U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES

Job/Task Analysis for a Commercial Building Energy Auditor: Public Comment Draft

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Commercial Building Energy Auditor
Job Description

A Commercial Building Energy Auditor is an energy solutions professional who assesses facility systems, observes site conditions, analyzes and evaluates equipment and energy usage, and recommends strategies to reduce energy, water and associated costs to help clients meet established goals.

A proposed content outline resulting from this Job/Task Analysis follows.

Commercial Building Energy Auditor	
A	Determining the Job Scope
B	Collecting and Reviewing Preliminary Data
C	Inspecting Building Conditions and Operations
D	Identifying and Evaluating Measures
E	Reporting Findings

This Job/Task Analysis used input from a broad group of industry practitioners and was facilitated by Professional Testing, Inc. for the National Renewable Energy Laboratory and the U.S. Department of Energy.

Contents

1.0 Introduction

The National Renewable Energy Laboratory secured the services of Professional Testing to help develop a job/task analysis (JTA) for commercial building energy auditors.

JTA is a procedure for analyzing the tasks performed by individuals in an occupation, as well as the knowledge, skills, and abilities required to perform those tasks. Specifically, a JTA can be defined as "any systematic procedure for collecting and analyzing job-related information to meet a particular purpose" (Raymond 2001). JTA can be used to describe, classify, and evaluate jobs; ensure compliance with legal and quasi-legal requirements; develop training, promote worker mobility, plan workforces, increase efficiency and safety, and appraise performance (Brannick et al. 2007).

JTA is traditionally used by secondary and postsecondary educators, test developers, and business, industry, government, and military trainers to help identify core knowledge areas, critical work functions, and skills that are common across a representative sampling of current practitioners.

This project used the "developing a curriculum" (DACUM) method to conduct a JTA. DACUM is an occupational analysis led by a trained facilitator, where practitioners in a specific occupation come together for a multiday workshop to provide input about the specific tasks, knowledge, and skills needed to perform their job.

This document provides draft results of the analysis and will form the basis for a subsequent "industry validation" phase, where a larger group of industry practitioners will evaluate the list of job-related tasks. This group will ensure that the identified tasks and weighting factors accurately represent the job of a commercial building energy auditor. This step will also provide an opportunity for industry to identify any missed tasks or any that were included erroneously.

The content presented in this document was created by industry practitioners and is intended to portray the job of a commercial building energy auditor as currently practiced.

2.0 Subject Matter Expert Selection Process

Professional Testing helped to establish the criteria for selecting the DACUM panel of subject matter experts (SMEs). To be eligible for the workshop panel, applicants were required to submit an electronic application and to demonstrate that they were active practitioners in their field. To create a representative panel of practitioners, Professional Testing selected SMEs from a larger applicant pool to ensure:

- Geographic diversity
- Representation of a wide range of experience levels (novice to expert)
- No single organization or organization size dominated the group
- All sectors were represented with no single sector dominating (public versus private)
- Diversity of industry-related credentials, represented by the panelists.

Twelve applicants meeting the above criteria were selected to create the commercial building energy auditor SME panel.

3.0 Job/Task Analysis Workshop

The commercial building energy auditor JTA workshop was held in Denver, Colorado, May 11–13, 2011.

Day 1 consisted of an introduction to the DACUM process. The trained DACUM facilitator explained the JTA process and provided the SME panel with duty and task statement definitions. A duty reflects a large area of work for a specific profession; multiple tasks describe how to perform each duty. The presentation then shifted to a discussion about commercial building energy auditors, more specifically the "who, how, what, and why" of the profession. The SME panelists compiled this information into a comprehensive list to capture key commercial building energy auditor job components.

The DACUM Philosophy:

- **Practitioners can describe and define their jobs more accurately than anyone else.**
- **One of the most effective ways to define a job is to describe the tasks practitioners perform.**
- **All jobs can be effectively and sufficiently described in terms of the tasks successful workers perform.**
- **All tasks, to be performed correctly, demand certain knowledge, skills, abilities, attributes, and tools.**

The next step was to identify duty (or domain) areas. Once the SME panelists reached consensus on the duty areas, they delineated each duty by identifying the required tasks.

On Day 2, the facilitator projected a spreadsheet that contained the identified duty areas and corresponding task statements. The SMEs were asked to list the steps under each task and to identify the knowledge, skills, abilities, and tools needed to complete each task.

On Day 3, work concluded with the SMEs finalizing an overarching job description for commercial building energy auditors.

4.0 Results

This document presents aspects of a commercial building energy auditor, as captured by the 12-member panel during the May 11–13, 2011 JTA workshop in Denver, Colorado. The tables that follow reflect job requirements and are meant to provide a clear understanding and detailed description of the work performed.

5.0 References

Brannick, M. T., Levine, E. L., & Morgeson, F. P. (2007). Job and work analysis: Methods, research and *applications for human resource management*. Thousand Oaks, CA: Sage.

Raymond, M.R. (2001). Job analysis and the specification of content for licensure and certification examinations. *Applied Measurement in Education 14*(4), 369-415.

6.0 Nomenclature

Table 1 provides a list of the acronyms and abbreviations used in this document. In addition to increasing the efficiency of communications, many technical and process acronyms are useful in memory retention and learning. Occupational acronyms are therefore of interest to trainers and curriculum designers.

Table 1: List of Acronyms and Abbreviations

Nomenclature	Definition
AC	Alternating current
ACCA	Air Conditioning Contractors of America
AFC	Alkaline fuel cell
AFD	Adjustable frequency drive
AHJ	Authority having jurisdiction
AHU	Air handling unit
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BAS	Building automation system
bhp	Brake horsepower
BTU	British thermal unit
CAV	Constant air volume
cfm	Cubic feet per minute
CO	Carbon monoxide
CO_2	Carbon dioxide
CT	Current transformer
DACUM	Developing a curriculum
DC	Direct current
DDC	Direct digital controls
DMFC	Direct methanol fuel cell
DOAS	Dedicated outdoor air system
DOE	Department of Energy
DSIRE	Database of State Incentives for Renewable Energy
DX	Direct expansion
EA-QUIP	Energy Audit using the Queens Information Package
ECM	Electronically commutated motor
EISA	Energy Independence and Security Act
EMS	Energy management system
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
EUI	Energy use index
F	Fahrenheit
HERS	Home Energy Rating Systems
HRSG	Heat recovery steam generator
HVACR	Heating, ventilation, air-conditioning, and refrigeration
IAPMO	International Association of Plumbing and Mechanical Officials
IESNA	Illuminating Engineering Society of North America
IGV	Inlet guide vane
IPMVP	International Performance Measurement and Verification Protocol

Table 1 (Continued): List of Acronyms and Abbreviations

Nomenclature	Definition
JTA	Job/task analysis
LBNL	Lawrence Berkeley National Laboratory
M&V	Measurement and verification
MCCs	Motor control centers
MCFC	Molten carbonate fuel cell
MHEA	Mobile Home Energy Audit
MZ	Multi(multiple) zone(s)
NEAT	National Energy Audit Tool
NIBS	National Institute of Building Sciences
OA	Outdoor air
O&M	Operations and maintenance
OEM	Original equipment manufacturer
OSHA	Occupational Safety and Health Administration
PAFC	Phosphoric acid fuel cell
PEMFC	Polymer electrolyte membrane fuel cell
PPE	Personal protective equipment
PSC	Permanent split capacitor
PSI	Pounds per square inch
PTAC	Packaged terminal air conditioner
PV	Photovoltaic
QI	Quality installation
REM	Residential Energy Management/Rating software
RETScreen	Renewable-energy and Energy-efficient Technologies Screening Software
RH	Relative humidity
RHA	Real Home Analyzer
RTU	Remote terminal unit
SCADA	Supervisory control and data acquisition
SME	Subject matter expert
SOFC	Solid oxide fuel cell
SZ	Single zone
TAP	Tariff Analysis Project
TES	Thermal energy storage
TIAP	Tax Incentives Assistance Project
TREAT	Target Residential Energy Analysis Tool
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
US	United States
USB	Universal serial bus
VAV	Variable air volume
VFD	Variable frequency drive
VRV	Variable refrigerant volume
WVO	Waste vegetable (or vehicle) oil

7.0 Proposed Content Blueprint

The SMEs rated the list of job-related duties and tasks defined during the JTA workshop based on a two-factor scale: the importance of the duty area or task to overall job performance and the frequency with which duties and tasks are performed. The result is a weighted ranking of the duties and tasks known as a *content blueprint*.

The proposed content blueprint provides an initial basis from which an assessment (e.g., a certification or licensure examination) may be constructed and provides curriculum developers with a model to align training to the core needs of the occupation.

Table 2: Proposed Content Blueprint for Commercial Building Energy Auditors

Duties and Tasks		Weighting
A	**Determining the Job Scope**	**18%**
1	Determine the Client's Intentions/Expectations	4%
2	Determine the Report Audiences	4%
3	Write Audit Scope of Work	4%
4	Develop the Audit Proposal	3%
5	Estimate the Energy Audit Fee	3%
B	**Collecting and Reviewing Preliminary Data**	**23%**
1	Conduct Pre-Audit Interviews	3%
2	Request Documents	3%
3	Identify the Audit Team	3%
4	Evaluate Utility Usage	4%
5	Research Incentives, Rebates and Credits	3%
6	Review Documents	4%
7	Develop Preliminary Audit Plan	3%
C	**Inspecting Building Conditions and Operations**	**32%**
1	Conduct General Onsite Activities	4%
2	Conduct Building Envelope Audit	4%
3	Conduct Building Mechanical Systems Audit	4%
4	Conduct Building Interior Audit	4%
5	Conduct Water Systems Audit	4%
6	Conduct Interior/Exterior Building Lighting Audit	4%
7	Conduct Building Controls Audit	4%
8	Conduct Interviews of Interested Parties	4%
D	**Identifying and Evaluating Measures**	**16%**
1	Develop Conceptual Solutions	4%
2	Develop Analysis Approach	4%
3	Develop Selected Measures	4%
4	Perform Financial Analyses	4%
E	**Reporting Findings**	**11%**
1	Create Draft Report of Findings	4%
2	Finalize Energy Audit Report	4%
3	Present the Energy Audit Findings	3%
Total		**100%**

8.0 Knowledge

The SMEs identified and categorized specific types of knowledge needed to be a proficient commercial building energy auditor (Table 3). General knowledge areas (calculations, basic measurements, and communications), although not exclusive to this occupation, were also identified using a group consensus process (Table 4). The panelists concluded that a practitioner must master the knowledge in both tables to be competent as a commercial building energy auditor.

Table 3: Specialized Knowledge Required of Commercial Building Energy Auditors

Specialized Knowledge	
Accounting principles	Energy recovery methods
Alternate sources for required documents	ENERGY STAR portfolio manager
Alternative HVACR system configurations	Engineering economics
Analysis methods	Engineering principles
Appropriate personnel for scope	Equipment specifications
Auditing processes	Existing and emerging technologies
Background basis for simulation software	Expected water use
Basic electrical practices and safety	Facility management documentation
Benchmark data resources	Financial software
Building construction practices	General business practices
Building control devices and strategies	Greenhouse gas calculations
Building envelope	Health and safety hazards
Building functionality and serviceability	HVACR controls
Building life cycle	Hydronic systems
Building materials	Impact of occupancy
Building mechanical systems	Impact on operational systems
Building ownership models	Incentives, rebates and credits
Building sciences (thermodynamics, heat transfer, etc.)	Industry terminology, jargon, and acronyms
Building systems and usage	Integrated lighting system design
Building terminology	Internal rate structures
Client procurement methods	Irrigation systems/controls
Codes, standards, and guidelines	Job descriptions of personnel
Construction documents	Life cycle costing
Construction practices	Lighting systems/controls
Construction techniques and costs	Lighting levels for space types
Controls and control points	Limitations and capabilities of analyses tools
Controls integration and protocols	Local jurisdictional (AHJ) requirements
Conversion factors	M&V protocols
Costs for services	Maintenance practices
Costs involved in an energy audit	Measure interactions
Current market rates for auditing	Mechanical systems
Data loggers (installation, setup)	Non-potable water systems
Diagnostic equipment operating parameters	O&M procedures
Document process management	Occupant comfort requirements
EMS or SCADA systems	On-site and district energy sources
Energy auditing processes/resources	Operating/maintenance procedures for HVACR
Energy calculation methodologies	Optimization techniques
Energy efficiency measures	Organizational structure
Energy projects and implementation	Plug loads

Table 3 (Continued): Specialized Knowledge Required of Commercial Building Energy Auditors

Specialized Knowledge	
Potential efficiency measures	Trending systems/trend data
Pump controls and operation	Typical and unique space requirements
Regulatory and reporting requirements	Typical control anomalies
Renewable energy	Typical facility uses
Roles and responsibilities	Typical measure costs
Safety requirements and procedures	Typical mechanical operating parameters and conditions
Simulation software	Typical ownership leases
Special site requirements	Typical project costs
Survey design	Unit conversion factors
Sustainable landscape principles	Utility analysis tools
System integration	Utility rate structures and contracts
System interactions	Water and sewer rate structures
Tax implications and expiration dates (credits, deductions, depreciation, etc.)	Water efficiency measures
Thermostat capabilities	Weather normalization

Table 4: General Knowledge Required of Commercial Building Energy Auditors

General Knowledge	
Calculations	
Change numbers from fractions into decimals and back	Perform simple math operations of addition
Change numbers from percentages into decimals and back	Perform simple math operations of division
Collect information to solve a problem	Perform simple math operations of multiplication
Compare numbers	Perform simple math operations of subtraction
Figure averages	Solve formula calculations with one or more unknowns
Make rough estimates	Solve percent problems
Measure angles	Solve problems with graphs
Multiply and factor algebraic expressions	Solve ratio problems
Perform math operations using exponential numbers	Solve right triangle problems using Pythagorean theorem
Perform math operations using signed (positive and negative) numbers	Solve right triangle trigonometry problems
Perform math operations using single and multiple digit numbers	Transfer number sequences from a source into a column
Perform mathematical operations with decimals	Use a calculator
Perform mathematical operations with fractions	

Table 4 (Continued): General Knowledge Required of Commercial Building Energy Auditors

General Knowledge	
Basic Measurements	
Calculate the perimeter and areas of common figures	Measure board feet
Convert measurements from one unit into another (English to metric, etc.)	Measure length to 1/4 of an inch
Estimate and approximate measurements	Measure linear distances (length, width, etc.)
Find distances and directions on land maps	Read and apply coefficient measurements indicated in a table or chart
Find the dimensions of an object from a scale drawing	Read and use the scale of a drawing
Measure temperature to within 1 degree F	Read measurements taken with common measuring tools
Measure volume (cubic inches, liters, etc.)	Read, interpret, and use size-scale relationships
Make simple scale drawings	Record measurements, using appropriate unit notations (feet, yards, etc.)
Measure area (square inches, square centimeters, etc.)	Use tools to measure quantities and solve problems involving measurements
Communications	
Apply assertiveness	Participate in brainstorming
Ask questions	Present to others
Communicate using the vocabulary/terminology of a related trade	Read and follow a map, chart, plan, etc.
Communicate with co-workers and/or business people in writing (letters, memos)	Read and follow directions found in equipment manuals and code books
Communicate with co-workers and/or business people verbally (face-to-face)	Read and interpret directions found on labels, packages, or instruction sheets
Communicate with co-workers and/or business people verbally (telephone, radio)	Read codes (building codes, electrical codes, standards, etc.)
Compare names	Read drawings and specifications sheets
Evaluate options/alternatives	Read flowcharts
Evaluate solutions	Read information from tables and graphs (bar, circle, etc.)
Explain procedures	Read statistical data
Find information in catalogs	Research information
Find information in references (Machinery Handbook, tap/drill charts, etc.)	Summarize information
Follow verbal job instructions	Write reports
Listen	Write words and numbers legibly

9.0 Skills, Abilities, and Attributes

A proficient worker possesses key skills, abilities, and attributes that influence job success. Skills are developed through experience and training and may apply to a wide range of tasks; proper skills enable workers to perform their tasks with precision and quality.

Abilities and attributes are more fundamental than knowledge and skills; they represent underlying, enduring traits, both cognitive and physical, that support the successful performance of a wide range of job tasks.

The panelists identified task-specific skills and abilities, as well as broad attributes (e.g., analytic, creative, patient), to define the recommended traits a commercial building energy auditor should possess (Table 5).

Human Resource professionals and job analysts often analyze skills, abilities, and attributes to compare jobs in terms of worker characteristics.

Table 5: Skills, Abilities, and Attributes Required of Commercial Building Energy Auditors

Skills, Abilities, and Attributes	
Ability to accept constructive criticism	Critical thinker
Ability to comprehend mechanical/technical documentation	Customer-oriented
Ability to conceptualize solutions	Dependable
Ability to create spreadsheet calculations	Detail-oriented
Ability to create graphical presentations	Diplomatic
Ability to decipher construction drawings	Documentation skills
Ability to estimate costs	Eager to learn new things
Ability to interpret reports	Engineering skills
Ability to match expertise to audit scope	Enthusiastic
Ability to research logistics costs (hotels, travel, etc.)	Ethical
Ability to translate technical documents to laymen terms	Focused
Ability to use simulation software	Free of substance abuse
Ability to visualize or conceptualize	Friendly
Ability to write for appropriate audiences	Goal-oriented
Ability to write for multi-disciplinary audiences	Helpful
Accurate/precise	Honest
Adaptable/flexible	Humility
Analytical skills	Industrious
Appropriate dresser	Tactful
Basic design skills	Initiative
Basic statistics skills	Integrity
Brevity	Interpersonal skills
Business writing skills	Interviewing skills
Common sense	Investigative skills
Computer skills	Leadership skills
Confident	Listening skills
Conscientious	Manages stress or pressure
Cooperative	Math skills (basic & advanced)
Courteous	Meticulous
Creative	Multi-tasker

Table 5 (Continued): Skills, Abilities, and Attributes Required of Commercial Building Energy Auditors

Skills, Abilities, and Attributes	
Neat	Research skills
Non-aggressive	Respectful
Observational skills	Responsible/accountable
Open-minded to change	Safety conscious
Organizational skills	Self-discipline
Patience	Self-motivated
Persistent	Sensitive to thoughts of others
Personal hygiene	Situational awareness
Physical stamina	Social skills
Planning and prioritization skills	Spreadsheet skills
Positive attitude	Team player
Presentation skills	Technical writing skills
Pride in job	Time management skills
Professional	Tolerant
Proposal writing skills	Trustworthy
Punctual	Unbiased
Quality focused	Verbal communication skills
Questioning ability	Written communication skills
Report generation skills	

10.0 Physical Conditions

In any job, the environment in which tasks are completed and the specific physical requirements necessary to complete each task must be understood. Awareness of physical conditions is useful for a variety of purposes, including ergonomic design, safety analysis, and the identification of job elements that are deemed essential functions for compliance with The Americans with Disabilities Act.

Table 6 contains the list of panelist-recommended physical conditions a commercial building energy auditor should possess.

Table 6: Physical Conditions Recommended for Commercial Building Energy Auditors

Physical Conditions	
Bend forward frequently	Work around or near high voltage power sources or equipment
Carry objects of up to 25 pounds	Work around or near magnetic equipment or materials
Climb ladders, stairs, poles, etc. using legs and/or arms	Work at heights of 76 feet or higher above ground or floor level
Crawl or creep	Work in changing temperatures (in and out of buildings repeatedly)
Detect abnormal noises	Work in confined spaces
Feel size, shape and temperature or texture of objects with the hands	Work in damp places (high humidity, some standing water)
Handle hot or cold objects	Work in dry places (lacking any natural moisture or humidity)
Hear speech	Work in dust, oils, fumes, or smells
Hold or move objects using the fingers	Work in high temperatures (85 to 130 degrees F)
Judge depth (the position and distance of objects) with the eyes	Work in low temperatures (0 to 45 degrees F)
Pull objects with arms or hands	Work in sub-zero temperatures (0 and lower)
Push objects with arms or hands	Work in noisy places (85 decibels or higher with ear protection)
Reach with arms and hands in any direction	Work in one place (no change of work location)
See and discriminate colors	Work in stale air (with some oxygen depletion)
See clearly at 20 feet or more (with/without optical assistance)	Work inside
See clearly at 20 inches or less (with/without optical assistance)	Work on slippery surfaces
Sit part of the time	Work outside
Stand all of the time	Work while sitting or standing on high roofs, overhangs, or I-beams
Stand at all	Work while standing on portable ladders
Stand part of the time	Work while standing on scaffolding
Stoop, kneel, or crouch	Work while wearing protective equipment (respirators, hoods, etc.)
Talk	Work with hands and arms over head level
Walk	Work with or near fiberglass or asbestos materials

11.0 Tools, Equipment, and Resources

Each occupation requires a unique set of support materials. It is important to identify the tools, equipment, and other tangible objects, as well as the resources (e.g., information technologies, codes and standards) required for a worker to effectively accomplish tasks. Table 7 lists the panelist-identified inventory of tools, equipment, and resources necessary to perform the identified tasks.

Table 7: Tools, Equipment, and Resources Used by Commercial Building Energy Auditors

Tools, Equipment, and Resources	
General Tools, Equipment, and Resources	
Access to building control systems front-end	DSIRE website
Architectural tools	Government information/websites
Calculator	Large work area
Client historical information	Projection equipment
Computer/internet access	Reproduction tools for documents
Controls operations manual	Standardized questionnaire
Controls operator	Telephone
Controls service vendor	Utility websites/rate information
Cost estimating resources (construction cost data, vendor cost sheets, cost estimating guides, etc.)	Vendor specifications/manuals/websites
Digital recorder	Weather data
Auditing Tools	
5 gallon bucket	Multimeter with CT clamps
Ballast checker (discriminator)	Nut driver
Blower door testing apparatus	Occupancy logger
Calculator	Power drill
CO detector	Power meter
CO_2 sensor	Psychrometer or hygrometer
Combustion analyzer	Replacement batteries
Compass	RH logger
Digital camera	Screwdriver
Energy loggers	Solar pathfinder
Extendable Flexible Mirror	State logger
Flashlight	Static pressure sensing devices
Flow meters	Stopwatch
Flow hood	Tachometer
Infrared camera	Tape measure or laser measuring device
Infrared temperature sensor	Temperature logger
Ladder	Temperature sensor
Light level meter	USB flash drive
Light logger	Walk-off wheel
Manometer	Water pressure sensor or gauge

Table 7 (Continued): Tools, Equipment, and Resources Used by Commercial Building Energy Auditors

Tools, Equipment, and Resources	
Software	
EA-QUIP	Project planning software
Financial analysis software	RHA
HERS	Report generation software
Lifecycle costing software	REM
MHEA	Spreadsheet software
Modeling software	TREAT
NEAT	Utility bill analysis software
Productivity software	
Online Resources	
A non-profit organization spun out of US DOE initiative for IPMVP	http://www.evo-world.org/
Average daily temperature archive; University of Dayton	http://academic.udayton.edu/kissock/http/Weather/default.htm
DSIRE; DOE funded based in North Carolina	http://dsireusa.org/
Iowa State University resource on DDC	http://www.ddc-online.org/
RETScreen; a Canadian government sponsored resource	http://www.retscreen.net/ang/home.php
TAP; DOE/LBNL funded resource on several electric tariffs in the US	http://minotaur.lbl.gov/tariffs/
TIAP; a public funded resource on tax incentives	http://energytaxincentives.org/
US DOE resource and links for various weather data sources	http://apps1.eere.energy.gov/buildings/energyplus/cfm/weather_data.cfm
US DOE resource for energy simulation models input file generation	http://apps1.eere.energy.gov/buildings/energyplus/cfm/inputs/
US EPA resource for facility energy benchmarking	http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
Codes, Standards, and Guidelines	
ACCA 5 QI Standard	EISA 2007
ASHRAE Standards 14, 55, 62.1, 62.2, 90.2, 100, 189	EPA guidelines
ASHRAE Design Guides	EPACT 2005
ASHRAE Guidelines 0, 1.1 & 2	Green Technical Supplement to UMC/UPC (IAPMO)
ASHRAE Guidelines Procedures for Commercial Building Energy Audits	IESNA
ASTM E2797-11	IPMVP
Building codes	NIBS Guideline GL3
DOE guidelines	OSHA

Table 7 (Continued): Tools, Equipment, and Resources Used by Commercial Building Energy Auditors

Tools, Equipment, and Resources	
Personal Protective Equipment (PPE)	
CO personal monitor	Hardhat
Coveralls (disposable)	Respirator
Dust mask	Safety glasses/goggles
Ear protection/hearing protection	Safety harness
Gloves	Safety shoes

12.0 Systems Audited

The supplemental information presented in Table 8 was identified by the panelists and details building systems that may be included in an audit performed by a commercial building energy auditor.

Table 8: Systems Audited by Commercial Building Energy Auditors

Systems Audited by Commercial Building Energy Auditors
Primary HVACR Systems and Accessories
Central HVACR Systems and Accessories
Boiler burners, controllers, linkages, servo-motors, gas trains, single/dual fuels, oil/propane atomizers etc.
Boiler feed water, deaerators (various types), flash tanks/systems, boiler Hartford loop, etc.
Central plant control systems and controllers (SCADA, BAS, EMS, OEM-controllers, etc.)
Chillers - absorption (low temp, high temp, other)
Chillers - air cooled packaged, air cooled split DX (scroll, screw, reciprocating, other)
Chillers - water cooled (centrifugal, centriful with magnetic bearings, scroll, other)
chillers compressor inlet guide vanes, adaptive/variable frequency drives, purse units, OEM controllers
Combustion air systems for boiler room
Compressed air systems (simplex, duplex, air cooled, water cooled, AFDs/VFDs, dryers, storage tanks etc.)
Condensate return system (tanks, pumps, traps, etc.)
Cooling towers - evaporative (induced draft, forced draft, architectural/custom-build, other)
Dry coolers (packaged, remote, other)
Energy recovery systems (stack energy reclaim systems etc.)
Heat exchanges (various types - plate and frame, tube and shell, etc.)
Hot water boilers - condensing (various types)
Hot water boilers - high temperature non-condensing (specially manufactured)
Hot water boilers -non-condensing (cast iron, marine, fire tube, water tube, others)
Large motors AFDs/VFDs (air cooled, water cooled, refrigerant cooled, other)
Piping, hydronic distribution system, and accessories (see plumbing systems)
Pump stations and controllers (packaged, field assembled, other)
Pumps - water (chilled/condenser/hot), condensate, booster, other (various pump types)
Refrigerant monitoring systems
Small (non-district energy) chilled water storage (TES tanks etc.)
Small (non-district energy) ice storage systems (ice tanks, etc.)
Steam boilers - low pressure (<15psi), medium pressure, high pressure (>100psi)
Tower basin - within tower, remote/underground, free protection heaters, etc.
Tower fans - motors, drives AFD/VFD, gears, belts, blades, etc.
Tower fill - draft eliminators, drift eliminators, mist eliminators, etc.
Ventilation air systems for equipment room
Water treatment systems - water filters (sand filters, others), water softeners, chemical treatment, non-chemical treatment systems, etc.

Table 8 (Continued): Systems Audited by Commercial Building Energy Auditors

Systems Audited by Commercial Building Energy Auditors
Primary HVACR Systems and Accessories
Central Air-Handling Systems and Accessories
Large AHU air distribution ducts (low pressure, medium pressure, etc.)
Large AHU controllers, IGVs, VFDs, pressure sensors, temperature sensors, etc.
Large AHU dampers, valves, actuators (pneumatic, high torque, etc.)
Large AHU fans and motors (axial, centrifugal, dual fan, belt drive, direct drive, etc.)
Large AHU filters (bag, special, pre, post, other)
Large AHU furnace (packaged, staging, single/multiple burners, etc.)
Large AHU return, relief, and exhaust systems (various damper types, various fans - inline, utility, custom, etc.)
Large AHU sound attenuators and duct liners
Large AHUs application - dual duct, SZ, MZ, CAV, VAV, other
Large AHUs coils - hot water, steam, chilled water, DX cooling
Large AHUs configuration (blow thru, draw thru, hot/cold deck, etc.)
Large AHUs or RTUs (30,000 - 120,000 cfm) - packaged, custom build, other
District Energy Systems and Accessories
District energy boiler plants (central, satellite plants, other; usually >150 bhp installed)
District energy chiller plants (central, satellite plants, other; usually >2500 tons installed)
District energy cogeneration system waste heat systems (HRSGs, recuperators, etc.)
District energy distribution systems (pipes, accessories, BTU meters, pressure-independent valves, etc.)
District energy hydronic distribution system and accessories (see plumbing systems)
District energy SCADA systems and OEM controllers
District energy storage systems (large TES tanks, >500,000 gallons; buried, partial buried, above ground etc.)
District energy waste to energy systems

Table 8 (Continued): Systems Audited by Commercial Building Energy Auditors

Systems Audited by Commercial Building Energy Auditors
Secondary HVACR Systems and Accessories
AHU air distribution ducts (low pressure, medium pressure etc.)
AHU controllers, IGVs, VFDs, pressure sensors, temperature sensors, etc.
AHU dampers, valves, actuators (pneumatic, high torque DDC etc.)
AHU fans and motors (centrifugal, dual fan, belt drive, direct drive etc.)
AHU filters (bag, special, pre, post, other)
AHU furnace (packaged, staging, single/multiple burners, etc.)
AHU return, relief, and exhaust systems (various damper types, various fans - inline, utility, custom, etc.)
AHU sound attenuators and duct liners
AHUs application (induction air system, dual duct, SZ, MZ, CAV, VAV, other)
AHUs coils (hot water, steam, chilled water, DX cooling)
AHUs configuration (blow thru, draw thru, hot/cold deck, etc.)
AHUs or RTUs; 1,000 - 30,000 cfm (packaged with coils, with coils & furnace, packaged DX, split DX, other)
Humidifiers (steam fed, electric steamers, water atomizers, other)
Cooling only AHUs
Energy recovery AHUs/RTUs - packaged (with heat wheel, with run-around coils, other)
Exhaust systems (hazard, lab exhausts, etc.)
Exhaust systems (non-hazard, general exhausts, garage exhausts, kitchen exhausts, etc.)
Natatorium (indoor pools) / dehumidification AHUs/RTUs (packaged, field retrofitted, other)
Packaged cooling only AHUs (usually water cooled with or without waterside economizer; space reheat with electric or hot water)
Packaged heat pump AHUs/RTUs (usually water cooled - cooling towers, geothermal, hybrid)
Split DX AHUs/RTUs (typically <10 tons, air cooled)
Ventilation AHUs/RTUs - also called 100% OA or DOAS (similar configuration as energy recovery AHUs/RTUs)
Ventilation fans (utility fans, etc.)
VRV systems (air or water cooled, 1,2,3-pipe refrigerant loop with tertiary/terminal cassettes/devices with evaporative cooling/reheat coil)

Table 8 (Continued): Systems Audited by Commercial Building Energy Auditors

Systems Audited by Commercial Building Energy Auditors
Tertiary HVACR Systems and Accessories
Cabinet unit heaters
Chilled beams
Fan coil units (2-pipe, 4-pipe, 2-way, 3-way valves, wild flow; standard fan motor, ECM fan motor)
Hydronic terminal cassettes or units (refrigerant, water, other)
Induction air units (uses primary air from AHUs / modicum pressure; 2-pipe, 4-pipe, 2-way, 3-way valves, wild flow; no fans)
Other terminal systems and devices
Packaged terminal air conditioners (also known as PTACs)
Terminal box (CAV, VAV, VAV with plenum fan - series, parallel configuration)
Terminal box with reheat - electric heating coils - staged, hot water heating coils
Under floor air distribution system
Unit ventilators
Window air conditioners (also known as window shakers)
Plumbing and Fuel Systems
Chilled water distribution systems
City or municipal water filtration and distribution systems
Condensate collection and boiler feed systems
Condensation capture, reclaim systems
Condenser water systems
Domestic service water systems (potable, cold water, hot water, recirculation water)
Fuel Systems (natural gas, propane, oil, propane-air atomized, landfill gas, etc.)
Geothermal and/or hybrid systems (ground or lake water; open, closed loop)
Gray water, rain water systems
High temperature hot water distribution systems (operates at high pressure)
Hot water distribution systems
Irrigation (lawn watering) systems
Plumbing systems interface with fire protection (sprinkler systems)
Pool water circulation, filtration, fill systems
Refrigerant distribution systems (usually with VRV systems)
Sewer, waste water, drainage systems (distribution, process, slug, digesters, etc.)
Solar thermal (hot water) systems
Steam distribution systems (low pressure <15psi, medium pressure, high pressure >100psi)
Storm water systems
Well water systems (including submersible pumps, pressurization and distribution system)

Table 8 (Continued): Systems Audited by Commercial Building Energy Auditors

Systems Audited by Commercial Building Energy Auditors
Electrical Systems
Circuit breakers and panels
Electric compressors (air cooled, water cooled, refrigerant cooled)
Electric motors (ECM, PSC, synchronous, AC, DC, inverter duty, various enclosures and rating, etc.)
Electric substations, gears, feed systems (various types)
Electric transformers (at or within client facility)
Fixed transportation systems (escalators, elevators, moving walkways; various types)
Lighting systems electric circuits (various types)
Motor control centers (MCCs)
On-site co-generation or power systems (turbines, micro turbines, fuel cells, solar PV)
On-site emergency power systems
On-site waste to energy systems
Lighting Systems
Fluorescent lighting systems
High intensity discharge lighting systems
Incandescent lighting systems (halogen, etc.)
Induction lighting systems
Light emitting diodes lighting systems
Lighting control systems (timers, scheduling, digital, management systems, etc.)
Lighting sensors (photocells, occupancy, etc.)
Natural/daylighting (light tubes, fiber optics, clerestories, skylights, other)
Specialized lighting systems (theaters, emergency, ice rinks, stadiums, etc.)
Control Systems and Controls Integration
Control systems (equipment level controllers, unit controllers, plant level controllers and SCADA, enterprise controls, etc.)
Control protocols (legacy or proprietary protocols; non-proprietary protocols, etc.)
Control system components (hardware, software, accessories; user interface - front ends, dash boards etc.)
Control system integrations (interface without EM controllers, software drivers, algorithms etc.; hardware and accessories)
Renewable Energy and Hybrid Systems
Fuel cells (PEMFC, DMFC, AFC, PAFC, MCFC, SOFC, other; various applications)
Solar energy (solar PV, solar thermal, solar thermal-cooling, solar thermal - electric, other; various types and configurations)
Geothermal (geothermal energy, ground source, lake source, open loop, closed loop, various types, configurations)
Hybrid systems (partial renewable with partial conventional energy systems, etc.)
Waste to energy (WVOs, etc.)
Envelope Elements
Doors (high efficiency rapid closure, traditional - exterior, interior etc.; various types)
Fenestration (glazed walls, clerestories, skylights, windows, etc.; various types)
Floors and flooring (various types)
Roofs and insulation (cool roofs, traditional - built-up, etc.)
Shading elements (vertical, horizontal, natural, artificial, indoor blinds etc.; various types)
Walls and insulation (various types)

13.0 DACUM Chart

The DACUM chart (Table 9) is a tabular representation of the JTA. Capital letters identify major job duty areas. Numbers identify tasks, and lowercase letters identify the steps required to accomplish each task. Moving horizontally across the chart, adjacent columns detail (1) specialized knowledge, (2) skills and abilities, and (3) tools, equipment, and resources required to perform each task. The information contained in these columns is related to each task and does not necessarily correspond to a specific step.

The importance of the DACUM chart is to show the relationship between job tasks and the specialized knowledge, skills and abilities, and tools, equipment, and resources required to perform each task. This concept, called *job-relatedness*, is essential to compliance with key legal and professional validity standards pertaining to the use of JTA information in employee selection. Such information is also critical to the development of high-stakes assessments for occupational licensing and certification examinations.

The DACUM chart depicts the job element relationships associated with each task, and can therefore easily be used to assess the relevance of current programs (curriculum), develop instructional objectives and training content, sequence instructional materials, and develop examination, competency, and performance evaluation instruments.

Table 9: DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
A	**Determining the Job Scope**			
1	Determine the Client's Intentions/Expectations			
a	Ask probing open ended questions	• Costs involved in an energy audit • Energy auditing processes/resources • Typical facility uses	• Interviewing skills • Listening skills • Verbal communication skills	• Digital recorder • Telephone
b	Ask the client to describe their business case			
c	Educate the client regarding the options available			
d	Determine client's financial criteria			
e	Assist the client in developing reasonable objectives			
f	Establish the amount client is willing to spend			
g	Determine client's timeline			
h	Review contracting methods with the client			
i	Establish the client's limits of authority			
j	Communicate regulatory requirements to the client			
2	Determine the Report Audiences			
a	Ask the client who will be reading the report	• Organizational structures	• Ability to write for multi-disciplinary audiences • Listening skills	• Telephone
b	Ask the client how the report will be used			
c	Determine number of copies of report needed			
d	Determine the format of the report			
e	Determine report special requirements for varying audiences			
f	Identify the "hot buttons" for the client's executives			
3	Write Audit Scope of Work			
a	List tasks to be performed	• Energy auditing processes/resources	• Business writing skills • Technical writing skills	• Computer/internet access • Productivity software
b	Describe the audit scope limitations			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
A	**Determining the Job Scope**			
4	Develop the Audit Proposal			
a	Estimate the fees for the proposal	• Costs for services • Energy auditing processes/resources • Safety requirements and procedures	• Ability to estimate costs • Computer skills • Math skills (basic & advanced) • Proposal writing skills • Time management skills • Verbal communication skills • Written communication skills	• Calculator • Computer/internet access • Productivity software • Project planning software • Telephone
b	Develop a schedule (tasks, phases, etc.)			
c	Develop cover letter and narrative of the proposed scope of work			
d	List assumptions and exclusions			
e	Create a list of client responsibilities			
f	Describe firm's qualifications			
g	Develop terms and conditions			
h	Identify and describe the deliverables			
i	Determine the safety requirements for the site			
j	Identify special access requirements (safety, security, insurance, background checks, etc.)			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
A	**Determining the Job Scope**			
5	Estimate the Energy Audit Fee			
a	Calculate square footage	• Appropriate personnel for scope • Client procurement methods • Current market rates for auditing • Energy auditing processes/resources • Internal rate structures • Job descriptions of personnel • Regulatory and reporting requirements • Special site requirements	• Ability to decipher construction drawings • Ability to research logistics costs (hotels, travel, etc.) • Math skills (basic & advanced) • Spreadsheet skills	• Calculator • Computer/internet access • Productivity software
b	Estimate man-hours for on-site survey			
c	Estimate man-hours for engineering analysis			
d	Calculate travel costs			
e	Calculate variable overhead			
f	Identify skill levels of personnel required for the job			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
B	**Collecting and Reviewing Preliminary Data**			
1	Conduct Pre-Audit Interviews			
a	Coordinate delivery of a questionnaire for client (formal or informal)	• Auditing processes • General business practices • Survey design	• Organizational skills • Questioning ability • Verbal communication skills	• Computer/internet access • Telephone
b	Coordinate delivery of a survey to administer to building occupants			
c	Verify roles and responsibilities of client's personnel and consultants			
d	Describe audit process to the interviewee			
e	Discuss client expectations			
f	Coordinate on-site visit (security, site access, escorts, safety, etc.)			
g	Identify key players and obtain contact information			
h	Review contractual documents and requirements			
i	Educate the client			
J	Obtain buy-in from key players			
k	Communicate the value of the audit			
2	Request Documents			
a	Request drawings and schedules (equipment, fixtures, etc.)	• Alternate sources for required documents • Auditing processes • Building systems and usage • Building terminology • Construction documents • ENERGY STAR portfolio manager • Equipment specifications • Facility management documentation	• Ability to translate technical documents to laymen terms • Verbal communication skills	• Computer/internet access • Telephone
b	Request maintenance records			
c	Request previous audits			
d	Request O&M schedule			
e	Request major equipment list			
f	Request building ENERGY STAR information			
g	Request utility data			
h	Request vendor/service provider list and scopes			
i	Acquire sequence of operation for systems/integration			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
B	**Collecting and Reviewing Preliminary Data**			
3	Identify the Audit Team			
a	Review in-house expertise	• Energy auditing processes/resources	• Ability to match expertise to audit scope	
b	Identify external expertise required			
4	Evaluate Utility Usage			
a	Place utility bill data into a spreadsheet or analysis tool	• Benchmark data resources • Industry terminology, jargon, and acronyms • On-site and district energy sources • Renewable energy • Unit conversion factors • Utility analysis tools • Utility rate structures and contracts • Weather normalization	• Basic statistics skills • Investigative skills • Math skills (basic & advanced) • Report generation skills • Spreadsheet skills	• Client historical information • Computer/internet access • Report generation software • Spreadsheet software • Utility bill analysis software • Weather data
b	Evaluate utility rate structures/conduct a utility bill audit			
c	Evaluate patterns of usage			
d	Weather normalize utility data			
e	Calculate the EUI			
f	Benchmark building against similar type buildings			
g	Identify anomalies in usage patterns			
h	Look for building balance points (regression models)			
i	Gather and review interval data			
j	Conduct spark spread analysis			
k	Establish marginal or baseline utility rates			
l	Evaluate on-site generation and usage			
m	Aggregate data for analyses and reports			
5	Research Incentives, Rebates and Credits			
a	Research Federal programs	• Incentives, rebates, and credits	• Research skills • Verbal communication skills • Written communication skills	• Computer/internet access • DSIRE website
b	Research State and local programs			
c	Research demand-response programs			
d	Research utility programs			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
B	**Collecting and Reviewing Preliminary Data**			
6	Review Documents			
a	Verify completeness of requested documents	• Building systems and usage • Construction documents • Energy auditing processes/resources	• Ability to decipher construction drawings • Engineering skills	• Architectural tools • Computer/internet access • Large work area • Reproduction tools for documents
b	Request additional or clarifying documentation			
c	Conduct plan review			
d	Develop a walk-through plan			
e	Print satellite views			
7	Develop Preliminary Audit Plan			
a	Identify equipment to bring on-site	• Energy auditing processes/resources	• Planning and prioritization skills • Time management skills	• Auditing tools • Computer/internet access • Project planning software
b	Develop a walk-about plan			
c	Generate internal documents (checklists, spreadsheets, forms, contact lists, etc.)			
d	Tailor the approach based on preliminary review and interview			
C	**Inspecting Building Conditions and Operations**			
1	Conduct General Onsite Activities			
a	Check in with site contact	• Building systems and usage • Energy auditing processes/resources • Existing and emerging technologies • Health and safety hazards • Impact of occupancy • Impact on operational systems	• Documentation skills • Interpersonal skills • Investigative skills • Observational skills • Organizational skills • Verbal communication skills	• Auditing tools • Codes, standards, and guidelines • PPE
b	Conduct an introduction meeting			
c	Inspect the exterior of building and site			
d	Conduct an orientation walkthrough			
e	Review the occupancy and operation schedules			
f	Review documents on-site (maintenance logs, balancing reports, drawings, submittals, etc.)			
g	Identify factors that affect the energy use of the building			
h	Note obvious health and safety hazards			
i	Document on-site findings			
j	Identify potential measures			
k	Conduct a night inspection			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
2	Conduct Building Envelope Audit			
a	Inspect facades	• Auditing processes • Building envelope • Building life cycle • Building materials • Construction practices • Diagnostic equipment operating parameters • Energy efficiency measures • Existing and emerging technologies • Industry terminology, jargon, and acronyms • Safety requirements and procedures	• Basic design skills • Creative • Detail-oriented • Documentation skills • Investigative skills • Observational skills	• Auditing tools • Codes, standards, and guidelines
b	Inspect roof			
c	Inspect fenestrations (windows, doors, skylights, etc.)			
d	Inspect insulation			
e	Inspect shading			
f	Inspect mechanical penetrations (walls, roofs, flashing, etc.)			
g	Identify construction abnormalities			
h	Take evidentiary photos			
i	Taking instantaneous measurements			
j	Document on-site findings			
k	Identify potential measures			
l	Evaluate constructability of potential measures			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
3	Conduct Building Mechanical Systems Audit			
a	Ask investigative questions	• Alternative HVACR system configurations • Auditing processes • Building mechanical systems • Construction practices • Data loggers (installation, setup) • EMS or SCADA systems • Energy efficiency measures • Existing and emerging technologies • HVACR controls • Operating and maintenance procedures for HVACR • System integration • Typical mechanical operating parameters/conditions • Typical project costs	• Ability to comprehend mechanical/ technical documentation • Ability to conceptualize solutions • Creative • Detail-oriented • Documentation skills • Math skills (basic & advanced) • Organizational skills • Patience	• Auditing tools • Codes, standards, and guidelines • PPE
b	Collect nameplate data			
c	Conduct a detailed inspection of major equipment components			
d	Determine water treatments			
e	Document on-site findings			
f	Evaluate constructability of potential measures			
g	Identify operational anomalies			
h	Identify potential measures			
i	Identify problems with major systems			
j	Identify system abnormalities			
k	Investigate the HVACR systems functionality			
l	Place data loggers or set up trending			
m	Review the central plant			
n	Take evidentiary photos			
o	Take instantaneous measurements			
p	Trace major systems			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
4	Conduct Building Interior Audit			
a	Observe occupant behavior	• Auditing processes • Building construction practices • Data loggers (installation, setup) • Energy recovery methods • Existing and emerging technologies • Hydronic systems • Optimization techniques • Plug loads • Potential efficiency measures • Thermostat capabilities • Typical and unique space requirements • Typical measure costs	• Documentation skills • Interviewing skills • Investigative skills • Math skills (basic & advanced) • Observational skills	• Auditing Tools • Codes, standards, and guidelines • PPE
b	Take evidentiary photos			
c	Taking instantaneous measurements			
d	Place data loggers or set up trending			
e	Identify process loads			
f	Document on-site findings			
g	Identify potential measures			
h	Evaluate constructability of potential measures			
I	Identify building space and zone usage			
j	Document thermostat settings, locations and types			
k	Collect interior environmental measurements (temperature, humidity, light, etc.)			
l	Identify plug loads			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
5	Conduct Water Systems Audit			
a	Review irrigation system use	• Codes, standards, and guidelines • Construction practices • Existing and emerging technologies • Expected water use • Irrigation systems/controls • Maintenance practices • Non-potable water systems • Pump controls and operation • Sustainable landscape principles • Water and sewer rate structures • Water efficiency measures	• Creative • Detail-oriented • Documentation skills • Math skills (basic & advanced) • Organizational skills	• Auditing tools
b	Review domestic water use			
c	Review process/service water use			
d	Take evidentiary photos			
e	Audit non-potable water systems			
f	Taking instantaneous measurements			
g	Document on-site findings			
h	Identify potential measures			
i	Evaluate constructability of potential measures			
j	Review water supply systems and treatment			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
6	Conduct Interior/Exterior Building Lighting Audit			
a	Document fixture type and count	• Basic electrical practices and safety • Data loggers (installation, setup) • Existing and emerging technologies • Integrated lighting system design • Lighting systems/controls • Lighting levels for space types • Potential efficiency measures • Trending systems/trend data • Typical measure costs	• Ability to conceptualize solutions • Detail-oriented • Documentation skills • Math skills (basic & advanced) • Organizational skills	• Auditing tools • Codes, standards, and guidelines
b	Taking instantaneous measurements			
c	Place data loggers or set up trending			
d	Document on-site findings			
e	Identify potential measures			
f	Evaluate constructability of potential measures			
g	Evaluate day lighting opportunities			
h	Evaluate lighting controls			
i	Verify lighting schedules			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
C	**Inspecting Building Conditions and Operations**			
7	Conduct Building Controls Audit			
a	Document control settings and sequences	• Building construction practices • Building control devices and strategies • Controls integration and protocols • Existing and emerging technologies • Mechanical systems • System interactions • Typical control anomalies	• Analytical skills • Computer skills • Creative • Interviewing skills • Math skills (basic & advanced)	• Access to building control systems front-end • Auditing tools • Controls operations manual • Controls operator • Controls service vendor
b	Document on-site findings			
c	Identify potential measures			
d	Identify control system capabilities			
e	Determine building personnel's ability to use building controls			
f	Obtain trend data			
g	Identify building control anomalies, alarms, and overrides			
h	Audit control devices (valves, actuators, dampers, etc.)			
i	Ask question to controls operator			
j	Identify controls integration opportunities			
8	Conduct Interviews of Interested Parties			
a	Interview building occupants	• Building systems and usage • Occupant comfort requirements • Organizational structure • Roles and responsibilities	• Documentation skills • Interpersonal skills • Interviewing skills • Investigative skills • Situational awareness	• Standardized questionnaire
b	Interview facility staff			
c	Interview operations and maintenance personnel			
d	Interview vendors/service providers			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
D	**Identifying and Evaluating Measures**			
1	Develop Conceptual Solutions			
a	List the identified measures (low cost/no cost, capital, etc.)	• Building sciences (thermodynamics, heat transfer, etc.) • Building systems and usage • Construction techniques and costs • Energy auditing processes/resources • Energy projects and implementation • Existing and emerging technologies • Utility rate structures and contracts	• Analytical skills • Computer skills • Creative • Listening skills • Math skills (basic & advanced) • Organizational skills • Research skills • Verbal communication skills • Written communication skills	• Computer/internet access • Cost estimating resources (RS Means, vendor cost sheets, cost estimating guides, etc.) • Lifecycle costing software • Telephone • Utility websites/rate information
b	Estimate preliminary savings, costs and pay-back for measures			
c	Discuss potential measures with client			
d	Select measures for further analysis			
e	Create a draft description of the potential measures			
f	Research applicable technologies			
g	Consider alternative technologies and renewables			
h	Identify potential rebates and incentives			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
D	**Identifying and Evaluating Measures**			
2	Develop Analysis Approach			
a	Review data for quality and completeness	• Analysis methods • Energy auditing processes/resources • Existing and emerging technologies • Limitations and capabilities of analyses tools • Measure interactions • System integration	• Ability to comprehend mechanical/ technical documentation • Ability to visualize or conceptualize • Analytical skills • Detail-oriented • Engineering skills • Math skills (basic & advanced) • Team player • Verbal communication skills • Written communication skills	• Computer/internet access • Government information/ websites • Modeling software • Productivity software • Utility websites/rate information • Vendor specifications/ manuals/websites • Weather data
b	Determine the level of analysis required			
c	Determine the analysis method (spreadsheet, modeling software, outsourcing, etc.)			
d	Determine the level of interactions between potential measures			
e	Determine the sequence of the measures			
f	Determine impact of implementation scenarios			
g	Analyze client's specific needs (ENERGY STAR reporting, building certifications, etc.)			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
D	**Identifying and Evaluating Measures**			
3	Develop Selected Measures			
a	Allocate utility breakdown by end use	• Analysis methods • Background basis for simulation software • Building functionality and serviceability • Controls and control points • Conversions factors • Energy auditing processes/resources • Engineering principles • Existing and emerging technologies • Greenhouse gas calculations • Limitations and capabilities of analyses tools • Local jurisdictional (AHJ) requirements • M&V protocols • Measure interactions • O&M procedures • Simulation software • System integration • Trending systems/trend data • Utility rate structures and contracts	• Ability to accept constructive criticism • Ability to conceptualize solutions • Ability to use simulation software • Computer skills • Confident • Detail-oriented • Engineering skills • Humility • Interpersonal skills • Math skills (basic & advanced) • Organizational skills • Research skills • Team player • Verbal communication skills • Written communication skills	• Computer/internet access • Modeling software
b	Perform a trend data analysis			
c	Gather equipment performance specifications from vendors			
d	Run computer simulations			
e	Calculate energy/water savings			
f	Calculate greenhouse gas emissions			
g	Consult with equipment vendors			
h	Develop an implementation description for the measures			
i	Evaluate the impact on operations and maintenance (financial and tasking)			
j	Develop a proposed sequences of operations			
k	Develop control points lists			
l	Evaluate the feasibility of the potential solutions			
m	Review compliance requirements (codes, standards, guidelines, etc.)			
n	Identify outside expertise required for each project			
o	Create a description of the measures' impact on occupants			
p	Report measures' expected lifetime and impact on other equipment's service life			
q	Consider training requirements for O&M staff			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
D	**Identifying and Evaluating Measures**			
4	Perform Financial Analyses			
a	Determine possible incentives/rebates	• Accounting principles • Building ownership models • Construction techniques and costs • Engineering economics • Engineering principles • Financial software • Incentives, rebates, and credits • Industry terminology, jargon and acronyms • Life cycle costing • Tax implications and expiration dates (credits, deductions, depreciation, etc.) • Typical ownership leases	• Ability to create spreadsheet calculations • Ability to interpret reports • Analytical skills • Detail-oriented • Engineering skills • Interviewing skills • Math skills (basic & advanced) • Spreadsheet skills • Verbal communication skills • Written communication skills	• Calculator • Computer/internet access • Financial analysis software • Lifecycle costing software
b	Estimate measure costs			
c	Analyze the life cycle of the building			
d	Consult with equipment vendors			
e	Conduct a feasibility analysis			
f	Analyze life cycle costing of the measures			
g	Conduct a tax analysis (accelerated depreciation, etc.)			
h	Calculate financial return metrics			
i	Perform annual cash flow analysis			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
E	**Reporting Findings**			
1	Create Draft Report of Findings			
a	Identify deliverable requirements	• Building systems and usage • Construction practices • Document process management • Energy auditing processes/resources • Energy calculation methodologies • Engineering principles • Existing and emerging technologies • Industry terminology, jargon and acronyms • M&V protocols • O&M procedures • System integration	• Ability to create graphical presentations • Ability to visualize or conceptualize • Ability to write for appropriate audiences • Accurate/precise • Brevity • Detail-oriented • Engineering skills • Organizational skills • Technical writing skills • Time management skills • Verbal communication skills • Written communication skills	• Computer/internet access • Productivity software
b	Determine the reporting structure			
c	Develop an energy action plan			
d	Discuss operational opportunities			
e	Gather equipment cut sheets			
f	Identify additional assessment needs			
g	Create a description and document conditions of existing facilities and systems			
h	Quality check the draft report			
i	Create an executive summary of recommended measures			
j	Summarize the assumptions and calculations methodology for each measure			
k	Create a description and document systems affected by measure			
l	Create description of recommended measures			
m	Deliver draft report to the client			

Table 9 (Continued): DACUM Chart for Commercial Building Energy Auditors

	Duties, Tasks, and Steps	Specialized Knowledge	Skills and Abilities	Tools, Equipment, and Resources
E	**Reporting Findings**			
2	Finalize Energy Audit Report			
a	Obtain feedback from client regarding draft report	• Energy auditing processes/resources	• Diplomatic • Interpersonal skills • Listening skills • Verbal communication skills • Written communication skills	• Computer/internet access • Productivity software • Telephone
b	Incorporate comments from client into the report			
c	Quality check the final report			
d	Deliver final report to the client			
3	Present the Energy Audit Findings			
a	Prepare finding presentations	• Energy auditing processes/resources	• Confident • Diplomatic • Interpersonal skills • Listening skills • Presentation skills • Verbal communication skills	• Computer/internet access • Productivity software • Projection equipment
b	Rehearse finding presentations			
c	Make formal presentation to client			

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