control variable to its maximum value to drive supply temperature downward (for example, temporarily replace outside temperature signal with a high fixed temperature value for outside air temperature, or temporarily override zone damper signals to imitate all zones calling for maximum cooling). If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value (for example, modify the reset schedule to create an outside air setpoint high limit below the current outside air temperature).Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.
- Verify that supply air temperature is within +/-2 degree F of the control setpoint.

Step2: Override reset control variable to its minimum value to drive supply temperature upward. If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value. Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.
- Verify that supply air temperature is within +/-2 degree F of the control setpoint.

Step 3: Restore reset control variable to automatic control, and/or restore the high and low limits of the reset control variable. Remove all system overrides initiated during test. Verify and document the following:

- Supply air temperature setpoint is reset to meet the appropriate value.
- Actual supply air temperature changes to meet setpoint.

NA9.2.4 Condenser Water Supply Temperature Reset Controls

The following acceptance tests apply to supply air temperature reset controls.

NA9.2.4.1 Construction Inspection

Prior to functional testing, verify and document the following:

- Condenser water supply temperature control sequence, including condenser water supply high and low limits, is available and documented in the building documents.
- Cooling tower fan control sequence, including tower design wetbulb temperature and approach, is available and documented in the building documents.
- Temperature, pressure, and flow gauges and sensors are installed where appropriate.
- All ambient dry bulb temperature, relative humidity, and pressure sensors used by controller have been calibrated, or read accurately against a standard calibrated sensor. Attach a copy of calibration certificate or field verification results.
- All cooling tower fan motors are operational.

- All cooling tower fan speed controls (e.g. VSDs) are installed, operational, and connected to cooling tower fan motors.
- Document current outdoor ambient air dry bulb and wet bulb temperatures, entering condenser water supply temperature, and leaving chilled water temperature readings from the control system.

NA9.2.4.2 Functional Testing

- The system cooling load must be sufficiently high to run the test. If necessary, artificially increase the evaporator load to perform the functional tests, or wait until a time of stable chiller operation. If necessary, reverse Steps 1 & 2 in the test based on atmospheric conditions and buildings loads.
- If testing in cold ambient conditions, ensure that freeze protection controls are installed and functional to prevent equipment damage.
- If the actual control sequence differs significantly from that implied by the tests, attach a description of the control sequence, a description of the tests that were done to verify the system operates according to the sequence, and the test results.

Step 1: Using the desired reset strategy, change the reset control variable to its minimum value to drive condenser water supply temperature downward towards lower limit (for example, temporarily replace signal of outdoor air wetbulb temperature to a low fixed value). If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value (for example, adjust the sequence to set the maximum outdoor air wetbulb temperature to below the current temperature). Allow time for the system to stabilize. Verify and document the following:

- Condenser water supply temperature setpoint changes to meet appropriate value.
- Actual condenser water supply temperature changes to meet setpoint.
- Cooling tower fan(s) stage properly and/or adjust speed according to fan schedule, to meet lower condenser water supply setpoint.

Step 2: Using the desired reset strategy, override reset control variable towards its maximum value to drive condenser water supply temperature upward to high limit. If the reset control variable input cannot be modified, then change the limit of the variable around the currently occurring value. Allow time for the system to stabilize. Verify and document the following:

- Condenser water supply temperature setpoint changes to meet appropriate value.
- Actual condenser water supply temperature changes to meet setpoint.
- Cooling tower fan(s) stage properly and/or adjust speed according to fan schedule, to meet higher condenser water supply setpoint.

Step 3: Restore all controls and equipment to original settings, and/or restore the high and low limits of the reset control variable. Remove all system overrides initiated during test. Verify and document the following:

- Condenser water supply temperature setpoint is reset to the appropriate value.
- Cooling tower fan(s) and chiller(s) return to normal operation.

~~NA8.3~~NA9.3 ~~Indoor~~ Lighting Control ~~Systems~~Acceptance Requirements

Lighting control acceptance testing ~~is~~ shall be performed on:

- ~~Manual daylighting controls.~~
- ~~Automatic daylighting controls.~~
- ~~Occupancy sensors.~~

- Automatic time-switch control
- Automatic Daylighting Controls complying with Section 130.1(d)
- Shut-off Controls complying with Section 130.1(c)
- Demand Responsive Controls in accordance with Section 130.1(e).

NA8.3.1 Automatic Daylighting Controls Acceptance

NA8.3.2NA9.3.1 Acceptance tests for Automatic Daylighting Controls complying with Section 130.1(d)

NA8.3.2.1NA9.3.1.1 Construction Inspection

Prior to Functional testing, verify and document the following:

All control devices (photocontrols) have been properly located, field-calibrated and set for appropriate set points and threshold light levels.

Installer has provided documentation of setpoints, setting and programming for each device.

Luminaires located in primary or secondary sidelit zone(s) or in skylit area(s) are controlled separately from non-daylit areas. Compare location of daylighting controlled luminaires against description of sidelit and skylit zones on the building plans.

Luminaires located in primary or secondary sidelit zone(s) are controlled separately from skylit area(s)

The location where calibration adjustments are made is remote from photosensor.

Verify that automatic daylighting controls qualify as one of the required control types, are installed, and fully functional in accordance with Section 130.1(d), or that there is a specific Excepted from Section 130.1(d); as follows:

- Luminaires in the primary and secondary sidelit zone in parking garages are controlled by automatic daylighting controls as described in Section 130.1(d)3. are controlled independently by fully functional automatic daylighting controls that meet the applicable requirements of Section 110.9, and the applicable requirements below:
  - Parking garage area with combined total of 36 square feet or more of glazing or opening, luminaires providing general lighting that are in the combined primary and secondary sidelit daylit zones are controlled independently by automatic daylighting control devices.
  - If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant
  - In parking garages, when primary sidelit zones receive illuminance levels greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power consumption is zero, or the application meets one of the exceptions. List any exceptions.
  - Photo sensors are located so that they are not readily accessible to unauthorized personnel.
  - The location where calibration adjustments are made to an automatic daylighting control device are readily accessible and accessible only to authorized personnel.

- In indoor spaces other than parking garages, luminaires providing general lighting in or partially in the Skylit Daylit Zones and the Primary Sidelit Daylit Zones are controlled independently by fully functional automatic daylighting controls that meet the applicable requirements of Section 110.9, and the applicable requirements below:

- o All Skylit Daylit Zones and Primary Sidelit Daylit Zones are shown on the plans.
- o Luminaires in the Skylit Daylit Zone are controlled separately from those in the Primary Sidelit Daylit Zones
- o Luminaires that fall in both a Skylit and Primary Sidelit Daylit Zone are controlled as part of the Skylit Daylit Zone
- o Secondary Sidelit Daylit Zones are shown on plan,
- o Luminaires in the Secondary Sidelit Daylit Zones are controlled separately from those in the Primary Sidelit Daylit Zones and Skylit Daylit Zones,
- o Luminaires that fall in a Skylit and Secondary Sidelit Daylit Zone are controlled as part of the Skylit Daylit Zone.
- o If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant
- o Photo sensors are located so that they are not readily accessible to unauthorized personnel.
- o The location where calibration adjustments are made to an automatic daylighting control device are readily accessible and accessible only to authorized personnel.
- o Automatic daylighting controls provide functional multi-level lighting, including continuous dimming, and have at least the number of control steps specified in Table 130.1-A, or meet one of the exceptions. List any exceptions
- o For each space, the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available
- o In areas served by lighting that is daylight controlled, when the illuminance received from the daylight is greater than 150 percent of the illuminance received from the general lighting system, the general lighting power in that daylight zone is reduced by a minimum of 65 percent, or the application meets one of the exceptions. List any exceptions.

~~NA8.3.2.2~~NA9.3.1.2 Functional testing

All photocontrols serving more than 5,000 ft² of daylit area shall undergo functional testing. Photocontrols that are serving smaller spaces may be sampled as follows:

For buildings with up to five (5) photocontrols, all photocontrols shall be tested. For buildings with more than five (5) photocontrols, sampling may be done on spaces with similar sensors and cardinal orientations of glazing. If the first photocontrol in the sample group passes the functional test, the remaining building spaces in the sample group also pass. If the first photocontrol in the sample group fails the functional test, the rest of the photocontrols in the group shall be tested. If any tested photocontrol fails the functional test, it shall be repaired, replaced or adjusted until it passes the test.

For each photocontrol to be tested do the following:

Test each group of lights controlled separately by the photocontrol according to the following protocol. In all interior spaces other than parking garages, a separate test shall be conducted for daylighting control of the primary sidelit zone separate from the secondary sidelit zone.

Continuous Dimming Control Systems

This requirement is for systems that have more than 10 levels of controlled light output in a given zone.

Step 1: Identify the minimum daylighting location in the controlled zone (Reference Location). This can be identified using either the illuminance method or the distance method.

Illuminance Method

Turn OFF controlled lighting and measure daylight illuminance within zones illuminated by controlled luminaires.

Identify the Reference Location; this is the task location with lowest daylight illuminance in the zone illuminated by controlled luminaires. This location will be used for illuminance measurements in subsequent tests.

~~Turn controlled lights back ON~~.

Distance Method

Identify the task location within the zone illuminated by controlled luminaires that is farthest away from daylight sources. This is the Reference Location and will be used for illuminance measurements in subsequent tests.

Step 2: No daylight test. Simulate or provide conditions without daylight. Verify and document the following:

Automatic daylight control system provides appropriate control so that electric lighting system is providing full light output unless otherwise specified by design documents.

Document the reference illuminance, which is the electric lighting illuminance level at the reference location identified in Step 1.

Light output is stable with no discernable flicker.

Step 3: Full daylight test. Simulate or provide bright conditions. Verify and document the following:

Lighting power reduction is at least 65 percent under fully dimmed conditions and light output is stable with no discernable flicker.

Only luminaires in daylit zones are affected by daylight control. . If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant

Step 4: Partial daylight test. Simulate or provide ~~bright~~ daylight conditions where illuminance (fc) from daylight only at the Reference Location is between 60 and 95 percent of Reference Illuminance (fc) documented in Step 2. Verify and document the following:

Measure that the combined illuminance of daylight and controlled electric lighting (fc) at the reference location is no less than the electric lighting illuminance (fc) at this location during the no daylight test documented in Step 2.

Measure that the combined illuminance of daylight and controlled electric lighting (fc) at the Reference Location is no greater than 150 percent of the reference illuminance (fc) documented in Step 2.

Light output is stable with no discernable flicker.

Stepped Switching or Stepped Dimming Control Systems

This requirement is for systems that have no more than 10 discrete steps of control of light output.

If the control has 3 steps of control or less, conduct the following tests for all steps of control. If the control has more than 3 steps of control, testing 3 steps of control is sufficient for showing compliance.

Step 1: Identify the minimum daylighting location(s) in the controlled zone. (Reference Location). This can be identified using either the illuminance method or the distance method.

~~If lighting controls are staged so that one stage is closer to the daylight source, identify a minimum daylighting location for each stage of control. If all stages of control are equally close to the daylight source, select a single minimum daylighting location representing all stages of the control. This minimum daylighting location for each stage of control is designated as the reference location for that stage of control and will be used for illuminance measurements in subsequent tests. The reference location can be identified using either the illuminance method or the distance method.~~

Illuminance Method

Turn OFF controlled lighting and measure daylight illuminances within a zone illuminated by controlled luminaires.

Identify the reference location; this is the task location with lowest daylight illuminance in the zone illuminated by controlled luminaires. This location will be used for illuminance measurements in subsequent tests.

Turn controlled lights back ON.

Distance Method

Identify the task location within the zone illuminated by controlled luminaires that is farthest away from daylight sources. This is the reference location and will be used for illuminance measurements in subsequent tests.

Step 2: No daylight test. Simulate or provide conditions without daylight for a stepped switching or stepped dimming control system. Verify and document the following:

If the control is manually adjusted (not self commissioning), make note of the time delay and override time delay or set time delay to minimum setting. This condition shall be in effect through step 4.

Automatic daylight control system turns ON all stages of controlled lights unless it is documented that multi-level luminaires have been "tuned" to less than full output and providing design illuminance (fc) levels

Stepped dimming control system provides reduced flicker over the entire operating range per §110.9~~(f)2~~.

Document the reference illuminance which is the electric lighting illuminance level measured at the reference location identified in Step 1.

Step 3: Full daylight test. Simulate or provide bright conditions. Verify and document the following:

Lighting power reduction of controlled luminaires is at least 65 percent

Only luminaires in daylit zones (toplit zone, primary sidelit zone and secondary sidelit zone) are affected by daylight control. If the daylighting controls control lighting outside of the daylight zones including those behind obstructions as described in Section 130.1(d)1, the control system is not compliant

Step 4: Partial daylight test. For each control stage that is tested in this step, the control stages with lower setpoints than the stage tested are left ON and those stages of control with higher setpoints are dimmed or controlled off. Simulate or provide conditions so that each control stage turns on and off or dims. Verify and document the following for each control stage:

~~The measured illuminance contribution from the control stage tested at its corresponding reference location.~~

~~The~~ Document the total daylight and electric lighting illuminance level measured at its reference location just after the stage of control dims or shuts off a stage of lighting:

1. The total measured illumination shall be no less than the reference illuminance measured at this location during the no daylight test documented in Step 2.
2. The total measured illumination shall be no greater than 150 percent of the reference illuminance.

The control stage shall not cycle on and off or cycle between dim and undimmed while daylight illuminance remains constant.

Only luminaires in daylit zones (toplit zone, primary sidelit zone, and secondary sidelit zone) are affected by daylight control.

Step 5: Verify time delay.

Verify that time delay automatically resets to normal mode within 60 minutes.

Set normal mode time delay to at least three minutes.

Confirm that there is a time delay of at least 3 minutes between the time when illuminance exceeds the setpoint for a given dimming stage and when the control dims or switches off the controlled lights.

NA9.3.2 Acceptance tests for Shut-off Controls complying with Section 130.1(c)

NA9.3.2.1 Construction Inspection and Acceptance Tests

- Verify that the shut-off control qualifies as one of the required control types, is installed, and is fully functional in accordance with Section 130.1(c), or that the application meets one of the exceptions. List the exceptions.

~~NA8.3.3 Occupancy Sensor Acceptance~~

~~NA8.3.3.1~~NA9.3.2.2 Occupancy Sensing Lighting Control Construction Inspection

Prior to Functional testing, verify and document the following:

Occupancy sensor has been located to minimize false signals:

No closer than four (4) feet from a HVAC diffuser.

PIR sensor pattern does not enter into adjacent zones.

Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.

Ultrasonic occupancy sensors do not emit audible sound.

~~NA8.3.3.2~~NA9.3.2.3 Occupancy Sensing Lighting Control Functional testing

For buildings with up to seven (7) occupancy sensors, all occupancy sensors shall be tested. For buildings with more than seven (7) occupancy sensors, sampling may be done on spaces with similar sensors and space geometries. If the first occupancy sensor in the sample group passes the acceptance test, the remaining building spaces in the sample group also pass. If the first occupancy sensor in the sample group fails the acceptance test the rest of the occupancy sensors in that group must be tested. If any tested occupancy sensor fails it shall be repaired, replaced or adjusted until it passes the test.

For each sensor to be tested do the following:

Step 1: For a representative sample of building spaces, simulate an unoccupied condition. Verify and document the following:

Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from the start of an unoccupied condition per §119(d).

The occupant sensor does not trigger a false "on" from movement in an area adjacent to the space containing the controlled luminaires or from HVAC operation.

Signal sensitivity is adequate to achieve desired control.

Step 2: For a representative sample of building spaces, simulate an occupied condition. Verify and document the following:

Status indicator or annunciator operates correctly.

Lights controlled by occupancy sensors turn on immediately upon an occupied condition, OR sensor indicates space is "occupied" and lights are turned on manually (automatic OFF and manual ON control strategy).

~~NA8.3.4 Manual Daylighting Controls Acceptance~~

~~NA8.3.4.1 Construction Inspection~~

~~Prior to Functional testing, verify and document the following:~~

~~If dimming ballasts are specified for light fixtures within the primary sidelit zone or skylit zone, make sure they meet all the Standards requirements, including "reduced flicker operation" for manual dimming control systems.~~

~~NA8.3.4.2 Functional testing~~

~~Step 1: Perform manual switching control. Verify and document the following:~~

~~Only lights in the primary sidelit zone or the skylit zone as defined in §131(c) are controlled. Compare daylighting controlled luminaires against description of the primary sidelit and skylit zones on the building plans.~~

~~Manual switching or dimming achieves a lighting power reduction of at least 50 percent.~~

~~The amount of light delivered to the space is uniformly reduced.~~

~~NA8.3.5 Automatic Time Switch Control Acceptance~~

~~NA8.3.5.1~~NA9.3.2.4 Automatic Time Switch Lighting Control Construction Inspection

Prior to Functional testing, verify and document the following:

Automatic time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.

Document for the owner automatic time switch programming including weekday, weekend, holiday schedules as well as all set-up and preference program settings.

Verify the correct time and date is properly set in the time switch.

Verify the battery back-up (if applicable) is installed and energized.

Override time limit is set to no more than 2 hours.

Override switches remote from area with controlled luminaires have annunciator lights.

~~NA8.3.5.2~~NA9.3.2.5 Automatic Time Switch Lighting Control Functional testing

Step 1: Simulate occupied condition. Verify and document the following:

All lights can be turned on and off by their respective area control switch.

Verify the switch only operates lighting in the enclosed space (ceiling-height partitioned area) in which the switch is located.

Step 2: Simulate unoccupied condition. Verify and document the following:

All non-exempt lighting turn off per §131(d)1.

Manual override switch allows only the lights in the enclosed space (ceiling height partitioned) where the override switch is located to turn on or remain on until the next scheduled shut off occurs.

NA9.3.3 Acceptance tests for Demand Responsive Controls in accordance with Section 130.1(e).

NA9.3.3.1 Construction Inspection

Prior to Functional testing, verify and document the following:

- That the demand responsive control is capable of receiving a demand response signal directly or indirectly through another device.
- If the demand response signal is received from another device (such as an EMCS), that system must itself be capable of receiving a demand response signal from a utility meter or other external source.

NA9.3.3.2 Functional testing of Demand Responsive Lighting Controls

For buildings with up to seven (7) enclosed spaces requiring demand responsive lighting controls, all spaces shall be tested. For buildings with more than seven (7) enclosed spaces requiring demand responsive lighting controls, sampling may be done on additional spaces with similar lighting systems. If the first enclosed space with a demand responsive lighting control in the sample group passes the acceptance test, the remaining building spaces in the sample group also pass. If the first enclosed space with a demand responsive lighting control in the sample group fails the acceptance test the rest of the enclosed spaces in that group must be tested. If any tested demand responsive lighting control system fails it shall be repaired, replaced or adjusted until it passes the test.

Test the reduction in lighting power due to the demand responsive lighting control using one or the following two methods.

Method 1: Illuminance Measurement. Measure the reduction in illuminance in enclosed spaces required to meet Section 131(b), as follows:

- In each space, select one location for illuminance measurement. The chosen location must not be in a primary skylit or sidelit area. When placed at the location, the illuminance meter must not have a direct view of a window or skylight. If this is not possible, perform the test at a time and location at which daylight illuminance provides less than half of the design illuminance. Mark each location to ensure that the illuminance meter can be accurately located.
- Full output test
    - Using the manual switches/dimmers in each space, set the lighting system to full output. Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at less than full output, or may be off.
    - Take one illuminance measurement at each location, using an illuminance meter.
    - Simulate a demand response condition using the demand responsive control.
    - Take one illuminance measurement at each location with the electric lighting system in the demand response condition.
    - Calculate the area-weighted average reduction in illuminance in the demand response condition, compared with the full output condition. The area-weighted reduction must be at least 15% but must not reduce the combined illuminance from electric light and daylight to less than 50% of the design illuminance in any individual space.
- Minimum output test
    - Using the manual switches/dimmers in each space, set the lighting system to minimum output (but not off). Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at more than minimum output, or may be off.
    - Take one illuminance measurement at each location, using an illuminance meter.
    - Simulate a demand response condition using the demand responsive control.
    - Take one illuminance measurement at each location with the electric lighting system in the demand response condition.

- o In each space, the illuminance in the demand response condition must not be less than the illuminance in the minimum output condition or 50% of the design illuminance, whichever is less.

  EXCEPTION: In daylit spaces, the illuminance in the demand response condition may reduce below the minimum output condition, but in the demand response condition the combined illuminance from daylight and electric light must be at least 50% of the design illuminance.

Method 2: Current measurement. Measure the reduction in electrical current in spaces required to meet Section 131(b), as follows:

- At the lighting circuit panel, select at least one lighting circuit that serves spaces required to meet Section 131(b).
- Full output test
  - o Using the manual switches/dimmers in each space, set the lighting system to full output. Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at less than full output, or may be off.
  - o Take one electric current measurement for each selected circuit.
  - o Simulate a demand response condition using the demand responsive control.
  - o Take one illuminance measurement at each location with the electric lighting system in the demand response condition.
  - o Add together all the circuit currents, and calculate the reduction in current in the demand response condition, compared with the full output condition. The combined reduction must be at least 15% but must not reduce the output of any individual circuit by more than 50%.
- Minimum output test
  - o Using the manual switches/dimmers in each space, set the lighting system to minimum output (but not off). Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at more than minimum output, or may be off.
  - o Take one electric current measurement for each selected circuit.
  - o Simulate a demand response condition using the demand responsive control.
  - o Take one electric current measurement for each selected circuit with the electric lighting system in the demand response condition.
  - o In each space, the electric current in the demand response condition must not be less than 50% or the electric current in the minimum output condition, whichever is less.

    EXCEPTION: Circuits that supply power to the daylit portion of enclosed spaces as long as lighting in non-daylit portions of the

NA9.4 Lighting Control Installation Requirements

Lighting control installation inspection shall be performed on:

4. Lighting control systems installed to comply with Section 110.9(b).
5. Energy Management Control System installed to comply with Section 130.5(f)1
6. All line-voltage track lighting integral current limiters in accordance with Section 110.9 and Section 130.0
7. All dedicated line-voltage track lighting supplementary overcurrent protection panels in accordance with Section 110.9 and Section 130.0
8. Shutoff control installed to comply with Section 130.1(c)
9. Automatic daylighting controls installed to comply with Section 130.1(d)

10. Demand responsive controls installed to comply with Section 130.1(e)
11. Interlocked lighting systems serving an area in accordance with Section 140.6(a)1
12. Lighting controls installed to earn a Power Adjustment Factor (PAF) in accordance with Section 140.6(a)2
13. Lighting for a Videoconferencing Studio in Accordance with Exception to Section 140.6(a)3T
14. Outdoor lighting systems installed to comply with Section 130.2(c)

NA9.4.1 Lighting Control Systems Installed to Comply with Section 110.9(b)

NA9.4.1.1 Installation Inspection

If a lighting control required by Title 24, Part 6 is a field assembled system consisting of two or more components, verify the system components meet all of the requirements for each lighting control type, in accordance with Section 110.9, On the approved installation compliance form, identify, list, and verify each type of lighting control system as follows:

- Separately identify and list each type of lighting control system. When there are identical lighting control systems in a single building, identical lighting control system may be listed together.
- Identify and list all requirements for the type of self-contained lighting control device for which the lighting control system is installed to function as, in accordance with Section 110.9 and in accordance with the Title 20 Appliance Efficiency Regulations.
- Verify the lighting control system complies with all of the applicable requirement as listed
- If the lighting control system does not meet all applicable requirements, the installation fails.

NA9.4.2 Energy Management Control System (EMCS) Installed in Accordance with Section 130.1(f)

NA9.4.2.1 Installation Requirements

- The EMCS shall be separately tested for each respective lighting control system for which it is installed to function as.
- List and verify functional compliance with all applicable requirements in accordance with Sections 130.1 through 130.5.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 140.6.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 140.7.
- If applicable, list and verify functional compliance with all applicable requirements for all applications for which the EMCS is installed to function as, in accordance with Section 150(k)

NA9.4.3 Track Lighting Integral Current Limiter

NA9.4.3.1 Certification requirements

- Verify that the track lighting integral current limiter is certified to the Energy Commission in accordance with Section 110.9 by checking the Energy Commission database. If the track current limiter has not been certified to the Energy Commission, this method for determining installed lighting power shall not be used for compliance with Title 24, Part 6, and the installation test shall be terminated.

NA9.4.3.2 Installation Inspection

Verify and document the following on the approved installation compliance form:

- The track current limiter is used exclusively on the same manufacturer's track for which it is designed
- The track current limiter is designed and installed so that the track current limiter housing is permanently attached to the track so that the system will be irreparably damaged if the integral track current limiter housing were to be removed after installation into the track. Methods of attachment may include but are not limited to one-way barbs, rivets, and one-way screws
- The track current limiter has identical volt-ampere (VA) rating of the track current limiter, as installed and rated for compliance with Title 24, Part 6, clearly marked as follows:
    - So that it is visible for the building officials' field inspection without opening cover-plates, fixtures, or panels
    - Permanently marked on the circuit breaker
    - On a factory-printed label that is permanently affixed to a non-removable base-plate inside the wiring compartment
- The track current limiter employs tamper resistant fasteners for the cover to the wiring compartment
- The track current limiter has a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring, or bypassing the device.
- Each electrical panel from which track lighting integral current limiters are connected has a factory printed label permanently affixed and prominently located, with the following information: "NOTICE: Current limiting devices installed in track lighting integral current limiters connected to this panel shall only be replaced with the same or lower amperage. Adding track or replacement of existing current limiters with higher continuous ampere rating will void the track lighting integral current limiter certification, and will require re-submittal and re-certification of California Title 24, Part 6 compliance documentation."
- For installations where a total of five or less track current limiters are installed in a single building, all integral track current limiters shall be inspected. For installations where a total of more than five track current limiters are installed in a single building, no less than five track current limiters shall be inspected, up to five inspections for each 20 installed track current limiters.
- If any of the above requirements fail, the track current limiter fails the installation test, and this method for determining installed lighting power shall not be used for compliance with Title 24.

NA9.4.4 Line-Voltage Track Lighting Supplementary Overcurrent Protection Panel

NA9.4.4.1 Construction Inspection

Verify and document the following on the approved compliance form:

- The supplementary overcurrent protection panel is Listed, as defined in Section 100.1
- The supplementary overcurrent protection panel is used only for line voltage track lighting. No other lighting or building power is connected to a track-lighting supplementary overcurrent protection panel
- No overcurrent protection panel has been used to determine installed wattage for any lighting system other than line-voltage track lighting.
- The supplementary overcurrent protection panel is installed in an electrical equipment room, or permanently installed adjacent to the lighting panel board providing supplementary overcurrent protection for the track lighting circuits served by the supplementary over current protection pane
- There is a prominently labeled permanently attached to the panel by the manufacturer with the following information: "NOTICE: This Panel for Track Lighting Energy Code Compliance Only. The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other

overcurrent protective device shall be added to this panel. Adding to, or replacement of existing overcurrent protective device(s) with higher continuous ampere rating, will void the panel listing and require re-submittal and re-certification of California Title 24, Part 6 compliance documentation."

- If any of the above requirements fail, the supplementary overcurrent protection panel fails the Installation test, and this method for determining installed lighting power shall not be used for compliance with Title 24.

NA9.4.5 Interlocked Lighting Systems Serving an Area in Accordance with Section 140.6(a)1

NA9.4.5.1 Installation Inspection

Verify and document the following:

- The space qualifies only as one or more the following types: Auditorium, convention center, conference room, multipurpose room, or theater, in accordance with the definitions of those space types in Section 100.1,
- There are no more than two interlocked lighting systems serving the space.
- The two lighting systems are interlocked with a non-programmable double throw switch to prevent simultaneous operation.
- If all of the above in not true, the installation fails, and all connected lighting in the space shall be counted as part of the total installed lighting power.

NA9.4.6 Lighting Controls Installed to Earn a Power Adjustment Factor (PAF) in Accordance with Section 140.6(a)2

NA9.4.6.1 Construction Inspection

Verify and document the following:

- Separately list all requirements for each PAF that is claimed in accordance with Sections 110.9, and 140.6(a)2, and Table 140.6-A
- Verify the installation complies with all applicable requirements in accordance with Sections 110.9, and 140.6(a)2, and Table 140.6-A
- If all of the above in not true, the installation fails, and the PAF cannot be used.

NA9.4.7 Lighting for a Videoconferencing Studio in Accordance with Exception to Section 140.6(a)3T

NA9.4.7.1 Installation Inspection

Verify and document the following:

- The videoconferencing studio is using only the Area Category Method for compliance. The extra lighting allowance shall not be taken when using the Complete Building Method or Tailored Method of compliance.
- The Videoconferencing Studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites.
- General lighting is switched in accordance with Table 130.1-A
- Wall wash lighting is separately switched from the general lighting system.
- All of the lighting is controlled by a multiscene programmable control system (scene preset control system);

- If all of the above is not true, the installation fails, and the extra wattage for videoconferencing studio lighting cannot be used.

~~NA8.4~~NA9.5 ~~Outdoor Lighting Acceptance Tests~~ Outdoor Lighting Controls Installed to Comply with Section 130.2(c)

~~NA8.4.1 Outdoor Motion Sensor Acceptance~~

NA9.5.1.1 Construction inspection and installation requirements

Verify that outdoor lighting controls qualify as one of the required control types, are installed, and are fully functional in accordance with Section 130.1(e); as follows:

- All installed outdoor lighting is controlled by a photocontrol or astronomical time lighting control that automatically turns off the outdoor lighting when daylight is available, or it the application meets one of the exceptions. List any exceptions.
- All installed outdoor lighting is circuited and controlled to turn off independently from other electrical loads.
- All installed outdoor lighting where the bottom of the luminaire is mounted 24 feet or less above the ground, is controlled with motion sensors. The motion sensor is capable of automatically reducing the lighting power of each luminaire by at least 40 percent but not exceeding 80 percent, or provide continuous dimming through a range that includes 40 percent through 80 percent, and employs auto-on functionality. No more than 1,500 watts of lighting power is controlled together, or the application meets one of the exceptions. List any exceptions.
- Outdoor Sales Frontage, Outdoor Sales Lots, and Outdoor Sales Canopies lighting, an automatic lighting control is installed that meets the requirements in Section 130.2.
- Building Facade, Ornamental Hardscape and Outdoor Dining lighting, an automatic lighting control is installed that meets one or more of the following requirements in Section 130.2, or the application meets the exception. List the exception.

NA9.5.1.2 Outdoor Motion Sensor Acceptance

~~NA8.4.1.1~~NA9.5.1.3 Construction Inspection

Prior to Functional testing, verify and document the following:

- Motion sensor has been located to minimize false signals.
- Sensor is not triggered by motion outside of adjacent area.
- Desired motion sensor coverage is not blocked by obstructions that could adversely affect performance.

~~NA8.4.1.2~~NA9.5.1.4 Functional testing

Step 1: Simulate motion in area under lights controlled by the motion sensor. Verify and document the following:

- Status indicator operates correctly.
- Lights controlled by motion sensors turn on immediately upon entry into the area lit by the controlled lights near the motion sensor.
- Signal sensitivity is adequate to achieve desired control.

Step 2: Simulate no motion in area with lighting controlled by the ~~sensor but with motion adjacent to this area~~. Verify and document the following:

- Lights controlled by motion sensors ~~turn off~~ reduce light output within a maximum of 30 minutes from the start of an unoccupied condition per §110.9(d).
- The occupant sensor does not trigger a false "on" from movement outside of the controlled area
- Signal sensitivity is adequate to achieve desired control.

~~NA8.4.2~~NA9.5.2 Outdoor Lighting Shut-off Controls

~~NA8.4.2.1~~NA9.5.2.1 Construction Inspection

Prior to Functional testing, verify and document the following:

- Controls to turn off lights during daytime hours are installed.
- Astronomical and standard time switch control is programmed with acceptable weekday, weekend, and holiday (if applicable) schedules.
- Demonstrate and document for the owner time switch programming including weekday, weekend, holiday schedules as well as all set-up and preference program settings.
- Lighting systems that meet the criteria of §130.2(c)~~2 shall have a scheduling control (time switch) installed which is able to schedule separately:~~
  - ~~Aa reduction in outdoor lighting power by 50 to 80 percent~~
  - ~~turningTurns off all outdoor lighting covered by §130.2(c)2~~
- ~~Verify that the correct time and date is properly set in the standard and astronomical time switch.~~
- ~~Verify that the correct latitude, longitude and time zone are set in the astronomical time switch.~~
- ~~Verify the battery back-up (if applicable) is installed and energized in the standard and astronomical time switch.~~

~~NA8.4.2.2 Outdoor Photocontrol Functional testing~~

~~Note photocontrol mustshall be used in conjunction with time switch or motion sensor to meet the requirements of §130.2(c)2.~~

~~Step 1: Nighttime test. Simulate or provide conditions without daylight. Verify and document:~~

- ~~Controlled lights turn on.~~

~~Step 2: Sunrise test: Provide between 10 and 30 horizontal footcandles (fc) to photosensor. Verify and document the following:~~

- ~~Controlled lights turn off.~~

~~NA8.4.2.3 Astronomical Time Switch Functional testing~~

~~Step 1: Power off test. Program control with location information, local date, time and schedules. Disconnect control from power source for at least 1 hour. Verify and document:~~

- ~~Control retains all programmed settings and local date and time~~

~~Step 2: Night schedule ON test. Simulate or provide times when the sun has set and lights are scheduled to be ON. Verify and document:~~

- ~~Controlled lights turn on~~

~~Step 3: Night schedule OFF test. Simulate or provide times when the sun has set and lights are scheduled to be OFF. Verify and document:~~

- ~~Controlled lights turn off~~

~~Step 4: Sunrise test: Simulate or provide the programmed offset time after the time of local sunrise.~~

- ~~Controlled lights turn off~~

~~*NA8.4.2.4 Standard (non-astronomical) Time Switch Functional Testing*~~

~~Note: this control shall be used in conjunction with a photocontrol to meet requirements of §132(c).~~

~~Step 1: Power off test. Program control with local date, time and schedules. Disconnect control from power source for at least 1 hour. Verify and document:~~

- ~~Control retains all programmed schedules and local date and time~~

~~Step 2: On schedule test. Simulate or provide times when lights are scheduled to be ON. Verify and document:~~

- ~~Controlled lights turn on~~

~~Step 3: Schedule test. Simulate or provide times when the sun has set and lights are scheduled to be OFF. Verify and document:~~

- ~~Controlled lights turn off~~

~~NA8.5~~NA9.6 Sign Lighting Acceptance Tests

Reserved For Future Use

NA9.7 Refrigerated Warehouse Refrigeration System Acceptance Tests

The measurement devices used to verify the refrigerated warehouse controls shall be calibrated once every two years using a NIST traceable reference. The calibrated measurement devices to be used in these acceptance tests are called the "standard" and shall have the following measurement tolerances: The temperature measurement devices shall be calibrated to +/- 0.7°F between -30°F and 200°F. The pressure measurement devices shall be calibrated to +/- 2.5 psi between 0 and 500 psig. The relative humidity (RH) measurement devices shall be calibrated to +/- 1% between 5% and 90% RH.

NA9.7.1 Electric Resistance Underslab Heating System

NA9.7.1.1 Construction Inspection

Prior to functional testing, verify and document the following for all electric resistance underslab heating systems:

- Verify that summer on-peak period is programmed into all underslab heater controls to meet the requirements of Section 120.6(a)2.

NA9.7.1.2 Functional Testing

Step 1: Using the control system, lower slab temperature set point. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is off.

Step 2: Using the control system, raise the slab temperature set point. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is on.

Step 3: Using the control system, change the control system's time and date corresponding to the local utility's summer on-peak period. If control system only accounts for time, set system time corresponding to the local utility's summer on-peak period. Verify and document the following using an electrical test meter:

- The underslab electric resistance heater is off.

Step 4: Restore system to correct schedule and control set points.

NA9.7.2 Evaporators and Evaporator Fan Motor Variable Speed Control

NA9.7.2.1 Construction Inspection

Prior to functional testing, document the following on all evaporators:

- All refrigerated space temperature sensors used for control are verified to read accurately (or provide an appropriate offset) using a temperature standard.
- All refrigerated space humidity sensors used for control are verified to read accurately (or provide an appropriate offset) using a humidity standard.
- All refrigerated space temperature and humidity sensors are verified to be mounted in a location away from direct evaporator discharge air draft.
- Verify that all fans motors are operational and rotating in the correct direction.
- Verify that fan speed control is operational and connected to evaporator fan motors.
- Verify that all speed controls are in "auto" mode.

NA9.7.2.2 Functional Testing

Conduct and document the following functional tests on all evaporators.

Step 1: Measure current space temperature or humidity. Program this temperature or humidity as the test temperature or humidity set point into the control system for the functional test steps. Allow 5 minutes for system to normalize.

Step 2: Using the control system, lower test temperature or humidity set point in 1 degree or 1% RH increments below any control dead band range until:

- Evaporator fan controls modulate to increase fan motor speed.
- Evaporator fan motor speed increases in response to controls.
- Verify and document the above.

Step 3: Using the control system, raise the test temperature or humidity set point in 1 degree or 1% RH increments above any control dead band range until fans go to minimum speed. Verify and document the following:

- Evaporator fan controls modulate to decrease fan motor speed.
- Evaporator fan motor speed decreases in response to controls.
- Minimum fan motor control speed (rpm or percent of full speed).

Step 4: Restore control system to correct control set points.

NA9.7.3 Condensers and Condenser Fan Motor Variable Speed Control

NA9.7.3.1 Evaporative Condensers and Condenser Fan Motor Variable Speed Control

NA9.7.3.1.1 Construction Inspection

Prior to functional testing, document the following:

- Verify the minimum condensing temperature control set point is at or below 70°F.
- Verify the master system controller saturated condensing temperature input is the temperature equivalent reading of the condenser pressure sensor.
- Verify all drain leg pressure regulator valves are set below the minimum condensing temperature/pressure set point.
- Verify all receiver pressurization valves, such as the outlet pressure regulator (OPR), are set lower than the drain leg pressure regulator valve setting.
- Verify all condenser inlet and outlet pressure sensors read accurately (or provide an appropriate offset) using a pressure standard.
- Verify all ambient dry bulb temperature sensors used by controller read accurately (or provide an appropriate offset) using a temperature standard.
- Verify all relative humidity sensor used by controller read accurately (or provide an appropriate offset) using RH standard.
- Verify all temperature sensors used by the controller are mounted in a location that is not exposed to direct sunlight.
- Verify that all sensor readings used by the condenser controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature; dry bulb and relative humidity sensor readings are correctly converted to wet bulb temperature, etc.)
- Verify that all fan motors are operational and rotating in the correct direction.
- Verify that all condenser fan speed controls are operational and connected to condenser fan motors to operate in unison the fans serving a common condenser loop.
- Verify that all speed controls are in “auto” mode.

NA9.7.3.1.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase evaporator loads or decrease compressor capacity (manually turn off compressors, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2:

- Document current outdoor ambient air dry bulb and wet bulb temperatures, relative humidity and refrigeration system condensing temperature/condensing pressure readings from the control system.
- Calculate and document the temperature difference (TD), defined as the difference between the wet bulb temperature and the refrigeration system saturated condensing temperature (SCT).
- Document current head pressure control set point.

Step 3: Using the desired condenser fan motor cycling or head pressure control strategy, program into the control system a set point equal to the reading or calculation obtained in Step 2. This will be referred to as the "test set point." Allow 5 minutes for condenser fan speed to normalize.

Step 4: Using the control system, raise the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to minimum fan motor speed. Verify and document the following:

- Fan motor speed decreases.
- All condenser fan motors serving common condenser loop decrease speed in unison in response to controller output.
- Minimum fan motor control speed (rpm or percent of full speed).
- If the refrigeration system is already operating at minimum saturated condensing temperature/head pressure, reverse Steps #4 and 5.

Step 5: Using the control system, lower the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to increase fan motor speed. Verify and document the following:

- Fan motor speed increases.
- All condenser fan motors serving common condenser loop increase speed in unison in response to controller output.

Step 6: Document the current minimum condensing temperature set point. Using the control system, change the minimum condensing temperature set point to a value greater than the current operating condensing temperature. Verify and document the following:

- Condenser fan controls modulate to decrease capacity.
- All condenser fans serving common condenser loop modulate in unison.
- Condenser fan controls stabilize within a 5 minute period.

Step 7: Using the control system, reset the system head pressure controls, fan motor controls and minimum condensing temperature control set point to original settings documented in Steps #3 and 6.

Step 8: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality. Reset the minimum condensing temperature set point to the value documented in Step #6.

NA9.7.3.2 Air-Cooled Condensers and Condenser Fan Motor Variable Speed Control

Conduct and document the following functional tests on all air-cooled condensers.

NA9.7.3.2.1 Construction Inspection

Prior to functional testing, document the following:

- Verify that the minimum condensing temperature control set point is at or below 70°F.
- Verify that the master system controller saturated condensing temperature input is the temperature equivalent reading of the condenser pressure sensor.
- Verify all drain leg pressure regulator valves are set below the minimum condensing temperature/pressure set point.
- Verify all receiver pressurization valves, such as the outlet pressure regulator (OPR), are set lower than the drain leg pressure regulator valve setting.
- Verify all condenser inlet and outlet pressure sensors read accurately (or provide an appropriate offset) using a pressure standard.
- Verify all ambient dry bulb temperature sensors used by controller read accurately (or provide an appropriate offset) using temperature standard.

- Verify all temperature sensors used by the controller are mounted in a location that is not exposed to direct sunlight.
- Verify that all sensor readings used by the condenser controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature, etc.)
- Verify that all fan motors are operational and rotating in the correct direction.
- Verify that all condenser fan speed controls are operational and connected to condenser fan motors to operate in unison the fans serving a common condenser loop.
- Verify that all speed controls are in "auto" mode.

NA9.7.3.2.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase evaporator loads or decrease compressor capacity (manually turn off compressors, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2:

- Document current outdoor ambient air dry bulb temperature and refrigeration system condensing temperature/condensing pressure readings from the control system.
- Calculate and document the temperature difference (TD), defined as the difference between the dry bulb temperature and the refrigeration system saturated condensing temperature (SCT).
- Document current head pressure control set point.

Step 3: Using the desired condenser fan motor cycling or head pressure control strategy, program into the control system a set point equal to the reading or calculation obtained in Step 2.

- This will be referred to as the "test set point." Allow 5 minutes for condenser fan speed to normalize.

Step 4: Using the control system, raise the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to minimum fan motor speed. Verify and document the following:

- Fan motor speed decreases.
- All condenser fan motors serving common condenser loop decrease speed in unison in response to controller output.
- Minimum fan motor control speed (rpm or percent of full speed).
- If the refrigeration system is already operating at minimum saturated condensing temperature/head pressure, reverse Steps #4 and 5.

Step 5: Using the control system, lower the test set point in 1 degree (or 3 psi) increments until the condenser fan control modulates to increase fan motor speed. Verify and document the following:

- Fan motor speed increases.
- All condenser fan motors serving common condenser loop increase speed in unison in response to controller output.

Step 6: Document current minimum condensing temperature set point. Using the control system change the minimum condensing temperature set point to a value greater than the current operating condensing temperature. Verify and document the following:

- Condenser fan controls modulate to decrease capacity.
- All condenser fans serving common condenser loop modulate in unison.

- Condenser fan controls stabilize within a 5 minute period.

Step 7: Using the control system, reset the system head pressure controls, fan motor controls and minimum condensing temperature control set point to original settings documented in Steps #3 and 6.

Step 8: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality. Reset the minimum condensing temperature set point to the value documented in Step #6.

NA9.7.4 Variable Speed Screw Compressors

Conduct and document the following functional tests on all variable-speed screw compressors.

NA9.7.4.1 Construction Inspection

Prior to functional testing, document the following:

- Verify all single open-drive screw compressors dedicated to a suction group have variable speed control.
- Verify all compressor suction and discharge pressure sensors read accurately (or provide an appropriate offset) using a standard.
- Verify all input or control temperature sensors used by controller read accurately (or provide an appropriate offset) using temperature standard.
- Verify that all sensor readings used by the compressor controller convert or calculate to the correct conversion units at the controller (e.g., saturated pressure reading is correctly converted to appropriate saturated temperature, etc.)
- Verify that all compressor speed controls are operational and connected to compressor motors.
- Verify that all speed controls are in “auto” mode.
- Verify that compressor panel control readings for “RPMs”, “% speed”, “kW”, and “amps” match the readings from the PLC or other control systems.
- Verify that compressor nameplate data is correctly entered into the PLC or other control system.

NA9.7.4.2 Functional Testing

Note: The system cooling load must be sufficiently high to run the test. Artificially increase or decrease evaporator loads (add or shut off zone loads, change set points, etc.) as may be required to perform the Functional Testing.

Step 1: Override any heat reclaim, floating suction pressure, floating head pressure and defrost functionality before performing functional tests.

Step 2: Measure and document the current compressor operating suction pressure and saturated suction temperature.

Step 3: Document the suction pressure/saturated suction temperature set point. Program into the control system a target set point equal to the current operating condition measured in Step #2. Allow 5 minutes for system to normalize. This will be referred to as the “test suction pressure/saturated suction temperature set point”.

Step 4: Using the control system, raise the test suction set point in 1 psi increments until the compressor controller modulates to decrease compressor speed. Verify and document the following:

- Compressor speed decreases.
- Compressor speed continues to decrease to minimum speed.
- Any slide valve or other unloading means does not unload until after the compressor has reached its minimum speed (RPM).

Step 5: Using the control system, lower the test suction set point in 1 psi increments until the compressor controller modulates to increase compressor speed. Verify and document the following:

- Any slide valve or other unloading means first goes to 100 percent before compressor speed increases from minimum.
- Compressor begins to increase speed.
- Compressor speed continues to increase to 100 percent.

Step 6: Using the control system, program the suction target set points back to original settings as documented in Step #3.

Step 7: Restore any heat reclaim, floating suction pressure, floating head pressure and defrost functionality.

NA9.8 Commercial Kitchen Exhaust System Acceptance Tests

NA9.8.1 Kitchen Exhaust Systems with Type I Hood Systems

The following acceptance tests apply to commercial kitchen exhaust systems with Type I exhaust hoods. All Type I exhaust hoods used in commercial kitchens shall be tested.

NA9.8.1.1 Construction Inspection

Step 1: Verify exhaust and replacement air systems are installed, power is installed and control systems such as demand control ventilation are calibrated

Step 2: For kitchen/dining facilities having total Type 1 and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, calculate the maximum allowable exhaust rate for each Type 1 hood per Table ~~140.9~~141.0(b)-A.

NA9.8.1.2 Functional Testing at Full Load Conditions

The following acceptance test applies to systems with and without demand control ventilation exhaust systems. These tests shall be conducted at full load conditions.

Step 1: Operate all sources of outdoor air providing replacement air for the hoods

Step 2: Operate all sources of recirculated air providing conditioning for the space in which the hoods are located

Step 3: Operate all appliances under the hoods at operating temperatures

Step 4: Verify that the thermal plume and smoke is completely captured and contained within each hood at full load conditions by observing smoke or steam produced by actual cooking operation and/or by visually seeding the thermal plume using devices such as smoke candles or smoke puffers. Smoke bombs shall not be used (note: smoke bombs typically create a large volume of effluent from a point source and do not necessarily confirm whether the cooking effluent is being captured). For some appliances (e.g., broilers, griddles, fryers), actual cooking at the normal production rate is a reliable method of generating smoke). Other appliances that typically generate hot moist air without smoke (e.g., ovens, steamers) need seeding of the thermal plume with artificial smoke to verify capture and containment.

Step 5: Verify that space pressurization is appropriate (e.g. kitchen is slightly negative relative to adjacent spaces and all doors open/close properly).

Step 6: Verify that each Type 1 hood has an exhaust rate that is below the maximum allowed.

Step 7: Make adjustments as necessary until full capture and containment and adequate space pressurization are achieved and maximum allowable exhaust rates are not exceeded. Adjustments may include:

- Adjust exhaust hood airflow rates

- Add hood side panels
- Add rear seal (back plate)
- Increase hood overhang by pushing equipment back
- Relocate supply outlets to improve the capture and containment performance

Step 8: Measure and record final exhaust airflow rate per Type 1 hood.

NA9.8.1.3 Functional Testing for Exhaust Systems with Demand Control Ventilation

The following additional acceptance test shall be performed on all exhaust hoods with demand control ventilation exhaust systems.

Step 1: Turn off all kitchen hoods, makeup air and transfer systems

Step 2: Turn on one of the appliances on the line and bring to operating temperature. Confirm that:

- DCV system automatically switches from off to the minimum flow setpoint.
- The minimum flow setpoint does not exceed the larger of

  a. 50% of the design flow, or

  b. the ventilation rate required per Section 120.1.
- The makeup air and transfer air system flow rates modulate as appropriate to match the exhaust rate
- Appropriate space pressurization is maintained.

Step 3: Press the timed override button. Confirm that system ramps to full speed and back to minimum speed after override times out.

Step 4: Operate all appliances at typical conditions. Apply sample cooking products and/or utilize smoke puffers as appropriate to simulate full load conditions. Confirm that:

- DCV system automatically ramps to full speed.
- Hood maintains full capture and containment during ramping to and at full-speed
- Appropriate space pressurization is maintained.

NA9.9 Parking Garage Ventilation System Acceptance Tests

NA9.9.1 Construction Inspection

Verify and document the following tests prior to the functional testing:

- Carbon monoxide control sensor is factory-calibrated per Section 120.6(c).
- The sensor is located in the highest expected concentration location in its zone per Section 120.6(c).
- Control setpoint is at or below the CO concentration permitted by Section 120.6(c).

NA9.9.2 Functional Testing

Conduct the following tests with garage ventilation system operating in occupied mode and with actual garage CO concentration well below setpoint.

Step 1: With all sensors active and all sensors reading below 25 ppm, observe that fans are at minimum speed and fan motor demand is no more than 30 percent of design wattage

Step 2: Apply CO span gas with a concentration of 30 ppm, and a concentration accuracy of +/- 2%, one by one to 50% of the sensors but no more than 10 sensors per garage and to at least one sensor per proximity zone. For each sensor tested observe:

- CO reading is between 25 and 35 ppm
- Ventilation system ramps to full speed when span gas is applied
- Ventilation system ramps to minimum speed when span gas is removed.

Step 3: Temporarily override the programmed sensor calibration/replacement period to 5 minutes.

- Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore calibration/replacement period.

Step 4: Temporarily place the system in unoccupied mode and override the programmed unoccupied sensor alarm differential from 30% for 4 hours to 1% for 5 minutes. Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore programming.

Step 5: Temporarily override the programmed occupied sensor proximity zone alarm differential from 30% for 4 hours to 1% for 5 minutes. Wait 5 minutes and observe that fans ramp to full speed and an alarm is received by the facility operators. Restore programming.

NA9.10 Compressed Air System Acceptance Tests

NA9.10.1 Construction Inspection

Prior to functional testing, compressed air system with 2 or more air compressors must verify and document the following:

- Size, rated capacity, and type of each air compressor
- Total system capacity (the sum of the individual capacities)
- System operating pressure
- Compressor(s) designated as trim compressors
- Method and tools for observing and recording the states of each compressor in the system, which shall include at least the following states:
  - Off
  - Unloaded
  - Partially loaded
  - Fully loaded
  - Short cycling (loading and unloading more often than once per minute)
  - Blow off (venting compressed air at the compressor itself)
- Method and tools for measuring the current air demand as a percentage of the total system capacity, including any necessary calibrations.

NA9.10.2 Functional Testing

Step 1: Per the test methods outlined in the Construction Inspection, verify that these methods have been employed, so that the states of the compressors and the current air demand can be observed and recorded during testing.

Step 2: Run the system steadily (at as close to a constant load as can be practically implemented) between 50% and 85% of total system capacity, for a duration of at least 10 minutes.

Step 3: Observe and record the states of each compressor and the current air demand during the test.

Step 4: Confirm that the combinations of compressors states meet the following criteria:

- No compressor exhibits short-cycling.
- No compressor exhibits blowoff.
- For new systems, the trim compressors shall be the only compressors partially loaded, while the base compressors will either be fully loaded or off by the end of the test.

NA9.11 Commercial Refrigeration Acceptance Tests

Commercial refrigeration acceptance requirements shall be approved by the Energy Commission on or before January 1, 2013.

NA9.11.1 Air-Cooled Condensers and Fluid Coolers

NA9.11.1.1 Construction Inspection

NA9.11.1.2 Functional Testing

NA9.11.2 Evaporative Condensers, Fluid Coolers and Cooling Towers

NA9.11.2.1 Construction Inspection

NA9.11.2.2 Functional Testing

NA9.11.3 Compressor Floating Suction Controls

NA9.11.3.1 Construction Inspection

NA9.11.3.2 Functional Testing

NA9.11.4 Liquid Subcooling

NA9.11.4.1 Construction Inspection

NA9.11.4.2 Functional Testing

NA9.11.5 Display Case Lighting

NA9.11.5.1 Construction Inspection

NA9.11.5.2 Functional Testing

NA9.11.6 Refrigeration Heat Recovery

NA9.11.6.1 Construction Inspection

NA9.11.6.2 Functional Testing