

California Energy Commission
STAFF REPORT

FINAL EVALUATION REPORT

APPLICATION FOR COMPLIANCE OPTION FOR
Open Cell, Low-Density Spray Polyurethane Foam
(ocSPF) Insulation



CALIFORNIA
ENERGY COMMISSION
Edmund G. Brown Jr., Governor

DECEMBER 2011
CEC-400-2011-006-SF

CALIFORNIA ENERGY COMMISSION

David W. Ware
Payam Bozorgchami
Primary Authors

Gary Flamm
Supervisor

Bill Pennington
Office Manager
***High Performance Buildings and
Standards Development Office***

Panama Bartholomy
Deputy Director
Efficiency and Renewable Energy Division

Robert P. Oglesby
Executive Director

DISCLAIMER

Staff members of the California Energy Commission prepared this report. As such, it does not necessarily represent the views of the Energy Commission, its employees, or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Energy Commission nor has the Commission passed upon the accuracy or adequacy of the information in this report.

ABSTRACT

The Spray Polyurethane Foam Alliance (SPFA) has submitted an application and supporting information requesting approval of a compliance option for open cell, low-density spray polyurethane foam (ocSPF) insulation. The application is consistent with the compliance options procedures in Section 10-109 of the Building Energy Efficiency Standards (Standards).

The SPFA seeks this compliance option application to allow this product type to receive energy compliance credit for Quality Insulation Installation (QII) for residential buildings.

California Energy Commission staff believes the application is complete and the general content of the SPFA proposed changes to compliance documentation is appropriate. Staff believes that compliance with the Standards would be best served through the development of a single comprehensive QII procedure covering both ocSPF and closed cell, medium-density spray polyurethane foam (ccSPF) insulation.

Staff has solicited stakeholder comments and has conducted a public workshop to review the proposals, which are included with the application for a compliance option. This final evaluation report represents staff's review and final recommendation for a proposed QII energy compliance credit for open cell low-density spray polyurethane foam insulation. Staff recommends that the Energy Commission approve the proposed compliance option, which is the subject of this final evaluation report.

Keywords: California Energy Commission; Compliance Options; Building Energy Efficiency Standards; Quality Insulation Installation

Ware, David W., 2011. FINAL EVALUATION REPORT, Application for Compliance Option for Open Cell, Low-Density Spray Polyurethane Foam (ocSPF) Insulation. California Energy Commission, High Performance Buildings and Standards Development Office. CEC-400-2011-006-SF

TABLE OF CONTENTS

ABSTRACT	i
Introduction	1
Background	2
Effectiveness of Insulation	2
Insulation Installation Quality	2
SPFA Compliance Option Application	3
Public Review of the Proposed SPFA Compliance Option.....	3
Attachment 1: Alternative Quality Insulation Installation Procedures for Spray Polyurethane Foam (SPF) Insulation: <i>Medium-Density Closed Cell and Low-Density Open Cell</i>	4
Attachment 2: 2008 Reference Appendices – Appendix JA4 - U-factor, C-factor, and Thermal Mass Data	5
Attachment 3: 2008 Residential Compliance Manual	6
Attachment 4: Compliance Forms	6
Conclusion	6

Introduction

On November 1, 2010, the California Energy Commission received an application and supporting information from representatives of the Spray Polyurethane Foam Alliance (SPFA) requesting approval of a compliance option for open cell low-density spray polyurethane foam (ocSPF) insulation. The application is consistent with the compliance options procedures in Section 10-109 (b) 4 of the Building Energy Efficiency Standards (Standards) and those described in the *Compliance Options Approval Manual for the Building Energy Efficiency Standards: CEC400-2005-007*.

SPFA seeks this compliance option application to allow ocSPF insulation to receive compliance credit for Quality Insulation Installation (QII). The SPFA application seeks approval to apply the same QII credit to ocSPF that is currently approved for closed cell medium-density spray polyurethane foam (ccSPF) insulation when installed and inspected through third-party verification to meet specified QII procedures.

Since ocSPF's thermal performance and installation processes are similar to that of ccSPF insulation, the SPFA has proposed a QII procedure for ocSPF insulation that is based on the current approved QII procedure for ccSPF insulation in the Reference Joint Appendix (JA7) of the Reference Appendices.

- SPFA's application does not require modifications to performance Standards computer modeling nor does it propose modifications to the prescriptive packages.
- SPFA's application proposes to use the same R-value per inch for ocSPF that is currently allowed in compliance reference documents.

The compliance option request from SPFA is supported by the following proposed compliance documents:

- A proposed QII installation procedure for ocSPF
- Editorial modifications to specific Reference Appendix JA4 tables and their respective footnotes contained in the *2008 Reference Appendices*
- Editorial modifications to the *2008 Residential Compliance Manual*
- Modifications to the QII Installer (CF-6R) and HERS Rater (CF-4R) forms

Background

Effectiveness of Insulation

Research completed by the Energy Commission has found that typical residential insulation installations have construction flaws that degrade thermal performance. Three categories of problems commonly occur when insulation is improperly installed:

- Insulation not in contact with the air barrier causes a “short-circuit” of the insulation’s thermal resistance due to unconditioned air circulation between the insulation and the air barrier
- Gaps and voids in the insulation lead to uninsulated portions of the building envelope and
- Overly compressed insulation or insulation installed at less than prescribed levels degrades insulation performance. This can occur in entire cavities or around and under wiring, piping, and electrical and other service components.

Beginning with the 2005 Standards, performance modeling of all insulation materials was changed to reflect these common installation defects, reducing expected thermal resistance of insulation assemblies by about 19 percent.

Insulation Installation Quality

To address these common installation defects and to encourage quality installation of insulation materials, a compliance credit was provided beginning with the 2005 Standards for following quality installation procedures. The credit, available when using the performance approach to demonstrate compliance with the Standards, requires verification by a third-party, certified Home Energy Rating System (HERS) rater. Specific verification procedures were adopted as part of the Standards Reference Appendices and are known as the High Quality Insulation Installation (QII) Procedures.

QII protocols were developed for the predominant insulation materials used in residential construction at the time: mineral fiber batts, blown-in mineral fiber, and cellulose loose fill material.

During the development of the 2008 Standards, representatives from the SPFA worked with the Energy Commission to develop QII procedures for ccSPF insulation. QII procedures for ccSPF were adopted in the 2008 Standards and included in the *2008 Reference Appendices*, Reference Appendix JA7 – *Installation Procedures for Medium-Density, Closed-Cell Spray Polyurethane Foam (SPF)*.

Since the adoption of the 2008 Standards, the SPFA has worked closely with its members and the Energy Commission to develop QII procedures for ocSPF insulation.

SPFA Compliance Option Application

The SPFA's application for a compliance option for residential buildings proposes to allow ocSPF insulation to receive compliance credit for Quality Insulation Installation (QII). Its application is supported by the following proposed compliance documents:

- A proposed QII installation procedure for ocSPF
- Editorial modifications to specific Reference Appendix JA4 tables and their respective footnotes contained in the *2008 Reference Appendices*
- Editorial modifications to the *2008 Residential Compliance Manual*
- Modifications to the QII Installer (CF-6R) and HERS Rater (CF-4R) forms

Staff believes that compliance with the Standards would be best served through developing a single comprehensive QII procedure covering both ocSPF and ccSPF product types. This approach was discussed and agreed to by the SPFA.

Public Review of the Proposed SPFA Compliance Option

On July 25, 2011, Energy Commission staff held a public workshop to present the staff draft recommendations regarding the application from SPFA for approval of a compliance option. The proposed compliance option would allow ocSPF insulation to receive the QII energy compliance credit. Participants in the workshop, and comments received in writing, supported the proposed compliance option and staff's draft recommendations regarding the proposed QII energy compliance credit for ocSPF insulation.

Two primary changes were suggested by proponents to the proposed QII HERS rater verification procedures: (1) the removal of staff's proposed requirement that ocSPF insulation must fill the cavity of 2x6 inch framed wall assemblies; and (2) the allowance for ocSPF to be used as an air barrier when installed at a thickness consistent with ASTM International (formally known as the American Society for Testing and Materials) standard tests.

Staff's final modifications to the proposed QII procedures are intended to ensure that the integrity of the installed ocSPF insulation can be checked in the field by a HERS rater. Staff's recommended changes in response to the public workshop suggestions are discussed below:

- Filling of framed cavities:
Framed cavities of 2x4 inch or less must be completely filled. Framed cavities greater than 2x4 inch (i.e., 2x6 inch or greater) may be filled to the thickness necessary to meet the required R-value used for compliance, provided that the bottom and top plates of vertical framing and both

ends of horizontal framing (e.g., band and rim joists) are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 5.5 inches away from the framing for ocSPF insulation or 2.0 inches for ccSPF, or filled to a distance equal to the thickness required to meet ASTM E2678 or ASTM E283 testing as an air barrier.

The provision to fill the ends of framed cavities, even though ocSPF insulation may not fill the rest of the framed cavity to full thickness, ensures that installed ocSPF insulation minimizes air leakage at the ends of each framed assembly where it is installed to avoid the insulating R-value of the assembly to be compromised due to possible air circulation of unconditioned air in the cavity. This change also is consistent with the intent of the current QII procedures for loose fill and batt insulation that must be in contact with all six sides of the cavity in framed assemblies.

- Air barrier:

To serve as an air barrier, ocSPF insulation shall be installed at a thickness that meets an air permeance no greater than 0.02 L/s-m² at 75 Pa pressure differential when tested in accordance to ASTM E2178 or ASTM E283; alternatively ocSPF shall be installed a minimum of 5.5 inches in thickness.

Several manufacturers of ocSPF insulation have tested their material to meet air leakage performance levels. Specifying a criteria for ocSPF insulation to qualify as an air barrier control, based on a minimum installed thickness of 5.5 inches, allows some product types and/or installations to meet the QII air barrier requirement when product testing has not been conducted, or when verification of testing is not provided with compliance information at the job site.

Summarized below are key aspects of each of the proposed final compliance documents that support the SPFA Compliance Option application.

Attachment 1: Alternative Quality Insulation Installation Procedures for Spray Polyurethane Foam (SPF) Insulation: *Medium-Density Closed Cell and Low-Density Open Cell SPF*

- Staff and the SPFA acknowledge there are strong similarities in the procedures needed to provide quality installation and third-party verification for both ocSPF and ccSPF insulation. The proposed single QII document covering installation procedures for SPF insulation would be an alternative to the current procedure focused solely on ccSPF, which has been adopted by regulation in Reference Appendix JA7 of the 2008 Reference Appendices.
- The Reference Appendix JA7 procedure has been reorganized to more clearly identify key elements affecting installation and field verification. Additional criteria have also been added in Section 5 to ensure quality of the installation.
- Section 3 provides a new R-value table for ocSPF insulation based on the prescribed R-3.6 per inch currently allowed in compliance reference documents. Additional language has been added for ccSPF and ocSPF recognizing that approved performance

compliance software may specify other thicknesses to achieve a specific R-value used for compliance. Onsite field verification of installed thickness must always be completed. The HERS rater is required to check installed thickness using probes or similar devices at several locations within the building, and standard wall assemblies with 2x4 inch framing must be completely filled when ocSPF insulation is used. Allowance is made for not filling the cavity of 2x6 inch and greater framed assemblies, provided all ends of vertical and horizontal framing have a specified amount of insulation installed to prevent air leakage into the cavity.

- Section 3 allows ocSPF to be installed as the air barrier provided it is installed to a minimum thickness of 5.5 inches or has been tested to meet a specific air leakage rate consistent with standard ASTM testing.
- Section 3 allows the average installed thickness of ocSPF to be used to determine the installed R-value, allowing up to 10 percent of the surface area to have small depressions not less than 1 inch of the minimum thickness required to achieve the specified R-value on compliance documentation.
- Cautionary language has been added in Sections 5, 8 (d), and 9 (a & e) regarding insulation installation in unvented attics, including the amount of insulation required, the requirement to insulate gable ends, and the requirement to check for the safety of fuel burning appliances when they are present in the attic area.

Attachment 2: 2008 Reference Appendices—Appendix JA4 – U-factor, C-factor, and Thermal Mass Data

The values in Reference Appendix JA4 are used for all residential and nonresidential compliance calculations: prescriptive, overall envelope, and building performance. Energy Commission approved compliance software may make adjustments to the table values using procedures described in this appendix. Under Section 4.1.1 of Reference Appendix JA4, information regarding the assembly tables in Reference Appendix JA4 can be modified or new information included upon approval by the Energy Commission's Executive Director.

- A new Section 4.1.7 is proposed to be added to this attachment to accompany the changes in the tables and their respective footnotes, to provide baseline performance guidance for SPF insulation, including descriptions of ccSPF and ocSPF insulation, their designated R-value per inch, and nominal thicknesses.
- Clarifications have been made to table descriptions, footnotes, and assumptions. No changes have been made to R-values or U-factors with one exception: Table 4.3.3 – U-factors of Metal Framed Walls for Nonresidential Construction, has been modified to include a low R-value (R-5) cavity insulation condition in combination with exterior continuous sheathing (R-12) to better account for combinations of insulating material being used in nonresidential construction.

Attachment 3: 2008 Residential Compliance Manual

- Modifications to Chapter 3, Building Envelope Requirements, of the Residential Compliance Manual (RCM) are proposed to describe more clearly the performance characteristics of SPF insulation both for ccSPF and ocSPF. Modifications to Section 3.3.7 describe ocSPF's allowance to receive the QII compliance credit upon verification by a HERS Rater. The RCM is not adopted by regulation. Staff makes periodic editorial changes to the RCM to help improve the information contained in this manual, and provides public notice of those updates when they are made available.

Attachment 4: Compliance Forms

- The success of the requirements in the Standards depends on enforcement and verification in the field. Inclusion of a QII compliance credit for ocSPF insulation necessitates modifying QII compliance forms to cover installation and field verification checklists for use at both the framing and insulation stages of insulation installation.

Conclusion

The application for a compliance option submitted by the Spray Polyurethane Foam Alliance is complete. Staff has received comments and recommendations from the public and stakeholders, and modifications to staff's proposed QII energy compliance credit for open cell spray polyurethane foam insulation have been made. Staff recommends that the Energy Commission approve this Compliance Option and accompanying proposed modifications to the Quality Insulation Installation procedures, which are included in this Final Evaluation Report.