Evaluation of Market Transformation Strategies for Verifying a Quality Installation Specification

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ABSTRACT

HVAC industry stakeholders continue to work at the local, regional, and national levels to improve HVAC installation practices, which will result in improvements in occupant health, comfort, safety, and energy efficiency. The current focal point of the national effort is the development of a consensus quality installation (QI) specification, which is being spearheaded by the Air Conditioning Contractors of America (ACCA). This stakeholder-supported specification is aimed at providing the market with a common definition for a quality installation. This paper outlines a range of verification options that identify when the specification requirements are met. A spectrum of options, ranging from self-verification by the installing technician to 100% in-field inspection by a credible independent party, has been evaluated. The authors – representing both HVAC contractors and efficiency program administrators – will summarize several verification scenarios and outline the relative costs, benefits, and uncertainties of each.

The Sufficient Market Conditions for Achieving QI

Many efforts are already underway to promote installation of high-efficiency equipment that will perform optimally in the field. While there have been successes, buildings are still more likely to have improperly installed HVAC systems than systems installed for optimized performance. This is likely because while some of the *necessary* market conditions for a QI now exist, those conditions are not currently *sufficient* to catalyze market transformation in the direction of QI. Key stakeholders have begun to identify both the *necessary* and *sufficient* market conditions that must exist for QI to become more common (Taylor, Hourahan, and Parlapiano, 2004). These market conditions include: 1) stakeholder agreement on the definition of QI; 2) QI verified and measured in the field; 3) supply-side market players able/willing to deliver QI (including the HVAC contractor sales staff who often specify the equipment size and component selections, and 4) building owners who value the benefits of QI and can identify and select QI in the marketplace. This paper summarizes progress made on the first necessary market condition, and evaluates options for achieving the second.

The ACCA QI Specification

ACCA is the largest HVAC contractor association in the United States. It publishes numerous technical manuals, with the objective of providing industry-supported guidelines for HVAC contractors. ACCA recognized that, until now, there has been no universally-accepted definition for a quality installation across the broad spectrum of the industry (manufacturers,

distributors, contractors, user groups, customers, utilities, environmental groups, associations/professional societies, governmental agencies, etc.).

To this end, ACCA has convened stakeholders from various sectors (e.g., contracting, OEM, utility, building science, federal government) to develop a consensus definition of what constitutes a quality residential and small commercial HVAC installation. In May 2006, the *HVAC QI Specification* was submitted by ACCA to the American National Standards Institute (ANSI) for a 45-day public review period. The QI Specification provides installing contractors with credible guidelines to improve their business (which will lead to increased occupant comfort, health, and safety while ensuring increased equipment reliability and energy efficiency). Additionally, the ACCA QI Specification may serve other varied objectives, including: enhancement of training curricula; guidelines for complying with existing LEED programs or with other local energy efficiency programs; basis for a future ENERGY STAR Program; and a defining standard for a contractor accreditation program.

The specification details the requirements and acceptable procedures for executing a quality installation. It also defines acceptable forms of documentation for demonstrating that the requirements are met. There are two main parts to this specification:

Part I:
Quality Contractor Elements focus on how a contracting business operates, safeguards its employees, and addresses customer concerns. The specification acknowledges that there are certain contractor attributes and minimum business practices that are necessary to enable/maintain quality HVAC installations by installing/servicing technicians. With a focus on the "business side of things" as an indicator that a HVAC contractor is positioned to properly support its technicians in providing/servicing quality systems, specific contractor requirements have been identified that are associated with Business Prerequisites, Supporting Business Practices, and Achieving Customer Satisfaction.

Part II:
Quality Installation Elements focus on the actual installation and how well the HVAC system is selected and installed. When addressing HVAC installations, it is acknowledged that QI is more than just the use of high-efficiency products and systems. QI also includes the adequate selection of equipment/controls, proper component sizing, and correct equipment installation to ensure optimum occupant satisfaction and energy savings. This specification defines core elements representative of quality installation, and identifies appropriate field verification approaches: Design, Equipment Installation, Air Distribution, System Documentation, and Owner Education.

This paper focuses on options for verifying when Part II – *Quality Installation Elements* – is achieved.

The Importance of Verification

For stakeholders to successfully promote QI, it must be practical to identify when QI has been performed. Ideally, QI would be identified and quantified through verification of proper system performance. At a minimum, a checklist of prescriptive requirements – based on the definition of QI accepted by all stakeholders – must be verifiable. Differentiating between

today's typical (possibly sub-par) installation and QI will allow stakeholders to combat invalid claims by low-quality contractors. This will maintain the integrity of the specification, the installing contractor, and the sponsoring program administrator. Improved documentation of QI system performance – in terms of comfort, safety, and energy savings – would also strengthen consumer marketing campaigns, and better enable efficiency program administrators and the federal government to justify expenditures towards this energy-saving opportunity.

"Verification" Defined

The word "verification" can be interpreted differently. The Merriam Webster Dictionary defines verification as "The act or process of establishing the truth, accuracy, or reality by establishing the correspondence of actual facts or details with those proposed or guessed at." Verification can be synonymous with *confirmation* (the removal of doubt about by authoritative act or indisputable fact), *validation* (the attestation to the truth or validity of something), *substantiation* (the offering of evidence that sustains a contention), *testing* (a critical examination, observation, or evaluation), *inspection* (viewing closely in critical appraisal), and *quality assurance* (a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met). For the balance of this paper, which focuses on market transformation strategy, the authors characterize verification as the *minimum requirements* to ensure the desired outcome is accurately and consistently achieved.

Who Can Implement a Quality Installation Verification Program

Many types of organizations are potential program administrators at the local, regional, or national level. The most important characteristics of a program administrator are credibility with key stakeholders – including building owners – and the ability to administer an effective (i.e., accurate and consistent) program. Establishing credibility requires confidentiality agreements between the program administrator and participating contractors regarding installation data and strict data integrity protocols. HVAC contractors must be certain that their highly valued customer data is not used for any purpose other than ensuring that a quality installation is achieved. Prospective administrators must also possess the necessary resources to administer the program. Possible program administrators could include equipment manufacturers, building inspection services, equipment distributors, state energy offices, trade associations, nonprofit organizations, production builders, and utilities.

Criteria for Evaluating Verification Program Options

Prospective program administrators have several options for verifying that a quality installation specification is achieved, each of which has relative strengths and weaknesses. The authors believe the following criteria are most important in evaluating verification strategies:

Program effectiveness (accurate and consistent): The primary objective of a verification program is to ensure the desired outcome is achieved with a high degree of certainty. A program strives to be both accurate (i.e., minimize false positives and false negatives) and

consistent (i.e., delivering the same installation results time after time). Also, any HVAC verification program must deliver value to building owners/occupants. The additional cost passed on to a building owner for a verified quality installation must be less than the health, comfort, safety, durability, and long-term energy savings benefits he or she accrues over the operating life of the equipment.

Designing an effective verification program includes consideration of numerous elements. A complete discussion of each is outside of the scope of this paper, but they merit mentioning:

1. Credibility of program sponsor/organizer
2. Sampling protocols
3. Qualifications of installing contractors
4. Qualifications of verifiers
5. Robustness of installation specification
6. Verification tools and methods
7. Complaint resolution/recourse for disputes

An effective program is essential to maintaining integrity and credibility with program participants, supporters, and customers. This criterion must be given particular attention in program design considerations.

Program administration cost: While large energy saving opportunities justify large program budgets. The total cost, however, is often a limiting factor in program design decisions. Costs of a verification program may include staff time, hiring of an implementation contractor or verification service provider, subsidizing the costs of technician diagnostic tools, and technician training. HVAC system performance impacts human health, comfort, and safety as well as building integrity. As such, organizations taking responsibility for verifying a quality HVAC installation may be exposed to some degree of legal responsibility. Strategies with higher risk and legal exposure also increase the administrative cost of the program.

HVAC contractor participation: Critical to the success of any verification program is the willing participation of HVAC contracting businesses. Ultimately, participation in any program will require contractors to weigh the costs (i.e., program participation requirements, incremental job time, costs of necessary tools, and training) against the benefits (i.e., market differentiation, staff education, program promotion to new customers, financial incentives) of participating, and conclude that doing so will support their business and increase their bottom line. Even when the contractor is committed to delivering QI, the possible high cost of QI implementation, as a percentage of the total project, may limit owners' willingness to participate even when the contractor wishes to participate.

Persistence of benefits: Related to HVAC contractor participation is the duration of the benefits that result from implementing a verification program. It is hoped that contractors choosing to participate in an incentive program will continue to perform quality installations after the program ends. The best incentive programs will become embraced by owners, and result in lasting market transformation even when programmatic incentives are no longer offered.

Common Components of a Verification Program

When designing a verification program, a number of components are necessary. Each requires decisions to be made that must be carefully evaluated. A diagram summarizing these options is contained in Figure 1.

1) ***Initial Application from Contracting Business:*** All administrators will require interested contractors to file an initial application in order to participate in a program. Part 1 of the ACCA Quality Installation Specification ("Quality Contactor Attributes") provides guidance on potential requirements for the initial application. For formal programs, this application will include an agreement, or contract, between the administrator and the contracting business, that also defines the conflict resolution process for the program. Part 2 of the QI Specification ("Quality Installation Attributes") provides guidance on the requirements and acceptable procedures for executing a quality installation, as well as acceptable forms of documentation for demonstrating the requirements are met; all this information should be distributed to participating contractors as early as possible

2) ***Installation Documentation by Installing Technician/Contractor:*** In order to evaluate the quality of an HVAC installation, measurements must be taken and inspections performed. Data must be collected on the various elements contained in the QI Specification by the installing technician/contractor, and the acceptable evidence must be filed. This may be accomplished in a commissioning report, or collected electronically using advanced diagnostic tools.

3) ***Documentation Review:*** After the installing technician/contractor documents that the installation has occurred according to the QI Specification, someone other than the installing technician must review that documentation for every installation. This back-office data review may be conducted by:

   3A *An independent third-party organization* (i.e., someone not directly involved in the sale or installation of the equipment). Examples of potential independent third-parties include the program administrator's staff, an implementation contractor hired to represent the program administrator, and other verification service providers.

   3B *An in-house inspection program administered by the installing contractor*. Some HVAC contracting businesses have established in-house quality control programs in an effort to self-police their work (more common in new construction installations). This option takes advantage of an existing business model, increasing the likelihood it will be embraced by HVAC contractors. However, because the installing contracting business has a stake in the outcome of the verification process, the program administrator is likely to request additional quality assurance protocols to ensure a credible outcome.

Ideally, this documentation will be passed on to the entity responsible for performing the next step of installation verification. It is important to note that the QI Specification includes several elements that must be verified, and conceivably different verification strategies may be employed to verify different requirements of the specification.

4) Installation Verification: In addition to a back-office data review, a robust verification program requires analysis of data collected during the installation. A broad spectrum of options exists for verifying that a quality installation specification is achieved – all with varying levels of effectiveness, administration cost, HVAC contractor participation, persistence of benefits, and building owner satisfaction. These options may not be mutually exclusive and program administrators may make use of different verification strategies for different aspects of the QI Specification. The scope of this paper does not allow for a comprehensive discussion of every hybrid approach, but we discuss three broad categories of verification strategies. It is important to note that *on-site technician self-verification* is not included in this discussion. Using the technician who is performing the installation to collect and analyze performance data is a convenient, low-cost option. However, the installing technician has a direct financial stake in the outcome of the verification, thus greater probabilities of false positives exist. Therefore, the authors conclude that technician self-attestation is not a viable verification strategy.

4A *On-site independent third-party verification:* The most rigorously viewed verification programs likely involve an independent third party (i.e., an entity not involved in the sale and installation of the equipment) reviewing documentation from the technician, visiting the jobsite, performing measurements, collecting and analyzing necessary data, and verifying that the specification requirements have been met. Also, strict protocols must be enforced by the program administrator to ensure consistent outcomes, even when different individuals perform the in-field verification. The installing technician should be invited to attend the verification. The technician's presence allows for immediate feedback and resolution of any problems identified by the verifier. Inviting the installing technician to be physically present during the verification will also reduce the concern that the verifier will poorly represent the installing contractor's work to the building owner.

The verifier should not disclose any negative results of the verification to the building owner until after consulting with the program administrator and/or the installing contractor, which requires care if the owner is also monitoring the verification process. Also, to avoid any perception of bias, the program administrator may stipulate that organizations performing verifications not be eligible for program incentives as an installation contractor (a potential issue if a local HVAC contractor is also an implementation contractor for the verification program). This verification approach likely involves the highest financial cost to the program administrator as an independent, skilled verifier must be sent to the job site. Additionally, it is most disruptive to the owner as it requires another visit to

the building when an occupant is available. This will vary depending on the percentage of installations that are verified. While higher certainty can be achieved by inspecting 100% of installations, some program administrators will likely develop practical approaches for achieving high levels of certainty with sampling protocols (e.g., reducing inspections for contractors who demonstrate consistent ability to deliver QI).

4B *Remote independent third-party verification:* Having the technician who is performing the installation interact with a remote independent third party is a convenient, lower-cost option. No additional people are required to visit the job site, thus reducing travel and payroll costs. If a problem is identified, the installing contactor can rectify it immediately. However, the installing technician has a stake in the outcome of the verification, so potential for false positives exist. Robust procedures for analyzing data collected by the technician must exist to detect any incorrect submissions (accidental or otherwise). In an effort to balance the practical benefits of having the installing contractor verify his own work with the desires of program implementers to have an effective program, a number of companies currently offer remote independent third-party verification services for specific (and perhaps limited) QI elements. This option requires contractor training and data collection. Verification can take place by telephone or internet, depending on the support protocols used by the service provider. The verification service provider will likely charge a fee to train contractors and verify data submissions, which may be paid by the program administrator, the installing contractor, or the building owner. Effectiveness and cost may vary by service provider. Efficiency program administrators have indicated success in reaching their objectives by structuring several different service providers to participate within a single program. This approach needs additional guidelines for contractors and may necessitate implementing a secondary verification (i.e., sampling) on some jobs. Many of these services also aid the installing technician in commissioning his/her work, and therefore can have an ancillary training benefit.

4C *On-site contractor verification program:* Currently, some HVAC contracting businesses implement an in-house quality control program that employs inspectors who ensure their installers are achieving QI. The integrity and effectiveness of these efforts depend on how dedicated the business is to pleasing customers, reducing callbacks and risk of lawsuits, and differentiating themselves in the market. At a minimum this will require a "firewall" between the installation and inspection teams. While this strategy still requires a second individual to visit the jobsite, efficiencies may be achieved because of the increased communication enabled by having the installer and verifier work for the same business. Because some contractors are already employing this strategy, it should result in increased contractor participation, and holds promise as a business model that is sustainable in the absence of program support and incentives. Another benefit of this strategy is

that the person responsible for verification is also likely to be both qualified and authorized to rectify any problems with the installation. However, because the contracting business may have a financial incentive to achieve a "pass," the program administrator will likely need to administer a secondary verification on a percentage of jobs, or take some additional steps to ensure the verification is accurate.

5) ***Secondary On-Site Verification by Independent Third Party:*** To increase the validity of a verification program, a fraction of installations should by subjected to an on-site inspection by an independent third party. Therefore, programs employing options 4B (*remote verification*) and 4C (*installing contractor inspection program*) may call for this fifth component. The percentage of jobs actually subjected to a secondary on-site verification is to be quantified by the program administrator. The level of secondary verifications will affect the costs of the program, building owner satisfaction (additional quality assurance, but more time dedicated to purchasing an HVAC system), and the certainty of the outcome. However, just the threat of possible secondary inspections is likely to increase the effectiveness of a verification conducted by a remote party or the installing contractor. As with option 4A (*on-site inspection by independent third party*), the installing contractor should always be invited to attend the verification.

6) ***Verification Decision by Responsible Entity:*** Once all necessary data is documented and analyzed, the responsible party must decide whether the installation has achieved the requirements of the QI Specification. Ultimately, this determination is the responsibility of the program administrator, but it may be delegated to an implementation contractor.

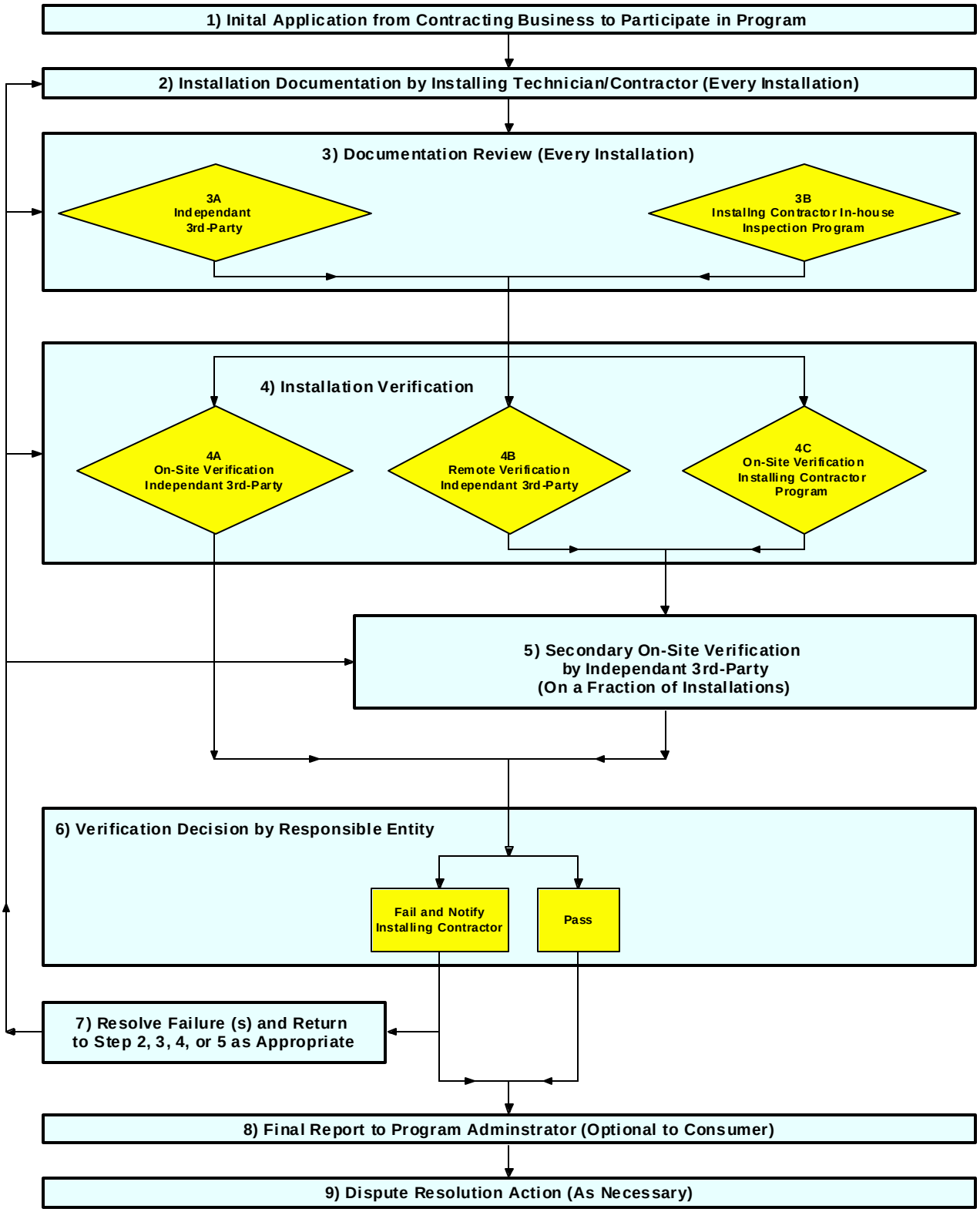
7) ***Resolve Deficiencies and Return to Step 2, 3, 4, or 5 as Appropriate:*** If the installation has deficiencies, the installing contractor should be notified as soon as possible and given feedback to help remedy any problems. When the verifier and installing contractor agree that there is an installation deficiency, corrections should be made, and new documentation by the installing technician/contractor (Step 2) should be created. If an error in the technician/contractor documentation is identified, it should be remedied and submitted for review (Step 3). If an error by the verifier has been made (or if ambient conditions changed between the installation and the verification, making duplication of results impossible), the verifier should remedy the error (Step 4 or 5) and issue a "pass" if appropriate. (Note: The possibility always exists that the installing contractor may be unable to resolve deficiencies due to lack of expertise and skills or because the building owner has declined the necessary work due to time and expense.)

8) ***Final Report Sent to Program Administrator (Optional to Owner):*** Regardless of who performs verification and whether it is a "pass" or "fail," a report summarizing the findings should be submitted to the program administrator. This is particularly important for installations that "pass" and are potentially eligible for an incentive. These reports serve several purposes, including evidence for dispute resolution if the

outcome is questioned, data for program evaluation and regulatory filings, tool for training technicians, and a starting point for any follow up by the program administrator. For building owners, this report will provide credible validation that a QI has been achieved, or potentially be a tool for identifying additional servicing or upgrade needs. However, great care must be taken when declaring an installation unsatisfactory. Many voluntary programs strive to identify exemplary products and services, and reward them with an incentive as opposed to deeming a product or service deficient.

9) ***Dispute Resolution Action (as Necessary)***: Developing a robust dispute resolution policy in the event the involved parties fail to agree on the findings of the verification program is an important communication and risk-minimization tool. Disputes may arise among the program administrator and the verifier, building owner, and/or contractor. In almost all verification programs, the program administrator will also maintain the right to perform additional quality assurance of verified installations to ensure the verification process is functioning as intended. This component generally is unnecessary when the primary verification is performed by the staff of the program implementer.

Figure 1. Design Considerations for a QI Verification Program



Relative Strengths of Verification Program Options

The primary objective of this paper is to provide stakeholders with a theoretical construct for evaluating alternative verification strategies that draws upon real-world verification experience. Table 1 summarizes the authors' findings. A subsequent paper will explore the strengths and weaknesses of each of these approaches in further detail.

Table 1. Relative Strengths of Verification Options for Each Criterion

	Administration Cost	**Effectiveness**	**Level of Contractor Participation**	**Persistence of Program Benefit**
On-Site Installing Contractor Program	Low	Low to Medium	High	High
Remote Independent Third-party Verification	Medium	Medium	Medium	Medium to High
On-site Independent Third-party Verification	High	Medium to High	Low to Medium	Low to Medium

Empowering Quality HVAC Contractors – Contractor Accreditation

The authors maintain that some level of verification is necessary to transform the HVAC marketplace. It is also recognized that the primary drivers for a quality HVAC contractor to participate in a voluntary QI Program is the desire to differentiate itself from other HVAC contractors and to maintain profit margins inline with higher quality work effort. The most meaningful differentiation likely stems from credentials awarded by a credible organization that enforces stringent requirements and also provides a useful marketing platform. An effective contractor accreditation program requires both a consensus definition of QI (the ACCA Specification) that is supported by key stakeholders, and viable approaches for verifying when the specification is achieved.

Implications for the ENERGY STAR© Program

The authors believe lasting market transformation will require a national program manager that shepherds the QI specification as it evolves, develops supporting documents that provide guidelines and direction for prospective local program administrators, and enforces these guidelines in a manner that maintains integrity. In addition to HVAC industry organizations, the ENERGY STAR© Program is one potential entity that could fulfill the need for providing a general framework for local efforts.

The Environmental Protection Agency (EPA) has committed to creating an ENERGY STAR program that encourages quality residential HVAC installations. The authors believe ENERGY STAR© can play an integral role in achieving some of the sufficient market conditions, particularly by furthering acceptance of the ACCA Specification as a consensus definition of QI, encouraging building owners to value the benefits of QI, and enabling building

owners to identify and select QI in the marketplace. Through their public awareness campaigns and network of partners, ENERGY STAR© can also help to market local verification programs as credible and necessary.

Conclusions and Next Steps

When designing a QI verification program, one must evaluate the magnitude of the potential benefit (e.g., energy savings, comfort, IAQ, etc.), the acceptable administration costs, the anticipated level of sustained HVAC contractor program participation, and the level of acceptable uncertainty (i.e., false positives and false negatives over the course of the entire program). These decisions depend on local market conditions and no silver bullet has yet been identified. However, the authors believe a precursory step in identifying preferred verification strategies is to address two key program design issues: (1) the criteria that are most important in measuring the success of a verification program, and (2) the basic verification strategies that are to be followed. While other promising approaches beyond those specifically identified here may arise, the authors wish to initiate dialogue and begin a nationwide effort to identify and, through existing infrastructure, implement effective verification options. The authors, working with key stakeholders will continue to identify practical options for verifying QI, and evaluate the strengths, weaknesses and opportunities of these options.

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