



**Appendices: Baseline Characterization
Market Effects Study of Investor-Owned
Utility Residential and Small Commercial
HVAC Quality Installation and Quality
Improvement Programs in California
(Work Order 054)**

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Appendix A California IOU Programs Promoting HVAC Quality Installation and Quality Maintenance

The California IOU quality installation (QI) and quality maintenance (QM) programs are described in this section based on interviews with seven program staff at Southern California Edison (1 interviewee), Pacific Gas & Electric (4 interviewees), and San Diego Gas & Electric (2 interviewees) who are responsible for the design and implementation of initiatives to promote awareness and adoption of quality maintenance (QM) and quality installation (QI) practices. While QI and QM programs for each of the three IOUs are discussed separately, it is important to note that coordination among IOUs is a key facet of the statewide implementation of QM/QI programs, and as such, the program implementation plan that the utilities use is nearly identical across all three IOUs.

Appendix A begins with a discussion of the programs' background and rationale (Appendix A.1) Appendices A.2, A.3, and A.4, respectively discuss the Southern California Edison, Pacific Gas & Electric, and San Diego Gas & Electric Quality Installation programs, respectively, while Appendices A.5, A.6, and A.7 discuss the Southern California Edison, Pacific Gas & Electric, and San Diego Gas & Electric Quality Installation programs, respectively.

Following the QI and QM program descriptions, Appendix A.8 summarizes the standards for Quality Installation and Appendix A.9 summarizes the standards for Quality Maintenance. Finally, Appendix A.10 lists the incentives provided to distributors for energy efficient HVAC systems by Southern California Edison (Pacific Gas & Electric and San Diego Gas & Electric provide similar incentives).

A.1 Program Background and Rationale

The program background and rationale encompasses both QM and QI programs. The California IOUs have undertaken efforts to encourage quality maintenance and installation in support of the CPUC's 2008 Long-Term Strategic Plan, which is seeking to establish QM/QI as an industry norm. In developing and implementing QM/QI programs, California IOUs are attempting to address what some of the program staff interviewed referred to as a "race to the bottom" in the market for HVAC service and installation. Because customers are generally not experienced in identifying points of contrast between the work products of different HVAC maintenance contractors, the market tends to favor contractors who do the job the fastest and for the least amount of money, without regard for quality of work. Air Conditioning Contractors of America (ACCA) industry standards provide a framework that not only helps contractors determine what tasks should be included in a given maintenance plan or an installation but also, by extension, gives customers an understanding of how to compare contractor service offerings. In this way, the IOUs hope to transform the market for HVAC installation and maintenance in such a way as to force poor-quality contractors to adopt QM/QI practices in order to compete, and to reduce price pressure on contractors who want to do the best job possible.

Ongoing relationships between customers and contractors are stipulated in the standards as being the vehicles for market transformation. Therefore, IOUs tend to view quality maintenance as the foundation of and precursor to quality installation, in that it encourages planned (rather than emergency) equipment replacement. Contractors approved for participation in QM programs are usually the same contractors targeted for participation in QI, although the two programs utilize different standards and thus require separate training.

Several of the program staff members interviewed cited utility co-branding as an anticipated advantage in recruiting qualified contractors into QM/QI programs. Reportedly, the perception among contractors is that being affiliated with the utility company through participation in QM/QI lends legitimacy. Contractors already capable of performing quality work but who are being undercut by their less conscientious peers welcome opportunities to co-brand with utility companies as a way of differentiating themselves.

A.2 Southern California Edison Quality Installation Programs

The QI programs at SCE are the longest-running among the three IOUs. SCE is alone among the IOUs in designating QI as a core program and administering all program activities in-house, up to and including the intensive training that participating contractors must complete.

SCE commercial QI programs target non-residential buildings with rooftop units, split systems, or heat pumps; the targeting strategy is different from the other two IOUs. Program offerings for large commercial buildings; that is, non-residential buildings of 10,000 square feet or more are more robust than they might necessarily need to be, and conversely that offerings for residential and small commercial buildings are not quite as comprehensive as they could be, according to the staff member interviewed. The rationale behind targeting larger buildings is that the equipment tonnage in smaller buildings typically does not provide contractors with enough work to justify taking on the project. Therefore, focusing on larger buildings makes the program more cost-effective. (This rationale also applies to SCE QM programs.)

The purpose of the SCE QI as a program is to diagnostically verify manufacturer ratings, rather than perform a checklist of tasks. The SCE interviewee identified QI as a logical next step for a given QM customer, but also something that utility companies and the HVAC industry are still in the process of defining.

The SCE commercial QI program offers a set of incentives to participating contractors:

1. \$150 toward equipment sizing and selection, per system
2. \$250 toward equipment installation, per system
3. \$300 toward duct distribution and air balance, per duct system
4. \$50 per system for system documentation
5. Rebates for the equipment itself, which are stratified by type of equipment and efficiency rating (SEER/EER or HSPF)

These incentives, along with a number of non-incentive services, are intended to help customers to offset a number of cost barriers, including costs associated with purchasing equipment, researching contractors, and obtaining permits.

The ENERGY STAR guidelines for quality installation form the basis of SCE's residential QI program along with the ACCA 5 standard. The residential and commercial QI programs at SCE are different from one another primarily in name—the incentive structure is nearly identical, as are the quantitative program targets, barriers to be overcome, common statewide marketing materials and other implementation details, and program goals.

A.3 Pacific Gas & Electric Quality Installation Programs

PG&E's QI programs were launched in 2012. PG&E interviewees reported that the policies, procedures, incentive structure, and training materials are, to the greatest possible extent, identical to those used by SCE. However, unlike SCE, PG&E has hired a third-party implementation contractor to manage contractor outreach, training, and review of qualifications, as well as quality assurance and data tracking.

Contractors must satisfy a number of requirements before participating. In addition to requiring a certain number of years of experience, possession of a C-20 license, and a certain number of NATE¹-certified workers – all qualifications required by SCE as well – PG&E requires each technician to undergo a background check. Once a contractor qualifies, they are compelled to perform all the ACCA standard items necessary to bring a unit up to a certain baseline condition. However, the program pays them for only five of those tasks, and in some cases, a contractor must perform up to 12 tasks to bring a unit up to baseline operating condition.²

The original product implementation plan (PIP) developed by PG&E stipulated that their quality installation program would be based upon ENERGY STAR standards for residential QI as well as on ACCA 5 and ACCA 9. Prior to PG&E's planning process, SCE had successfully implemented this strategy; however, it did not prove to be cost-effective for PG&E. PG&E subsequently refocused its efforts on training, having committed to increasing contractor course offerings by 50% over what it had historically offered. When contractors complete the training, their company's name is added to the implementation contractor's website, which allows them to access rebates covering roughly half the cost of ACCA and CPUC-approved tools and software (neither SCE nor SDG&E offer rebates to defray the cost of this equipment).

A.4 San Diego Gas & Electric Quality Installation Programs

The SDG&E commercial QI program was also launched in 2012 using ACCA 5 and ACCA 9 for small commercial structures. SDG&E QI is a contractor-based program focused on contractor

¹ NATE: North American Technician Excellence

² SCE Commercial HVAC Optimization Program Manual, Appendix D, Incentive Strategy and Payment Process, 12/30/11

outreach, training, and qualification. The participating QI contractors are drawn from the pool of contractors participating in QM.

SDG&E's third-party implementation contractor manages the program's relationships with participating contractors. Additionally, as a customer-interface measure, SDG&E has also developed a special C&I services branch, which conducts customer-direct marketing activities. One interviewee pointed out that Honeywell Utility Solutions, the implementation contractor, is the program's branding entity. SDG&E does not offer co-branding to their participating contractors, a factor that both SCE and PG&E cited as a major driver of program uptake among contractors.

SDG&E's residential QI program utilizes the ENERGY STAR guidelines for quality installation, which are not substantively different from the ACCA 5 and ACCA 9 standards. SDG&E has coordinated with ENERGY STAR and industry associations to initiate co-branding between those organizations and the program. SDG&E suspects that HVAC contractors in their service area do not possess the skills necessary to participate in the QI program and thus tries to aggressively recruit and screen contractors for participation in residential QI. Interviewees reported a number of factors considered in qualifying potential contractor participants such as having a local presence, acceptable insurance, and financial stability. The length of time the business has been in operation and their Better Business Bureau rating are also considered as is field and written testing on the ability to perform ENERGY STAR QI work.³

A.5 Southern California Edison Quality Maintenance Programs

The linchpin of SCE's commercial quality maintenance program is a mandatory three-year maintenance agreement between the contractor and the customer. The customer receives a cash incentive in exchange for continuing with the maintenance agreement, which is disbursed in increments over the life of the contract: customers receive 20% of the incentive upon signing the service contract, 25% at the end of the first year, 35% at the end of the second year, and the remaining 20% at the end of the third and final year. The amount of the incentive is determined by the type and number of rooftop units at a given site. In order to qualify for the Maintenance Agreement Incentive, customers cannot have taken part in a similar program for the past three years.

The program also includes three contractor incentives to offset the extra effort that participating contractors must undertake:

- A Cooling Service Analysis (CSA) Incentive, based on equipment characteristics, helps to compensate for the cost of performing any or all of the 12 qualified tasks that may be required to bring a given unit up to the operating level required by the program
- A Contractor Program Incentive of \$75 per unit, intended to compensate for some of the hassle associated with doing program paperwork

³ SDG&E AC Quality Care (Residential Quality Maintenance & Residential Quality Installation) Scope of Work.

- A Baseline Incentive of \$50 per unit, which helps to cover the cost of miscellaneous repairs necessary to bring a given unit up to baseline yet are not included in the list of qualified tasks and therefore not covered by the CSA Incentive

All these incentives work together to coax customers and contractors into the longer-term service relationships which interviewees identified as the vehicles for disseminating awareness of what constitutes quality maintenance.

The SCE residential QM program includes a one-year, optional agreement. There are five rebates available for residential projects:

- A system assessment rebate of \$50 to offset the cost of a computer-based diagnostic assessment
- A system optimization rebate of \$100 in exchange for bringing the unit up to ACCA 4 baseline operating efficiency
- A preventive maintenance rebate of \$50 to offset the cost of purchasing a one-year, pre-paid maintenance agreement with a participating contractor
- An advanced airflow rebate of \$250 for repairing the airflow of a unit to 400cfm/ton or greater
- A rebate of \$150 for installing a brushless fan motor

Rebates are paid directly to the participating contractor who performs the work, who then deducts the amount from the service invoice.

A.6 Pacific Gas & Electric Quality Maintenance Programs

PG&E's QM programs were launched in 2011. As noted in the case of QI programs, PG&E QM policies, procedures, incentive structure, and training materials are, to the greatest possible extent, identical to those used by SCE with a third-party implementation contractor managing contractor outreach, training, review of qualifications, as well as quality assurance and data tracking. PG&E's commercial and residential QM programs include the same contractor incentives offered by SCE. PG&E, however, is not as heavily focused on large commercial projects as SCE.

The PG&E interviewee noted that focus groups with prospective residential customers revealed that they were not receptive to three-year service contracts, citing the very distrust of the industry that the program is trying to ameliorate. PG&E thus considers the length of the contract a barrier to participation for customers, along with the generally higher cost of quality maintenance compared to the less rigorous work that has dominated the market.

A.7 San Diego Gas & Electric Quality Maintenance Programs

SDG&E offered a quality maintenance program before the release of the CPUC Long-Term Strategic Plan in 2008; thus, SDG&E developed their current programs by modifying what was

already offered to align with the more comprehensive activities stipulated in the Strategic Plan and ACCA/ANSI standards. The updated programs were launched in 2011 and are managed by different implementation contractors for commercial and residential customers.

More than twenty contractors had qualified to participate in the original SDG&E HVAC programs. These contractors needed to re-apply for the new programs, signifying a clean break between the current QM programs and their antecedents, which was not ACCA standard-based. However, SDG&E is alone among IOUs in not explicitly requiring its participating contractors to possess any particular certifications, although they encourage NATE or Institute for Credentialing Excellence (ICE) certification.

The SDG&E commercial QM program covers small commercial projects, which the other IOUs cover under their residential programs, since there are not many large commercial contractors operating in the SDG&E service territory. SDG&E's commercial QM program offerings are organized in three tiers: silver, gold, and platinum.

- Silver package – A baseline ACCA 180-compliant inspection and maintenance package, excluding combustion analysis.
- Gold package – A more comprehensive inspection which includes minor system repair available to customers who purchase a one-year maintenance agreement and commit to renew for a three-year term. This package includes a \$50 QM completion incentive, a \$75 maintenance agreement incentive, and customer incentives up to \$3,836 per eligible unit for QM services performed under a three-year maintenance agreement.
- Platinum package – Includes all the services in the Gold package plus an additional incentive of \$50 per enrolled unit, and requires that the customer agree to a three-year maintenance agreement. This package also requires customer co-payment of \$100 for services over and above those offered in the Gold package. Of the three, the Platinum package is the most similar to the SCE and PG&E commercial QM program design.

SDG&E's residential QM program is similar to those offered by SCE and PG&E; additionally, it offers the option of purchasing a one-year, pre-paid Preventive Maintenance Agreement.

The SDG&E interviewees pointed out the difficulty inherent in achieving significant customer acceptance of QM. Customers are often not prepared to incur the costs of participating in QM programs if they do not understand the value of quality maintenance. Therefore, in addition to technical training on the standards, SDG&E contractors engage in customer interaction and sales training to ensure their ability to convey the advantages of participating in the program. SDG&E has also developed an aggressive, customer-oriented marketing campaign that takes into account seasonal shifts in the HVAC industry, and has considered holding seminars for potential customers on the benefits of the program.

A.8 ACCA Standard 5 for Quality Installation

This section contains excerpts from the ACCA Standard 5—HVAC Quality Installation Specification issued in 2010 covering the Foreword, Introduction and Scope. The entire document may be found at <http://www.acca.org/wp-content/uploads/2014/02/qi-spec-english1.pdf>.

FOREWORD

Market Awareness

A significant market opportunity for improving the quality of HVAC equipment installations and service involves raising the awareness of consumers and building owners / operators about the benefits provided by professional contractors following industry-recognized quality installation practices (e.g., correct equipment selection, installation, and commissioning). Building owners / operators and residential consumers need to be informed of the links between comfort, humidity levels, utility bills, and indoor air quality with a proper HVAC system design and installation. Once aware, consumers will better understand the value of a quality installation (QI) from their HVAC contractor. Consumers and building owners/operators who understand QI will also help position consumers and building owners / operators to consider the complete value-to-cost equation, not merely the “first price,” when making HVAC equipment purchasing decisions. Customers who select contractors that promote QI and high performance HVAC equipment enjoy enhanced comfort, reduced energy usage, improved occupant productivity, and enhanced occupant safety.

Industry Need

There is a need to establish a raised bar to improve the core competencies of contractors to ensure that quality installations occur. This is beneficial not only as a process improvement for HVAC businesses, but, more importantly, for fulfilling the needs of building owners/operators in quality installations – comfortable, safe, energy-efficient indoor environments. This Standard provides a universally accepted definition for quality installation across a broad spectrum of the HVAC industry (e.g., manufacturers, distributors, contractors, user groups, customers, utilities, efficiency advocates, trade associations professional societies, and, governmental agencies). Full observance of the quality installation elements may increase the initial “first cost” to the residential or commercial building owner/operator. However, the increased “value” – resulting from improved energy efficiency, better comfort, enhanced IAQ, improved equipment reliability, longer equipment life, etc. – is expected to far exceed any added upfront price. Additionally, adherence to the elements in this specification provides intangible societal benefits in the form of reduced power grid energy demand that aids in reducing pollution and dependence on foreign oil.

Specification Intent

This specification is written with the intent that various HVAC industry stakeholders may use the criteria in diverse manners for new construction as well as replacement applications. Examples include:

- Contractors – to demonstrate their commitment to quality HVAC installations in residential and commercial building applications
- Equipment manufacturers – to highlight and encourage quality contractor practices, resulting in better equipment performance and durability
- HVAC trainers – to assist in the ongoing development of appropriate course curricula and training programs
- Utilities – to integrate the recommendations into their incentive programs
- Building owners/operators – to identify quality contractor practices and to ensure that quality installations are received

INTRODUCTION

In this Standard, the QI elements focus on the actual installation and how well the system is selected and installed. Quality installation is more than just using high-efficiency products and systems. The correct design, proper installation, and final testing have a large impact on occupant satisfaction and energy savings. For this Standard, core areas that characterize a quality installation include:

Design Aspects:

- Ventilation
- Building heat gain/loss load calculations
- Proper equipment capacity selection
- Geothermal heat pumps ground heat exchanger
- Matched systems

Distribution Aspects:

- Duct leakage
- Airflow balance
- Hydronic balance

Equipment Installation Aspects:

- Airflow through indoor heat exchangers
- Water flow through heat exchangers
- Refrigerant charge
- Electrical requirements

- On-rate for fuel- fired equipment
- Combustion venting system
- System controls

System Documentation and Owner Education Aspects:

- Proper system documentation to the owner
- Owner/operator education

This Standard, focusing on new installation requirements, assumes that HVAC equipment and components are in new, factory clean condition. However, if the HVAC equipment is operated during construction phases, or otherwise allowed to deviate from normal cleanliness and/or maintenance parameters, then the newly-installed HVAC systems may not perform as expected even when proper installation procedures are observed. In these instances, it may first be necessary to perform system maintenance or to restore the equipment cleanliness and condition before functional testing and verification is undertaken. Users of this specification are encouraged to review the references in Appendix D pertaining to HVAC system maintenance and cleaning.

This Standard details a level of performance that, if satisfactorily achieved, serves as an indicator that sound industry practices were likely followed during the design and equipment installation phases. Users of this document are advised to consider additional good practices not provided in the body of this specification. An illustrative list of additional important good practices and considerations is presented in Appendix A. For convenience to the user, Appendix B contains generally-accepted industry definitions for a number of terms and acronyms used within the standard. Appendix C identifies business practices that contractors may find advantageous in positioning themselves to deliver quality installations on a consistent basis in the field. Finally, Appendix D highlights other references that may aid in the design, installation, servicing, maintenance, and cleaning of HVAC systems. Program Administrators and third party verifiers are encouraged to also review ANSI/ACCA 9 QIvp (*HVAC Quality Installation Verification Protocols*). The QIvp Standard establishes minimum requirements for verifying that residential and light commercial HVAC systems meet the requirements of this QI Standard.

SCOPE

This standard applies to HVAC equipment/components being installed in residential and commercial buildings:

- Unitary air conditioners, air-source/water-source heat pumps, and geothermal
- heat pumps,
- Furnaces (gas-fired, oil-fired, electric, and other)
- Boilers (gas-fired, oil-fired, electric, and other).

EXCEPTIONS:

Due to differing design aspects and control/operation situations, built-up systems (i.e., chillers, custom or specialty-built penthouse units, etc.) are not included in this specification. Buildings employing built-up systems are generally designed by architects or professional engineers. Additionally, commercial buildings using built-up equipment are more likely to benefit from increased owner scrutiny via building commissioners, owner agents, etc.

EQUIPMENT SYSTEMS / COMPONENTS

Heating Systems / Components – Single Zone and Multizone

- Heating-only equipment and heat pumps including air-source, water-source, and geothermal heat pumps.
- Hot-water coil and/or fin-tube radiation, and/or unit heaters, and/or unit ventilators
- Electric resistance coil and/or fin-tube radiation, and/or gas unit heaters, and/or unit ventilators
- Hot air heating (fossil fuel or electric furnace, direct-fired and indirect-fired makeup air equipment)
- Radiant heat equipment

Cooling Systems / Components – Single Zone and Multizone

- Cooling-only equipment and heat pumps including air-source, water-source, and geothermal heat pumps.
- Rooftop single zone, rooftop multi-zone (hot-deck/cold-deck)
- Single-zone unitary (packaged terminal air conditioners/heat pumps, split coil-ductless)

A.9 ACCA Standard 4 for Quality Maintenance

This section contains excerpts from the ACCA Standard 4—Maintenance of Residential HVAC Systems issued in 2013 covering the Foreword, Introduction and Scope. The entire document may be found at <http://www.acca.org/wp-content/uploads/2014/02/quality-maintenance.pdf>.

FOREWORD

Heating Ventilating and Air-conditioning (HVAC) Contractors use different approaches for inspecting and maintaining HVAC systems. There are many types and intensity levels of “seasonal tune-ups”, “clean and checks”, and “maintenance services” performed on HVAC equipment. This standard establishes the minimum level of acceptable compliance for HVAC equipment maintenance inspections for residential applications.

For the public good, it is essential that residential HVAC systems support a comfortable, healthy indoor environment and operate efficiently throughout their lifecycles. This standard provides a nationally recognized, manufacturer-endorsed set of inspection tasks to meet this need. From this base, consumers can compare the value of the additional recommended corrective actions needed to remedy identified faults. For contractors, it provides a common platform for creating a customized maintenance programs, allowing for bundling different recommended corrective actions at competitive fee structures.

HVAC contractors who perform maintenance on residential HVAC systems should be properly licensed or, where necessary, certified. These contractors should strive to have the highest quality technician perform this standard’s tasks for their customers. These technicians should be fully acquainted with the proper operation of the systems they are working on, including the components that comprise the subsystems. Technicians who are certified by an industry-recognized national program have demonstrated that they possess a body of knowledge which supports proper implementation of this standard.

It is recommended that HVAC contractors relate the importance of routine maintenance of the HVAC system to their clients. This will likely take the form of annual/semiannual visits to perform the inspection and applicable remediation actions, though the exact frequency may vary.

The performance objective of the system will be based primarily on the equipment manufacturer’s performance data. Acquiring this performance data, however, may be more difficult for older equipment. Original Equipment Manufacturers (OEMs) will generally have performance data for equipment dating back several decades, and the data is usually available at the distributor level.

Some HVAC systems are unable to achieve the manufacturer’s performance objectives because the system:

- Was incorrectly designed, selected, or installed, or
- Is beyond the normal service life, or
- Has suffered neglect for long periods of time.

These systems may require levels of remediation beyond the scope of this document or require replacement of the equipment or components. Practitioners are referred to the ACCA 5 QI (Quality Installation Specification) and ACCA 6 QR (Restoring System Cleanliness) Standards.

Additionally, other documents listed in Appendix C (Bibliography and Resources) may be helpful to contractors to assess which additional activities may be required.

INTRODUCTION

Mechanical systems require routine monitoring, adjustments, periodic cleaning, and eventual replacement of components. Regularly scheduled inspections and maintenance are often required to maintain the original equipment manufacturer's (OEM) warranty.

This standard prescribes basic maintenance inspection tasks and offers recommended corrective actions to maintain most residential HVAC systems. It provides checklists for the inspection of typical residential HVAC systems to meet the minimum maintenance requirements. These equipment checklists are divided by equipment type and provide the minimum visual inspections, performance tests, and measurements. The recommended corrective actions provide generic guidance that should return the equipment to good working order.

Conducting regularly scheduled inspections, maintenance, and remediation of HVAC systems prolongs equipment efficiency, promotes healthy clean air, supports lower utility costs, guards against unexpected failures, and prolongs equipment life. Occupants and the environment will both benefit.

SCOPE

This standard provides minimum requirements for the inspection, by appropriately licensed HVAC contractors¹, of residential HVAC equipment found in one- or two-family dwellings of three or fewer stories.

This standard includes checklist tasks for inspecting, testing, and measuring electrical, controls, mechanical, venting, air distribution, and piping systems of residential HVAC systems. The checklists also provides recommended corrective actions which the HVAC contractor shall present to the homeowner to remedy identified faults like cleaning, or adjusting, and/or replacing equipment and components on a periodic basis.

This standard presumes that the HVAC system was designed, installed, and tested in accordance with original equipment manufacturer's (OEM) instructions, applicable codes, and other industry standards.

This standard shall not be used to circumvent safety, health, environmental, or the equipment manufacturer's requirements.

A.10 HVAC Distributor Incentives

Southern California Edison Commercial HVAC Distributor Incentive Program

2010-2012 Qualifying Minimum Equipment Efficiencies & Incentive Levels for Commercial Air Conditioners and Heat Pumps

(The same incentive tiers and levels were used by Pacific Gas & Electric and San Diego Gas & Electric)

Three Phase Package and Split Equipment							
Equipment Type	Tier	Size Category	Sub-Category	Full Load Cooling Efficiency		Seasonal/Part Load Cooling Efficiency	Incentive (\$/ton)
Air-Cooled	1	<65 kBtuh (<5.4 tons)	Split System w/TXV	12.0 EER	or	14.0 SEER	\$70
			Single Package	11.6 EER	or	14.0 SEER	
	2	<65 kBtuh (<5.4 tons)	Split System w/TXV	12.5 EER	or	15.0 SEER	\$120
			Single Package	12.0 EER	or	15.0 SEER	
	3	<65 kBtuh (<5.4 tons)	Split System w/TXV	13.0 EER	or	16.0 SEER	\$250
			Single Package	12.4 EER	or	16.0 SEER	
	4	<65 kBtuh (<5.4 tons)	Split System w/TXV	13.5 EER	or	17.0 SEER	\$400
			Single Package	13.0 EER	or	17.0 SEER	
	1	≥ 65 kBtuh and <135 kBtuh	Split System and Single Package	11.5 EER	or	11.7 IEER	\$90
	2	(≥5.4 tons and <11.3 tons)		12.0 EER	or	12.2 IEER	\$125
	1	≥ 135 kBtuh and <240 kBtuh	Split System and Single Package	11.5 EER	or	11.7 IEER	\$90
	2	(≥ 11.3 tons and <20 tons)		12.0 EER	or	12.2 IEER	\$115
	1	≥ 240 kBtuh and <760 kBtuh	Split System and Single Package	10.5 EER	or	10.6 IEER	\$60
	2	(≥ 20 tons and <63.3 tons)		10.8 EER	or	10.9 IEER	\$110
1	≥ 760 kBtuh	Split System and Single Package	10.0 EER	or	10.1 IEER	\$100	
2	(≥ 63.3 tons)		10.2 EER	or	10.3 IEER	\$130	
Water Source HP; Water/Evap. Cooled AC (Three Phase and Single Phase)	1	<65 kBtuh (<5.4 tons)	Split System and Single Package	14.0 EER			\$150
	2			15.0 EER			\$200
	3			16.0 EER			\$250
	1	≥ 65 kBtuh and <135 kBtuh (≥5.4 tons and <11.3 tons)	Split System and Single Package	14.0 EER			\$175
	1	≥ 135 kBtuh and <240 kBtuh (≥ 11.3 tons and <20 tons)	Split System and Single Package	14.0 EER			\$175
	1	≥ 240 kBtuh (≥ 20 tons)	Split System and Single Package	13.0 EER			\$175

Single Phase Equipment							
Equipment Type	Tier	Size Category	Sub-Category	Full Load Cooling Efficiency	and	Seasonal Cooling Efficiency	Incentive (\$/ton)
Air-Cooled	1	<65 kBtuh (<5.4 tons)	Split System	12.0 EER	and	14.0 SEER	\$60
			Single Package	11.0 EER	and	14.0 SEER	

Single Phase Ductless Mini and Multi-Split Equipment						
Equipment Type	Tier	Size Category	Sub-Category	Seasonal Cooling Efficiency		Incentive (\$/ton)
Ductless Mini-split	1	<65 kBtuh (<5.4 tons)	Air Conditioner	16 SEER		\$20
	2			19 SEER		\$125
	1	<65 kBtuh (<5.4 tons)	Heat Pump	16 SEER		\$160
	2			19 SEER		\$400
	3			22 SEER		\$600
Ductless Multi-split	1	<65 kBtuh (<5.4 tons)	Air Conditioner	16 SEER		\$125
	1	<65 kBtuh	Heat Pump	16 SEER		\$150
	2	(<5.4 tons)		19 SEER		\$215

2010-2012 Qualifying Minimum Equipment Efficiencies & Incentive Levels for Air-Cooled Chillers, Water-Cooled Chillers and Variable Refrigerant Flow (VRF) Equipment

Three Phase Air-Cooled Chiller Equipment							
Equipment Type	Tier	Size Category	Sub-Category	Full Load Cooling Efficiency	or	Part Load Cooling Efficiency	Incentive (\$/ton)
Air-Cooled	1	All	with Condenser*	2.95 COP	or	4.19 IPLV (COP)	\$25
				10.07 EER	or	14.29 IPLV (EER)	
				1.19 kW/Ton	or	0.87 IPLV (kW/Ton)	
	2	All	with Condenser*	3.19 COP	or	4.39 IPLV (COP)	\$44
				10.90 EER	or	15.0 IPLV (EER)	
				1.10 kW/Ton	or	0.80 IPLV (kW/Ton)	
	3*	All	with Condenser*	3.38 COP	or	4.69 IPLV	\$90
				11.5 EER	or	16.0 IPLV	
				1.04 kW/ton	or	0.75 IPLV	

Three Phase Water-Cooled Chiller Equipment						
Equipment Type	Size Category	Sub-Category	Minimum Qualifying Efficiency: Percent (%) Improvement above T-24			Incentive (\$/ton per 1% improvement over Title 24 IPLV/NPLV)
			Full Load		IPLV/NPLV	
Water-Cooled Chillers	<150 tons	Screw, Scroll	Title 24 Minimum	and	20.0%	\$7.75
	≥150 tons < 300 tons	Screw, Scroll	Title 24 Minimum	and	20.0%	\$5.00
	≥ 300 tons	Screw, Scroll	Title 24 Minimum	and	10.0%	\$3.50
	≥150 tons < 300 tons	Centrifugal	Title 24 Minimum	and	15.0%	\$3.50
	≥ 300 tons	Centrifugal	Title 24 Minimum	and	20.0%	\$3.00

Three Phase Variable Refrigerant Flow (VRF) Equipment					
Equipment Type	Tier	Size Category	Sub-Category	Full Load Cooling Efficiency	Incentive (\$/ton)
VRF Heat Pump	1	<960 kBtuh (<80 tons)	Heat Pump	Interim Department of Energy Waiver	\$990
	1	≥960 kBtuh (≥80 tons)		Interim Department of Energy Waiver	\$630
VRF Heat Recovery	1	<960 kBtuh (<80 tons)	Heat Recovery	Interim Department of Energy Waiver	\$1,530
	1	≥960 kBtuh (≥80 tons)		Interim Department of Energy Waiver	\$1,170

Appendix B Additional Tables Regarding Quality Installation

Appendices B.1 and B.2 list tables from the contractor and customer surveys, respectively, regarding quality installation that NMR did not include in the main report.

B.1 Contractor Perspectives on Quality Installation

Table B-1 Determine the Correct Refrigerant Charge in HVAC Units—Installation Contractors

Tasks	Residential Installation Contractors	Small Commercial Installation Contractors
<i>Sample Size (multiple response)</i>	116	114
Check sub cooling for TXV and compare with manufacturer's recommended sub cooling ^(a)	65%	59%
Check superheat for fixed orifice and compare with manufacturer's recommended superheat	58	55
Check temperature split across coil before using gauges	52	59
Check both superheat and sub cooling (regardless of metering device)	50	52
Check sub cooling for TXV and compare with a generic table (e.g. T24)	38	34
Check superheat for fixed orifice and compare with a generic table (e.g. T24)	32	34
Sub cooling per manufacturer's target	3	--
Other	4	4
Don't know	--	3

(a) The survey incorrectly stated "manufacturer's recommended superheat." As EMI has noted, it is likely that respondents recognized this mistake and correctly assumed the intended meaning of the question.

Table B-2: Percent of Companies That Have Formal Policies for Following-up With Customers after an Installation Job

Have policy for following up	Residential Installation Contractors	Small Commercial Installation Contractors
<i>Sample Size</i>	116	114
Yes	62%	63%
No	36	35
No answer	2	2

Table B-3: Installation Contractors' Perceived Benefits of Proper HVAC Installation

Benefit	Residential Installation Contractors	Small Commercial Installation Contractors
<i>Sample Size</i>	<i>116</i>	<i>114</i>
Increase energy savings and reduce electric bills		
Strongly agree	83%	74%
Agree	9	16
Neutral	1	2
Disagree	--	1
Strongly disagree	7	8
No answer	1	--
Increase customer comfort		
Strongly agree	76%	73%
Agree	15	18
Neutral	1	1
Disagree	--	--
Strongly disagree	7	9
No answer	2	--
Improve a system's reliability		
Strongly agree	80%	66%
Agree	11	22
Neutral	1	3
Disagree	--	--
Strongly disagree	7	8
No answer	1	2
Prolong a system's operational lifespan		
Strongly agree	81%	71%
Agree	8	17
Neutral	3	2
Disagree	--	--
Strongly disagree	7	9
Don't know	--	1
No answer	1	1
Prevent expensive repairs		
Strongly agree	76%	61%
Agree	11	25
Neutral	5	5
Disagree	--	--
Strongly disagree	7	8
No answer	1	--
Improve indoor air quality		
Strongly agree	70%	56%
Agree	17	31
Neutral	4	4
Disagree	1	1
Strongly disagree	7	8
No answer	1	--

Table B-4: Perceived Effectiveness of Training Methods for Teaching the Technical Skills Needed to Perform Quality Installation

Training effectiveness	Very Effective	Effective	Somewhat Effective	Not at All Effective	No Opinion	Not Familiar with Training	No Answer
Residential installation contractors (<i>sample size = 116</i>)							
On-the-job training	72%	20	3	--	2	1	3
Technical or trade school	36%	34	18	4	1	3	4
Certification training	36%	35	18	2	2	3	3
Manufacturer training	32%	37	22	1	2	2	4
Private training institute	32%	26	23	2	4	10	3
Training offered by electric utility	28%	37	22	--	5	5	3
Distributor training	22%	43	26	2	3	2	3
Community College	19%	35	29	9	2	3	3
Union apprenticeship	16%	23	15	3	14	24	4
Online HVAC Course	6%	22	44	6	3	15	3
Small commercial installation contractors (<i>sample size = 114</i>)							
On-the-job training	73%	22	2	1	--	1	2
Manufacturer training	35%	41	12	4	3	2	4
Technical or trade school	34%	43	16	1	--	4	3
Certification training	30%	40	16	4	3	5	3
Union apprenticeship	27%	26	13	4	11	13	5
Training offered by electric utility	22%	47	17	1	2	8	4
Private training institute	21%	41	18	3	4	11	4
Distributor training	18%	40	33	4	2	3	3
Community College	18%	42	22	7	4	3	4
Online HVAC Course	5%	25	40	13	4	6	6

Table B-5: Perceived Effectiveness of the Certification Process for Preparing a Technician to Perform Quality Installation

Certification effectiveness	Very Effective	Effective	Somewhat Effective	Not at All Effective	No Opinion	Not Familiar with Training	No Answer
Residential installation contractors (<i>sample size = 116</i>)							
NATE	39%	25	10	3	10	6	7
HVAC Excellence	12%	15	7	3	17	32	15
RSES	10%	14	9	4	17	31	15
UA STAR	5%	14	5	4	16	38	17
PAHRA/Industry Competency Exam	4%	14	4	4	17	40	16
TABB	3%	11	7	4	18	38	18
BPI	1%	--	1	--	--	--	99
Manufacturer Certifications	1%	--	--	--	--	--	99
SCE	1%	--	--	--	--	--	99
Small commercial installation contractors (<i>sample size = 114</i>)							
NATE	31%	27	10	8	4	13	7
RSES	13%	18	12	5	10	32	10
HVAC Excellence	11%	18	10	4	9	37	11
TABB	6%	17	7	7	13	37	13
PAHRA/Industry Competency Exam	5%	16	11	4	11	39	15
UA STAR	4%	15	10	6	11	41	12

B.2 Customer Perspectives on Quality Installation

Table B-6: Customers' Definition of Quality Installation, Unaided

Meaning of Quality Installation	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
High/Best standard of quality	2%	4%	3%	1%	1%	1%
Meets installation standards	1%	3%	2%	2%	1%	2%
Proper sizing/ducts are insulated/test for leakage	1%	3%	2%	1%	--	<1%
Qualified individual performs the work	3%	--	2%	2%	3%	3%
Complies with all codes	1%	--	2%	--	--	--
Work is done properly	3%	--	1%	3%	3%	3%
Saves energy	--	2%	1%	1%	--	<1%
Installed to manufacturer specifications	1%	--	1%	1%	--	<1%
Installation is guaranteed	1%	--	<1%	--	--	--
The quality rating of wall and attic insulation	<1%	--	<1%	--	--	--
Prevent problems with equipment	--	--	--	2%	--	1%
Professional approach to installation	--	--	--	--	1%	1%
Includes feasibility study	--	--	--	<1%	--	<1%
Other	1%	--	1%	--	7%	3%
No meaning	1%	--	<1%	--	--	--
Don't know/Refused	1%	2%	1%	1%	2%	2%
No Unaided Awareness Of Quality Installation ^ψ	84%	84%	84%	86%	80%	83%

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table B-7: Customers' Perception of Quality Installation Benefits, Unaided

Benefits	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
Achieve safe operating conditions	5%	7%	6%	3%	6%	4%
Increase energy savings and reduce energy bills	4%	7%	5%	5%	13% [†]	9%
Improve a system's reliability	5%	3%	4%	5%	7%	6%
Prevent expensive repairs	1%	4%	3%	--	--	--
Work is done properly	4% [†]	--	2%	1%	5%	2%
Ensure equipment works efficiently	1%	3%	2%	--	--	--
Ensure indoor air quality	1%	2%	2%	1%	1%	1%
Prolong a system's operational lifespan	1%	2%	1%	3%	3%	3%
Ensure comfort	<1%	2%	1%	1%	--	1%
Better performance from equipment	1%	--	1%	--	--	--
Properly sized	1%	--	1%	--	--	--
Ensure equipment works properly	1%	--	1%	1%	1%	1%
Ensure proper equipment selection	--	--	--	1%	3%	2%
Ensuring equipment is installed to national standards/industry guidelines	--	--	--	1%	1%	1%
Good quality product and good service	--	--	--	<1%	1%	1%
None	<1%	--	<1%	--	--	--
Other	1%	2%	1%	2% [†]	--	1%
Don't know/Refused	3%	6%	4%	3%	5%	4%
Not aware of Quality Installation ^ψ	75%	75%	75%	79% [†]	63%	72%

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

Table B-8: Duration of Installation Visit Reported by Residential Customers

Duration	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
Less than 4 hours	1%	--	1%
Between 4 and 6 hours	2	--	1
Between 6 and 8 hours	2	2%	2
Between 8 and 10 hours	1	2	1
Between 10 and 12 hours	1	--	<1
Between 12 and 14 hours	1	--	<1
Between 14 and 16 hours	2	--	1
More than 16 hours	1	2	2
Don't know/Refused	2	3	2
Have not installed Central AC within last 2 years ^ψ	89	93	90
Average Duration*	10.3	11.0	10.5

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

*For the purposes of estimating the average duration of the installations, the midpoint from each response category is used to represent the number of installation hours to allocate to each respondent. If respondents indicated that the installation lasted “More than 16 hours,” 17 hours is used as proxies for their responses.

Table B-9: Duration of Installation Visit Reported by Small Commercial Customers

Duration	Inland	Mild	Total
<i>Sample Size</i>	235	65	300
Less than 8 hours	10% [†]	3%	7%
Between 8 and 11 hours	1	1	1
Between 12 and 16 hours	--	--	--
More than 16 hours	5	6	6
Don't know/Refused	3	1	2
Have not purchased new cooling equipment* ^ψ	81	89 [†]	85
Average Duration**	8.6	12.38	9.8

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

*Includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

***For the purposes of estimating the average duration of the installations, the midpoint from each response category is used to represent the number of installation hours to allocate to each respondent. If respondents indicated that the installation lasted “More than 16 hours,” 17 hours is used as proxies for their responses.

Table B-10: Customers Who Believe Contractor Used Quality Installation Guidelines

Contractor Installed New Equipment According to Quality Installation Guidelines	Residential Customers			Small Commercial Customers*		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
Yes	3%	3%	3%	4% [†]	1%	3%
Don't know/Refused	<1	--	<1	--	6 [†]	2
Have not purchased new cooling equipment ^ψ	89	93	90	81	89 [†]	85
Purchased new equipment but not aware of Quality Installation ^ψ	7	5	6	14 [†]	4	10

*Equipment includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

^ψ The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table B-11: Customer Rating of Quality of Installation

Rating	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
5 - Extremely good quality installation	9%	6%	8%	11%	7%	9%
4	1	--	1	5	2	4
3	1	2	1	1	--	<1
2	--	--	--	1	1	1
1 - Extremely poor quality installation	--	--	--	--	--	--
Don't know/Refused	--	--	--	2 [†]	--	1
Have not purchased new cooling equipment* ^ψ	89	93	90	81	89 [†]	85
Average rating	4.8	4.6	4.7	4.5	4.4	4.5

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

*Includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

^ψ The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table B-12: Reasons for Rating of Quality of Installation Performed

Reasons for Rating*	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
Reasons for High (4 or 5) Rating						
<i>Sample Size</i>	24	3	27	35	6	41
HVAC technician did a good job	35%	2	41%	18%	1	23%
HVAC technician is trustworthy	9	1	20	--	--	--
Equipment worked well after installation	16	--	11	15	2	18
Exceeded expectations	15	--	11	--	--	--
Amount of time HVAC technician spent	7	--	5	4	--	3
HVAC technician is efficient	--	--	--	16	1	15
Have no problems/complaints	--	--	--	10	--	7
Did a good job but left a big mess	--	--	--	--	1	4
Done in a timely manner at a good price	--	--	--	5	--	3
Average performance	--	--	--	4	--	3
Good relationship with HVAC technician	--	--	--	3	--	2
Technician was informative	--	--	--	2	--	1
Other	19	--	13	21	1	19
Performed own installation	--	--	--	2	--	1
Reasons for Moderate (3) Rating (unweighted counts)						
<i>Sample Size</i>	1	1	2	1	0	1
Unit is noisy	--	1	1	--	--	--
Have had recurring problems	1	--	1	--	--	--
Cost too much	--	--	--	1	--	1
Reasons for Low (1 or 2) Rating (unweighted counts)						
<i>Sample Size</i>	0	0	0	1	1	2
Have had recurring problems	--	--	--	--	1	1
Technician did a terrible job and was in too much of a hurry	--	--	--	1	--	1

*Results are reported as unweighted counts where sample size is less than 20.

Table B-13: Most Important Concerns in New Cooling Equipment Purchase

Most Important Concerns	Residential Customers			Small Commercial Customers*		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
Saving energy/Energy efficiency of unit	2%	2%	2%	4% [†]	--	2%
Able to cool home/building	1	3	2	1	--	1
Purchase cost of unit	1	2	2	4	5	4
Lifecycle cost of unit	--	2	1	--	--	--
Product quality	1	--	1	--	--	--
Speed of installation	1	--	1	1	--	<1
Reliability	1	--	<1	2	1	1
Global Warming	1	--	<1	--	--	--
Obtaining rebate	1	--	<1	--	--	--
Operating cost of unit	<1	--	<1	--	2	1
Reputation of contractor	<1	--	<1	1	--	<1
Comfort	--	--	--	3 [†]	--	2
Quality of installation work	--	--	--	1	--	1
Improving health and safety of facility	--	--	--	1	1	1
Other	2 [†]	--	1	1	--	1
Don't know/Refused	<1	--	<1	1	1	2
Have not purchased new cooling equipment [‡]	89	93	90	81	89 [†]	85

*Includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

[‡]The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table B-14: Additional Concerns about New Cooling Equipment Purchase

Additional Concerns	Residential Customers			Small Commercial Customers*		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
No other concerns	7%	6%	7%	11%	8%	10%
Wanted quiet equipment	--	2%	1%	--	--	--
Purchase cost equipment	1%	--	1%	3%	1%	2%
Old equipment broke	1%	--	<1%	--	--	--
Reliability	1%	--	<1%	<1%	--	<1%
Saving energy/Energy efficiency of equipment	1%	--	<1%	1%	--	1%
Wanted high quality equipment	1%	--	<1%	1%	--	1%
Operating cost of equipment	<1%	--	<1%	--	--	--
Comfort provided	--	--	--	--	1%	1%
Equipment brand reputation	--	--	--	<1%	--	<1%
Installation quality	--	--	--	<1%	--	<1%
Other	--	--	--	1%	--	1%
Don't know/Refused	<1%	--	<1%	--	--	--
Have not purchased new cooling equipment [‡]	89%	93%	90%	82%	89%	85%

*Includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

[‡]The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table B-15: Importance Ratings of Quality Installation Benefits

Percentage of Respondents Assigning a High (4 or 5) Importance Rating on Scale of 1 to 5	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
Sample Size	236	61	297	235	65	300
Prevent expensive repairs	89%	90%	89%	91%	85%	89%
Prolong a system's operational lifespan	89%	84%	87%	91%	91%	91%
Achieve safe operating conditions	88%	83%	86%	91%	84%	88%
Increase energy savings and reduce energy bills	86%	85%	86%	92%	87%	90%
Ensure a system's reliability	86%	84%	85%	91% [†]	78%	86%
Ensure good indoor air quality	76%	80%	78%	87%	87%	87%
Ensure comfort	79%	78%	78%	88% [†]	78%	84%

Table B-16: Unaided Customer Awareness of Cooling Equipment Rebate Programs

Awareness of Cooling Equipment Rebate Programs	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
Aware programs exist but cannot name	18%	14%	16%	57%	61%	59%
Demand response programs, general	5% [†]	--	3%	<1%	6% [†]	3%
Equipment rebates	2% [†]	--	1%	1%	--	1%
SCE/PG&E CARE (or Quality Care)*	<1%	--	<1%	--	--	--
Maintenance incentives	<1%	--	<1%	1%	--	<1%
“Swamp cooler rebates”	<1%	--	<1%	--	--	--
PG&E SmartDays	<1%	--	<1%	--	--	--
ENERGY STAR rebates	<1%	--	<1%	<1%	--	<1%
Summer Saver Program	<1%	--	<1%	--	1%	1%
Reduce Your Use Program	<1%	--	<1%	--	--	--
“Flex Plan” **				1%	--	<1%
Non-cooling programs	2%	--	<1%	--	--	--
Not aware of any programs [‡]	72%	86% [†]	79%	40%	32%	36%

* All three IOUs offer the California Alternate Rates for Energy (CARE) program which reduces energy billing rates for low income customers. It is unclear if respondents (one SCE and one PG&E) were referring to the CARE program or to SCE or PG&E’s Quality Care programs.

** This respondent was likely referring to Energy Upgrade California’s Flex Path Pilot Program

[‡] The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Appendix C Additional Tables Regarding Quality Maintenance

Appendices C.1 and C.2 list tables from the contractor and customer surveys, respectively, regarding quality maintenance that NMR did not include in the main report.

C.1 Contractor Perspectives on Quality Maintenance

Table C-1: Description of Contractors' Formal Policies/Guidelines for Implementing Maintenance Procedures

Description	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	<i>109</i>	<i>110</i>
Have a checklist/set of procedures/manual	31%	35%
Check air flow, and discharge air temp.	6	3
Check/change filters	6	9
Check Freon/sub cooling and superheat for refrigerant charge	5	--
Wash condenser/outdoor coils	5	9
Check electrical connections/wiring and operation/use a dielectric compound on aluminum wiring connections	4	4
Talk to the customer/provide information/Point out conditions to customers/make adjustments as the customer allows	4	2
Check/lube motors	3	3
Promote healthy systems/ equipment reliability	1	1
Measure, clean & adjust/Record readings for current and future reference and diagnostics/check for proper operation	1	6
Install a disconnect if the unit does not already have one	1	--
Follow SCE QM	1	--
Same as new install or replacement	1	--
Follow ACCA	1	--
Check amp draws	--	3
Check belts, pulleys	--	3
Check thermostats	--	1
Check drain flow/pan	--	1
Do not have a policy/guideline	31	39
Do not know if they have a policy/guideline	2	1
Did not indicate whether they have a policy/guideline	4	2
No answer	18	11

Table C-2: How Technicians Determine the Correct Refrigerant Charge in HVAC Units during a Typical Maintenance Visit

Method of Checking	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	109	110
Check temperature split across coil before using gauges	55%	45%
Check sub cooling for TXV and compare with manufacturer's recommended superheat	51	43
Check both superheat and sub cooling (regardless of metering device)	39	47
Check superheat for fixed orifice and compare with manufacturer's recommended superheat	29	40
Check sub cooling for TXV and compare with a generic table (e.g. T24)	37	29
Check superheat for fixed orifice and compare with a generic table (e.g. T24)	37	25
Temperature split WHILE using gauges	4	--
Air flow	1	1
Other	1	1
Don't know	1	1
Do not measure refrigerant charge	19	22
Did not indicate if measure refrigerant charge	2	1
No answer	26	21

Table C-3: Percentage of Maintenance Contractors Who Actively Sell Maintenance Services

Marketing of maintenance	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size</i>	109	110
Yes	63%	79%
No	33	18
No answer	4	3

Table C-4: Reasons that Maintenance Contractors Do Not Actively Sell Maintenance Services to Customers

Reasons for not actively selling maintenance services	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	<i>109</i>	<i>110</i>
Customers do not want to pay extra money for regular maintenance	17%	7%
Customers understand the value of maintenance, but are not interested in having maintenance performed on a regular basis	14	5
Customers are not willing to make long-term commitments	12	5
Customers do not understand the value of maintenance	7	7
We don't make enough money on maintenance contracts	6	4
Our technicians need more 'soft skills' training, such as communication skills, to be able to sell maintenance contract	6	--
There is no value in doing maintenance	2	--
Customers cannot afford/do not want to pay for	1	--
Our technicians need more 'soft skills' training, such as communication skills, to be able to sell maintenance contract	--	3
Our technicians need more technical training to be able to perform regular maintenance	--	1
Other	6	5
Not applicable	1	--
Did market maintenance services	63	79
Did not indicate whether they market maintenance services	4	3

Table C-5: Sales and Marketing Strategies for Finding New Customers to Purchase Maintenance Services

Strategies	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	<i>109</i>	<i>110</i>
Recommendations from current customers	43%	48%
Our main strategy is to transition existing/former customers that have received other services into purchasing maintenance work	25	28
Direct mailing	21	6
Online advertising	20	13
The phone book	16	10
Visibility through utility HVAC installation and maintenance programs	16	10
Recommendations from other contractor firms	14	25
Online postings including social media	14	6
Our company does not have a marketing strategy for finding new customers to purchase maintenance services	9	17
Advertising in newspapers	9	7
Advertising on the radio	5	3
Advertising in magazines	2	3
Advertising on television	2	1
Cold call	--	2
Other	1	2
Not applicable	1	--
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
Did not specify sales and marketing strategies	2	1

Table C-6: Approaches to Bidding Maintenance Contracts

Bidding Practices	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	109	110
We only have one level of maintenance	29%	37%
We have multiple tiers of maintenance (e.g. basic and premium) and each has a different price point	23	25
We offer performance contracts	9	5
We bid different prices for different market segments	8	24
We guarantee the lowest cost maintenance contracts	1	4
Depends on the equipment	--	1
Other	--	1
Not applicable	1	1
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	1	2

Table C-7: Does Your Company Have a Formal Set of Questions to Aid Bidding Maintenance Agreement?

Formal set of questions	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size</i>	109	110
Yes	24%	27%
No	39	47
Don't know	--	2
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	1	3

Table C-8: Do the Technicians at Your Company Sell HVAC Maintenance Services

Technician marketing	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size</i>	109	110
Yes, our technicians sell maintenance services directly to customers	46%	43%
Our technicians recommend that customers purchase maintenance services, but then refer the customer to a sales person who completes the sale	8	30
No, our technicians play no role in the maintenance service sales process	7	6
Other	1	1
Don't know	1	--
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	1	--

Table C-9: How Technicians Communicate the Benefits of Proper HVAC Maintenance

Communication of benefits	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	109	110
Our technicians provide a basic explanation of benefits a customers can get from proper maintenance	30%	31%
Our technicians are explicit with how maintenance addresses each benefit such as how maintenance impacts energy savings and electric bills and how maintenance impacts indoor air quality	21	15
Our technicians show the customer data gathered with diagnostic tools to demonstrate how much money they can save through maintenance	6	6
Our technicians write-up a service report that addresses benefits and costs	6	3
Other	--	1
Technicians do not sell or did not indicate that they sell maintenance services directly to customers	17	36
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	1	--

Table C-10: Does Your Firm Provide Technician Staff with Sales Training for Selling Maintenance Services?

Sales training	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size</i>	109	110
Yes	26%	13%
No	19	28
Don't know	1	1
Technicians do not sell or did not indicate that they sell maintenance services directly to customers	17	36
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	--	1

Table C-11: Selling Points Covered by Technician Training for Encouraging the Purchase of Maintenance Services

Selling points covered	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	109	110
The impact of maintenance on system longevity	24%	13%
The impact of maintenance on energy savings and electric bills	22	13
The impact of maintenance on system reliability	22	12
The impact of maintenance on customer comfort	21	8
The impact of maintenance on indoor air quality	18	7
Other	1	--
Company does not provide or the respondent did not indicate that company provides its technician staff with sales training that encourages residential customers to purchase maintenance services	46	30
Technicians do not sell or did not indicate that they sell maintenance services directly to customers	17	36
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3

Table C-12: Structure of Maintenance Contracts—Duration

Length of contract	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size</i>	<i>109</i>	<i>110</i>
Less than 12 months	5%	2%
Twelve months	40	51
Greater than 12 months	6	6
No Contract	4	2
Maintenance contract varies	3	--
Contracts are open-ended	2	6
Don't know	--	--
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	5	11

Table C-13: Pricing of Maintenance Contracts

Pricing of contracts	Residential Maintenance Contractors	Small Commercial Maintenance Contractors
<i>Sample Size (multiple response)</i>	<i>109</i>	<i>110</i>
The customer pays an hourly rate based on the time a technician spends working on site during each visit	14%	17%
The customer pays based on a rate specific to customer type (e.g., residential, small commercial, large commercial)	29	36
The customer pays based on a rate specific to system type (cooling capacity, design of HVAC unit, etc.)	17	25
The customer pays based on a rate specific to size of the unit	4	13
The customer pays based on the square footage of his home or facility	--	1
Level of service	1	1
Fixed price	2	6
Bid	--	1
Other	1	--
Not applicable	1	1
Do not market maintenance services	33	18
Did not indicate whether they market maintenance services	4	3
No answer	--	1

Table C-14: Perceived Effectiveness of Training Methods for Teaching the Technical Skills Needed to Perform Quality Maintenance

Training effectiveness	Very Effective	Effective	Somewhat Effective	Not at All Effective	No Opinion	Not Familiar with Training	No Answer
Residential maintenance contractors (<i>sample size = 109</i>)							
On-the-job training	70%	21	3	1	2	--	4
Technical or trade school	34%	38	18	2	3	3	3
Manufacturer training	31%	37	24	1	3	2	3
Certification training	30%	43	12	4	5	4	3
Private training institute	28%	33	21	--	6	7	5
Training offered by electric utility	27%	39	17	2	3	9	3
Union apprenticeship	17%	28	14	5	9	22	6
Distributor training	20%	45	25	2	4	1	4
Community College	15%	38	28	6	6	4	5
Online HVAC Course	6%	29	39	6	4	12	5
Small commercial maintenance contractors (<i>sample size = 110</i>)							
On-the-job training	76%	15	1	1	5	2	1
Technical or trade school	40%	36	16	1	5	3	1
Certification training	38%	36	16	1	3	4	2
Manufacturer training	34%	44	15	2	4	3	--
Training offered by electric utility	32%	28	19	3	6	11	2
Union apprenticeship	28%	25	12	5	14	15	3
Private training institute	26%	39	18	--	6	9	2
Distributor training	21%	36	35	3	3	3	1
Community College	24%	37	25	3	7	3	2
Online HVAC Course	7%	27	40	8	7	8	2

Table C-15: Perceived Effectiveness of the Certification Process for Preparing a Technician to Perform Quality Maintenance

Training effectiveness	Very Effective	Effective	Somewhat Effective	Not at All Effective	No Opinion	Not Familiar with Training	No Answer
Residential maintenance contractors (<i>sample size = 109</i>)							
NATE	34%	24	9	7	9	7	9
RSES	12%	13	5	6	15	28	22
HVAC Excellence	12%	12	6	4	16	31	19
UA STAR	5%	8	6	4	15	36	27
PAHRA/Industry Competency Exam	4%	11	4	5	16	37	25
TABB	3%	10	5	5	16	35	28
BPI	2%	1	1	--	--	--	96
Manufacturer Certifications	1%	--	--	--	--	--	99
Small commercial maintenance contractors (<i>sample size = 110</i>)							
NATE	39%	26	10	6	5	11	4
HVAC Excellence	13%	18	6	6	13	32	13
RSES	11%	11	25	10	11	26	12
TABB	7%	14	7	6	15	36	16
UA STAR	5%	16	6	7	14	38	15
PAHRA/Industry Competency Exam	4%	18	6	6	14	39	13

C.2 Customer Perspectives on Quality Maintenance

Table C-16: Customers' Definitions of Quality Maintenance

Unprompted Definition of Quality Maintenance	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
Regular inspection/cleaning of equipment	5%	5%	5%	5%	10%	7%
Make sure equipment works efficiently and properly	4%	6%	5%	2% [†]	--	1%
Good quality work/service	3%	4%	3%	2%	1%	2%
Thorough inspection	1%	4%	3%	1%	3%	2%
Rip off/Scam	2% [†]	--	1%	--	--	--
Prevent problems with equipment	1%	--	1%	3%	1%	2%
Qualified individual performs the work	1%	--	1%	1%	--	1%
Meeting Standards	<1%	2%	1%	<1%	--	<1%
Comprehensive maintenance agreement	--	--	--	--	3%	1%
Ensuring the best equipment is available	--	--	--	--	1%	1%
Work is done properly	--	--	--	1%	--	<1%
Expertise in motors and coils	--	--	--	<1%	--	<1%
Other	1%	--	1%	4% [†]	1%	3%
Don't know/Refused	2%	2%	2%	2%	1%	2%
No unaided awareness of Quality Maintenance ^ψ	78%	77%	78%	79%	78%	79%

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

^ψ The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-17: Customers' Perception Quality Maintenance Benefits, Unaided

Benefits	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
Improve a system's reliability	6%	10%	8%	5%	13% [†]	8%
Prolong a system's operational lifespan	9%	6%	8%	10%	12%	11%
Achieve safe operating conditions	3%	9%	6%	2%	1%	2%
Increase energy savings and reduce energy bills	3%	9%	5%	8%	13%	10%
Ensure equipment works efficiently	2%	5%	3%	1%	1%	1%
Prevent expensive repairs	2%	3%	3%	7%	4%	6%
Ensure equipment works properly	2%	3%	2%	2%	1%	2%
Improve indoor air quality	2%	1%	2%	1%	1%	1%
Guidelines/checklist utilized	2% [†]	--	1%	<1%	--	<1%
Better performance from equipment	1%	1%	1%	--	--	--
Increase comfort	<1%	1%	1%	<1%	1%	1%
Obtaining rebate/discount	1%	--	<1%	--	--	--
Maintenance that is performed correctly the first time	--	--	--	1%	--	<1%
Consistent with national standards	--	--	--	<1%	--	<1%
Other	2%	2%	2%	1%	1%	1%
None	--	--	--	--	1%	1%
Don't know/Refused	8%	5%	7%	4%	6%	5%
Not aware of Quality Maintenance ^ψ	65%	54%	60%	67%	59%	64%

[†] Significantly different from Inland or Mild customers at the 90% confidence level

^ψ The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-18: Rating of Quality of Most Recent Cooling Equipment Maintenance Visit

Rating	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
5 - Extremely good quality maintenance	42%	42%	42%	54% [†]	38%	48%
4	15	19	17	21	36 [†]	27
3	5	6	6	3	6	5
2	--	2	1	1	1	1
1 - Extremely poor quality maintenance	2 [†]	--	1	<1	--	<1
Don't know/Refused	4 [†]	--	2	4 [†]	1	3
Have never had equipment serviced ^ψ	20	22	21	9	8	9
Installed Central AC within last 2 years ^ψ	9	7	8	n/a	n/a	n/a
Don't recall last time equipment was serviced ^ψ	3	2	2	7	10	8
Average rating	4.5	4.5	4.5	4.6[†]	4.4	4.5

[†] Significantly different from Inland or Mild customers at the 90% confidence level.

^ψ The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-19: HVAC Maintenance Agreement Status

Status	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
Never had or been offered a cooling equipment maintenance agreement	53%	66% [†]	59%	57% [†]	45%	52%
Was offered a cooling equipment maintenance agreement but did not sign on	24 [†]	11	18	13	12	12
Currently have an HVAC system maintenance agreement with an HVAC contractor	8	10	9	20	33 [†]	25
Had a cooling equipment maintenance agreement in the past	7	9	8	2 [†]	--	1
Don't know/Refused	7	5	6	9	10	9

Table C-20: New Cooling Equipment Maintenance Agreement Offering

Contractor Offered Service Agreement	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
No	5%	3%	4%	9%	6%	8%
Yes	4	4	4	7	3	5
Don't know/Refused	2 [†]	--	1	3	1	2
Have not purchased new equipment* [‡]	89	93	90	81	89 [†]	85
Respondent Accepted Service Agreement**						
<i>Sample Size</i>	9	2	11	14	1	15
Yes	4	2	6	7	1	8
No	4	0	4	5	0	5
Don't know/Refused	1	0	1	2	0	2

*Includes the following types of equipment: Split Systems, Packaged Systems, Package terminal AC or Heat Pumps, and Individual AC or Heat Pump Units.

**Results are reported as unweighted counts where sample size is less than 20.

[‡] The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-21: Year Current HVAC Maintenance Agreement Began

Year	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
2010-Present	2%	7%	4%	6%	3%	5%
2005-2009	4	2	3	5	9	6
2000-2004	1	2	1	<1	2	1
1995-1999	1	--	<1	1	--	<1
1990-1994	--	--	--	1	--	1
Don't know/Refused	<1	--	<1	7	18 [†]	12
Do not currently have maintenance agreement [‡]	92	90	91	80 [†]	67	75

[‡] The survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-22: Duration of Current HVAC Maintenance Agreement

Years	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
1 year	4% [†]	1%	3%	10%	16%	13%
2 years	1	3	2	<1	--	<1
3 years	--	3	1	--	3	1
4 or more years	3	2	2	3	5	3
Don't know/Refused	1	1	1	6	8	7
Do not currently have maintenance agreement ^ψ	92%	90%	91%	80 [†]	67	75

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-23: Additional Reasons for Having Equipment Professionally Serviced

Additional Reasons	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size (multiple response)</i>	236	61	297	235	65	300
No other reasons	55%	54%	55%	66%	67%	67%
Routine/Regular maintenance/To make sure it keeps working properly	5% [†]	1%	4%	2%	4%	3%
System malfunction/Not working	2%	3%	2%	2% [†]	--	1%
To save energy	1%	2%	1%	2%	1%	1%
Household member has respiratory problems	1%	--	1%	--	--	--
Because it had never been done before	<1%	2%	1%	--	--	--
Ensure safety	<1%	--	<1%	--	--	--
To take advantage of incentive/rebate	<1%	--	<1%	--	--	--
To replace filters				2%	3%	3%
Other	2%	3%	2%	--	--	--
Don't know/Refused	2%	4%	3%	9%	8%	8%
Have never had equipment serviced ^ψ	20%	22%	21%	9%	8%	9%
Installed Central AC within last 2 years ^ψ	9%	7%	8%	n/a	n/a	n/a
Don't recall last time equipment was serviced ^ψ	3%	2%	2%	7%	10%	8%

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Table C-24: Reasons for Quality Rating of Cooling Equipment Maintenance

Reasons for Rating*	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
Reasons for High (4 or 5) Rating						
<i>Sample Size</i>	135	38	173	180	46	226
Equipment worked well after maintenance	13%	26% [†]	19%	21%	26%	23%
HVAC technician did a good job	16	19	18	39	37	38
Good relationship with HVAC technician	13 [†]	4	9	13	5	9
Met expectations	9	4	7	--	--	--
Have no problems/complaints	9	7	8	5	6	6
Technician seemed professional/knowledgeable	5	12	8	--	--	--
Technician was informative	6	8	7	2	2	2
Technician completed the job quickly	5	7	6	--	--	--
Good customer service/punctual	5	2	4	--	--	--
Exceeded expectations	2 [†]	--	1	--	--	--
Good price	--	--	--	1	--	1
Good job but there is always room for improvement	--	--	--	1	--	1
Improved the air quality in the building	--	--	--	<1	--	<1
Other	13	9	11	13	22	17
Performed own maintenance	--	--	--	--	2	1
Don't know/Refused	3 [†]	--	2	3	--	2
Reasons for Moderate (3) Rating (unweighted counts)						
<i>Sample Size</i>	12	3	15	9	5	14
Met expectations	4	1	5	--	--	--
Performance was okay, but not exceptional	--	--	--	3	1	4
Expected more	2	--	2	--	--	--
Water damage/left a mess	2	--	2	--	--	--
Have had recurring problems	--	--	--	--	2	2
Have no problems/complaints	1	--	1	--	--	--
Technician's attitude or behavior	1	1	2	1	1	2
Problem with equipment after maintenance	1	--	1	1	--	1
Equipment worked well after maintenance	--	--	--	1	--	1
Cost too much	--	--	--	1	--	1
Other	1	--	1	2	--	2
Don't know/Refused	--	1	1	--	1	1
Reasons for Low (1 or 2) Rating (unweighted counts)						
<i>Sample Size</i>	4	1	5	3	1	4
Problems with system after maintenance	2	--	2	--	1	1
Technician's attitude or behavior	1	1	2	1	--	1
Cost too much				1	--	1
Other	1	--	1	1	--	1

* Results are reported as unweighted counts where sample size is less than 20.

Table C-25: Importance of Quality Maintenance Benefits Ratings

Percentage of Respondents Assigning a High (4 or 5) Importance Rating on Scale of 1 to 5	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
Increase energy savings and reduce energy bills	83%	90%	86%	91%	89%	90%
Prolong a system's operational lifespan	82%	87%	84%	85%	87%	86%
Prevent expensive repairs	86%	82%	84%	88%	88%	88%
Improve a system's reliability	77%	87% [†]	82%	89%	85%	88%
Achieve safe operating conditions, control carbon monoxide, check wiring	82%	78%	80%	84%	79%	82%
Increase comfort	70%	74%	72%	82%	72%	78%
Improve indoor air quality	71%	70%	70%	83%	84%	84%

Table C-26: Residential Customers: HVAC Service Contractors Part of Utility Quality Maintenance Programs

HVAC Contractor Is Part of Program	Residential Customers			Small Commercial Customers		
	Inland	Mild	Total	Inland	Mild	Total
<i>Sample Size</i>	236	61	297	235	65	300
No	4%	5%	5%	4%	3%	3%
Yes	2	2	2	2	--	1
Don't know/Refused	3 [†]	--	2	2%	--	1
Not Aware of Quality Maintenance and/or (Specific) Quality Maintenance Programs ^ψ	91	93	92	93%	98%	95

^ψThe survey design filtered the questions asked of respondents so that if respondents were not aware of a topic, they were not asked further questions pertaining to it. Thus the respondents reported here were not asked this question but their responses are included so as to provide percentages based on the total sample of customers.

Appendix D Additional Tables Regarding HVAC Market Shares

Appendix D lists tables regarding HVAC market shares that NMR did not include in the main report.

Table D-1: Saturation and Average Age of Residential Central HVAC Cooling Systems in California by Unit Type

HVAC Unit Type	Existing Primary Heating System Types	Average Age of Units
<i>Sample Size</i>	1207	-
Split-system AC	76%	15.6 (n=325)
Packaged System AC	15%	13.0 (n=33)
Split-system Heat Pump	2%	10.5 (n=14)
Packaged System Heat Pump	1%	25.5 (n=2)
Common Building	1%	-
Evaporative Cooler	5%	4.8 (n=6)
All Central HVAC Systems	100%	15.1 (n= 380)

Table D-2: Saturation and Average Age of Residential Portable HVAC Space Cooling Systems in California by Unit Type

HVAC Unit Type	Existing Primary Cooling System Types	Average Age of Units
<i>Sample Size</i>	226	-
Window/Wall AC	80%	10.5 (n=18)
Window/Wall Heat Pump	2%	-
Portable/Stand Alone AC	18%	5.3 (n=6)
All HVAC Space Cooling Systems	100%	9.1 (n=24)

Table D-3: Saturation of Residential Portable HVAC Space Cooling Systems in California by Efficiency Level and Unit Type

Residential HVAC Unit Type	6-8.99 SEER	9-10.99 SEER	11-11.99 SEER
Window/Wall AC (n=135)	2%	98%	0%
Window/Wall Heat Pump (n=1)	-	100%	-
Portable/Stand Alone AC (n=12)	38%	57%	5%
All HVAC Space Cooling Systems (n=148)	4%	95%	1%

Percentages may not add to 100% because of rounding

Appendix E Additional Tables with Firmographics, Demographics, and Miscellaneous Information

Appendices E.1 and E.2 list tables from the contractor and customer surveys, respectively, regarding firmographics, demographics, and other data that NMR did not include in the main report.

E.1 Firmographics and other Contractor Data

Table E-1: Employment Positions of Online Survey Respondents

Employment positions	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size</i>	109	110	116	114
Owner	67%	69%	68%	69%
President/CEO	20	22	20	22
General Manager	6	6	6	5
Service Manager	1	2	1	2
Technician	2	1	2	1
All of the above	2	1	2	1
Other	2	--	2	--

Table E-2: Years in Business

Time in operation	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size</i>	109	110	116	114
Less than 5 years	15%	17%	16%	16%
5 to 9 years	17	26	16	28
10 to 19 years	22	23	20	23
20 to 29 years	25	19	27	18
30 years or more	21	16	21	16

Table E-3: Company's Annual Revenue

Revenues	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size</i>	109	110	116	114
Less than \$100,000	23%	27%	22%	25%
\$100,000 to \$249,000	27	26	31	25
\$250,000 to \$499,999	17	18	17	21
\$500,000 to \$999,999	13	10	12	10
\$1 million to \$2,999,999	11	12	10	11
\$3 million to \$7,999,999	3	4	3	4
\$8 million or more	2	--	2	--
Don't know	--	1	--	1
Prefer not to answer/did not answer	5	4	3	5

Table E-4: Facility Type

Facility type	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size (multiple response)</i>	109	108	116	114
Company's only location	92%	87%	94%	89%
A branch or franchise location of a company based in California	2	1	2	1
A branch or franchise location of a company based outside California	2	1	2	1
My home	2	--	1	1
Work in the field	1	6	1	5
The headquarters of a company with multiple locations	1	5	1	4
Other	2	1	1	--
No answer	--	2	--	2

Table E-5: Number of Employees

Employees	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size</i>	109	110	116	114
1-4	75%	75%	77%	75%
5-9	11	14	10	13
10-24	8	9	8	9
25-49	3	2	3	2
50-99	2	--	2	--
100 or more	1	1	1	1

Table E-6: Union Membership

Union membership	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size</i>	109	110	116	114
Yes	--	3%	--	4%
No	98	93	98	92
Don't know	--	2	--	2
No answer	2	3	2	3

Table E-7: Contractors' Employees' Union Memberships

Union membership	Maintenance	Installation
	Small Commercial Contractors	Small Commercial Contractors
<i>Sample Size</i>	110	114
Sheet Metal Workers International Association (SMWIA)	2%	2%
United Association (UA)	--	1
Other	1	1
Not union members	93	92
Do not know if they are union members	2	2
Did not indicate if they are union members	3	3

Table E-8: Contractors' Association Memberships

Associations	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size (multiple response)</i>	109	110	116	114
Company does not belong to any associations	62%	57%	66%	59%
Institute of Heating and Air Conditioning Industries (IHACI)	17	19	16	18
Air Conditioning Contractors of America (ACCA)	11	9	10	9
Refrigeration Service Engineers Society (RSES)	6	16	6	15
PHCC	3	--	3	--
Mechanical Service Contractors of America (MSCA)	2	--	2	--
BPI	2	--	2	--
NATE	1	--	1	--
ASHRAE	1	1	--	1
NCI	1	2	1	2
Sheet Metal and Air Conditioning Contractors National Association (SMACNA)	--	3	--	3
IGSHPA	--	2	--	2
Other	4	3	3	3
Don't know	3	1	3	1
No answer	1	4	1	4

Table E-9: Service Territory

Service Territories	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size (multiple response)</i>	<i>109</i>	<i>110</i>	<i>116</i>	<i>114</i>
Southern California Edison	53%	64%	52%	61%
Southern California Gas	47	46	46	44
Pacific Gas and Electric Company	45	30	45	33
Los Angeles Department of Water & Power	20	31	19	30
San Diego Gas and Electric	17	10	17	10
Sacramento Municipal Utility District	8	9	10	11
TID	2	2	2	2
MID	3	2	3	2
Imperial Irrigation	2	1	1	1
Roseville Electric	2	1	1	1
Riverside	1	2	1	2
Azusa Water & Power	1	1	1	1
REU	1	1	1	1
Southwest Gas	1	--	2	--
Pasadena Water & Power	1	--	1	--
Anaheim	--	1	--	1
Other	5	2	3	2
Don't know	--	1	--	1
No answer	--	2	--	2

Table E-10: Percent of Contractors Rating Each Tool in Top-3 When Asked Which They Use Most

Diagnostic tools	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size (multiple response)</i>	109	110	116	114
Multimeter-Group	68%	77%	69%	78%
Digital Thermometer-Group	46	53	47	52
Digital Refrigeration Gauges-Group	45	49	42	48
Analog Compound Gauges-Group	34	34	36	35
Pipe Clamp Thermometer-Group	25	14	24	15
Current Clamp-Group	18	23	18	21
Flow Hood-Group	1	3	1	3
Duct Leakage Tester-Group	8	6	9	6
Electronic Wet Bulb Thermometer-Group	6	7	9	8
Type K Thermocouples-Group	7	13	8	12
Anemometer-Group	5	9	4	9
Software-Group	5	1	4	1
Type K Thermocouple with Wet Sock-Group	4	1	3	1
Flow Plates-Group	1	--	1	--
Refrigerant gauges	1	1	1	1
Humidity Probe-Group	--	2	--	2
Other	1	--	2	--
No answer	6	3	4	3

Table E-11: Percent of Contractors Rating Each Tool in Top-3 When Asked Which They Need Most

Diagnostic tools	Maintenance		Installation	
	Residential Contractors	Small Commercial Contractors	Residential Contractors	Small Commercial Contractors
<i>Sample Size (multiple response)</i>	109	110	116	114
Multimeter-Group	73%	67%	73%	67%
Digital Refrigeration Gauges-Group	62	63	60	61
Digital Thermometer-Group	37	43	37	43
Analog Compound Gauges-Group	26	29	29	30
Current Clamp-Group	22	26	22	26
Electronic Wet Bulb Thermometer-Group	17	8	18	7
Pipe Clamp Thermometer-Group	15	19	16	17
Duct Leakage Tester-Group	14	5	14	6
Flow Hood-Group	9	6	10	7
Software-Group	7	4	7	4
Anemometer-Group	5	8	4	8
Type K Thermocouple with Wet Sock-Group	4	3	3	3
Type K Thermocouples-Group	3	9	3	8
Flow Plates-Group	--	--	--	--
Refrigerant gauges	--	--	--	--
Humidity Probe-Group	--	3	--	3
Other	1	1	--	1
No answer	2		1	--

E.2 Demographics and other Customer Data

Table E-12: Residential Customers: Home Type and Residency

Home Type	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
Single-family detached house	90%	90%	90%
Single-family attached house (townhouse, row house, excluding duplex)	6	7	7
Duplex	1	2	1
Building with 2-4 units	1	--	<1
Building with 5 or more units	1	2	1
Other	<1	--	<1
Residency			
<i>Sample Size</i>	236	61	297
Permanent year-round residence	99%	95%	97%
Partial-year or seasonal residence	1	4	3
Vacation home rental home	--	2	1

Table E-13: Residential Customers: Number of Years Lived in Home

Years Lived in Home	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
More than seven years	78%	74%	76%
Seven years	4	11 [†]	7
Six years	3 [†]	--	2
Five years	2	3	3
Four years	6	4	5
Three years	3	3	3
Two years	1	1	1
One year or less	3	4	3

Table E-14: Residential Customers: Year Home Was Built

Year Home Was Built	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
2008-2011	2%	3%	3%
2005-2008	7 [†]	2	5
2001-2004	8	6	7
1998-2000	6	8	7
1993-1997	6	4	5
1983-1992	17	18	17
1978-1982	8	11	10
1975-1977	4	6	5
1970-1974	7	4	6
1960-1969	16	19	18
1950-1959	11	8	10
1940-1949	1	8 [†]	4
Before 1940	4	3	3
Don't know/Refused	2 [†]	--	1

Table E-15: Residential Customers: Number of Bedrooms in Home

Number of Bedrooms	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
1	1%	2%	1%
2	8	12	10
3	43	55 [†]	48
4	37 [†]	23	31
5	10	6	8
6	2	2	2
7	<1	--	<1
Average Number of Bedrooms	3.5	3.3	3.4

Table E-16: Residential Customers: Square Footage of Home

Square Feet	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
Less than 250	1%	--	1%
250 - 500	1	--	1
501 - 750	1	2	1
751 - 1,000	1	2	1
1,001 - 1,250	7	3	5
1,251 - 2,000	32	55 [†]	42
2,001 - 2,500	20	16	18
2,501 - 3,000	14 [†]	--	8
3,001 - 4,000	11	10	10
4,001 - 5,000	4	4	4
More than 5,000	<1	1	1
Don't know/Refused	10	7	9

Table E-17: Residential Customers: Household Members by Age Group

Average Number of Household Members per Age Group	Inland	Mild	Total
<i>Sample Size</i>	236	61	297
Less than 18 years old	0.5	0.4	0.5
18 to 24	0.3	0.3	0.3
25 to 34	0.2	0.1	0.1
35 to 44	0.2	0.2	0.2
45 to 54	0.5	0.8 [†]	0.6
55 to 64	0.5	0.5	0.5
65 or older	0.6	0.6	0.6
Average Household Size	2.8	3.0	2.8
Median Household Size	2.0	3.0	2.8

Table E-18: Residential Customers: Race

Race	Inland	Mild	Total
Sample Size	236	61	297
White	68%	82% [†]	74%
Asian	2	7	4
Black or African American	4 [†]	--	2
White and Asian	<1	3	2
American Indian or Alaska Native	1	--	1
White and American Indian or Alaska Native	1	--	1
Pacific Islander	1	--	<1
Asian and Pacific Islander	1	--	<1
Other	15 [†]	5	10
Don't know/Refused	7	3	5

Table E-19: Residential Customers: Spanish, Hispanic or Latino Descent

Percentage of Respondents	Inland	Mild	Total
Sample Size	236	61	297
Spanish, Hispanic or Latino	16% [†]	5%	11%

Table E-20: Residential Customers: Educational Attainment

Highest Level of Education Completed	Inland	Mild	Total
Sample Size	236	61	297
Less than high school	1%	--	<1%
Some high school	2	1	1
High school graduate or equivalent	13	14	14
Some college	24	22	23
College graduate	29	26	28
Some graduate school	3	10 [†]	6
Graduate or professional degree	13	16	15
Post graduate	13	10	12
Don't know/Refused	1	--	1

Table E-21: Residential Customers: Annual Household Income

Annual Household Income	Residential Customers			California*
	Inland	Mild	Total	Total Households
Sample Size	236	61	297	12,433,172
Less than \$10,000	2% [†]	--	1%	5% [†]
\$10,000 - \$19,999	3	3	3	15 [†]
\$20,000 - \$24,999	4 [†]	1	3	
\$25,000 - \$29,999	3	2	2	9
\$30,000 - \$34,999	3	8	5	
\$35,000 - \$39,999	2	3	2	12 [†]
\$40,000 - \$49,999	3	9	6	
\$50,000 - \$59,999	11 [†]	1	7	17
\$60,000 - \$74,999	10	12	11	
\$75,000 - \$99,999	16	15	15	13
\$100,000 - \$149,999	11	7	9	15 [†]
\$150,000 or more	19	28	23 [†]	14
Don't know/Refused	12	12	12	--

*Source: U.S. Census Bureau, "Selected Economic Characteristics," 2007-2011 American Community Survey 5-Year Estimates, DP03.

Table E-22: Small Commercial Customers: Main Business Activity

Main Business Activity	Inland	Mild	Total
Sample Size	235	65	300
Office (non-medical)	20%	23%	21%
Services (salon/spa, gas, repair)	12	16	14
Retail stores	13	7	10
Health care	11	10	10
Public assembly (church, fitness, theatre, library, museum, convention)	10	10	10
Restaurant/food service	7	11	9
Warehouse	5	3	4
Industrial (food processing plant, manufacturing)	5	3	4
Condo association/apartment manager (garden style, mobile home park, high rise, townhouse)	4	3	4
Education	3	3	3
Food store (grocery/liquor/convenience)	3	3	3
Public service (fire, police, postal, military)	3	1	2
Lodging (hotel/rooms)	1	--	1
Agricultural (farms, greenhouses)	<1	--	<1
Other	2	9 [†]	5
Don't know/Refused	1	--	<1

Table E-23: Small Commercial Customers: Number of Buildings Occupied

Number of Buildings	Inland	Mild	Total
Sample Size	235	65	300
1	82%	83%	82%
2	6	4	5
3 to 4	5 [†]	--	3
5 to 10	4	9	6
More than 10	2	1	2
Don't know/Refused	2	3	2

Table E-24: Small Commercial Customers: Square Footage of Facility

Square Feet of Facility	Inland	Mild	Total
Sample Size	235	65	300
Less than 1,500	5%	9%	7%
1,500 – 5,000	28	21	25
5,000 – 10,000	16	13	15
10,000 – 25,000	14	10	12
25,000 – 50,000	4	2	4
50,000 – 75,000	2	5	3
75,000 – 100,000	1	--	1
Greater than 100,000	3	14 [†]	7
Don't know/Refused	27	26	27

Table E-25: Small Commercial Customers: Year Facility Was Built

Year Facility Was Built	Inland	Mild	Total
Sample Size	235	65	300
2001 to 2012	5%	21% [†]	12%
1991 to 2000	5	5	5
1981 to 1990	12	6	9
1971 to 1980	9	9	9
1951 to 1970	16	14	15
1921 to 1950	7	5	6
1920 or Earlier	4	5	4
Don't know/Refused	42	35	39
Average year	1970	1978	1974

Table E-26: Small Commercial Customers: Percentage of Building Occupied

Percentage of Building Occupied	Inland	Mild	Total
Sample Size	235	65	300
81 to 100%	42%	37%	40%
61 to 80%	2	1	2
41 to 60%	6	5	6
21 to 40%	12	8	10
11 to 20%	5	6	6
1 to 10%	10	16	13
Occupy > 1 building at this location	17	14	16
Don't know/Refused	6	13	9

Table E-27: Small Commercial Customers: Percentage of Facility Floor Area that Is Heated or Cooled

Percentage of Facility Floor Area	Inland	Mild	Total
Sample Size	235	65	300
81 to 100%	69%	70%	70%
51 to 80%	--	3	2
21 to 50%	8	11	9
0 to 20%	18 [†]	10	13
Don't know/Refused	6	6	6

Table E-28: Small Commercial Customers: Percentage of Customers that Own, Lease, or Manage Facility

Own, Lease, or Manage Facility	Inland	Mild	Total
Sample Size	235	65	300
Lease or Rent	54%	53%	54%
Own	39	43	41
Manage	4	4	4
Don't know/Refused	3 [†]	--	2

Table E-29: Small Commercial Customers: Percentage of Customers that Pay Electric and/or Gas Utility Bill

Pay the Electric and/or Gas Bill	Inland	Mild	Total
Sample Size	235	65	300
Yes	92%	95%	94%
No	7	3	6
Don't know/Refused	<1	1	1

Appendix F Additional Field Assessment Information

Appendices F.1 and F.2 contain more detailed information relating to the quality installation and quality maintenance field assessments, respectively, that NMR did not include in the main report.

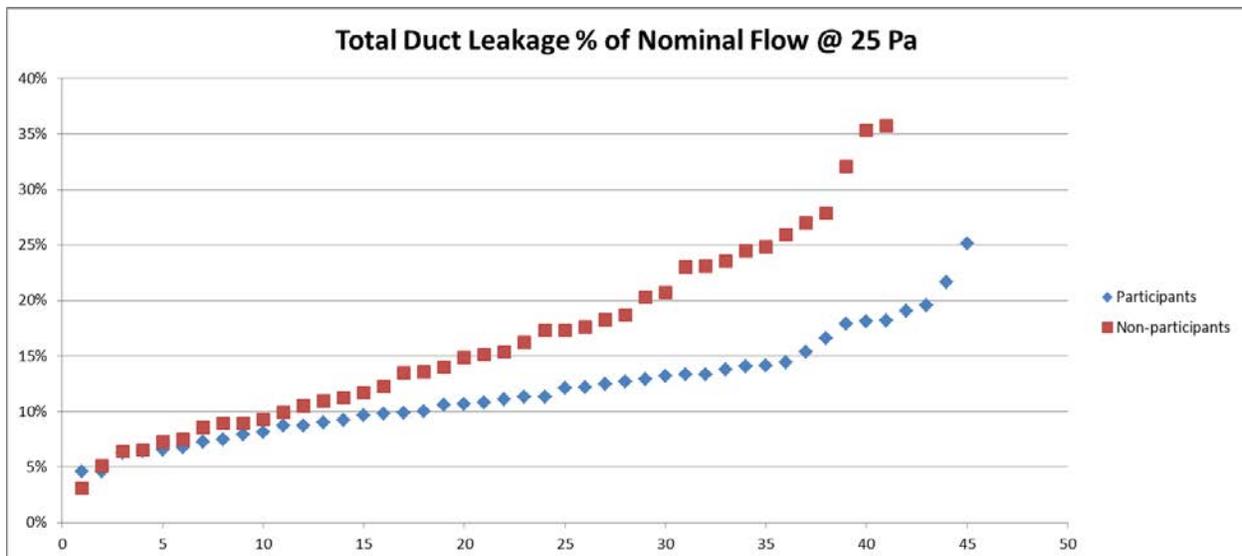
F.1 Quality Installation Field Assessments

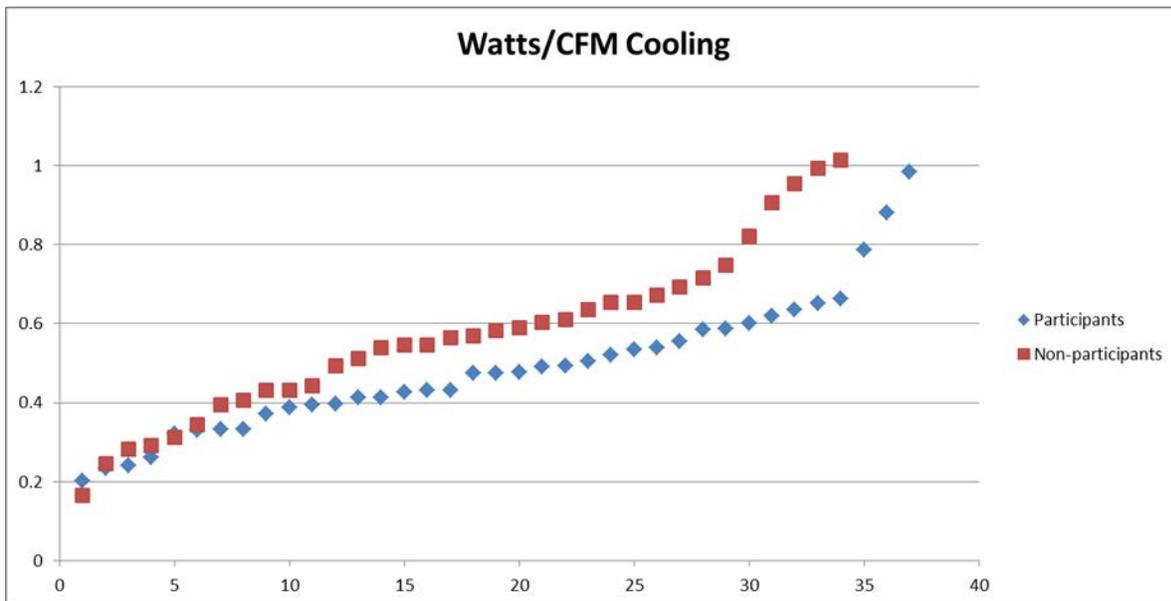
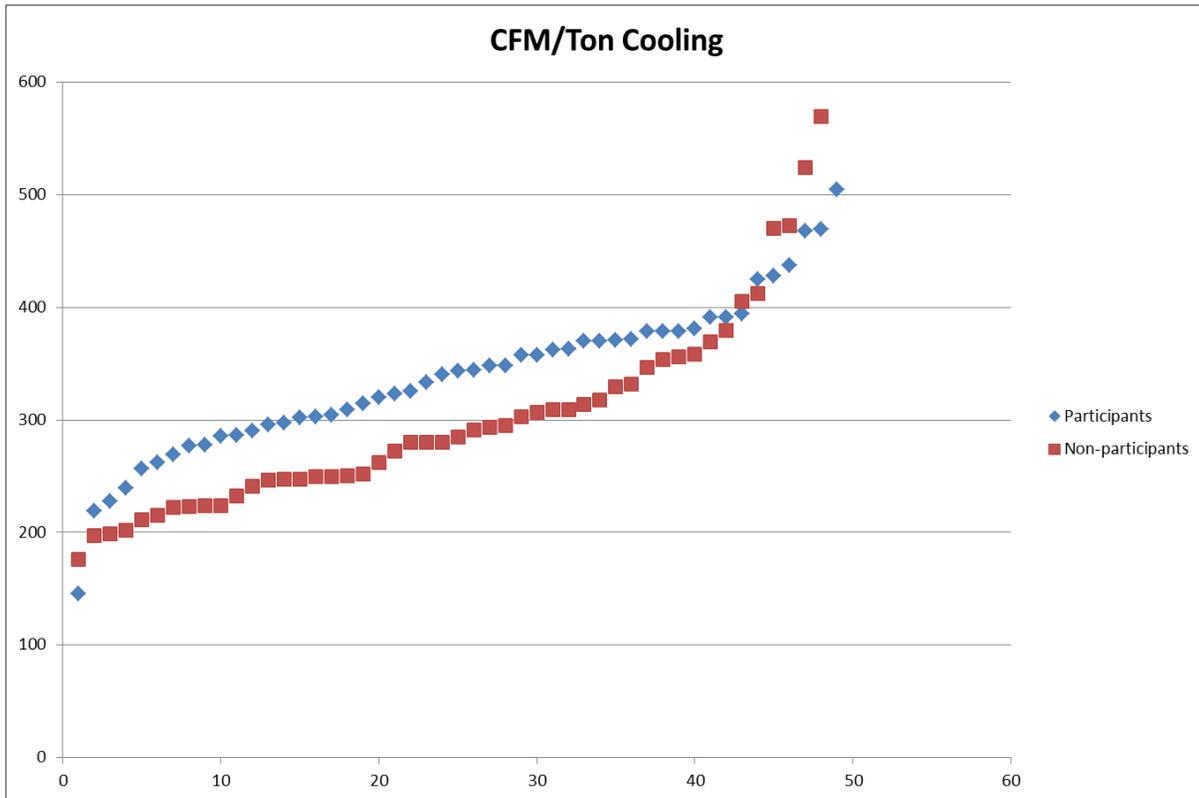
Field Findings on Duct Leakage. The leakage outside the conditioned space relative to actual measured airflow measurements reflect the actual delivered cooling and amount of leakage that has a direct energy impact on the energy lost. The difference between participants and non-participants is still around 4% but the percentage difference is higher than for total leakage. There were some extremely leaky non-participant ducts which distorted the averages made reviewing them difficult. The differences are statistically significant at the 90% confidence interval (CI).

Table F-1: Duct Leakage to Outside for Recent Residential Installations

	Participants	Nonparticipants
Sample Size	43	38
Average	7.42%	10.77%
Standard Deviation	0.037	0.073
90% CI Error Bound	+/- 0.009	+/- 0.019
Relative Precision	+/- 13%	+/- 18%

Distributions. The following diagrams display distributions of duct leakage and fan airflow.





F.2 Quality Maintenance Field Assessments

Field Findings on Duct Leakage. The leakage outside the conditioned space relative to actual measured airflow measurements reflect the actual delivered cooling and amount of leakage that has a direct energy impact on the energy lost. The team compared leakage to the outside to total leakage to look at the effective amount of leakage that leads to energy lost in existing systems. The leakage to the outside relative to the measured airflow was 27% for heating and 32% for cooling. These values further support the existence of additional potential for energy savings by sealing residential ducts.

Table F-2: Duct Leakage to Outside for Recently Maintained Residential Systems

Statistic	% Outside Leakage	
	Using measured Heating airflow	Using measured Cooling airflow
Sample Size	11	22
Average	27%	32%
Standard Deviation	17%	47%
90% CI Error Bound	+/- 8%	+/- 17%
Relative Precision	+/- 31%	+/- 52%

Refrigerant Charge—Issues Identified in Literature that Apply to Both Installations and Maintenance. While measurements were performed in accordance with Title 24, the results may be considered misleading based on recent laboratory studies by the Purdue University⁴ and the CPUC, conducted under Work Order 32 (WO32). The key takeaway for the market assessment is that while there are protocols being widely used to diagnose and remediate HVAC system faults, there is no single best practice or most-accurate method. Many systems have been misdiagnosed over the past decade and these practices are continuing today.

Three reports on laboratory findings are summarized in this section. The key takeaway is that indirect measurements of the charge level through diagnostics are not reliable due to many factors. The Purdue papers confirm that multiple methods cannot deal with interrelated faults including the presence of line restrictions, non-condensables in the refrigerant lines, and system airflow issues. The CPUC laboratory findings raise additional issues as many units in California

⁴ David P. Yuill and James E. Braun. “Evaluating Fault Detection and Diagnostics Protocols Applied to Air-Cooled Vapor Compression Air-Conditioners,” paper presented at the International Refrigeration and Air Conditioning Conference. West Lafayette, IN. 2012.

James E. Braun and David P. Yuill. Evaluation of the Effectiveness of Currently Utilized Diagnostic Protocols. Purdue University. West Lafayette, IN. 2014.

have economizers, which affect the diagnostic measurements and system performance. The CPUC testing also reveals certain sensors and sensor placements that have accuracy concerns.

Evaluating Fault Detection and Diagnostics Protocols Applied to Air-Cooled Vapor Compression Air-Conditioners (summary of Yuill and Braun study). Air-cooled vapor compression air-conditioning equipment is an excellent candidate for fault detection diagnostics (FDD) because:

- There is such a large number of these systems in use; and
- These systems typically receive less intensive maintenance than larger systems and are manufactured at relatively low cost, so they tend to have a high incidence of faults.

Determining how well FDDs actually work is difficult as there is currently no standard method of measuring the performance of FDD. Assessing the FDD tool's performance requires knowledge of accuracy in detecting and correctly diagnosing faults across a range of fault types and fault intensities, and under a range of operating conditions. The assessment is further complicated by the many different approaches taken and functionalities of existing FDD tools.

Fault Data Library. Data have been gathered from experiments conducted by several researchers in laboratories throughout the USA. Measurement data include temperatures, pressures, flow rates, humidity levels and electrical power from the applicable points in the system (on both the refrigerant-side and air-side). These measurement data come from systems with commonly used refrigerants, and using fixed orifice and thermostatically controlled expansion (TXV) devices as well as reciprocating and scroll compressors.

In six of the 13 systems in the data library there was a sufficient set of no-fault tests to enable development of a normal model. A normal model is a multiple linear regression of the driving conditions that predicts capacity or coefficient of performance (COP), where the coefficients are found using a least squares approach. The completed model is used to generate fault impact ratios (FIR), defined as:

$$FIR_{COP} = \frac{COP_{faulted}}{COP_{unfaulted}} \qquad FIR_{capacity} = \frac{capacity_{faulted}}{capacity_{unfaulted}}$$

Where the faulted COP and capacity values come from measurements, and the unfaulted values come from the normal model. The FIR values are included in the data library, and provide a convenient way to assess the significance of a fault that is detected or missed by a fault detection diagnostics (FDD) protocol. One advantage of generating the normal model is that it gives an indication of the random error associated with each experiment, and in some cases illuminates outliers that would otherwise be missed. Part of the task of compiling the fault library includes vetting the data for accuracy, and the normal model was one tool used to do this. There are six faults that are considered in the current project:

- Under- or over-charge (UC or OC)

- Low side heat transfer (EA)
- High side heat transfer (CA)
- Liquid line restriction (LL)
- Non-condensables (NC)
- Compressor valve leakage (VL)

Several researchers have proposed simulation of air-side fouling by covering portions of the face of the heat exchanger with paper, arguing that this better mimics the fault as it might occur. Some have also questioned whether reducing airflow can effectively mimic actual fouled coil surfaces. However, Yang et al. (2007) and Bell et al. (2012) both found that the effect of coil fouling on the heat transfer coefficient was quite small, the dominant effect being the increased air-side pressure drop, which causes reduced airflow in constant-speed systems. Since reduced airflow is easily quantified and replicated, it is the recommended method for imposing faults in the heat exchangers.

Liquid line restrictions can be caused by a crimped line, sediment in the filter/drier, or sediment lodged in some part of the expansion device. The fault is simulated with a valve in the liquid line causing a pressure drop. Implementing a non-condensables fault requires feeding nitrogen gas into the system.

To evaluate FDD protocols, the data from the fault library are fed to a candidate FDD protocol, and the results are compared with the known fault condition. For a protocol that detects and isolates faults, there are five exclusive outcomes possible for each test case:

- No response – the FDD protocol cannot be applied for a given input scenario, or does not give an output because of excessive uncertainty.
- Correct – the operating condition, whether faulted or unfaulted, is correctly identified.
- False alarm – no significant fault is present, but the protocol indicates the presence of a fault.
- Missed detection – a significant fault is present, but the protocol indicates that no fault is present.
- Misdiagnosis – a significant fault is present but the protocol misdiagnoses what type of fault it is.

Once the results for a given set of test cases are generated, statistics are generated to give some overall performance indications. First, percentages are generated⁵ for each of the five outcomes listed above. Response curves, which show the candidate FDD protocol's success (% correct) as a function of fault intensity, can be generated for each type of fault that the protocol can diagnose. Response curves require large numbers of data to be meaningful. This means that

⁵ It should be noted that because the denominators used to calculate these percentages are different, they do not sum to unity.

when using the data from the current data library, response curves can only be generated for the more common faults: UC, OC, EA and possibly CA.

Case Study of the Refrigeration Charge/Airflow (RCA) Protocol. This protocol is specified in Appendix RA of Title 24 – 2008 (CEC 2008), which is a California building energy code. The RCA is applied to cooling mode air-conditioners to determine whether an evaporator airflow fault (EA) is present, and if none is present to determine whether a refrigerant charge fault is present (UC or OC). The RCA uses the following as its inputs:

- Return air dry bulb and wet bulb
- Supply air dry bulb
- Ambient air dry bulb
- Either evaporator superheating for FXO systems, or sub cooling for TXV systems.

These inputs, and values from lookup tables, are used to determine whether temperature split (the air temperature difference across the evaporator) and superheat (FXO) or sub cooling (TXV) are within an acceptable range. The range of driving conditions for the lookup tables is limited, which means that the protocol can't be applied to some tests in the data library (i.e. gives “No Response” outcomes). The RCA was evaluated using the full library of 725 tests from 13 systems.

Table F-3 shows the results for FXO and for TXV equipped systems separately, since the protocol treats them differently. The performance for TXV is better overall. For each result category the percentage is shown for each expansion type and for all results combined.

Table F-3: Faulted and Unfaulted Systems from the RCA Protocol

	For FXO		For TXV		Total
	Unfaulted	Faulted	Unfaulted	Faulted	
Correct	166	41%	203	64%	51%
False Alarm	22	33%	17	28%	30%
Missed Detection	40	15%	23	9%	12%
Misdiagnosis	106	40%	62	25%	33%
Total # Tests	95	313	62	255	725
# of Responses	67	267	61	244	639
No Response	74	18%	12	4%	12%

The results, overall, seem quite poor. About half of the time it is applied, the RCA protocol gives a “Correct” result. The most serious problems are the high rates of False Alarm and Misdiagnosis (30% and 33%), because each of these outputs will result in costly and unnecessary service when the protocol is deployed. In practice, users of FDD on unitary equipment commonly have no tolerance for False Alarms, but are quite tolerant of Missed Detections, so it could be concluded that this protocol is overly sensitive.

There are two important points illustrated by the case study. The first is that there is a great need for a standardized method of evaluation, because it is likely that better-performing methods

currently exist, or could be developed, and could take the place of RCA, but with no method of evaluating them it is impossible to know what those methods are. The second important point is that the qualitative assessment offered here—that the results “seem quite poor”—is insufficient. Performance metrics are needed to combine with the methods of testing FDD performance to give more meaningful overall evaluations. Developing such metrics is one objective of the ongoing effort in the study.

Evaluation of the Effectiveness of Currently Utilized Diagnostic Protocols (summary of Yuill and Braun study). Fault detection and diagnostics (FDD) for unitary equipment is playing an increasingly important role and seeing more use each year. It is unknown how well most FDD tools work. The faults that these tools typically are used to find are: refrigerant charge faults, insufficient airflow across coils, liquid line restrictions, non-condensable gas in the refrigerant, and compressor valve leakage. A method for evaluating the performance of FDD protocols has been developed by Purdue University, as described above.

FDD tools for unitary equipment can be divided into two categories: handheld tools and on-board tools. The former are typically applied by technicians on equipment operating at steady conditions, and provide a snapshot in time of the performance of the unit. The measurements are fed into an algorithm that typically considers current operating conditions in determining whether operation is faulty. These handheld tools are the focus of the Yuill and Braun study.

Methodology. The Yuill and Braun study was undertaken to evaluate the performance of four protocols that are in use or being considered for use in public utility sponsored efficiency programs. These protocols are referred to as ADM, MPS, SA and TM (defined below).

- Protocol developed by ADM in ASHRAE RP-1274 (ADM)
- Hybrid of ADM and requirements for charge indicator device in Title 24 (MPS)
- Thermodynamic Metrics, based on Table 5-20 in ASHRAE/ACCA Standard 180 (TM)
- Service Assistant from FDSI (SA)

Each was programmed in Matlab and interfaced with the FDD Evaluator, software developed by Purdue to implement the evaluation process. Evaluations of all four protocols have been conducted using both experimental input data and simulation input data.

The study generated simulation data across a range of temperatures and fault-type/fault-level combinations (including the no-fault condition). These combinations were applied to models of eight different air-conditioner units. All fault cases included only one fault at a time. There are a total of 14,074 scenarios in the simulation library.

The even blanketing of simulated conditions in the input space gives different results than the experimental data library’s input space. The experimental data library was developed from tests carried out by other researchers on projects to study fault effects. These tests tend to be very heavily weighted at typical rating conditions, such as $T_{ra} = 80^{\circ}\text{F}$, $WB_{ra} = 67^{\circ}\text{F}$, $T_{amb} = 95^{\circ}\text{F}$. They also are heavily weighted on charge fault tests. Since FDD protocols perform better with some conditions and fault types than others, the evaluations based upon experimental results are

strongly influenced by the test distribution. Since the FDD methods are likely to have been developed with those same rating conditions in mind, it's reasonable to expect that some protocols' performance will be better for the experimental data library than for the simulation data library. Overall, the simulation-based results are likely a more meaningful measure of a FDD protocol's performance in application.

Findings. Each of the protocols was evaluated using the experimental data library and also the simulation data library. Evaluations were done using the full set of data.

The overall results are surprisingly poor. The ADM, MPS and TM protocols suffer from very high False Alarm rates (60-100% overall, with most categories over 95%), high Misdiagnosis rates and high No Diagnosis rates. The Missed Detection rates are low, suggesting that these protocols may be too sensitive. The TM protocol is the worst performer. Fundamentally, these protocols are overly simplistic methods for addressing a very complex problem. The SA protocol is presumably far more complex. Its performance, overall, is probably the best of any protocol yet evaluated. This assessment is based on heavily weighting the simulation results and heavily weighting the False Alarm results. However, we are surprised that it didn't perform better. There is clearly room for improvement, but it is difficult to qualify exactly how well it or the other protocols work. The best comparison, currently, might be to compare it with no FDD, and consider whether the benefit of detecting and correctly diagnosing some faults outweighs the cost of False Alarms and Misdiagnoses.

The results of this project are valuable, because they can help us to make good choices in using and choosing diagnostics. These results also provide some context for what range of performance might be expected from FDD. The issue of maintenance personnel believing in the protocols is important. The performance of diagnostic tools is part of a larger problem of quality maintenance. FDD provides no benefits if faults are not addressed (correctly). Handheld FDD is a tool intended to help maintenance personnel perform better service than they could with other methods. If they experience and identify False Alarms, Missed Detections, Misdiagnoses and No Diagnosis cases, it seems probable that they'll soon abandon diagnostics, or ignore them if FDD use is mandated.

Finally, in conducting the evaluations, some areas of potential expansion and improvement to the evaluation methodology were found and implemented, such as a new outcome category (No Diagnosis) and an improved definition for False Alarms.

Refrigerant Charge Diagnostics – CPUC Lab Study Interim Findings. In addition to the detailed findings in the full WO32 memorandum, overlapping interim findings from the field and laboratory efforts include laboratory tests, which indicate the issues associated with relying on refrigerant charge adjustments to improve efficiency are due to several factors. Packaged units in commercial quality maintenance programs will likely have high refrigerant tube temperature measurements due to measurement instrument errors, improper field procedures, and economizer or mixed-air damper leakage causing higher superheat or suction temperatures compared to manufacturer specifications. The combination of FDD errors and incentives for refrigerant

charge adjustments will cause many units to be overcharged, which can reduce efficiency and compressor life.

Laboratory Testing of Commercial HVAC. To understand the impacts of observed faults such as improper refrigerant charge and improper airflow, laboratory tests were conducted on a 7.5-ton dual-compressor packaged unit with an economizer. The tests were conducted at an AHRI-certified laboratory. The 7.5-ton unit was chosen for testing because it has 15% program market share, higher than any other unit.⁶ Based on discussions with the laboratory staff and the experience of the EM&V team, the laboratory tests with actual cabinet leakage and functioning economizers may be the first of their kind and have provided critical new findings on the diagnosis of system faults and the efficiency impacts of repairs.

The following interim laboratory results are available based on tests of the 7.5-ton dual-compressor packaged roof top unit.

- Tests of the “out-of-box” efficiency without an economizer indicate an 8.4 EER, which is 24% less efficient than the AHRI rating of 11 EER at outdoor conditions of 90°F dry bulb and indoor conditions of 80°F dry bulb and 67°F wet bulb temperatures. While adding charge can improve efficiency, it cannot overcome efficiency losses due to damper and cabinet leakage.
- Contrary to conventional wisdom, tests indicate that minimum outdoor airflow is 15% with closed dampers, sufficient to satisfy ASHRAE 62.1’s (and Title 24’s) minimum outside air requirement for most space occupancy types. The program training videos reviewed as part of this evaluation recommended a minimum damper position of three fingers open to achieve 15% outdoor air. However, laboratory tests showed that this setting actually provides 30% outside air and decreases efficiency between 11% and 62% (depending on outdoor conditions) compared to the fully closed damper setting.
- Outdoor airflow is 15% with closed dampers, 20% with one finger open, 23% with two fingers open, 30% with three fingers open, and 62% with dampers fully open. Designers, technicians, and program implementers incorrectly assume 2% outdoor airflow with closed dampers and 100% outdoor airflow with fully open dampers.
- Because of the significant damper leakage, tests of economizer change-over settings indicate negative efficiency benefits relative to the baseline closed damper first-stage cooling at outdoor conditions of 70°F dry bulb and 60°F (70/60°F) wet bulb and 65/57°F.⁷ Economizer operation at 60/54 and 55/51 improved efficiency more than economizer with first stage cooling. Control strategies should be implemented that take these findings into account.

⁶ Program market share is based on 2006-08 and 2010-12 tracking data for CQM programs.

⁷ At 70/60°F outdoor conditions the economizer fan-only is 83% less efficient than the baseline with a 1.5 EER and provides 92% less capacity.

- Based on DOE-2 simulations of a DEER prototype small office building, 82% of economizer energy savings are from first-stage cooling indicating the importance of integrating mechanical cooling and economizer control strategies to save energy.
- Due to the presence of the economizer, the manufacturers' diagnostic specifications by themselves cannot be used to adjust the unit back to original factor charge or adjust to the units' optimal efficiency.
 - Tests with and without an economizer and factory charge, circuit 1 and circuit 2 are above manufacturer charging chart specifications for suction temperature.
 - Tests of +60% overcharge relative to factory yield diagnostics within manufacturer ST specifications for both circuits. However, +60% overcharge yields negligible efficiency improvements of -8 to +2% compared to +20% overcharge laboratory optimal.
- Tests of 16% to 33% low airflow indicate a 2% to 24% reduction in efficiency depending on damper position. Low airflow has more impact on efficiency in extreme weather conditions even when dampers are closed.
- Tests indicate that open dampers can have a larger negative impact on EER than improper refrigerant charge and low airflow.
- Laboratory tests of field measurement instruments are in progress. Preliminary results indicate that some sensors provide readings that will lead to inaccurate fault diagnostics. Tests were conducted with eight sensors on liquid and suction lines. The largest differences are with the suction line measurements in which tube temperatures are 25°F to 40°F less than outdoor ambient temperature. The liquid line temperature is typically 8°F to 12°F above ambient, so there are smaller variations from measured temperatures to actual tube temperatures.
 - The smallest differences are with specific Type-K clamp probes with accuracy ranging from 1.1 +/- 0.6°F on suction lines at 115°F. Some Type-K clamp probes have suction line accuracy ranging from 6.8 +/- 1.0°F when tested at 115°F outdoor conditions. Differences in accuracy are attributable to design and manufacturing.
 - The largest differences were found with Type-K bead probes and thermistors. Insulated bead probes had differences of 10.7 +/- 3.3°F, insulated cylindrical thermistors had differences of 9.7 +/- 7.1°F, and clamp thermistors had differences of 5.4 +/- 2.1°F. Tests of other probes are in progress.
- Results also indicate that not allowing sensors to reach steady state can cause inaccurate measurements. Tests of measurement instruments indicate that it can take 5 to 10 minutes or longer for sensors to measure refrigerant temperatures.

Additional laboratory tests are being performed on packaged units from other manufacturers. Laboratory tests of field measurement instruments are in progress. Preliminary results indicate that some sensors provide readings that will lead to inaccurate fault diagnostics and that not allowing sensors to reach steady-state can cause inaccurate measurements

Appendix G On-line Contractor Survey Instrument from the California HVAC Contractor & Technician Behavior Study

SURVEY INTRO

Thank you for agreeing to participate in this CA HVAC Contractor & Technician Behavior Study sponsored by Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E) and administered by Energy Market Innovations, Inc.

The purpose of this survey is to help electric utilities in California better understand the HVAC industry. Your input will help inform the future design of utility programs.

[IF PHONE RECRUITED SKIP SCREENING QUESTIONS]

SCREENING QUESTIONS

- SCREEN SO THAT ONLY TARGETED RESPONDENTS COMPLETE SURVEY.
- SCREENING WILL ALSO BE USED TO ASSIGN RESPONDENTS TO THE APPROPRIATE SECTOR FACILITATING SKIP LOGIC IN SURVEY.
- IF RESPONDENT PHONE RECRUITED, SCREENING QUESTIONS WILL BE SKIPPED.

The first step is to answer a few questions to determine if you qualify for the study!

Click “Next >>” to begin.

IS1. Is your company currently working in the HVAC industry? **[REQUIRE RESPONSE]**

- Yes (1)
- No (2)
- Don't Know [THANK & TERMINATE – DO NOT QUALIFY]

IS2. [NOTE TWO DIFFERENT WORDINGS BASED ON IS1] [IF IS1 = 1:] According to our records, we have your company address as <COMPANY ADDRESS>, is this correct? [IF IS1 = 2:] According to our records, your company address was <COMPANY ADDRESS>, is that correct?

- Yes (1) [SKIP TO IS3]
- No (2)
- Don't Know [SKIP TO IS3]

If IS2 = 2

IS2b. What is/was the correct address?

- [OPEN-END]
- Don't Know [CONTINUE]

IS3. [NOTE TWO DIFFERENT WORDINGS BASED ON IS1] [IF IS1 = 1:] In order to ensure that we do not survey multiple people from your company, please confirm what is your company name. [IF IS1 = 2:] In order to ensure that we do not call multiple people from your company, please confirm what was your company name.

- [OPEN-END]
- Don't Know [CONTINUE]

IS4. Do you personally hold a C-20 license in the State of California? Please note that this information is strictly confidential and will not be shared with the state or used to take any negative actions against you or your firm. **[REQUIRE RESPONSE]**

- Yes (1)
 No (2)

IF IS1 = 2, THANK AND TERMINATE AFTER IS4.

IS5. Does any other employee of your firm hold a C-20 license in the State of California?

- Yes (1)
 No (2)
 Don't Know [THANK & TERMINATE – DO NOT QUALIFY IF IS4 = 2; CONTINUE TO IS7 IF IS4 = 1]
 Prefer not to answer [THANK & TERMINATE – DO NOT QUALIFY IF IS4 = 2; CONTINUE TO IS7 IF IS4 = 1]

ASK ONLY IF IS4 = 2 and IS5 = 1

IS6. To ensure our records are complete and that we don't call anyone else from your company, please provide the name and email address of others in your company that hold a C-20 license:

Name #1 _____ Email #1 _____

Name #2 _____ Email #2 _____

Name #3 _____ Email #3 _____

- Prefer not to answer [CONTINUE]

IF IS4 = 2, THANK AND TERMINATE – DO NOT QUALIFY

IS7. What percent of your company's work is done in the following HVAC market sectors? Please answer based on the number of jobs completed in each area and **not** on revenue. Your best estimate is fine.

(Please make sure responses add to 100%.)

IS7a Residential _____%

IS7b Small Commercial _____%

IS7c Large Commercial _____%

IF (IS7a + IS7b + IS7c ≠ 100) THEN DO NOT ADVANCE TO NEXT QUESTION, AND DISPLAY THE FOLLOWING MESSAGE: Your responses must total to 100%.

COMPUTE NEW VARIABLE "SECTOR."

SECTOR = 3 IF LARGE COMMERCIAL > or = 10%.

IF LARGE COMMERCIAL < 10%, THEN:

SECTOR = 2 IF SMALL COMMERCIAL > or = 20%.

OTHERWISE SECTOR = 1 (RESIDENTIAL).

IS10. Approximately what percent of your company's business (based on the number of jobs completed and **not** revenue) comes from service calls, maintenance visits, and installation jobs? Your BEST ESTIMATE is fine. **[REQUIRE RESPONSE]**

- By **service calls**, we mean appointments that are made to fix a fault in HVAC systems that either shut the system down or inhibit the system's operation to the point that the

customer detects a problem.

- By **maintenance visits**, we mean checkups to inspect, test, measure, and preserve an HVAC system.
- By **installation jobs**, we mean projects where the primary purpose is to install new equipment or replace existing equipment.

[Please make sure responses add to 100%.]

IS10a. Service calls ___ %

IS10b. Maintenance visits ___ %

IS10c. Installation jobs ___ %

IF (IS10a + IS10b + IS10c ≠ 100) THEN DO NOT ADVANCE TO NEXT QUESTION, AND DISPLAY THE FOLLOWING MESSAGE: Your responses must total to 100%. IF SKIPPED IS7, THANK AND TERMINATE AFTER IS10c.

BEGIN SURVEY

Congratulations! You have qualified for this survey. The survey should take approximately thirty minutes to complete and we will email you a \$75 gas card within 3 weeks of successfully completing the survey. All of your responses will be kept confidential.

If you have any questions about the study, please contact Donna Whitsett at (206) 621-1160 or by email at survey@emiconsulting.com.

FIRMOGRAPHICS

F1. What is your primary role in the company where you work?

- Owner (1)
- President/CEO (2)
- General Manager (3)
- Service Manager (4)
- Technician (5)
- Other (Specify) _____ (6)

F2. How long has your company been operating?

- Less than 5 years (1)
- 5 to 9 years (2)
- 10 to 19 years (3)
- 20 to 29 years (4)
- 30 years or more (5)
- Don't know (6)

F3. What is your company's annual revenue?

- Less than \$100,000 (1)
- \$100,000 to \$249,999 (2)
- \$250,000 and \$499,999 (3)
- \$500,000 and \$999,999 (4)
- \$1 million and \$2,999,999 (5)
- \$3 million and \$7,999,999 (6)

- \$8 million or more (7)
- Prefer not to answer (8)
- Don't know (9)

F4. The facility where you work is:

- Your company's only location (1)
- The headquarters of a company with multiple locations (2)
- A branch or franchise location of a company based in California (3)
- A branch or franchise location of a company based outside California (4)
- Other (Specify) _____ (5)
- Don't know (6)

F5. How many employees, including yourself, work at your company?

- 1-4 (1)
- 5-9 (2)
- 10-24 (3)
- 25-49 (4)
- 50-99 (5)
- 100 or more (6)
- Don't know (7)

F6. Are the employees at your company members of a union?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF F6 = 1

F6b. Which union(s) do the employees at your company belong to? (Check all that apply).

- United Association (UA) (1)
- Sheet Metal Workers International Association (SMWIA) (2)
- Other (Specify) _____ (3)
- Don't know (4)

F7. Does your company belong to any of the following associations? If so, please indicate each association your company belongs to by checking the corresponding box:

- No, my company does not belong to any associations (1)
- Air Conditioning Contractors of America (ACCA) (2)
- Institute of Heating and Air Conditioning Industries (IHACI) (3)
- Refrigeration Service Engineers Society (RSES) (4)
- Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) (5)
- Mechanical Service Contractors of America (MSCA) (6)
- Other (Specify) (7)
- Don't know

RESPONSE OPTIONS 2-6 RANDOMIZED

F7b. Does your company have any of the certifications listed below? If so, please indicate each certification your company has by checking the corresponding box.

(Check all that apply).

- Our company has none of these certifications (6)
- ACCA Quality Assured (1)
- MSCA STAR (2)

- NATE C3 (3)
- Associated Air Balance Council (AABC) (4)
- National Balancing Council (NBC) (5)
- Other (Specify) _____ (7)

RESPONSE OPTIONS 1-5 RANDOMIZED

F8. Which service territories does your company operate within?

(Check all that apply).

- Pacific Gas and Electric Company (1)
- San Diego Gas and Electric (2)
- Southern California Edison (3)
- Southern California Gas (4)
- Los Angeles Department of Water & Power (5)
- Sacramento Municipal Utility District (6)
- Other 1 (Specify) _____ (7)
- Other 2 (Specify) _____ (8)
- Don't know (8)

RESPONSE OPTIONS 1-6 RANDOMIZED

F9. Research indicates that technicians use an array of tools when they are performing diagnostic tests on HVAC systems. What tools do your company's technicians most use to perform the following diagnostic tests on HVAC systems?

Click-and-drag from the list on the left into each box on the right.

Digital Refrigeration Gauges(1)	1 st Most Used
Analog Compound Gauges (2)	
Flow Hood (3)	
Anemometer (4)	
Flow Plates (5)	
Duct Leakage Tester (6)	
Humidity Probe (7)	2 nd Most Used
Type K Thermocouple with Wet Sock (8)	
Electronic Wet Bulb Thermometer (9)	
Digital Thermometer (10)	
Type K Thermocouples (11)	
Pipe Clamp Thermometer (12)	3 rd Most Used
Current Clamp (13)	
Multimeter (14)	
Software (15)	
Other (Specify) _____ (16)	

RESPONSE OPTIONS 1-15 RANDOMIZED

F10. If you had to choose, what tools do technicians **need** the most in order to successfully perform diagnostic tests on HVAC systems?

Click-and-drag the three tools from the list on the left, to the appropriate boxes on the right.

Digital Refrigeration Gauges (1)	1 st Most Important
Analog Compound Gauges (2)	
Flow Hood (3)	
Anemometer (4)	
Flow Plates (5)	
Duct Leakage Tester (6)	
Humidity Probe (7)	2 nd Most Important
Type K Thermocouple with Wet Sock (8)	
Electronic Wet Bulb Thermometer (9)	
Digital Thermometer (10)	
Type K Thermocouples (11)	
Pipe Clamp Thermometer (12)	3 rd Most Important
Current Clamp (13)	
Multimeter (14)	
Software (15)	
Other (Specify) _____ (16)	

RESPONSE OPTIONS 1-15 RANDOMIZED

ASK SERV.Res Module IF SECTOR = 1 AND IS10a > or = 1%.

SERVICE– RESIDENTIAL (SERV.Res Module)

Next is a set of service-focused questions specific to your **residential** customers.

Serv5.Res

In your opinion, what factors influence residential customers’ decision-making of whether to replace or repair an HVAC unit?

Please rank the following factors from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Financial cost (1)
- Our company’s recommendation of whether to replace or repair (2)
- Speed with which unit can be made operational (3)
- Age of unit (4)
- SEER rating of unit (5)
- Other (Specify) _____ (6)

RESPONSE OPTIONS 1-5 RANDOMIZED

Serv7.Res

What would trigger your company to recommend replacement rather than repair for residential customers?

(Check all that apply).

- Repair cost is high relative to replacement cost (1)
- System is old (2)
- System is inefficient (3)
- System is under capacity (4)
- System is over capacity (5)
- Other (Specify) _____ (6)
- Don't know (7)

RESPONSE OPTIONS 1-5 RANDOMIZED

Serv6.Res

At what percentage of replacement cost does your company recommend replacement instead of repair for residential customers?

- When repair costs are equal to the cost of replacement (100%) (1)
- When repair costs are about 90% of the cost of replacement (2)
- When repair costs are about 80% of the cost of replacement (3)
- When repair costs are about 70% of the cost of replacement (4)
- When repair costs are about 60% of the cost of replacement (5)
- When repair costs are about 50% of the cost of replacement (6)
- When repair costs are about 40% of the cost of replacement (7)
- When repair costs are about 30% of the cost of replacement (8)
- When repair costs are about 20% of the cost of replacement (9)
- When repair costs are about 10% of the cost of replacement (10)
- Don't know (11)

Serv8.Res

How does your company price a service call for residential customers? By service calls, we mean appointments that are made to fix a fault in HVAC systems that either shut the system down or inhibit the system's operation to the point that the customer detects a problem.

(Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site (1)
- The customer pays based on the number and type of repairs performed (2)
- The customer pays based on the type of HVAC equipment in his/her home (3)
- The customer pays based on the square footage of his/her home (4)
- Other (Specify) _____ (5)
- Don't know (6)

RESPONSE OPTIONS 1-4 RANDOMIZED

ASK MAINT.Res Module IF SECTOR = 1 AND IS10b > or = 1%.

MAINTENANCE– RESIDENTIAL (MAINT.Res Module)

Next is a set of maintenance-focused questions specific to your residential customers. By maintenance, we mean checkups to inspect, test, measure, and preserve an HVAC system.

Maint1.RES

Approximately what percentage of your residential customers have at least one maintenance check-up per year for their HVAC systems?

- Less than 10 percent (1)
- 10 to 24 percent (2)
- 25 to 49 percent (3)
- 50 to 74 percent (4)
- 75 to 100 percent (5)
- Don't know (6)

Maint2.RES

How often does your company recommend that homeowners have maintenance check-ups for their home HVAC systems?

- We do not recommend that our customers schedule maintenance appointments (1)
- Every other year (2)
- Once a year (3)
- Twice a year (4)
- Three times a year (5)
- Four times a year (6)
- Other (Specify) _____ (7)

Maint3.RES

Please indicate your level of agreement or disagreement with the following statements.

Regular, proper maintenance of a residential customer’s HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don't know (5)
Improve indoor air quality (1)	<input type="radio"/>					
Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a system’s operational lifespan (4)	<input type="radio"/>					
Prevent	<input type="radio"/>					

expensive repairs (5)						
Improve a system's reliability (6)	<input type="radio"/>					

RESPONSE OPTIONS 1-6 RANDOMIZED

Maint4.RES

Does your company have a formal policy or set of guidelines that technicians are required to follow for residential maintenance procedures?

- Yes – Please explain or describe: _____ (1)
- No (2)
- Don't know (3)

Maint6.RES

Which of the following tasks do your company's technicians perform during a typical residential maintenance visit?

Please indicate each task that your technicians perform by checking the corresponding box.

(Check all that apply).

- Inspect filters for particulate accumulation and clean/replace as needed (1)
- Inspect air filter housing integrity and air seal (2)
- Inspect grilles, registers and diffusers for dirt accumulation (3)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (4)
- Inspect integrity of all accessible ductwork insulation (5)
- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (6)
- Test system controls' modes of operation and control sequences (7)
- Visually inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g. cracks, perforations, bulges) (8)
- Measure airflow across heat exchanger/coil (9)
- Inspect condensing coil and clean/adjust as needed (10)
- Inspect evaporator coil and clean/adjust as needed (11)
- Measure refrigerant charge (13)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (14)
- Inspect all electrical components for proper operation (15)
- Inspect blower motors for proper operation (16)
- Inspect cabinet, cabinet fasteners, and cabinet panels (17)
- Inspect condensate drains (and traps) for proper operation (18)
- Inspect economizers (19)
- Other 1 (Specify) _____ (20)
- Other 2 (Specify) _____ (21)
- Other 3 (Specify) _____ (22)
- Other 4 (Specify) _____ (23)
- Other 5 (Specify) _____ (24)

- Other 6 (Specify) _____ (25)
- Our company's technicians do not perform any of these tasks (26)

RESPONSE OPTIONS 1-19 RANDOMIZED**SHOW ONLY IF Maint6.RES = 13****Maint6b.RES**

You indicated that your company's technicians check an HVAC unit's refrigerant charge during a typical residential maintenance visit. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer's recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer's recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)
- Check temperature split across coil before using gauges (6)
- Other (Specify)
- Don't know

RESPONSE OPTIONS 1-6 RANDOMIZED**Maint5.RES**

Are you aware of "ACCA Standard 4: Maintenance of Residential HVAC Systems", developed by Air Conditioning Contractors of America (ACCA)?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint5.RES = 1**Maint5b.RES**

How would you characterize your company's use or implementation of the specifications or guidelines of ACCA Standard 4?

- We are aware of the standard but do not adhere to it on a job (1)
- We adhere to some of the standard's specifications on a job, but not all of the specifications (2)
- We adhere to the majority of the standard's specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard's specifications on job (4)

Maint7.RES

During a typical residential maintenance visit, how long does a technician from your company spend working on each unit?

- Less than 15 minutes (1)
- Between 15 and 29 minutes (2)
- Between 30 and 44 minutes (3)
- Between 45 minutes and 59 minutes (4)
- Between 1 hour and 1 hour and 59 minutes (5)
- Between 2 hours and 2 hours and 59 minutes (6)
- Between 3 hours and 3 hours and 59 minutes (7)

- 4 hours or more (8)
- Don't know (9)

Maint8 .RES

For jobs with residential customers, how does your company define “quality maintenance”?

OPEN-ENDED RESPONSE _____

Maint9.RES

How effective do you think the following training methods are at teaching someone the technical skills needed to *perform* quality maintenance on residential HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I'm not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Community college (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Union apprenticeship (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Private training institute (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Online HVAC course (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training offered by an electric utility (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Distributor training (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Manufacturer training (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Certification training (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

On-the-job training (10)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (11)	<input type="radio"/>					

RESPONSE OPTIONS 1-10 RANDOMIZED

Maint12.RES

Does your company actively try selling or marketing HVAC maintenance services to your residential customers?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.RES = 2

Maint13.RES

For what reasons does your company not actively try and sell maintenance services to your residential customers?

(Check all that apply).

- There is no value in doing maintenance (1)
- Customers do not understand the value of maintenance (2)
- Customers understand the value of maintenance, but are not interested in having maintenance performed on a regular basis (3)
- Customers are not willing to make long-term commitments (4)
- Customers do not want to pay extra money for regular maintenance (5)
- We don't make enough money on maintenance contracts (6)
- Our technicians need more technical training to be able to perform regular maintenance (7)
- Our technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance contracts to customers (8)
- Other (Specify) _____ (9)

[RANDOMIZE OPTIONS 1 THROUGH 8]

Maint14.RES

In your opinion, what are your residential customers’ priorities when it comes to their HVAC systems?

Please rank the following benefits from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Reliability (1)
- Cost efficiency (2)
- Longevity of unit (3)

- Occupant comfort (4)
- Minimizing repair costs (5)
- Peace of mind (6)
- Energy efficiency (7)
- Other (Specify)

RESPONSE OPTIONS 1-7 RANDOMIZED

Maint15.RES

What do you see as the primary barriers to your company *selling* HVAC maintenance services to your residential customers?

(Check all that apply).

- There are no barriers, all our customers have maintenance performed on their HVAC systems regularly (1)
- Customers do not know that maintenance can reduce their electric bills (2)
- Customers do not know that maintenance can improve the performance and longevity of their cooling system (3)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it (4)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it unless someone can show them evidence of how much money they can save (5)
- Technicians need more technical training to be able to perform maintenance (6)
- Technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance to customers (7)
- Equipment warranties make certain customers less willing to have maintenance performed on their HVAC units (8)
- Other barrier 1 (Specify) _____ (9)
- Other barrier 2 (Specify) _____ (10)
- Other barrier 3 (Specify) _____ (11)

[RANDOMIZE 2 THROUGH 8]

→ If Maint12.RES = 2 Or Maint12.RES = 3, SKIP TO Inst1.RES

SHOW ONLY IF Maint12.RES = 1

Maint16.RES

What are your company’s sales and marketing strategies for finding new residential customers to purchase maintenance services?

(Check all that apply).

- Our company does not have a marketing strategy for finding new customers to purchase maintenance services (1)
- Our main strategy is to transition existing/former customers that have received other services into purchasing maintenance work (2)
- Recommendations from current customers (3)
- Recommendations from other contractor firms (4)
- The phone book (5)
- Online postings including social media (6)
- Online advertising (7)
- Direct mailing (8)

- Advertising in newspapers (9)
- Advertising in magazines (10)
- Advertising on the radio (11)
- Advertising on television (12)
- Visibility through utility HVAC installation and maintenance programs (13)
- Other (Specify) _____ (14)

RESPONSE OPTIONS 2-13 RANDOMIZED**SHOW ONLY IF Maint12.RES = 1****Maint17.RES**

What is your company's practice for bidding various maintenance approaches to residential customers?

(Check all that apply)

- We only have one level of maintenance (1)
- We have multiple tiers of maintenance (e.g. basic and premium) and each has a different price point (3)
- We bid different prices for different market segments (4)
- We guarantee the lowest cost maintenance contracts (5)
- We offer performance contracts (6)
- Other (Specify) _____ (7)

SHOW ONLY IF Maint12.RES = 1**Maint18.RES**

Do the individuals in your company that sell maintenance agreements to residential customers have a formal set of questions that they ask customers to determine how to bid a maintenance agreement?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.RES = 1**Maint19.RES**

Do the technicians at your company sell HVAC maintenance services to your residential customers?

- Yes, our technicians sell maintenance services directly to customers (1)
- Our technicians recommend that customers purchase maintenance services, but then refer the customer to a sales person who completes the sale (2)
- No, our technicians play no role in the maintenance service sales process (3)
- Other (Specify) _____ (4)
- Don't know (5)

SHOW ONLY IF Maint19.RES = 1**Maint20.RES**

When selling maintenance services, how does your company communicate to residential customers the benefits of proper air conditioner maintenance versus the cost?

(Check all that apply).

- Our technicians provide a basic explanation of benefits a customers can get from proper

maintenance (1)

- Our technicians are explicit with how maintenance addresses each benefit such as how maintenance impacts energy savings and electric bills and how maintenance impacts indoor air quality (2)
- Our technicians show the customer data gathered with diagnostic tools to demonstrate how much money they can save through maintenance (3)
- Our technicians write up a service report that addresses benefits and costs (4)
- Other (Specify) _____ (5)

SHOW IF Maint19.RES =1

Maint21.RES

Does your company provide its technician staff with sales training that encourages residential customers to purchase maintenance services?

- Yes (1)
- No (2)
- Don't know (3)

SHOW IF Maint19.RES =1 AND Maint21.RES =1

Maint22.RES

If your company's training covers any of the following selling points, please check the corresponding boxes.

(Check all that apply).

- The impact of maintenance on indoor air quality (1)
- The impact of maintenance on energy savings and electric bills (2)
- The impact of maintenance on customer comfort (3)
- The impact of maintenance on system longevity (4)
- The impact of maintenance on system reliability (5)
- Other (Specify) _____ (6)
- Don't know (7)

SHOW ONLY IF Maint12.RES = 1

Maint23.RES

Do the maintenance services your company sells to residential customers stipulate a certain number of maintenance visits at regularly scheduled intervals (i.e. a contract), or are they single maintenance visits?

- Contracts (1)
- Single visits (2)
- Don't know (3)

SHOW ONLY IF Maint12.RES=1

Maint24.RES

What percentage of your existing maintenance contracts with residential customers fail to renew each year (for any reason)?

- Less than 5 percent (1)
- 5 to 9 percent (2)
- 10 to 19 percent (3)
- 20 to 29 percent (4)
- 30 to 39 percent (5)

- 40 to 49 percent (6)
- 50 percent or more (7)
- Prefer not to answer (8)
- Don't know (9)

SHOW ONLY IF Maint12.RES=1

Maint25.RES

What is the structure of your company's residential maintenance contracts in terms of:

	Enter response (1)
The number of maintenance visits per year (1)	_____
Length of contract (in months) (2)	_____

SHOW ONLY IF Maint12.RES=1

Maint26.RES

How does your company price a maintenance contract with residential customers?

(Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site during each visit (1)
- The customer pays based on a rate specific to customer type (e.g., residential, small commercial, large commercial) (2)
- The customer pays based on a rate specific to system type (cooling capacity, design of HVAC unit, etc.) (3)
- The customer pays based on a rate specific to size of the unit (4)
- The customer pays based on the square footage of his home or facility (5)
- Other (Specify) _____ (6)

ASK INST.RES Module IF SECTOR = 1 AND IS10c > or = 1%.

INSTALLATION – RESIDENTIAL (INST.RES MODULE)

Next is a set of installation-focused questions specific to your residential customers. By installation jobs, we mean projects where the primary purpose is to install new equipment or replace existing equipment.

Inst0.RES

For jobs with residential customers, how does your company define “quality installation”?

OPEN-ENDED RESPONSE _____

Inst1.Res

Please indicate your level of agreement or disagreement with the following statements.

Proper installation of a residential customer's HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don't know (5)
Improve indoor air quality (1)	<input type="radio"/>					

Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a system's operational lifespan (4)	<input type="radio"/>					
Prevent expensive repairs (5)	<input type="radio"/>					
Improve a system's reliability (6)	<input type="radio"/>					

RESPONSE OPTIONS 1-6 RANDOMIZED

Inst2.RES

Does your company have a formal policy or set of guidelines that technicians are required to follow for residential installation procedures?

- Yes (1)
- No (2)
- Don't know (3)

Inst5.RES

Which of the following tasks do your company's technicians perform during a typical residential installation?

Please indicate each task that your technicians perform by checking the corresponding box.

(Check all that apply).

EQUIPMENT

- Calculate correct sizing for equipment using Manual J (1)
- Install a properly matched indoor coil and outdoor unit (AC & heat pump only) (2)
- Test ductwork to determine maximum system size (3)
- Install new refrigerant lines (not reuse existing lines) (4)
- Install programmable thermostat (if not already in use) (5)
- Setup programmable thermostat with customer (if not already in use) (6)
- Consider zoning, with separate temperature controls for different areas (7)

DUCT WORK

- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (8)
- Inspect integrity of all accessible ductwork insulation (9)
- Make repairs to existing ductwork if necessary (10)
- If insulating ducts, seal all duct seams before insulating (11)
- Test to confirm that duct leakage does not exceed recommended levels (12)
- Inspect air filter housing integrity and air seal (13)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (14)

VERIFICATION & MAINTENANCE

- Show customer how to replace air filter(s) in new system (15)
- Leave all manuals with customer (16)
- Provide customer with documentation of installation procedures, including Manual J calculations, AHRI certificate, and records of any measurements or testing (17)
- Confirm proper levels of refrigerant and airflow across the coil (18)
- Inspect cabinet, cabinet fasteners, and cabinet panels (19)
- Inspect condensate drains (and traps) for proper operation (20)
- Test system controls' modes of operation and control sequences (21)
- Measure airflow across heat exchanger/coil (22)
- Measure refrigerant charge (23)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (24)
- Inspect all electrical components for proper operation (25)
- Inspect blower motors for proper operation (26)
- Inspect cabinet, cabinet fasteners, and cabinet panels (27)
- Inspect condensate drains (and traps) for proper operation (28)

OTHER

- Other 1 (Specify) _____ (29)
- Other 2 (Specify) _____ (30)
- Other 3 (Specify) _____ (31)
- Other 4 (Specify) _____ (32)
- Other 5 (Specify) _____ (33)
- Other 6 (Specify) _____ (34)
- Our company's technicians do not perform any of the tasks above (35)

RESPONSE OPTIONS RANDOMIZED IN EACH SECTION**SHOW ONLY IF Inst5.RES = 23****Inst6.RES**

You indicated that your company's technicians check an HVAC unit's refrigerant charge during a typical residential installation. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer's recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer's recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)

- Check temperature split across coil before using gauges (6)
- Other (Specify)
- Don't know

RESPONSE OPTIONS 1-6 RANDOMIZED

Inst3.Res

Are you aware of “ACCA Standard 5: HVAC Quality Installation Specification”, developed by Air Conditioning Contractors of America (ACCA)?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Inst3.RES = 1

Inst4.RES

How would you characterize your company's use or implementation of the specifications or guidelines of ACCA Standard 5 for residential installations?

- We are aware of the standard but do not adhere to it on a job (1)
- We adhere to some of the standard's specifications on a job, but not all of the specifications (2)
- We adhere to the majority of the standard's specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard's specifications on a job (4)

Inst7.RES

How effective do you think the following training methods are at teaching someone the technical skills needed to perform quality installation of residential HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I'm not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Community college (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Union apprenticeship (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Private training institute (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Online HVAC course (5)	<input type="radio"/>					
Training offered by an electric utility (6)	<input type="radio"/>					
Distributor training (7)	<input type="radio"/>					
Manufacturer training (8)	<input type="radio"/>					
Certification training (9)	<input type="radio"/>					
On-the-job training (10)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (11)	<input type="radio"/>					

RESPONSE OPTIONS 1-10 RANDOMIZED

Inst8.RES

Does your company have a formal policy or process for following up with residential customers after an installation?

- Yes (1)
- No (2)
- Don't know (3)

INST8.RES=1

Inst9.RES

After an installation, what kind of follow up procedures with residential customers does your company perform?

OPEN-ENDED RESPONSE _____

Inst10.RES

What are the primary barriers to contractors *implementing* high quality installation services for residential customers?

(Check all that apply).

- There are no barriers (1)
- Contractor/owner's knowledge of what is necessary (2)
- Technicians' knowledge of what is necessary (3)
- Available technical training in the market (4)

- Access to the right diagnostic tools (5)
- Access to quality maintenance checklists (6)
- Customers don't want to pay for it (7)
- Other (Specify) _____(8)
- [RANDOMIZE 2 THROUGH 7]

ASK SERV.SC Module IF SECTOR = 2 AND IS10a > or = 1%.

SERVICE CALLS – SMALL COMMERCIAL (SERV.SC MODULE)

Next is a set of service-focused questions specific to your small commercial customers.

Serv5.SC

In your opinion, what factors influence small commercial customers' decision-making of whether to replace or repair an HVAC unit?

Please rank the following factors from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Financial cost (1)
- Our company's recommendation of whether to replace or repair (2)
- Speed with which unit can be made operational (3)
- Age of unit (4)
- SEER rating of unit (5)
- Other (Specify) _____ (6)

RESPONSE OPTIONS 1-5 RANDOMIZED

Serv7.SC

What would trigger your company to recommend replacement rather than repair for small commercial customers?

(Check all that apply).

- Repair cost is high relative to replacement cost (1)
- System is old (2)
- System is inefficient (3)
- System is under capacity (4)
- System is over capacity (5)
- Other (Specify) _____ (6)
- Don't know (7)

RESPONSE OPTIONS 1-5 RANDOMIZED

Serv6.SC

At what percentage of replacement cost does your company recommend replacement instead of repair for small commercial customers?

- When repair costs are equal to the cost of replacement (100%) (1)
- When repair costs are about 90% of the cost of replacement (2)
- When repair costs are about 80% of the cost of replacement (3)
- When repair costs are about 70% of the cost of replacement (4)
- When repair costs are about 60% of the cost of replacement (5)
- When repair costs are about 50% of the cost of replacement (6)

- When repair costs are about 40% of the cost of replacement (7)
- When repair costs are about 30% of the cost of replacement (8)
- When repair costs are about 20% of the cost of replacement (9)
- When repair costs are about 10% of the cost of replacement (10)
- Don't know (11)

Serv8.SC

How does your company price a service call for small commercial customers? By **service calls**, we mean appointments that are made to fix a fault in HVAC systems that either shut the system down or inhibit the system's operation to the point that the customer detects a problem.

(Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site (1)
- The customer pays based on the number and type of repairs performed (2)
- The customer pays based on the type of the HVAC equipment in his/her facility (3)
- The customer pays based on the square footage of his facility (4)
- Other (Specify) _____ (5)
- Don't know (6)

RESPONSE OPTIONS 1-4 RANDOMIZED

ASK MAINT.SC Module IF SECTOR = 2 AND IS10b > or = 1%.

MAINTENANCE - SMALL COMMERCIAL (MAINT.SC MODULE)

Next is a set of **maintenance-focused** questions specific to your **small commercial customers**. By **maintenance**, we mean checkups to inspect, test, measure, and preserve an HVAC system.

Maint1.SC

Approximately what percentage of your **small commercial customers** have at least one maintenance check-up per year for their HVAC systems?

- Less than 10 percent (1)
- 10 to 24 percent (2)
- 25 to 49 percent (3)
- 50 to 74 percent (4)
- 75 to 100 percent (5)
- Don't know (6)

Maint2.SC

How often does your company recommend that **small commercial customers** have maintenance check-ups for their facility HVAC systems?

- We do not recommend that our customers schedule maintenance appointments (1)
- Every other year (2)
- Once a year (3)
- Twice a year (4)
- Three times a year (5)
- Four times a year (6)
- Other (Specify) _____ (7)

Maint3.SC

Please indicate your level of agreement or disagreement with the following statements.
 Regular, proper maintenance of a small commercial customer’s HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don't know (5)
Improve indoor air quality (1)	<input type="radio"/>					
Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a system’s operational lifespan (4)	<input type="radio"/>					
Prevent expensive repairs (5)	<input type="radio"/>					
Improve a system’s reliability (6)	<input type="radio"/>					

RESPONSE OPTIONS 1-6 RANDOMIZED

Maint4.SC

Does your company have a formal policy or set of guidelines that technicians are required to follow for small commercial maintenance procedures?

- Yes (1) – Please explain or describe: _____
- No (2)
- Don't know

Maint6.SC

Which of the following tasks do your company's technicians perform during a typical small commercial maintenance visit?

Please indicate each task that your technicians perform by checking the corresponding box.
 (Check all that apply).

- Inspect filters for particulate accumulation and clean/replace as needed (1)
- Inspect air filter housing integrity and air seal (2)
- Inspect grilles, registers and diffusers for dirt accumulation (3)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (4)
- Inspect integrity of all accessible ductwork insulation (5)
- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (6)
- Test system controls' modes of operation and control sequences (7)
- Visually inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g. cracks, perforations, bulges) (8)
- Measure airflow across heat exchanger/coil (9)
- Inspect condensing coil and clean/adjust as needed (10)
- Inspect evaporator coil and clean/adjust as needed (11)
- Measure refrigerant charge (13)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (14)
- Inspect all electrical components for proper operation (15)
- Inspect blower motors for proper operation (16)
- Inspect cabinet, cabinet fasteners, and cabinet panels (17)
- Inspect condensate drains (and traps) for proper operation (18)
- Inspect economizers (19) Other 1 (Specify) _____ (20)
- Other 2 (Specify) _____ (21)
- Other 3 (Specify) _____ (22)
- Other 4 (Specify) _____ (23)
- Other 5 (Specify) _____ (24)
- Other 6 (Specify) _____ (25)
- Our company's technicians do not perform any of these tasks (20)

RESPONSE OPTIONS 1-19 RANDOMIZED

SHOW ONLY IF Maint6.SC = 13

Maint6b.SC

You indicated that your company's technicians check an HVAC unit's refrigerant charge during a typical small commercial maintenance visit. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer's recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer's recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)
- Check temperature split across coil before using gauges (6)
- Other (Specify) (7)
- Don't know (8)

RESPONSE OPTIONS 1-6 RANDOMIZED

Maint5.SC

Are you aware of "ACCA/ASHRAE Standard 180: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems", developed by Air Conditioning

Contractors of America (ACCA) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)?

- Yes (1)
- No (2)
- Don't know

[Ask if Maint5.SC = 1.]

Maint5b.SC

How would you characterize your company's use or implementation of the specifications or guidelines of ACCA/ASHRAE Standard 180?

- We are aware of the standard, but do not know adhere to it on a job (1)
- We adhere to some of the standard's specifications on a job, but not all of the specifications (2)
- We adhere to the majority of the standard's specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard's specifications on a job (4)

Maint7.SC

During a typical small commercial maintenance visit, how long does a technician from your company spend working on each unit?

- Less than 15 minutes (1)
- Between 15 and 29 minutes (2)
- Between 30 and 44 minutes (3)
- Between 45 minutes and 59 minutes (4)
- Between 1 hour and 1 hour and 59 minutes (5)
- Between 2 hours and 2 hours and 59 minutes (6)
- Between 3 hours and 3 hours and 59 minutes (7)
- 4 hours or more (8)
- Don't know

Maint8.SC

For jobs with small commercial customers, how does your company define "quality maintenance"?

OPEN-ENDED RESPONSE _____

Maint9.SC

How effective do you think the following training methods are at teaching someone the technical skills needed to perform quality maintenance on small commercial HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I'm not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Community college (2)	<input type="radio"/>					
Union apprenticeship (3)	<input type="radio"/>					
Private training institute (4)	<input type="radio"/>					
Online HVAC course (5)	<input type="radio"/>					
Training offered by an electric utility (6)	<input type="radio"/>					
Distributor training (7)	<input type="radio"/>					
Manufacturer training (8)	<input type="radio"/>					
Certification training (9)	<input type="radio"/>					
On-the-job training (10)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (11)	<input type="radio"/>					

RESPONSE OPTIONS 1-10 RANDOMIZED

Maint12.SC

Does your company actively try selling or marketing HVAC maintenance services to your small commercial customers?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.SC = 2

Maint13.SC

For what reasons does your company not actively try and sell maintenance services to your small commercial customers?

(Check all that apply).

- There is no value in doing maintenance (1)
- Customers do not understand the value of maintenance (2)
- Customers understand the value of maintenance, but are not interested in having maintenance performed on a regular basis (3)
- Customers are not willing to make long-term commitments (4)
- Customers do not want to pay extra money for regular maintenance (5)
- We don't make enough money on maintenance contracts (6)
- Our technicians need more technical training to be able to perform regular maintenance (7)
- Our technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance contracts to customers (8)
- Other (Specify) _____ (9)
- [RANDOMIZE 1 THROUGH 8]

Maint14.SC

In your opinion, what are your small commercial customers' priorities when it comes to their HVAC systems?

Please rank the following benefits from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Reliability (1)
- Cost efficiency (2)
- Longevity of unit (3)
- Occupant comfort (4)
- Minimizing repair costs (5)
- Peace of mind (6)
- Energy efficiency (7)
- Other (Specify)

RESPONSE OPTIONS 1-7 RANDOMIZED**Maint15.SC**

What do you see as the primary barriers to your company *selling* HVAC maintenance services to your small commercial customers?

(Check all that apply).

- There are no barriers, all our customers have maintenance performed on their HVAC systems regularly (1)
- Customers do not know that maintenance can reduce their electric bills (2)
- Customers do not know that maintenance can improve the performance and longevity of their cooling system (3)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it (4)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it unless someone can show them evidence of how much money they can save (5)

- Technicians need more technical training to be able to perform maintenance (6)
- Technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance to customers (7)
- Equipment warranties make certain customers less willing to have maintenance performed on their HVAC units (8)
- Other barrier 1 (Specify) _____ (9)
- Other barrier 2 (Specify) _____ (10)
- Other barrier 3 (Specify) _____ (11)

RESPONSE OPTIONS 2-8 RANDOMIZED

→ If Maint12.SC = 2 Or Maint12.SC = 3, SKIP TO Inst1.SC

SHOW ONLY IF Maint12.SC = 1

Maint16 .SC

What are your company’s sales and marketing strategies for finding new small commercial customers to purchase maintenance services?

(Check all that apply).

- Our company does not have a marketing strategy for finding new customers to purchase maintenance services (1)
- Our main strategy is to transition existing/former customers that have received other services into purchasing maintenance work (2)
- Recommendations from current customers (3)
- Recommendations from other contractor firms (4)
- The phone book (5)
- Online postings including social media (6)
- Online advertising (7)
- Direct mailing (8)
- Advertising in newspapers (9)
- Advertising in magazines (10)
- Advertising on the radio (11)
- Advertising on television (12)
- Visibility through utility HVAC installation and maintenance programs (13)
- Other (Specify) _____ (14)

RESPONSE OPTIONS 2-13 RANDOMIZED

SHOW ONLY IF Maint12.SC = 1

Maint17.SC

What is your company’s practice for bidding various maintenance approaches to small commercial customers?

(Check all that apply)

- We only have one level of maintenance (1)
- We have multiple tiers of maintenance (e.g. basic and premium) and each has a different price point (3)
- We bid different prices for different market segments (4)
- We guarantee the lowest cost maintenance contracts (5)
- We offer performance contracts (6)
- Other (Specify) _____ (7)

SHOW ONLY IF Maint12.SC = 1

Maint18.SC

Do the individuals in your company that sell maintenance agreements to small commercial customers have a formal set of questions that they ask customers to determine how to bid a maintenance agreement?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.SC = 1

Maint19.SC

Do the technicians at your company sell HVAC maintenance services to your small commercial customers?

- Yes, our technicians sell maintenance services directly to customers (1)
- Our technicians recommend that customers purchase maintenance services, but then refer the customer to a sales person who completes the sale (2)
- No, our technicians play no role in the maintenance service sales process (3)
- Other (Specify) _____ (4)
- Don't know (5)

SHOW ONLY IF Maint19.SC = 1

Maint20.SC

When selling maintenance services, how does your company communicate to small commercial customers the benefits of proper air conditioner maintenance versus the cost?

(Check all that apply).

- Our technicians provide a basic explanation of benefits a customers can get from proper maintenance (1)
- Our technicians are explicit with how maintenance addresses each benefit such as how maintenance impacts energy savings and electric bills and how maintenance impacts indoor air quality (2)
- Our technicians show the customer data gathered with diagnostic tools to demonstrate how much money they can save through maintenance (3)
- Our technicians write up a service report that addresses benefits and costs (4)
- Other (Specify) _____ (5)

SHOW IF Maint19.SC =1

Maint21.SC

Does your company provide its technician staff with sales training that encourages small commercial customers to purchase maintenance services?

- Yes (1)
- No (2)
- Don't know (3)

SHOW IF Maint19.SC =1 AND Maint21.SC =1

Maint22.SC

If your company's training covers any of the following selling points, please check the corresponding boxes.

(Check all that apply).

- The impact of maintenance on indoor air quality (1)
- The impact of maintenance on energy savings and electric bills (2)
- The impact of maintenance on customer comfort (3)
- The impact of maintenance on system longevity (4)
- The impact of maintenance on system reliability (5)
- Other (Specify) _____ (6)
- Don't know (7)

SHOW ONLY IF Maint12.SC = 1

Maint23.SC

Do the maintenance services your company sells to small commercial customers stipulate a certain number of maintenance visits at regularly scheduled intervals (i.e. a contract), or are they single maintenance visits?

- Contracts (1)
- Single visits (2)
- Don't know (3)

SHOW ONLY IF Maint12.SC=1

Maint24.SC

What percentage of your existing maintenance contracts with small commercial customers fail to renew each year (for any reason)?

- Less than 5 percent (1)
- 5 to 9 percent (2)
- 10 to 19 percent (3)
- 20 to 29 percent (4)
- 30 to 39 percent (5)
- 40 to 49 percent (6)
- 50 percent or more (7)
- Prefer not to answer (8)
- Don't know (9)

SHOW ONLY IF Maint12.SC=1

Maint25.SC

What is the structure of your company's small commercial maintenance contracts in terms of:

	Enter response
The number of maintenance visits per year (1)	_____
Length of contract (in months) (2)	_____

SHOW ONLY IF Maint12.SC=1

Maint26.SC

How does your company price a maintenance contract with small commercial customers? (Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site during each visit (1)
- The customer pays based on a rate specific to customer type (e.g., residential, small commercial, large commercial) (2)

- The customer pays based on a rate specific to system type (cooling capacity, design of HVAC unit, etc.) (3)
- The customer pays based on a rate specific to size of the unit (4)
- The customer pays based on the square footage of his home or facility (5)
- Other (Specify) _____ (6)

ASK INST.SC Module IF SECTOR = 2 AND IS10c > or = 1%.

INSTALLATION – SMALL COMMERCIAL (INST.SC MODULE)

Next is a set of installation-focused questions specific to your small commercial customers. By installation jobs, we mean projects where the primary purpose is to install new equipment or replace existing equipment.

Inst0.SC

For jobs with small commercial customers, how does your company define “quality installation”?

OPEN-ENDED RESPONSE _____

Inst1.SC

Please indicate your level of agreement or disagreement with the following statements.

Proper installation of a small commercial customer’s HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don’t know (5)
Improve indoor air quality (1)	<input type="radio"/>					
Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a system’s operational lifespan (4)	<input type="radio"/>					
Prevent expensive repairs (5)	<input type="radio"/>					

Improve a system's reliability (6)	<input type="radio"/>					
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RESPONSE OPTIONS 1-6 RANDOMIZED

Inst2.SC

Does your company have a formal policy or set of guidelines that technicians are required to follow for small commercial installation procedures?

- Yes (1)
- No (2)
- Don't know (3)

Inst5.SC

Which of the following tasks do your company's technicians perform during a typical small commercial installation?

Please indicate each task that your technicians perform by checking the corresponding box. (Check all that apply).

EQUIPMENT

- Calculate correct sizing for equipment using Manual J (1)
- Install a properly matched indoor coil and outdoor unit (AC & heat pump only) (2)
- Test ductwork to determine maximum system size (3)
- Install new refrigerant lines (not reuse existing lines) (4)
- Install programmable thermostat (if not already in use) (5)
- Setup programmable thermostat with customer (if not already in use) (6)
- Consider zoning, with separate temperature controls for different areas (7)

DUCT WORK

- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (8)
- Inspect integrity of all accessible ductwork insulation (9)
- Make repairs to existing ductwork if necessary (10)
- If insulating ducts, seal all duct seams before insulating (11)
- Test to confirm that duct leakage does not exceed recommended levels (12)
- Inspect air filter housing integrity and air seal (13)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (14)

VERIFICATION & MAINTENANCE

- Show customer how to replace air filter(s) in new system (15)
- Leave all manuals with customer (16)
- Provide customer with documentation of installation procedures, including Manual J calculations, AHRI certificate, and records of any measurements or testing (17)
- Confirm proper levels of refrigerant and airflow across the coil (18)
- Inspect cabinet, cabinet fasteners, and cabinet panels (19)
- Inspect condensate drains (and traps) for proper operation (20)
- Test system controls' modes of operation and control sequences (21)
- Measure airflow across heat exchanger/coil (22)

- Measure refrigerant charge (23)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (24)
- Inspect all electrical components for proper operation (25)
- Inspect blower motors for proper operation (26)
- Inspect cabinet, cabinet fasteners, and cabinet panels (27)
- Inspect condensate drains (and traps) for proper operation (28)
- Inspect Economizers (29)

OTHER

- Other 1 (Specify) _____ (30)
- Other 2 (Specify) _____ (31)
- Other 3 (Specify) _____ (32)
- Other 4 (Specify) _____ (33)
- Other 5 (Specify) _____ (34)
- Other 6 (Specify) _____ (35)
- Our company's technicians do not perform any of the tasks above(36)

RESPONSE OPTIONS RANDOMIZED IN EACH SECTION**SHOW ONLY IF Inst5.SC = 23****Inst6.SC**

You indicated that your company's technicians check an HVAC unit's refrigerant charge during a typical small commercial installation. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer's recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer's recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)
- Check temperature split across coil before using gauges (6)
- Other (Specify)
- Don't know

RESPONSE OPTIONS 1-6 RANDOMIZED**Inst3.SC**

Are you aware of "ACCA Standard 5: HVAC Quality Installation Specification", developed by Air Conditioning Contractors of America (ACCA)?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Inst3.SC = 1**Inst4.SC**

How would you characterize your company's use or implementation of the specifications or guidelines of ACCA Standard 5 for small commercial installations?

- We are aware of the standard but do not adhere to it on a job (1)
- We adhere to some of the standard's specifications on a job, but not all of the specifications (2)

- We adhere to the majority of the standard’s specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard’s specifications on a job (4)

Inst7.SC

How effective do you think the following training methods are at teaching someone the technical skills needed to perform quality installation of small commercial HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I’m not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Community college (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Union apprenticeship (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Private training institute (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Online HVAC course (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training offered by an electric utility (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Distributor training (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Manufacturer training (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Certification training (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
On-the-job training (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (Specify) <hr/>	<input type="radio"/>					
(11)						

RESPONSE OPTIONS 1-10 RANDOMIZED

Inst8.SC

Does your company have a formal policy or process for following up with small commercial customers after an installation?

- Yes (1)
- No (2)
- Don't know (3)

ASK IF INST8.SC=1

Inst9.SC

After an installation, what kind of follow up procedures with small commercial customers does your company perform?

OPEN-ENDED RESPONSE _____

Inst10.SC

What are the primary barriers to contractors *implementing* high quality installation services for small commercial customers?

(Check all that apply).

- There are no barriers (1)
- Contractor/owner’s knowledge of what is necessary (2)
- Technicians' knowledge of what is necessary (3)
- Available technical training in the market (4)
- Access to the right diagnostic tools (5)
- Access to quality maintenance checklists (6)
- Customers don’t want to pay for it (7)
- Other (Specify) _____(8)

[RANDOMIZE 2 THROUGH 7]

ASK SERV.LC Module IF SECTOR = 3 AND IS10a > or = 1%.

SERVICE CALLS – LARGE COMMERCIAL (SERV.LC MODULE)

Next is a set of service-focused questions specific to your large commercial customers.

Serv5.LC

In your opinion, what factors influence large commercial customers’ decision-making of whether to replace or repair an HVAC unit?

Please rank the following factors from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Financial cost (1)
- Our company’s recommendation of whether to replace or repair (2)
- Speed with which unit can be made operational (3)

- Age of unit (4)
- SEER rating of unit (5)
- Other (Specify) _____ (6)

RESPONSE OPTIONS 1-5 RANDOMIZED**Serv7.LC**

What would trigger your company to recommend replacement rather than repair for large commercial customers?

(Check all that apply).

- Repair cost is high relative to replacement cost (1)
- System is old (2)
- System is inefficient (3)
- System is under capacity (4)
- System is over capacity (5)
- Other (Specify) _____ (6)
- Don't know (7)

RESPONSE OPTIONS 1-5 RANDOMIZED**Serv6.LC**

At what percentage of replacement cost does your company recommend replacement instead of repair for large commercial customers?

- When repair costs are equal to the cost of replacement (100%) (1)
- When repair costs are about 90% of the cost of replacement (2)
- When repair costs are about 80% of the cost of replacement (3)
- When repair costs are about 70% of the cost of replacement (4)
- When repair costs are about 60% of the cost of replacement (5)
- When repair costs are about 50% of the cost of replacement (6)
- When repair costs are about 40% of the cost of replacement (7)
- When repair costs are about 30% of the cost of replacement (8)
- When repair costs are about 20% of the cost of replacement (9)
- When repair costs are about 10% of the cost of replacement (10)
- Don't know (11)

Serv8.LC

How does your company price a service call for large commercial customers? By service calls, we mean appointments that are made to fix a fault in HVAC systems that either shut the system down or inhibit the system's operation to the point that the customer detects a problem.

(Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site (1)
- The customer pays based on the number and type of repairs performed (2)
- The customer pays based on the type of the HVAC equipment in his/her facility (3)
- The customer pays based on the square footage of his/her facility (4)
- Other (Specify) _____ (5)
- Don't know (6)

RESPONSE OPTIONS 1-4 RANDOMIZED

ASK MAINT.LC Module IF SECTOR = 3 AND IS10b > or = 1%.

MAINTENANCE –LARGE COMMERICAL (MAINT.LC MODULE)

Next is a set of **maintenance**-focused questions specific to your **large commercial** customers. By **maintenance**, we mean checkups to inspect, test, measure, and preserve an HVAC system.

Maint1.LC

Approximately what percentage of your **large commercial customers** have at least one maintenance check-up per year for their HVAC systems?

- Less than 10 percent (1)
- 10 to 24 percent (2)
- 25 to 49 percent (3)
- 50 to 74 percent (4)
- 75 to 100 percent (5)
- Don't know (6)

Maint2.LC

How often does your company recommend that **large commercial customers** have maintenance check-ups for their facility HVAC systems?

- We do not recommend that our customers schedule maintenance appointments (1)
- Every other year (2)
- Once a year (3)
- Twice a year (4)
- Three times a year (5)
- Four times a year (6)
- Other (Specify) _____ (7)

Maint3.LC

Please indicate your level of agreement or disagreement with the following statements.

Regular, proper maintenance of a large commercial customer’s HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don't know (5)
Improve indoor air quality (1)	<input type="radio"/>					
Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a	<input type="radio"/>					

system's operational lifespan (4)						
Prevent expensive repairs (5)	<input type="radio"/>					
Improve a system's reliability (6)	<input type="radio"/>					

RESPONSE OPTIONS 1-6 RANDOMIZED

Maint4.LC

Does your company have a formal policy or set of guidelines that technicians are required to follow for large commercial maintenance procedures?

- Yes – Please explain or describe: _____ (1)
- No (2)
- Don't know (3)

Maint6.LC

Which of the following tasks do your company's technicians perform during a typical large commercial maintenance visit?

Please indicate each task that your technicians perform by checking the corresponding box.

(Check all that apply).

- Inspect filters for particulate accumulation and clean/replace as needed (1)
- Inspect air filter housing integrity and air seal (2)
- Inspect grilles, registers and diffusers for dirt accumulation (3)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (4)
- Inspect integrity of all accessible ductwork insulation (5)
- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (6)
- Test system controls' modes of operation and control sequences (7)
- Visually inspect heat exchanger for signs of corrosion, fouling, structural problems (e.g. cracks, perforations, bulges) (8)
- Measure airflow across heat exchanger/coil (9)
- Inspect condensing coil and clean/adjust as needed (10)
- Inspect evaporator coil and clean/adjust as needed (11)
- Measure refrigerant charge (13)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (14)
- Inspect all electrical components for proper operation (15)
- Inspect blower motors for proper operation (16)
- Inspect cabinet, cabinet fasteners, and cabinet panels (17)
- Inspect condensate drains (and traps) for proper operation (18)
- Inspect economizers (19)

- Other 1 (Specify) _____ (20)
- Other 2 (Specify) _____ (21)
- Other 3 (Specify) _____ (22)
- Other 4 (Specify) _____ (23)
- Other 5 (Specify) _____ (24)
- Other 6 (Specify) _____ (25)
- Our company's technicians do not perform any of these tasks (26)

RESPONSE OPTIONS 1-19 RANDOMIZED

SHOW ONLY IF Maint6.LC = 13

Maint6b.LC

You indicated that your company's technicians check an HVAC unit's refrigerant charge during a typical large commercial maintenance visit. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer's recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer's recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)
- Check temperature split across coil before using gauges (6)
- Other (Specify) (7)
- Don't know (8)

RESPONSE OPTIONS 1-6 RANDOMIZED

Maint5.LC

Are you aware of "ACCA/ASHRAE Standard 180: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems", developed by Air Conditioning Contractors of America (ACCA) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)?

- Yes (1)
- No (2)
- Don't know (3)

Maint5b.LC

How would you characterize your company's use or implementation of the specifications or guidelines of ACCA/ASHRAE Standard 180?

- We are aware of the standard, but do not know adhere to it on a job (1)
- We adhere to some of the standard's specifications on a job, but not all of the specifications (2)
- We adhere to the majority of the standard's specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard's specifications on a job (4)

Maint7.LC

During a typical large commercial maintenance visit, how long does a technician from your company spend working on each unit?

- Less than 15 minutes (1)

- Between 15 and 29 minutes (2)
- Between 30 and 44 minutes (3)
- Between 45 minutes and 59 minutes (4)
- Between 1 hour and 1 hour and 59 minutes (5)
- Between 2 hours and 2 hours and 59 minutes (6)
- Between 3 hours and 3 hours and 59 minutes (7)
- 4 hours or more (8)

Maint8.LC

For jobs with large commercial customers, how does your company define “quality maintenance”?

OPEN-ENDED RESPONSE _____

Maint9.LC

How effective do you think the following training methods are at teaching someone the technical skills needed to perform quality maintenance on large commercial HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I’m not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Community college (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Union apprenticeship (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Private training institute (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Online HVAC course (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training offered by an electric utility (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Distributor training (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Manufacturer training (8)	<input type="radio"/>					
Certification training (9)	<input type="radio"/>					
On-the-job training (10)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (11)	<input type="radio"/>					

RESPONSE OPTIONS 1-10 RANDOMIZED

Maint12.LC

Does your company actively try selling or marketing HVAC maintenance services to your large commercial customers?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.LC = 2

Maint13.LC

For what reasons does your company not actively try and sell maintenance services to your large commercial customers?

(Check all that apply).

- There is no value to maintenance (1)
- Customers do not understand the value of maintenance (2)
- Customers understand the value of maintenance, but are not interested in having maintenance performed on a regular basis (3)
- Customers are not willing to make long-term commitments (4)
- Customers do not want to pay extra money for regular maintenance and we will not compromise our standards (5)
- We don't make enough money on maintenance contracts (6)
- Our technicians need more technical training to be able to perform regular maintenance (7)
- Our technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance contracts to customers (8)
- Other (Specify) _____ (9)

[RANDOMIZE 1 THROUGH 8]

Maint14.LC

In your opinion, what are your large commercial customers’ priorities when it comes to their HVAC systems?

Please rank the following benefits from most important (on top) to least important (on the bottom) by clicking-and-dragging them into the appropriate order.

- Reliability (1)
- Cost efficiency (2)
- Longevity of unit (3)
- Occupant comfort (4)
- Minimizing repair costs (5)
- Peace of mind (6)
- Energy efficiency (7)
- Other (Specify)

RESPONSE OPTIONS 1-7 RANDOMIZED

Maint15.LC

What do you see as the primary barriers to your company *selling* HVAC maintenance services to your large commercial customers?

(Check all that apply).

- There are no barriers, all our customers have maintenance performed on their HVAC systems regularly (1)
- Customers do not know that maintenance can reduce their electric bills (2)
- Customers do not know that maintenance can improve the performance and longevity of their cooling system (3)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it (4)
- Customers know about the benefits of maintenance, but do not want to pay extra money for it unless someone can show them evidence of how much money they can save (5)
- Technicians need more technical training to be able to perform maintenance (6)
- Technicians need more “soft skills” training, such as communication skills, to be able to sell maintenance to customers (7)
- Equipment warranties make certain customers less willing to have maintenance performed on their HVAC units. (8)
- Other barrier 1 (Specify) _____ (9)
- Other barrier 2 (Specify) _____ (10)
- Other barrier 3 (Specify) _____ (11)

[RANDOMIZE 2 THROUGH 8]

→ If Maint12.LC = 2 Or Maint12.LC = 3, SKIP TO Inst1.LC

SHOW ONLY IF Maint12.LC = 1

Maint16.LC

What are your company’s sales and marketing strategies for finding new large commercial customers to purchase maintenance services?

(Check all that apply).

- Our company does not have a marketing strategy for finding new customers to purchase maintenance services (1)
- Our main strategy is to transition existing/former customers that have received other services into purchasing maintenance work (2)

- Recommendations from current customers (3)
- Recommendations from other contractor firms (4)
- The phone book (5)
- Online postings including social media (6)
- Online advertising (7)
- Direct mailing (8)
- Advertising in newspapers (9)
- Advertising in magazines (10)
- Advertising on the radio (11)
- Advertising on television (12)
- Visibility through utility HVAC installation and maintenance programs (13)
- Other (Specify) _____ (14)

RESPONSE OPTIONS 2-13 RANDOMIZED**SHOW ONLY IF Maint12.LC = 1****Maint17.LC**

What is your company's practice for bidding various maintenance approaches to large commercial customers?

(Check all that apply)

- We only have one level of maintenance (1)
- We have multiple tiers of maintenance (e.g. basic and premium) and each has a different price point (3)
- We bid different prices for different market segments (4)
- We guarantee the lowest cost maintenance contracts (5)
- We offer performance contracts (6)
- Other (Specify) _____ (7)

SHOW ONLY IF Maint12.LC = 1**Maint18.LC**

Do the individuals in your company that sell maintenance agreements to large commercial customers have a formal set of questions that they ask customers to determine how to bid a maintenance agreement?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF Maint12.LC = 1**Maint19.LC**

Do the technicians at your company sell HVAC maintenance services to your large commercial customers?

- Yes, our technicians sell maintenance services directly to customers (1)
- Our technicians recommend that customers purchase maintenance services, but then refer the customer to a sales person who completes the sale (2)
- No, our technicians play no role in the maintenance service sales process (3)
- Other (Specify) _____ (4)
- Don't know (5)

SHOW ONLY IF Maint19.LC = 1

Maint20.LC

When selling maintenance services, how does your company communicate to large commercial customers the benefits of proper air conditioner maintenance versus the cost?

(Check all that apply).

- Our technicians provide a basic explanation of benefits a customers can get from proper maintenance (1)
- Our technicians are explicit with how maintenance addresses each benefit such as how maintenance impacts energy savings and electric bills and how maintenance impacts indoor air quality (2)
- Our technicians show the customer data gathered with diagnostic tools to demonstrate how much money they can save through maintenance (3)
- Our technicians write up a service report that addresses benefits and costs (4)
- Other (Specify) _____ (5)

SHOW IF Maint19.LC =1

Maint21.LC

Does your company provide its technician staff with sales training that encourages large commercial customers to purchase maintenance services?

- Yes (1)
- No (2)
- Don't know (3)

SHOW IF Maint19.LC =1 AND Maint21.LC =1

Maint22.LC

If your company's training covers any of the following selling points, please check the corresponding boxes.

(Check all that apply).

- The impact of maintenance on indoor air quality (1)
- The impact of maintenance on energy savings and electric bills (2)
- The impact of maintenance on customer comfort (3)
- The impact of maintenance on system longevity (4)
- The impact of maintenance on system reliability (5)
- Other (Specify) _____ (6)
- Don't know (7)

SHOW ONLY IF Maint12.LC = 1

Maint23.LC

Do the maintenance services your company sells to large commercial customers stipulate a certain number of maintenance visits at regularly scheduled intervals (i.e. a contract), or are they single maintenance visits?

- Contracts (1)
- Single visits (2)
- Don't know (3)

SHOW ONLY IF Maint12.LC=1

Maint24.LC

What percentage of your existing maintenance contracts with large commercial customers fail to

renew each year (for any reason)?

- Less than 5 percent (1)
- 5 to 9 percent (2)
- 10 to 19 percent (3)
- 20 to 29 percent (4)
- 30 to 39 percent (5)
- 40 to 49 percent (6)
- 50 percent or more (7)
- Prefer not to answer (8)
- Don't know (9)

SHOW ONLY IF Maint12.LC=1

Maint25.LC

What is the structure of your company's large commercial maintenance contracts in terms of:

	Enter response
The number of maintenance visits per year (1)	_____
Length of contract (in months) (2)	_____

SHOW ONLY IF Maint12.LC=1

Maint26.LC

How does your company price a maintenance contract with large commercial customers?
(Check all that apply).

- The customer pays an hourly rate based on the time a technician spends working on site during each visit (1)
- The customer pays based on a rate specific to customer type (e.g., residential, small commercial, large commercial) (2)
- The customer pays based on a rate specific to system type (cooling capacity, design of HVAC unit, etc.) (3)
- The customer pays based on a rate specific to size of the unit (4)
- The customer pays based on the square footage of his home or facility (5)
- Other (Specify) _____ (6)

ASK INST.LC Module IF SECTOR = 3 AND IS10c > or = 1%.

INSTALLATION –LARGE COMMERCIAL (INST.LC MODULE)

Next is a set of installation-focused questions specific to your large commercial customers. By installation jobs, we mean projects where the primary purpose is to install new equipment or replace existing equipment.

Inst0.LC

For jobs with large commercial customers, how does your company define “quality installation”?

OPEN-ENDED RESPONSE _____

Inst1.LC

Please indicate your level of agreement or disagreement with the following statements.
 Proper installation of a large commercial customer’s HVAC system can:

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (3)	Strongly Agree (4)	Don't know (5)
Improve indoor air quality (1)	<input type="radio"/>					
Increase customer comfort (2)	<input type="radio"/>					
Increase energy savings and reduce electric bills (3)	<input type="radio"/>					
Prolong a system’s operational lifespan (4)	<input type="radio"/>					
Prevent expensive repairs (5)	<input type="radio"/>					
Improve a system’s reliability (6)	<input type="radio"/>					

RESPONSE OPTIONS 1-6 RANDOMIZED

Inst2.LC

Does your company have a formal policy or set of guidelines that technicians are required to follow for large commercial installation procedures?

- Yes (1)
- No (2)
- Don't know (3)

Inst5.LC

Which of the following tasks do your company's technicians perform during a typical large commercial installation?

Please indicate each task that your technicians perform by checking the corresponding box.
 (Check all that apply).

EQUIPMENT

- Calculate correct sizing for equipment using Manual J (1)
- Install a properly matched indoor coil and outdoor unit (AC & heat pump only) (2)
- Test ductwork to determine maximum system size (3)
- Install new refrigerant lines (not reuse existing lines) (4)
- Install programmable thermostat (if not already in use) (5)
- Setup programmable thermostat with customer (if not already in use) (6)
- Consider zoning, with separate temperature controls for different areas (7)

DUCT WORK

- Inspect the integrity of all accessible ductwork including: duct strapping, hangers, sections, joints, and seams (8)
- Inspect integrity of all accessible ductwork insulation (9)
- Make repairs to existing ductwork if necessary (10)
- If insulating ducts, seal all duct seams before insulating (11)
- Test to confirm that duct leakage does not exceed recommended levels (12)
- Inspect air filter housing integrity and air seal (13)
- Inspect all accessible ductwork for areas of moisture accumulation or biological growth (14)

VERIFICATION & MAINTENANCE

- Show customer how to replace air filter(s) in new system (15)
- Leave all manuals with customer (16)
- Provide customer with documentation of installation procedures, including Manual J calculations, AHRI certificate, and records of any measurements or testing (17)
- Confirm proper levels of refrigerant and airflow across the coil (18)
- Inspect cabinet, cabinet fasteners, and cabinet panels (19)
- Inspect condensate drains (and traps) for proper operation (20)
- Test system controls' modes of operation and control sequences (21)
- Measure airflow across heat exchanger/coil (22)
- Measure refrigerant charge (23)
- Inspect accessible refrigerant lines, joints, and coils for oil leaks (24)
- Inspect all electrical components for proper operation (25)
- Inspect blower motors for proper operation (26)
- Inspect cabinet, cabinet fasteners, and cabinet panels (27)
- Inspect condensate drains (and traps) for proper operation (28)
- Inspect Economizers (29)

OTHER

- Other 1 (Specify) _____ (30)
- Other 2 (Specify) _____ (31)
- Other 3 (Specify) _____ (32)
- Other 4 (Specify) _____ (33)
- Other 5 (Specify) _____ (34)
- Other 6 (Specify) _____ (35)
- Our company's technicians do not perform any of the tasks above (36)

RESPONSE OPTIONS RANDOMIZED IN EACH SECTION**SHOW ONLY IF Inst5.LC = 23****Inst6.LC**

You indicated that your company’s technicians check an HVAC unit’s refrigerant charge during a typical large commercial installation. How do your technicians determine that you have the correct refrigerant charge in air conditioners? (Check all that apply)

- Check superheat for fixed orifice and compare with manufacturer’s recommended superheat (1)
- Check superheat for fixed orifice and compare with a generic table (e.g. T24) (2)
- Check sub cooling for TXV and compare with manufacturer’s recommended superheat (3)
- Check sub cooling for TXV and compare with a generic table (e.g. T24) (4)
- Check both superheat and sub cooling (regardless of metering device) (5)
- Check temperature split across coil before using gauges (6)
- Other (Specify)
- Don't know

RESPONSE OPTIONS 1-6 RANDOMIZED

Inst3.LC

Are you aware of “ACCA/ASHRAE Standard 180: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems”, developed by Air Conditioning Contractors of America (ACCA) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)?

- Yes (1)
- No (2)
- Don’t know (3)

SHOW ONLY IF Inst3.SC = 1

Inst4.LC

How would you characterize your company’s use or implementation of the specifications or guidelines of ACCA/ASHRAE Standard 180 for large commercial installations?

- We are aware of the standard but do not adhere to it on a job (1)
- We adhere to some of the standard’s specifications on a job, but not all of the specifications (2)
- We adhere to the majority of the standard’s specifications on a job, but not all of the specifications (3)
- We adhere to all of the standard’s specifications on a job (4)

Inst7.LC

How effective do you think the following training methods are at teaching someone the technical skills needed to perform quality installation of large commercial HVAC systems?

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I’m not familiar with the training method (6)
Technical or trade school (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Community college (2)	<input type="radio"/>					
Union apprenticeship (3)	<input type="radio"/>					
Private training institute (4)	<input type="radio"/>					
Online HVAC course (5)	<input type="radio"/>					
Utility training (6)	<input type="radio"/>					
Distributor training (7)	<input type="radio"/>					
Manufacturer training (8)	<input type="radio"/>					
Certification training (9)	<input type="radio"/>					
On-the-job training (10)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (11)	<input type="radio"/>					

RESPONSE OPTIONS 1-10 RANDOMIZED

Inst8.LC

Does your company have a formal policy or process for following up with large commercial customers after an installation?

- Yes (1)
- No (2)
- Don't know (3)

ASK IF INST8.LC=1

Inst9.LC

After an installation, what kind of follow up procedures with large commercial customers does your company perform?

OPEN-ENDED RESPONSE _____

Inst10.LC

What are the primary barriers to contractors *implementing* high quality installation services for large commercial customers?

(Check all that apply).

- There are no barriers (1)
- Contractor/owner's knowledge of what is necessary (2)
- Technicians' knowledge of what is necessary (3)
- Available technical training in the market (4)
- Access to the right diagnostic tools (5)
- Access to quality maintenance checklists (6)
- Customers don't want to pay for it (7)
- Other (Specify) _____(8)

[RANDOMIZE 2 THROUGH 7]

ASK Maint.PP Module IF IS10b > or = 1%.

PROGRAM PARTICIPATION – Maintenance (Maint.PP Module)

Next is a set of questions regarding HVAC maintenance programs offered by California utilities.

PP1

Some electric utilities in California offer Quality Maintenance programs designed to promote HVAC maintenance practices that improve the efficiency of existing residential and commercial HVAC systems. In addition to promoting common practices such as refrigerant charge and airflow (RCA) and residential duct testing and sealing (DTS), both the residential and commercial programs support additional measures that encourage taking a comprehensive approach to system maintenance. Participation in the program allows your customers to access utility rebates for Quality Maintenance services. Has your company ever participated in a HVAC quality maintenance program from a California utility?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF PP1 = 2**PP1b**

You indicated that your company has never participated in an electric utility's HVAC quality maintenance program. Please indicate why your company has not participated.

(Check all that apply).

- Never thought about it (1)
- I was not aware that electric utilities have HVAC quality maintenance programs (2)
- Utilities' HVAC quality maintenance programs would not benefit our business (3)
- Our customers would not care if we participated (4)
- Too much of a hassle (5)
- Other (Specify) _____ (6)

- Prefer not to answer (7)
- Don't know (8)

RESPONSE OPTIONS 2-5 RANDOMIZED**SHOW ONLY IF PP1 = 1****PP1c**

Is your company currently participating in a HVAC quality maintenance program from a California utility?

- Yes (1)
- No (2)

SHOW ONLY IF PP1 = 1**PP1e**

In your opinion, what are the main advantages to your company of participating in a utility's HVAC maintenance program?

(Check all that apply).

- It drives customers directly to us (1)
- It allows us to approach new customers (2)
- Customers get incentives, which makes them happier with us (3)
- Our company's technician staff have benefited from the program's training opportunities (4)
- Our customers get incentives to do maintenance correctly, which makes them more apt to hire us (5)
- There have been no significant advantages (6)
- Other (Specify) _____ (7)

RESPONSE OPTIONS 1-5 RANDOMIZED**ASK Inst.PP Module IF IS10c > or = 1%.**

PROGRAM PARTICIPATION – Installation (Inst.PP Module)

Next is a set of questions regarding HVAC installation programs offered by California utilities.

P-Inst1

Some electric utilities in California offer Quality Installation programs designed to promote proper HVAC installation practices. Quality installation criteria include correct sizing and correct charge (for non-factory charged units). New residential system installations are also required to satisfy duct leakage requirements. Participation in the program allows your customers to access rebates for installations of new HVAC systems. Has your company ever participated in a HVAC quality installation program from a California electric utility?

- Yes (1)
- No (2)
- Don't know (3)

SHOW ONLY IF P-Inst1 = 2**P-Inst1b**

You indicated that your company has never participated in an electric utility's HVAC quality installation program. Please indicate why your company has not participated.

(Check all that apply).

- Never thought about it (1)
- I was not aware that electric utilities have HVAC quality installation programs (2)
- Utilities' HVAC quality installation programs would not benefit our business (3)
- Our customers would not care if we participated (4)
- Too much of a hassle (5)
- Other (Specify) _____ (6)
- Refuse to answer (7)
- Don't know (8)

RESPONSE OPTIONS 2-5 RANDOMIZED

SHOW ONLY IF P-Inst1 = 1

P-Inst1c

Is your company currently participating in a HVAC quality installation program from a California electric utility?

- Yes (1)
- No (2)

SHOW ONLY IF P-Inst1 = 1

P-Inst1e

In your opinion, what are the main advantages to your company of participating in a utility's HVAC installation program?

(Check all that apply).

- It drives customers directly to us (1)
- It allows us to approach new customers (2)
- Customers get incentives, which makes them happier with us (3)
- Our company's technician staff have benefited from the program's training opportunities (4)
- Our customers get incentives to do installations correctly, which makes them more apt to hire us (5)
- There have been no significant advantages (6)
- Other (Specify) _____ (7)

RESPONSE OPTIONS 1-5 RANDOMIZED

WHOLE HOUSE

WH.1

Has your company ever participated in a utility-sponsored "Whole House" program that goes beyond HVAC and includes building envelope, lighting, or appliances?

- Yes (1)
- No (2)
- Don't know (3)

SHOW IF WH.1 = 2

WH.2

Would your company be interested in participating in a utility-sponsored "Whole House" program that goes beyond HVAC and includes building envelope, lighting, or appliances?

- Yes (1)
- No (2)

Don't know (3)

STAFFING AND TRAINING

ST1

Please indicate how many employees your company has on staff with the following roles:

	0 (1)	1 to 4 (2)	5 to 9 (3)	10 or greater (4)
Service/Maintenance Technician (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Installer (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design Engineer (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sales/Estimator(4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

RESPONSE OPTIONS 1-4 RANDOMIZED

ASK ST3.m IF JOB_TYPE = 1.

ST3.m

What percentage of technicians at your company that perform maintenance work currently has the following certifications?

	0-24% (1)	25-49% (2)	50-74% (3)	75-100% (4)	Don't know (5)
NATE (1)	<input type="radio"/>				
HVAC Excellence (2)	<input type="radio"/>				
PAHRA/Industry Competency Exam (3)	<input type="radio"/>				
TABB (4)	<input type="radio"/>				
RSES (5)	<input type="radio"/>				
UA STAR (6)	<input type="radio"/>				
Other (Specify) _____ (7)	<input type="radio"/>				

RESPONSE OPTIONS 1-6 RANDOMIZED

ASK ST3.i IF JOB_TYPE = 2.

ST3.i

What percentage of technicians at your company that perform installation work currently has the following certifications?

	0-24% (1)	25-49% (2)	50-74% (3)	75-100% (4)	Don't know (5)
NATE (1)	<input type="radio"/>				
HVAC Excellence (2)	<input type="radio"/>				
PAHRA/Industry Competency Exam (3)	<input type="radio"/>				
TABB (4)	<input type="radio"/>				
RSES (5)	<input type="radio"/>				
UA STAR (6)	<input type="radio"/>				
Other (Specify) _____ (7)	<input type="radio"/>				

RESPONSE OPTIONS 1-6 RANDOMIZED

ASK ST4.m IF JOB_TYPE = 1.

ST4.m

Please indicate how effective you think the following certifications are in preparing a technician to perform quality maintenance on HVAC systems.

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I'm not familiar with the certification (6)
NATE (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HVAC Excellence (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PAHRA/Industr y Competency Exam (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TABB (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RSES (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UA STAR (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (Specify) _____ (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

RESPONSE OPTIONS 1-6 RANDOMIZED

ASK ST4.i IF JOB_TYPE = 2.

ST4.i

Please indicate how effective you think the following certifications are in preparing a technician to perform quality installation on HVAC systems.

	Not at all effective (1)	Somewhat effective (2)	Effective (3)	Very effective (4)	No opinion (5)	I'm not familiar with the certification (6)
NATE (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
HVAC Excellence (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
PAHRA/Industry Competency Exam (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TABB (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
RSES (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UA STAR (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (Specify) _____ (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

RESPONSE OPTIONS 1-6 RANDOMIZED

ST5

What is the approximate turnover in your company's technician staff each year?

- Less than 5 percent (1)
- 5 to 9 percent (2)
- 10 to 19 percent (3)
- 20 to 29 percent (4)
- 30 to 39 percent
- 40 to 49 percent
- 50 percent or more (5)
- Prefer not to answer (6)
- Don't know (7)

ST6

How important are the following attributes when your company is thinking about hiring a technician?

	Not at all important (1)	Somewhat important (2)	Important (3)	Very important (4)	No opinion (5)
--	--------------------------	------------------------	---------------	--------------------	----------------

Formal HVAC education (1)	<input type="radio"/>				
Work experience (2)	<input type="radio"/>				
Certifications (3)	<input type="radio"/>				
Work ethic (4)	<input type="radio"/>				
Communication skills (5)	<input type="radio"/>				
Union membership (6)	<input type="radio"/>				
Presentation (e.g. neat, dressed appropriately) (7)	<input type="radio"/>				
Other (Specify) _____ (8)	<input type="radio"/>				

RESPONSE OPTIONS 1-7 RANDOMIZED

ST7

Please indicate how interested your company is in being involved in the following training opportunities:

	Not at all Interested (1)	Somewhat Interested (2)	Interested (3)	Very Interested (4)	No opinion (5)	I'm not familiar with the training opportunity (6)
Private training institute (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Online HVAC course (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Utility training (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Distributor training (4)	<input type="radio"/>					
Manufacturer training (5)	<input type="radio"/>					
IHACI training (7)	<input type="radio"/>					
Other (Specify)	<input type="radio"/>					
_____ (8)						

RESPONSE OPTIONS 1-11 RANDOMIZED

CONTACT INFO

CI1

In order to verify our records, please provide the following information:

- a. Company Name _____
- b. Company Address _____
- c. Company City _____
- d. Company State _____
- e. Company Zip _____
- f. Company Phone _____

Note: We do not share this information with marketers or sales people and be confident that we will keep your information strictly confidential.

INCENTIVE

As a thank you for your participation, we will be emailing you a \$75 gas card. Below, please enter your contact info so we can get you your gas card:

NAME1

Name _____

EMAIL1

Email address _____

[BOTH NAME1 and EMAIL WILL BE REQUIRED FIELDS]

Note that without this information we will be unable to send you your gas card. Please be confident that we do not share this information with marketers or sales people and will keep your information strictly confidential.

SURVEY END

Thank you for completing the survey! Your input is valuable to the development of the California HVAC industry.

You should be receiving your gas card within the next 3 weeks.

IF TERMINATED DURING SCREENING:

Sorry, you do not qualify for the remainder of the survey. Thank you very much for your time.

Appendix H Survey Instrument for Residential HVAC Customers

Hello, my name is _____ from NMR Group, Inc and I am calling on behalf of the California Public Utilities Commission. We are not selling anything. We are conducting research to better understand residential customers' energy use. As part of this research we are interviewing homeowners in your area.

[IF ASKED] We anticipate this interview will last about 15 minutes. Any information you provide will be treated as confidential.

Sample Read-ins in addition to contact information: Address, IOU, climate zone

Quotas:

PGE - Inland - 85 completes

PGE - Mild - 115 completes

SCE - Inland - 157 completes

SCE - Mild - 43 completes

SDGE - Mild - 100 completes

Total: 500 completes

SCREENING (1 Minute)

SC2. Does your home have a working central air conditioning/cooling system?

1. Yes [CONTINUE]
2. No [THANK AND TERMINATE]
3. Don't know / refused [THANK AND TERMINATE]

SC1. Do you own or rent your home?

1. Own [CONTINUE]
2. Rent [THANK AND TERMINATE]
3. Don't know / refused [THANK AND TERMINATE]

SC3. Which of the following types of housing units would you say best describes your home? Is it a...

1. Single-family detached house

2. Single-family attached house (townhouse, row house, excluding duplex)
3. Duplex
4. Building with 2-4 units
5. Building with 5 or more units
6. Mobile home or house trailer [THANK AND TERMINATE]
7. Other (Specify: _____)
8. Don't know / refused

SC2a. (IF SC2 = 1) Do you have more than one working central air conditioning/cooling system?

1. Yes
2. No
3. Don't know/Refused

AC System Information (2 Minutes)

ALL RESPONDENTS WILL BE ASKED AC1PA1 THROUGH AC7, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

First I would like to ask you some questions about your primary central air conditioner and your air conditioning use and habits. For these questions, please limit your responses to your central air conditioning system. Please note that I may also use the term central “AC” when talking about your central air conditioning system.

[IF SC2a = 1, ALSO SAY: IF YOUR CENTRAL AIR CONDITIONING UNITS ARE OF DIFFERENT AGES, PLEASE GIVE YOUR RESPONSES FOR THE NEWEST UNIT. IF YOU HAVE MORE THAN ONE UNIT, ALL OF THE SAME AGE, PLEASE PICK ONE UNIT AND GIVE RESPONSES FOR THAT UNIT.]

AC1. How old is your central air conditioning/cooling unit?

[Years: _____] [IF LESS THAN ONE YEAR, ENTER 1. RANGE = 1 to 40]

99. Don't know/Refused

AC1a. (IF AC1 = 99) Would you estimate that the age of your central air conditioning unit is ...

1. Less than one year
2. 1 – 2 years
3. 3 years
4. 4 – 8 years
5. 9 – 13 years
6. 14 – 30 years
7. Over 30 years
8. Don't know / refused

AC2. [SCREENER FOR AC INSTALLATION SECTION] Did you....

1. purchase your current central air conditioning system, OR
2. was it already installed when you moved in?
3. Don't know / refused

AC3. Do you know if your central air conditioner is...

1. A standard efficiency unit? Or is it
2. An energy efficient or high efficiency unit?
3. Don't know / refused

AC4. [IF AC3 = 2] Is your central air conditioning system an ENERGY STAR-qualified system?

1. Yes
2. No
3. Don't know / refused

AC5. [IF AC4 = 1] Can you tell me the SEER rating of your central air conditioning system?
[IF RESPONDENT ASKS, SEER = Seasonal Energy Efficiency Ratio]

ENTER SEER-Rating: _____ {RANGE = 6 to 26} [98 = Out of range response
99 = Don't know / refused]

AC6. How often would you say you use your central air conditioner during a typical summer?
Would you say...

1. Every day
2. Most days
3. Some days
4. Only a few days
5. Never
6. Don't know / refused

AC7. [ASK ALL RESPONDENTS] When was the last time your central air conditioning system was professionally serviced or maintained by an air conditioning contractor? Would you say you had it serviced...

1. In the last six months
2. In the last year
3. In the last two years
4. In the last three years
5. More than three years ago
6. Or have you never had it serviced
7. Don't know / refused

Program Awareness (2 Minutes)

ALL RESPONDENTS WILL BE ASKED PA1 THROUGH PA7, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

PA1. Do you know of any [IOU NAME FROM SAMPLE] rebate programs for central air conditioning systems? IF YES: Which ones? [99= Don't know / refused] 1. Gave Response
2. Do not know of any rebate programs

Have you heard of the following rebate program(s) for central air conditioning systems? [1 = YES, 2 = NO, 3 = DON'T KNOW /REFUSED]

[SCE SAMPLE ONLY]

PA2. Southern California Edison's (SCE) Rebates on Professional Air Conditioning Maintenance & Repair Program

PA3. Southern California Edison's (SCE) Rebates on Professional Air Conditioning Installation Program

[PG&E SAMPLE ONLY]

PA4. Pacific Gas and Electric's (PG&E) AC Quality Care Rebate Program

[SDG&E SAMPLE ONLY]

PA5. San Diego Gas & Electric's (SDG&E) AC Quality Care Rebate Program

PA6. [IF PA2 = 1 OR PA4 = 1 OR PA5 = 1] Have you ever received a rebate or incentive from [INSERT PROGRAM NAME FROM IF PA2 / PA4 / PA5] for maintenance of your central AC system?

1. Yes
2. No
3. Don't know / refused

PA7. [IF PA3 = 1 OR PA4 = 1 OR PA5 = 1] Have you ever received a rebate or incentive from [INSERT PROGRAM NAME FROM PA3 / PA4 / PA5] for the installation of a new central air conditioning system?

1. Yes
2. No
3. Don't know / refused

AC Service and Maintenance (8 minutes)

[IF (AC1 = 1 OR 2 AND AC2 = 1) OR (IF AC7 = 6 OR 7), GO TO M11]

[ELSE, CONTINUE]

**ONLY RESPONDENTS WHO HAVE NOT INSTALLED AN AC IN PAST TWO YEARS
AND**

INDICATE HAVING HAD THEIR AC SERVICED

**WILL BE ASKED M1 THROUGH M10, EXCEPT AS NOTED IN SPECIFIC
QUESTION SKIPS**

**ALL RESPONDENTS WILL BE ASKED M11 THROUGH M27, EXCEPT AS NOTED
IN SPECIFIC QUESTION SKIPS**

AC SERVICE / MAINTENANCE EXPERIENCE

M1. Thinking of the last time your central air conditioning system was serviced, approximately how long did the air conditioning technician spend working on your AC? [Probe for best estimate] [If ‘Don’t Know, Probe: ‘Was it less than or more than 1 hour?’ And work from there to get estimate.] [DO NOT READ]

1. Less than 4 hours
2. Between 4 and 6 hours
3. Between 6 and 8 hours
4. Between 8 and 10 hours
5. Between 10 and 12 hours
6. Between 12 and 14 hours
7. Between 14 and 16 hours
8. More than 16 hours
9. Don’t know / don’t remember / refused

M2. Thinking of the last time your central AC system was serviced, which of the following services were performed. . [RECORD 1 = YES, 2 = NO, 3 = DON’T KNOW / REFUSED FOR EACH ITEM a TO c]

- a. Routine tune up and maintenance
- b. Repairs that were identified during the service call
- c. Repairs that were identified before the service call

M3. What was the ONE most important reason you chose to have your central AC system professionally serviced? [DO NOT READ. SAME LIST AS M4 EXCLUDING 7.]

M4. [IF M3 ≠ 8] Were there any other reasons? [DO NOT READ]

1. System malfunction / not working
2. Routine / regular maintenance/ to make sure it keeps working properly
3. To save energy
4. To replace filters
5. To take advantage of incentive / rebate
6. Other (Specify: _____)
7. No other reasons
8. (Don't know / refused)

M5. Thinking of the last time your central AC system was maintained, how would you rate the quality of the maintenance that was done? Please give your response using a scale of 1 to 5, where 1 is “extremely poor quality maintenance” and 5 is “extremely good quality maintenance.” [RECORD A NUMBER 1-5, 6 = Don't know / refused]

M6. Why did you give this rating? [99= Don't know / refused]

M7. How frequently do you have a contractor service or maintain your central AC system, other than for repairs? Would you say you have a contractor come out and perform maintenance on your central AC system:

1. Three or more times a year,
2. Two times a year,
3. Once a year or annually,
4. Once every two years,
5. Once every three years,
6. Once every four years or less frequently, or
7. Never?
8. Don't know / refused

AC SERVICE CONTRACTS

M8. Do you currently have an AC system maintenance agreement with an air conditioning contractor?

1. Yes
2. No [GO TO M11]
3. Don't know / refused [GO TO M11]

M9. In what year did you get your current AC system maintenance agreement? [Range = 1960 TO 2012, 2099 = Don't know / refused]

M10. For how many total years is your current AC system maintenance agreement?

1. 1 year
2. 2 years
3. 3 years
4. 4 or more years
5. Don't know / refused

M11. [IF M8 \neq 1 OR (AC1 = 1 OR 2 AND AC2 = 1) OR (IF AC7 = 1 OR 7)]

Have you ever had or been offered a service agreement with a contractor for the maintenance of your central air conditioning system?

1. Had an AC maintenance agreement
2. Was offered an AC maintenance agreement but did not sign on
3. Never had or been offered an AC maintenance agreement
4. Don't know / refused

ALL RESPONDENTS WILL BE ASKED M12 THROUGH M27, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS

AWARENESS OF QM

M12. Have you heard of the term “Quality Maintenance” used to describe an approach to the routine maintenance or tune-ups of central air conditioning systems?

1. Yes [GO TO M14]
2. No
3. Don't know / refused

M13. [IF M12 = 2 OR 3] Quality Maintenance requires that the routine maintenance or tune-up of a central air conditioning system is done according to specific industry standards and guidelines so as to ensure that the system is operating efficiently. Have you heard of the term Quality Maintenance?

1. Yes [GO TO M15]
2. No
3. Don't know / refused

[IF M13 = 2 OR 3, SKIP TO PARAGRAPH ABOVE M21]

KNOWLEDGE & USE OF QM

M14. [IF M12 = 1] What do you understand is meant by the term “Quality Maintenance” of central air conditioning systems? [99= Don’t know / refused]

M15. Before this call today, were you aware of any Quality Maintenance guidelines or programs for central air conditioning systems?

1. Yes
2. No
3. Don’t know / refused

M16. [IF M15 = 1] Which Quality Maintenance guidelines or programs were you aware of? [DO NOT READ. CHECK ALL THAT APPLY]

1. ENERGY STAR
2. ACCA Standard 4
3. ACCA Standard 180
4. SCE rebates on Professional Air Conditioning Maintenance & Repair
5. PG&E AC Quality Care Rebate Program
6. SDG&E AC Quality Care Rebate Program
7. Other [SPECIFY: _____]
8. None / Don’t know / refused

M17. [IF PA2 = 1 OR PA4 = 1 OR PA5 = 1] Is your air conditioning service contractor part of the [INSERT UTILITY NAME] quality maintenance program?

1. Yes
2. No
3. Don’t know / refused

M18. At the time you were selecting a contractor to maintain your central AC system, did you specifically ask about their use of Quality Maintenance guidelines?

1. Yes
2. No
3. Don’t know / refused

M19. What do you understand to be the benefits of performing Quality Maintenance of central AC systems? [DO NOT READ. CHECK ALL THAT APPLY. IF RESPONDENT SAYS, “SYSTEM OPERATES EFFICIENTLY,” PROBE FOR SPECIFICS, ASK WHAT THEY MEAN WHEN THEY SAY THAT.]

1. Achieve safe operating conditions
2. Improve indoor air quality
3. Increase energy savings and reduce energy bills
4. Prolong a system’s operational lifespan
5. Prevent expensive repairs
6. Improve a system’s reliability
7. Increase comfort
8. Other [SPECIFY: _____]
9. Don’t know / can’t say / refused

M20. On average, what percentage savings on your electric bill do you think you will get from having a contractor perform quality maintenance on your central AC system two times a year? [RANGE = 0 TO 100 101= Don’t know / refused] ___%

An air conditioning system that is maintained according to Quality Maintenance standards may provide some potential benefits. I’m going to read you a list of possible benefits. Using a scale of 1 to 5, where 1 is “not at all important” and 5 is “extremely important,” how would you rate the benefits in terms of how important they are to you. [RANDOMIZE M21 - M27] [RECORD A NUMBER 1-5, 6 = Don’t know / refused]

- M21. Achieve safe operating conditions, control carbon monoxide, check wiring
- M22. Improve indoor air quality
- M23. Increase energy savings and reduce energy bills
- M24. Prolong a system’s operational lifespan
- M25. Prevent expensive repairs
- M26. Improve a system’s reliability
- M27. Increase comfort

AC Installation (8 Minutes)

[IF AC1 = 1 OR 2 AND IF AC2 = 1, CONTINUE, OTHERWISE GO TO I7]

ONLY RESPONDENTS WHO INSTALLED AN AC IN PAST TWO YEARS WILL BE ASKED I1 THROUGH I6 AND I22 THROUGH I25, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

ALL RESPONDENTS WILL BE ASKED I7 THROUGH I21, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

Now I would like to ask you some additional questions about your experiences when you purchased a new central air conditioning system.

AC INSTALLATION EXPERIENCE

- I1. Earlier you said you purchased a new central air conditioning system for your home. Was this a replacement for an existing central air conditioning system, an additional central air conditioning system, or the first central air conditioner for the home?
1. Replacement
 2. Additional system
 3. First system
 4. Don't know / refused
- I2. At the time you were making the decision to purchase your central air conditioning system, what was your ONE most important concern? [DO NOT READ. SAME LIST AS I3 EXCLUDING 13] [ACCEPT ONE RESPONSE] [INTERVIEWER NOTE: If "cost" ask: Is that purchase, installation, or operating cost?]
- I3. [IF I2 ≠ 14] Did you have any other concerns? [DO NOT READ] [ACCEPT MULTIPLE] [INTERVIEWER NOTE: If "cost" ask: Is that purchase, installation, or operating cost?]
1. Speed of installation
 2. Purchase cost of unit
 3. Installation cost of unit
 4. Operating cost of unit
 5. Reliability
 6. Comfort
 7. Improving health and safety of home
 8. Saving energy / energy efficiency of unit
 9. Reputation of equipment brand
 10. Reputation of contractor
 11. Quality of installation work
 12. Other (Specify: _____)
 13. No other concerns
 14. Don't know / refused

I4. Thinking of the work that the air conditioning contractor did when installing your new central AC system, how would you rate the quality of the installation? Please give your response using a scale of 1 to 5, where 1 is “extremely poor quality installation” and 5 is “extremely good quality installation.” [RECORD A NUMBER 1-5, 6 = Don’t know / refused]

I5. Why did you give this rating? [99= Don’t know / refused]

I6. Approximately how long did the air conditioning technician take to install your central AC system? [Probe for best estimate] [If ‘Don’t Know, Probe: ‘Was it less than or more than 4 hours?’ And work from there to get estimate.] [DO NOT READ]

1. Less than 4 hours
2. Between 4 and 6 hours
3. Between 6 and 8 hours
4. Between 8 and 10 hours
5. Between 10 and 12 hours
6. Between 12 and 14 hours
7. Between 14 and 16 hours
8. More than 16 hours
9. Don’t know / don’t remember / refused

ALL RESPONDENTS WILL BE ASKED I7 THROUGH I21, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.
--

AWARENESS OF QI

I7. Have you heard of the term “Quality Installation” used to describe an approach to the proper installation of central air conditioning systems?

1. Yes [GO TO I9]
2. No
3. Don’t know / refused

I8. [IF I7 = 2 OR 3] Quality Installation requires that a new central air conditioning system is selected and installed according to specific industry standards and guidelines so as to ensure the proper performance of the system. Have you heard of the term Quality Installation?

1. Yes [GO TO I10]
2. No
3. Don’t know / refused

[IF I8 = 2 OR 3, SKIP TO PARAGRAPH ABOVE I14]

KNOWLEDGE & USE OF QI

I9. [IF I7 = 1] What do you understand is meant by the term “Quality Installation” of central air conditioning systems? [99= Don’t know / refused]

I10. Before this call today, were you aware of any Quality Installation guidelines or programs?

1. Yes
2. No
3. Don’t know / refused

I11. [IF I10 = 1] Which Quality Installation guidelines or programs were you aware of? [DO NOT READ. CHECK ALL THAT APPLY]

1. ENERGY STAR
2. ACCA Standard 5
3. ACCA Standard 9
4. SCE rebates on Professional Air Conditioning Installation
5. PG&E AC Quality Care Rebate Program
6. SDG&E AC Quality Care Rebate Program
7. Other [SPECIFY: _____]
8. None / Don’t know / refused

I12. What do you understand to be the benefits of Quality Installation of central AC systems? [DO NOT READ. CHECK ALL THAT APPLY]

1. Achieve safe operating conditions
2. Ensure indoor air quality
3. Increase energy savings and reduce energy bills
4. Prolong a system’s operational lifespan
5. Prevent expensive repairs
6. Ensure a system’s reliability
7. Ensure comfort
8. Other [SPECIFY: _____]
9. Don’t know / can’t say / refused

I13. On average, what percentage savings on your electric bill do you think you will get from having a contractor perform a Quality Installation of your central air conditioning system? [RANGE = 0 TO 100, 101= Don’t know / refused] __%

A properly installed central air conditioning system may provide some potential benefits. I'm going to read you a list of possible benefits. Using a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important," how would you rate the benefits in terms of how important they are to you. [RANDOMIZE I14 TO I20] [RECORD A NUMBER 1-5, 6 = Don't know / refused]

- I14. Achieve safe operating conditions
- I15. Ensure indoor air quality
- I16. Increase energy savings and reduce energy bills
- I17. Prolong a system's operational lifespan
- I18. Prevent expensive repairs
- I19. Ensure a system's reliability
- I20. Ensure comfort

- I21. Are you aware of the ENERGY STAR label for energy efficient central air conditioning systems?
- 1. Yes
 - 2. No
 - 3. Don't know / refused

EXPERIENCE WITH CONTRACTOR

[IF AC1 = 1 OR 2 AND IF AC2 = 1, CONTINUE, OTHERWISE GO TO AKA1]

ONLY RESPONDENTS WHO INSTALLED AN AC IN PAST TWO YEARS WILL BE ASKED I22 THROUGH I25

- I22. [IF I7 = 1 OR I8 = 1] Did the contractor who installed your new central air conditioning system do so according to Quality Installation guidelines?
- 1. Yes
 - 2. No
 - 3. Don't know / refused
- I23. [IF I7 = 1 OR I8 = 1] At the time you were deciding upon a contractor to install your new central AC system, did you specifically ask about their use of Quality Installation guidelines?
- 1. Yes
 - 2. No
 - 3. Don't know / refused
- I24. At the time of purchase of your new central AC system, did the installing contractor offer you a service agreement for the maintenance of your AC system?
- 1. Yes
 - 2. No
 - 3. Don't know / refused

I25. [IF I24= 1] Did you accept the service agreement for the maintenance of your AC system?

1. Yes
2. No
3. Don't know / refused

AKA Questions (5 Minutes)**ALL RESPONDENTS WILL BE ASKED AKA1 THROUGH AKA3**

AKA1. I'm going to list several energy-efficient product labels or energy efficiency programs. For each, please tell me if you have heard of it. [RANDOMIZE LABELS/NAMES OF PROGRAMS EXCEPT "ENERGY STAR Most Efficient" SHOULD ALWAYS IMMEDIATELY FOLLOW "ENERGY STAR"]? [RECORD, 1 = YES, 2 = No, 3 = DK / Refused]

- a. ENERGY STAR
- b. ENERGY STAR Most Efficient
- c. Flex Your Power
- d. Top Ten
- e. Energy Upgrade California

AKA2. How worried are you about global warming? [READ CHOICES EXCEPT DK / Refused]

1. Not at all worried
2. A little worried
3. Somewhat worried
4. Very worried, or
5. Extremely worried
6. Don't know / refused

AKA3. Now, I'm going to read a few statements. Using a scale of 0 to 10 where 0 means *Not at all agree*, and 10 means *Completely agree*, please tell me how much you agree with each statement. [RANDOMIZE "a" - "m"] Range 0 to 10, 11 = DK/ Refused, 12= Only member of HH (j and i only)

- a. I sometimes worry whether there is enough money to pay my energy bill
- b. I often worry that the cost of energy for my home will increase
- c. I am very concerned about how energy use affects the environment
- d. It is my responsibility to use as little energy as possible to help the environment
- e. I feel guilty if I use too much energy
- f. I intend to conserve on gas or electricity consumption in my home this winter
- g. I intend to conserve electricity consumption in my home this summer
- h. If my utility bill goes up, I feel like I must do something to reduce it
- i. I have to take the lead in my household if we're going to keep our utility bills down
- j. If others in my household can't or won't change their behavior to lower our utility bills, I feel I should do even more to control our energy costs
- k. Household electricity use has an impact on the environment
- l. I believe that household energy use has an impact on global warming and climate change
- m. Conserving electricity will help reduce global warming

Demographics (2 Minutes)

ALL RESPONDENTS WILL BE ASKED D1 THROUGH D10

D1. Which of the following best describes your home? Is it a...

1. Permanent year-round residence
2. Partial-year or seasonal residence
3. Vacation home generally used only by family
4. Vacation home rental home
5. Don't know / refused

D2. How long have you lived in your current home?

1. One year or less
2. Two years
3. Three years
4. Four years
5. Five years
6. Six years
7. Seven years
8. More than seven years
9. Don't know / refused

D3. Approximately what year was your home built?

1. Before 1940
2. 1940-49
3. 1950-59
4. 1960-69
5. 1970-74
6. 1975-77
7. 1978-82
8. 1983-92
9. 1993-97
10. 1998-2000
11. 2001-2004
12. 2005-2008
13. 2008-2011
14. 2012
15. Don't know/refused

D4. How many bedrooms are in your home?

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9
10. 10
11. More than 10
12. No bedrooms (studio)
13. Don't know/refused

D5. How many square feet of living space are there in your home, including bathrooms, foyers and hallways?

1. Less than 250
2. 250 – 500
3. 501 – 750
4. 751 – 1000
5. 1001 – 1250
6. 1251 – 2000
7. 2001 – 2500
8. 2501 – 3000
9. 3001 – 4000
10. 4001 – 5000
11. More than 5000
12. Don't know/refused

D6. For each of the following age groups, how many people, including yourself, usually live in this home? [For each age group record: None, 1, 2, 3, 4, 5, 6, 7, 8 = 8 or more, 9 = DK/REF]

- a. Less than 18 years old
- b. 18 to 24
- c. 25 to 34
- d. 35 to 44
- e. 45 to 54
- f. 55 to 64
- g. 65 or older

D7. How would you describe your race? [DO NOT READ, UP TO 5 RESPONSES ALLOWED]

- a. White
- b. Black or African American

- c. American Indian or Alaska Native
- d. Asian
- e. Pacific Islander
- f. Other (Specify: _____)
- g. Don't know / refused

D8. Are you Spanish, Hispanic or Latino?

1. Yes
2. No
3. Don't know / refused

D9. What is the highest level of education you have completed? [DO NOT READ]

1. No schooling
2. Less than high school
3. Some high school
4. High school graduate or equivalent (GED)
5. Some college
6. College degree
7. Some graduate school
8. Graduate or professional degree
9. Post graduate
10. Don't know / refused

D10. Which of the following categories best describes your household's total annual income?

Just stop me when I get to the right category.

1. Less than \$10,000
2. \$10,000 - \$19,999
3. \$20,000 - \$24,999
4. \$25,000 - \$29,999
5. \$30,000 - \$34,999
6. \$35,000 - \$39,999
7. \$40,000 - \$49,999
8. \$50,000 - \$59,999
9. \$60,000 - \$74,999
10. \$75,000 - \$99,999
11. \$100,000 - \$149,999
12. \$150,000 or more
13. Don't know / refused

Thank you, those are all the questions I have for you.

Appendix I Survey Instrument for Small Commercial HVAC Customers

Hello, my name is _____ from NMR Group, Inc and I am calling on behalf of the California Public Utilities Commission. We are conducting research to better understand commercial customers' use of air conditioning (cooling) equipment in California. As part of this research we are interviewing businesses in your area.

[IF NEEDED] This is not a sales call.

[IF NEEDED] This is a fact-finding survey only, authorized by the California Public Utilities Commission. The CPUC wants to better understand how businesses like yours think about and manage their air conditioning equipment.

[IF ASKED] We anticipate this interview will last about 12 minutes. Any information you provide will be treated as confidential.

SCREENING (1 Minute)

SC1. May I speak with the person at your organization that is most knowledgeable about the air conditioning equipment at this facility?

4. No, that person is not available right now
5. Unable to refer to someone who can help
6. Yes, that would be me
7. Yes, let me transfer you to _____
8. Our property management handles this
9. We do not have an air conditioning system [THANK AND TERMINATE]
10. No, Other reason [SPECIFY: _____]
11. Don't know / refused [THANK AND TERMINATE]

SC2. [IF SC1 = 5] Could you give me the name and telephone number for your property manager?

1. Record name and telephone number
2. Refused
3. Don't know

SC3. [IF SC1 = 1] When would be a good day and time for us to call back?

1. Record day of the week, time of day and date to call back
2. Refused
3. Don't know

[IF REFERED TO ANOTHER GO BACK TO INTRO]

SC4. First, I'd like to I'd like to ask you a few questions about your organization and facility. Our records show your firm is located at [INSERT ADDRESS]. Is that correct?

4. Yes [CONTINUE]
5. No [THANK AND TERMINATE]
6. Don't know / refused [THANK AND TERMINATE]

[IF 2 or 3: We were attempting to reach the customer at [ADDRESS] and since you cannot confirm this address, those are all the questions that we have for you today, on behalf of the California Public Utilities Commission, thank you for your time.]

SC5. Does this facility have a working air conditioning system?

7. Yes [CONTINUE]
8. No [THANK AND TERMINATE]
9. Don't know / refused [THANK AND TERMINATE]

AC System Information (2 Minutes)**ALL RESPONDENTS WILL BE ASKED AC8 THROUGH AC16, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.**

- AC8. What type of equipment is used to cool this facility? (allow multiple) [1 = YES, 2 = NO, 3 = DON'T KNOW / REFUSED] **[READ CATEGORIES]**
9. Split systems (two components; compressor is separate from the supply air fan, air conditioner, or heat pump)
 10. Packaged systems (one component; rooftop units)
 11. Package terminal A/C or heat pumps (e.g., Hotel/Motel units)
 12. Individual A/C or heat pump units (e.g. unitary equipment, central A/C with multiple units, single unit) [NOTE: Ask if split or packaged system]
 13. Evaporative coolers (swamp coolers)
 14. Water chiller (central plant)
 15. Window/Wall units
 16. Fans
 17. Other [Specify: _____]
 18. No A/C [THANK AND TERMINATE]
 19. Don't know / refused

[IF AC8a, b, c, or d = YES, CONTINUE. OTHERWISE THANK AND TERMINATE]

- AC9. How old is this cooling equipment currently in use at your facility? Would you say it is...
1. Less than 5 years old
 2. Between 5 and 10 years old
 3. 10 to 20 years old
 4. More than 20 years old
 5. Don't know / refused

- AC10. What is the primary fuel used by this cooling equipment?
1. Electricity
 2. Natural Gas
 3. Both Electricity and Gas
 4. Other [Specify: _____]
 5. Don't know / refused

- AC11. [SCREENER FOR AC INSTALLATION SECTION] Since January 2009 have you purchased and installed any cooling equipment at this facility?
4. Yes
 5. No
 6. Don't know / refused

AC12. [IF AC2 = 1] What types of equipment were installed? [1 = YES, 2 = NO, 3 = DON'T KNOW / REFUSED] **[READ CATEGORIES]**

- a. Split systems (two components; compressor is separate from the supply air fan, air conditioner, or heat pump)
- b. Packaged systems (one component; rooftop units)
- c. Package terminal A/C or heat pumps (e.g., Hotel/Motel units)
- d. Individual A/C or heat pump units (e.g. unitary equipment, central A/C with multiple units, single unit) [NOTE: Ask if split or packaged system]
- e. Evaporative coolers (swamp coolers)
- f. Water chiller (central plant)
- g. Window/Wall units
- h. Fans
- i. Other [Specify: _____]
- j. Don't know / refused

AC13. [ASK ONCE FOR EACH EQUIPMENT TYPE IDENTIFIED IN AC8] Do you know if your [INSERT EQUIPMENT TYPE a-d] is...

4. A standard efficiency unit? Or is it
5. An energy efficient or high efficiency unit?
6. Don't know / refused

AC14. [ASK ONCE FOR EACH EQUIPMENT TYPE IDENTIFIED IN AC8 AND WHERE AC13 = 2] Is your [INSERT EQUIPMENT TYPE a-d] an ENERGY STAR-qualified system?

1. Yes
2. No
3. Don't know / refused

AC15. [ASK ONCE FOR EACH EQUIPMENT TYPE IDENTIFIED IN AC8 AND WHERE AC14 = 1] Can you tell me the EER rating for your [INSERT EQUIPMENT TYPE a-d]? EER-Rating: _____ [99 = Don't know / refused]

AC16. When was the last time any of your cooling equipment was professionally serviced by an HVAC contractor?

[Months: _____] [Years: _____]

[RECORD MONTHS AND YEARS, IF DON'T KNOW READ CATEGORICAL RESPONSES]

8. Never, no servicing since it was installed
9. In the last six months
10. More than six months ago
11. More than one year ago
12. More than two years ago
13. More than three years ago
14. Don't know / refused

Program Awareness (2 minutes)

ALL RESPONDENTS WILL BE ASKED THROUGH, EXCEPT AS NOTED IN SUBSEQUENT SKIPS.

PA1. Do you know of any [IOU NAME] rebate programs for central air conditioning systems?
IF YES: Which ones? [99= Don't know / refused]

Have you heard of the following rebate program(s) for central air conditioning systems? [1 = YES, 2 = NO, 3 = DON'T KNOW /REFUSED]

[SCE SAMPLE ONLY]

PA2. Southern California Edison's (SCE) Rebates on Professional Air Conditioning Maintenance & Repair Program

PA3. Southern California Edison's (SCE) Rebates on Professional Air Conditioning Installation Program

[PG&E SAMPLE ONLY]

PA4. Pacific Gas and Electric's (PG&E) AC Quality Care Rebate Program

[PG&E SAMPLE ONLY]

PA5. San Diego Gas & Electric's (SDG&E) AC Quality Care Rebate Program

PA6. [IF PA2= 1 OR PA4 = 1 OR PA5 = 1] Have you ever received a rebate or incentive from [INSERT PROGRAM NAME FROM IF PA2 / PA4 / PA5] for maintenance of your central AC system?

1. Yes
2. No
3. Don't know / refused

PA7. [IF PA3 = 1 OR PA4 = 1 OR PA5 = 1] Have you ever received a rebate or incentive from [INSERT PROGRAM NAME FROM PA3 / PA4 / PA5] for the installation of a new central air conditioning system?

1. Yes
2. No
3. Don't know / refused

AC Service and Maintenance (8 minutes)

[IF AC16 = 1 OR 7, GO TO PA18]

ONLY RESPONDENTS WHO INDICATE HAVING HAD THEIR AC SERVICED WILL BE ASKED PA8 THROUGH PA17, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS

ALL RESPONDENTS WILL BE ASKED PA18 THROUGH PA34, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS

AC SERVICE / MAINTENANCE EXPERIENCE

PA8. Thinking of the last time your cooling equipment was serviced, approximately how long did the HVAC technician spend working on your cooling equipment the last time it was serviced? [Probe for best estimate] [If 'Don't Know, Probe: 'Was it less than or more than 1 hour?' And work from there to get estimate.] [DO NOT READ]

10. Less than 15 minutes
11. Between 15 and 29 minutes
12. Between 30 and 44 minutes
13. Between 45 and 59 minutes
14. Between 1 hour and 1 hour and 59 minutes
15. Between 2 hours and 2 hours and 59 minutes
16. Between 3 hours and 3 hours and 59 minutes
17. 4 hours or more
18. Don't know / don't remember / refused

PA9. Thinking of the last time your cooling equipment was serviced, which of the following services were performed. Select all that apply. [RECORD 1 = YES, 2 = NO, 3 = DON'T KNOW / REFUSED]

1. Routine tune up and maintenance
2. Repairs that were identified during the service call
3. Repairs that were identified before the service call

PA10. What was the ONE most important reason you chose to have your cooling equipment professionally serviced? [DO NOT READ. SAME LIST AS M4.]

PA11. [IF M3 ≠ 7] Were there any other reasons? [DO NOT READ]

9. System malfunction / not working
10. Routine / regular maintenance/ to make sure it keeps working properly
11. To save energy
12. To replace filters
13. To take advantage of incentive / rebate
14. No other reasons
15. (Don't know / refused)

PA12. Thinking of the last time your cooling equipment was maintained, how would you rate the quality of the maintenance that was done? Please give your response using a scale of 1 to 5, where 1 is "extremely poor quality maintenance" and 5 is "extremely good quality maintenance." [RECORD A NUMBER 1-5, 6 = Don't know / refused]

PA13. Why did you give this rating? [99 = Don't know / refused]

PA14. How frequently do you have a contractor service or maintain your cooling equipment, other than for repairs? Would you say you have a contractor come out and perform maintenance on your cooling equipment:

9. Three or more times a year,
10. Two times a year,
11. Once a year or annually,
12. Once every two years,
13. Once every three years,
14. Once every four years or less frequently, or
15. Never?
16. Don't know / refused

AC SERVICE CONTRACTS

PA15. Do you currently have an HVAC system maintenance agreement with an HVAC contractor?

4. Yes
5. No [GO TO 0]
6. Don't know / refused [GO TO 0]

PA16. In what year did you get your current HVAC system maintenance agreement? [9999 = Don't know / refused]

PA17. For how many total years is your current HVAC system maintenance agreement?

6. 1 year

7. 2 years
8. 3 years
9. 4 or more years
10. Don't know / refused

PA18. [IF M8 = 2 or 3, OR AC16 = 1 or 7] Have you ever had or been offered a service agreement with a contractor for the maintenance of your cooling equipment?

5. Had an AC maintenance agreement
6. Was offered an AC maintenance agreement but did not sign on
7. Never had or been offered an AC maintenance agreement
8. Don't know / refused

ALL RESPONDENTS WILL BE ASKED M14 THROUGH PA34, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS

AWARENESS OF QM

PA19. Have you heard of the term “Quality Maintenance” used to describe an approach to the routine maintenance or tune-ups of commercial cooling systems?

4. Yes [GO TO PA21]
5. No
6. Don't know / refused

PA20. Quality Maintenance requires that the routine maintenance or tune-up of a cooling system is done according to specific industry standards and guidelines so as to ensure that the system is operating efficiently. Have you heard of the term Quality Maintenance?

1. Yes [GO TO PA22]
2. No
3. Don't know / refused

[IF PA20 = 2 OR 3, SKIP TO PARAGRAPH ABOVE PA28]

KNOWLEDGE & USE OF QM

PA21. [IF M14= 1] What do you understand is meant by the term “Quality Maintenance” of cooling systems? [99 = Don’t know / refused]

PA22. Before this call today, were you aware of any Quality Maintenance guidelines or programs for central air conditioning systems?

1. Yes
2. No
3. Don’t know / refused

PA23. [IF PA22= 1] Which Quality Maintenance guidelines or programs were you aware of?

[DO NOT READ. CHECK ALL THAT APPLY]

9. ENERGY STAR
10. ACCA Standard 4
11. ACCA Standard 180
12. SCE rebates on Professional Air Conditioning Maintenance & Repair
13. PG&E AC Quality Care Rebate Program
14. SDG&E AC Quality Care Rebate Program
15. Other [SPECIFY: _____]
16. None / Don't know / refused

PA24. [IF PA2= 1 OR PA4 = 1 OR PA5 = 1] Is your HVAC service contractor part of a [INSERT UTILITY NAME] quality maintenance program?

4. Yes
5. No
6. Don't know / refused

PA25. At the time you were deciding upon a contractor to maintain your cooling equipment, did you specifically ask about their use of Quality Maintenance guidelines?

4. Yes
5. No
6. Don't know / refused

PA26. What do you understand to be the benefits of performing Quality Maintenance of HVAC cooling equipment? [DO NOT READ. CHECK ALL THAT APPLY. IF RESPONDENT SAYS, "SYSTEM OPERATES EFFICIENTLY," PROBE FOR SPECIFICS, ASK WHAT THEY MEAN WHEN THEY SAY THAT.]

10. Achieve safe operating conditions
11. Improve indoor air quality
12. Increase energy savings and reduce energy bills
13. Prolong a system's operational lifespan
14. Prevent expensive repairs
15. Improve a system's reliability
16. Increase comfort
17. Other [SPECIFY: _____]
18. Don't know / can't say / refused

PA27. On average, what percentage savings on your electric bill do you think you will get from having a contractor perform quality maintenance on your cooling equipment two times a year? [0=No savings; 99= Don't know / refused] ___%

An HVAC system that is maintained according to Quality Maintenance standards may provide some potential benefits. I'm going to read you a list of possible benefits. Using a scale of 1 to 5, where 1 is "not at all important" and 5 is "extremely important," how would you rate the benefits in terms of how important they are to you. [RANDOMIZE M21 -M26] [RECORD A NUMBER 1-5, 6 = Don't know / refused]

PA28. Achieve safe operating conditions, control carbon monoxide, check wiring

PA29. Improve indoor air quality

PA30. Increase energy savings and reduce energy bills

PA31. Prolong a system's operational lifespan

PA32. Prevent expensive repairs

PA33. Improve a system's reliability

PA34. Increase comfort

AC Installation (8 Minutes)

[IF AC2 = 1 AND AC12a, b, c, or d = 1, CONTINUE, OTHERWISE GO TO I10]

RESPONDENTS WHO INSTALLED AN AC IN PAST TWO YEARS WILL BE ASKED I1 THROUGH I31 AND I22 THROUGH I25, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

ALL RESPONDENTS WILL BE ASKED I32 THROUGH I44, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

Now I would like to ask you some additional questions about your experiences when you purchased new cooling equipment.

I26. Earlier you said you purchased new cooling equipment for this facility. Was this a replacement for an existing HVAC system, an additional HVAC system, or the first HVAC system for this facility?

5. Replacement
6. Additional system
7. First system
8. Don't know / refused

I27. At the time you were making the decision to purchase new cooling equipment, what was your ONE most important concern? [DO NOT READ. SAME LIST AS I3.] [ACCEPT ONE RESPONSE]

I28. [IF I2 ≠ 14] Did you have any other concerns? [DO NOT READ] [ACCEPT MULTIPLE]

15. Speed of installation
16. Purchase cost of unit
17. Installation cost of unit
18. Operating cost of unit
19. Reliability
20. Comfort
21. Improving health and safety of facility
22. Saving energy / energy efficiency of unit
23. Reputation of equipment brand
24. Reputation of contractor
25. Quality of installation work
26. Other (Specify: _____)
27. No other concerns
28. Don't know / refused

I29. Thinking of the work that the HVAC contractor did when installing your new cooling equipment, how would you rate the quality of the installation? Please give your response

using a scale of 1 to 5, where 1 is “extremely poor quality installation” and 5 is “extremely good quality installation.” [RECORD A NUMBER 1-5, 6 = Don’t know / refused]

I30. Why did you give this rating? [99 = Don’t know / refused]

I31. Approximately how long did the HVAC technician take to install your cooling equipment? [Probe for best estimate] [If ‘Don’t Know, Probe: ‘Was it less than or more than 4 hours?’ And work from there to get estimate.] [DO NOT READ]

10. Less than 4 hours
11. Between 4 and 5 hours 59 minutes
12. Between 6 and 7 hours and 59 minutes
13. Between 8 and 9 hours and 59 minutes
14. Between 10 and 11 hours and 59 minutes
15. Between 12 and 13 hours and 59 minutes
16. Between 14 and 15 hours and 59 minutes
17. 16 hours or more
18. Don’t know / don’t remember / refused

ALL RESPONDENTS WILL BE ASKED I32 THROUGH I44, EXCEPT AS NOTED IN SPECIFIC QUESTION SKIPS.

AWARENESS OF QI

I32. Have you heard of the term “Quality Installation” used to describe an approach to the proper installation of commercial air conditioning systems?

1. Yes [GO TO I34]
2. No
3. Don’t know / refused

I33. [IF I32 = 2 OR 3] Quality Installation requires that a new commercial air conditioning system is selected and installed according to specific industry standards and guidelines so as to ensure the proper performance of the system. Have you heard of the term Quality Installation?

1. Yes [GO TO I35]
2. No
3. Don’t know / refused

[IF I10 = 2 OR 3, SKIP TO PARAGRAPH ABOVE I39]

KNOWLEDGE & USE OF QI

I34. What do you understand is meant by the term “Quality Installation” of commercial cooling systems? [99 = Don’t know / refused]

I35. Before this call today, were you aware of any Quality Installation guidelines or programs?

I36. [IF I35 = 1] Which Quality Installation guidelines or programs were you aware of? [DO NOT READ. CHECK ALL THAT APPLY]

- 9. ENERGY STAR
- 10. ACCA Standard 5
- 11. ACCA Standard 9
- 12. SCE rebates on Professional Air Conditioning Installation
- 13. PG&E AC Quality Care Rebate Program
- 14. SDG&E AC Quality Care Rebate Program
- 15. Other [SPECIFY: _____]
- 16. None / Don’t know / refused

I37. What do you understand to be the benefits of Quality Installation of HVAC equipment? [DO NOT READ. CHECK ALL THAT APPLY]

- 10. Achieve safe operating conditions
- 11. Improve indoor air quality
- 12. Increase energy savings and reduce energy bills
- 13. Prolong a system’s operational lifespan
- 14. Prevent expensive repairs
- 15. Improve a system’s reliability
- 16. Ensure comfort
- 17. Other [SPECIFY: _____]
- 18. Don’t know / can’t say / refused

I38. On average, what percentage savings on your electric bill do you think you will get from having a contractor perform a Quality Installation of your HVAC equipment? [0=No savings; 99= Don’t know / refused] ___%

A properly installed HVAC system may provide some potential benefits. I’m going to read you a list of possible benefits. Using a scale of 1 to 5, where 1 is “not at all important” and 5 is “extremely important,” how would you rate the benefits in terms of how important they are to you. [RANDOMIZE M21 -M26] [RECORD A NUMBER 1-5, 6 = Don’t know / refused]

I39. Achieve safe operating conditions

- I40. Improve indoor air quality
 - I41. Increase energy savings and reduce energy bills
 - I42. Prolong a system's operational lifespan
 - I43. Prevent expensive repairs
 - I44. Improve a system's reliability
 - I45. Ensure comfort
- I46. Are you aware of the ENERGY STAR label for energy efficient HVAC equipment?
- 4. Yes
 - 5. No
 - 6. Don't know / refused

EXPERIENCE WITH CONTRACTOR

[IF AC2 = 1 AND AC12a, b, c, or d = 1, CONTINUE, OTHERWISE GO TO D11]

ONLY RESPONDENTS WHO INSTALLED AN AC IN PAST TWO YEARS WILL BE ASKED I47 THROUGH I25

- I47. [IF I32 = 1 OR I10 = 1] Did the contractor who installed your new cooling equipment do so according to Quality Installation guidelines?
- 4. Yes
 - 5. No
 - 6. Don't know / refused
- I48. [IF I32 = 1 OR I10 = 1] At the time you were deciding upon a contractor to install your new HVAC equipment, did you specifically ask about their use of Quality Installation guidelines?
- 4. Yes
 - 5. No
 - 6. Don't know / refused
- I49. At the time of purchase of your new HVAC system, did the installing contractor offer you a service agreement for the maintenance of your HVAC system?
- 4. Yes
 - 5. No
 - 6. Don't know / refused
- I50. [IF I22 = 1] Did you accept the service agreement for the maintenance of your HVAC system?
- 4. Yes
 - 5. No
 - 6. Don't know / refused

Firmographics (2 Minutes)

D11. What is the main business activity at this facility?

6. Office (non-medical)
7. Restaurant/Food Service
8. Food Store (grocery/liquor/convenience)
9. Agricultural (farms, greenhouses)
10. Retail Stores
11. Warehouse
12. Health Care
13. Education
14. Lodging (hotel/rooms)
15. Public Assembly (church, fitness, theatre, library, museum, convention)
16. Services (hair, nail, massage, spa, gas, repair)
17. Industrial (food processing plant, Manufacturing)
18. Laundry (Coin Operated, Commercial Laundry Facility, Dry Cleaner)
19. Condo Association / Apartment Manager (garden style, mobile home park, high-rise, townhouse)
20. Public Service (fire, police, postal, military)
21. Other [Specify: _____]
22. Don't know / refused

D12. How many buildings does your business occupy at this location?

10. None (partial occupancy)
11. One
12. Record # of Buildings _____
13. Don't know / refused

D13. [IF D12 = 1] Does your business occupy a portion of the building?

1. Yes
2. No
3. Don't know / refused

D14. [IF D12 = 2] Does your business occupy your entire building?

1. Yes
2. No
3. Don't know / refused

D15. [IF D13 = 1 OR D14 = 2] What percentage of the building does your organization occupy at this location? [RECORD %]

D16. What is the total square footage at this facility?

14. Less than 1,500 sq. ft.
15. 1,500 – 5,000 sq. ft.
16. 5,000 – 10,000
17. 10,000 – 25,000
18. 25,000 – 50,000
19. 50,000 – 75,000
20. 75,000 – 100,000
21. Greater than 100,000
22. Don't know / refused

D17. Is the entire floor area of this facility heated or cooled?

13. Yes
14. No
15. Don't know / refused

D18. What percentage of floor area of this facility is heated or cooled? [RECORD %]

11. Some graduate school
12. Graduate or professional degree
13. Post graduate
14. Don't know / refused

D19. Does your organization own, lease or manage this facility?

14. Own
15. Lease/Rent
16. Manage
17. Don't know / refused

D20. Does your organization pay the electric and/or gas utility bill?

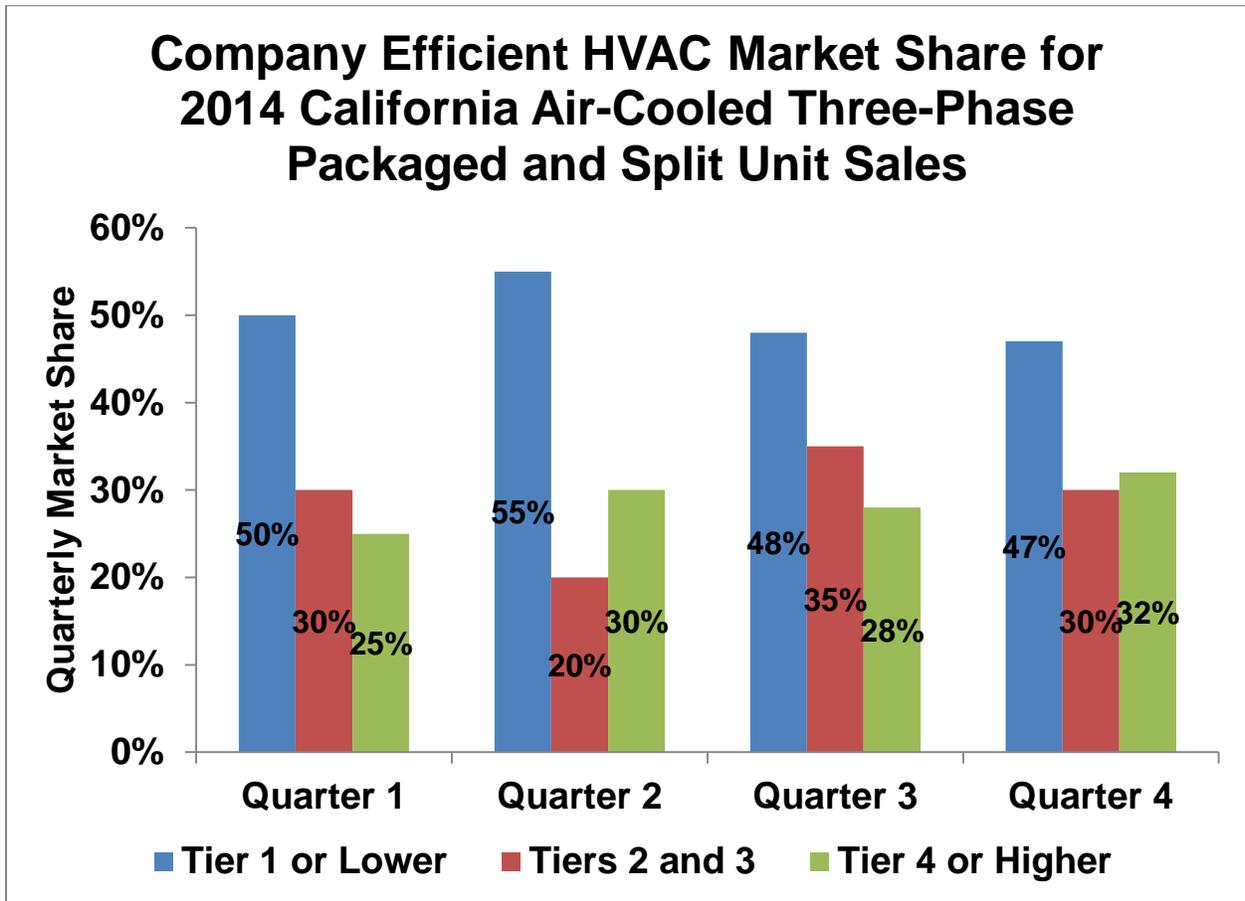
1. Yes
2. No
3. Don't know / refused

D21. In what year was the facility built? [RECORD YEAR]

Thank you, those are all the questions I have for you.

Appendix J Mock-up Materials to be Provided to Market Share Tracking System Participants

Mock-up of Graph Showing Distributor’s Market Share in a Particular Region



Mock-up of Table Showing Sales and Distributor’s Market Share in all Regions and California

Report for:				2014 Market Share Report								
Company Efficient HVAC				Air-cooled three-phase packaged and split units (<5.4 tons)								
Address												
Market Area	Tier 1 or Lower			Tiers 2 and 3			Tier 4 or Higher			Overall (All EER/SEER Levels)		
	Units Sold			Units Sold			Units Sold			Units Sold		
	Company Efficient HVAC	All Distributors	Market Share	Company Efficient HVAC	All Distributors	Market Share	Company Efficient HVAC	All Distributors	Market Share	Company Efficient HVAC	All Distributors	Market Share
Region 1												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
Region 2												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
Climate Zone 3												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
Climate Zone 4												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
Climate Zone 5												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
Statewide California												
1st Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
2nd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
3rd Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
4th Qtr	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%
YTD	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%	xx	xx	xx.x%