

Australian/New Zealand Standard™

Energy audits

Part 1: Commercial buildings



AS/NZS 3598.1:2014

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Australian Chamber of Commerce and Industry
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Part 1: Commercial buildings

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EN-001, Energy Auditing, to supersede, in part, AS/NZS 3598:2000, *Energy audits*.

Energy audits are an integral part of the energy management process. They determine how efficiently energy is being consumed, identify energy and cost saving opportunities, and highlight potential improvements in building services and occupant comfort. In most cases, implementing energy audit recommendations will achieve notable cost savings.

This Standard will assist organizations to decide on the appropriate type of audit for their commercial buildings, provide a guide when commissioning energy audits and present a uniform basis for preparing and comparing energy audit proposals for commercial buildings. It also aims to establish best practice for energy auditors, to support the establishment of energy management systems and contribute to the quality of existing energy and other management systems.

This Standard covers the general requirements for energy audits of commercial buildings and related operations. Requirements for other types of operation are provided in the following Standards:

- (a) AS/NZS 3598.2, *Energy audits, Part 2: Industrial and related activities*.
- (b) AS/NZS 3598.3, *Energy audits, Part 3: Transport related activities*.

In the preparation of this Standard reference was made to the following:

- (i) ISO 50002, *Energy audits—Requirements with guidance for use*.
- (ii) ISO 50015, *Energy management systems—Measurement and verification of energy performance of organizations—General principles and guidance*.

Acknowledgement is made of the assistance received therefrom.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

CONTENTS

	<i>Page</i>
FOREWORD.....	4
1 SCOPE.....	5
2 OBJECTIVES	5
3 APPLICATION.....	6
4 REFERENCED DOCUMENTS	6
5 DEFINITIONS	7
6 WHEN TO UNDERTAKE AUDITS	11
7 ENERGY AUDIT REQUIREMENTS	11
8 ENERGY AUDITOR REQUIREMENTS.....	12
9 ORGANIZATION'S ENGAGEMENT WITH THE AUDIT.....	13
10 AUDIT TYPES	16
11 DETAILED REQUIREMENTS FOR AUDIT TYPES.....	17
APPENDICES	
A MAIN AUDIT SPECIFICATIONS AND VARIATIONS FROM THE AUDIT TYPE	28
B PERFORMING AN ENERGY AUDIT	29
C CONTENT OF AN AUDIT REPORT EXECUTIVE SUMMARY.....	41
D SUMMARY OF TYPICAL ENERGY AUDIT DELIVERABLES.....	43
E ENERGY AUDITOR COMPETENCIES	46
F PRE-AUDIT CHECKLIST FOR THE ORGANIZATION	48
G AUDIT PROCESS FLOW CHART	50
H GUIDANCE	51
I EXAMPLES	59
BIBLIOGRAPHY.....	71

FOREWORD

Commercial building energy audits are investigations of energy use for a defined building or group of buildings, such as an office building, hotel or hospital campus. They enable the identification of energy use and costs, from which energy cost and consumption control measures can be implemented and reviewed. An energy audit is an important step for an organization, regardless of its size, type or area of operation. Organizations may commission energy audits to improve their energy performance, reduce energy consumption and achieve financial and environmental benefits, including greenhouse gas (GHG) emissions abatement.

An energy audit is best undertaken within the context of an energy management system that complies with an appropriate industry Standard, such as ISO 50001, *Energy management systems—Requirements with guidance for use*.

This Standard defines the attributes of an appropriate energy audit to enable the organization commissioning the audit and the energy auditor selected to conduct the audit to reach a common understanding of the audit's scope, process and deliverables. It states the minimum requirements for energy audits and corresponding obligations within the energy auditing process necessary for compliance with the Standard.

This Standard recognizes that there are differences in approach to energy auditing in terms of scope, boundary and objective, but seeks to harmonize common aspects of energy auditing in order to bring more clarity and transparency to the market for energy auditing services.

This Standard does not address the requirements for auditing an organization's energy management system, which are covered by ISO 50003*, *Energy management systems—Requirements for bodies providing audit and certification of energy management systems*.

* To be published.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Energy audits

Part 1: Commercial buildings

1 SCOPE

This Standard sets out minimum requirements for commissioning and conducting three prescribed types of commercial building energy audits that identify opportunities for cost effective investments to improve energy performance. These energy audits encompass all forms of energy used in commercial buildings and are undertaken by appropriately competent personnel either internal or external to the organization.

Requirements for each specified type of audit are designed to meet the organization's business needs, and provide sufficient analytical rigour to provide a degree of confidence in the results that is appropriate to meet these business needs.

Energy consumption in a commercial building is generally linked to the supply of comfort services, activities in the building and the use of utilities to support those activities, such as lighting, lifts or pumps. Energy audits in buildings may include the whole building or parts of the building or a specific technical system such as an HVAC system.

Requirements for industrial site energy audits are provided in AS/NZS 3598.2, while requirements for transport fleet energy audits are specified in AS/NZS 3598.3. Where auditing is to be carried out on an essentially commercial building that includes some industrial processes, the energy auditor may choose to apply AS/NZS 3598.2 to these industrial activities. If auditing warehousing sites as part of a distribution chain the energy auditor may choose to refer to AS/NZS 3598.3 for this activity.

The energy audit process is presented as a simple chronological sequence, but this does not preclude repeated iterations of certain steps. It applies to buildings operated by commercial, industrial, and public-sector organizations, but not individual private dwellings. In most cases, implementing energy audit recommendations will achieve notable cost savings.

This Standard does not deal with energy audit program/scheme properties such as program administration, training of energy auditors, and energy auditors' tools.

2 OBJECTIVES

The objectives of this Standard are to—

- (a) set out the process for organizations and auditors to follow when undertaking energy audits to identify opportunities for cost effective investments to improve energy performance;
- (b) assist organizations to decide which of the three defined types of audit is appropriate for their needs and to compare energy audit proposals;
- (c) provide auditors with a uniform basis for preparing energy audit proposals;
- (d) establish best practice for energy auditors to provide effective and ethical service;
- (e) place the energy audit in the context of an energy management system by specifying pre- and post-audit activities for the organization, and suitable reporting requirements; and
- (f) complement existing energy, business and quality management systems, such as ISO 50001, AS/NZS ISO 14001 and AS/NZS ISO 9001.

3 APPLICATION

This Standard is intended for use by any organization that operates commercial buildings of all types and anyone involved in the assessment of energy use and identification of opportunities to improve the management of energy in commercial buildings or within the organization. Organizations and auditors are encouraged to use this Standard when defining the scope of an energy audit and specifying audit procedures.

This Standard may be applied to commercial buildings throughout Australia and New Zealand. The audit may include the whole building or parts of it; building owner (landlord) services and processes and/or tenant (occupier) services and processes; and activities relating to tenants or clients temporarily within the building.

Energy in a commercial building is consumed for the following:

- (a) Control of factors that affect the environmental conditions within the building envelope.
- (b) HVAC services (e.g. heating, ventilation, air conditioning, cooling, humidity control, filtration).
- (c) Lighting services.
- (d) Water services (cold water, hot water, sewerage).
- (e) Transportation within the building (lifts, escalators, moving walkways) for people and goods.
- (f) Processes including electrical socket loads, where applicable. Examples include compressed air, refrigeration, kitchens, laundries, medical and sanitation equipment.
- (g) Server rooms and other information technology and communication equipment loads.

The Standard specifies requirements for energy auditors, provides guidance on the role of the organization in the audit process, and may also serve as a reference document for anyone interested in effective energy management for commercial buildings. This Standard has been developed to complement ISO 50001 and to be consistent with ISO 50002.

Depending on the ownership and management of the building(s) being audited, the audit may include the following:

- (i) The whole or part of the building.
- (ii) Building owner (landlord) services and processes.
- (iii) Tenant (occupier) services and processes.
- (iv) Activities relating to tenant or owner's visitors and/or clients temporarily within the building, e.g. hotel guests or hospital patients.

An audit may consequently focus on only a subset of the energy uses within the building(s).

4 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

NOTE: Documents for additional information are listed in the Bibliography.

AS

4121 Code of ethics and procedures for the selection of consultants

AS/NZS

3598.2 Energy audits, Part 2: Industrial and related activities

3598.3 Energy audits, Part 3: Transport related activities

AS/NZS ISO

9001	Quality management systems—Requirements
14001	Environmental management systems—Requirements with guidance for use
ISO	
19011	Guidelines for auditing management systems
50001	Energy management systems—Requirements with guidance for use
50002	Energy audits—Requirements with guidance for use
50004*	Energy management systems—Guidance for the implementation, maintenance and improvement of an energy management system
50006*	Energy management systems—Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI)—General principles and guidance
50015	Energy management systems—Measurement and verification of organizations—General principles and guidance

5 DEFINITIONS

For the purpose of this Standard the definitions below apply.

5.1 Accuracy

The level of accuracy of energy savings and financial costs and benefits from energy performance improvement actions. Three levels are classified as follows:

- (a) *Broad estimates*—Energy savings and capital costs estimated based on facility-level energy data and information from similar projects previously implemented or based on simple engineering calculations/estimations to a lower degree of accuracy. These are generally based on rules of thumb without any preliminary design work. Suitable for smaller projects with short paybacks and low risks.
- (b) *Medium accuracy*—Energy savings quantified using site and energy analysis as described for the Type 2 audit, including consideration of site-specific data, operations and other relevant context, with consideration of the detailed energy balance. Capital costs estimated based on a summation of major cost items based on the configuration of systems and equipment necessary to implement the energy savings measure.
- (c) *Higher accuracy*—Energy savings quantified using site and energy analysis as described for the Type 3 audit, including consideration of site-specific data, operations and other relevant context, with consideration of the detailed energy balance developed using the additional monitoring data. Capital costs estimated from contractor quotes and/or detailed cost estimates based on specific equipment selections and schematic designs. Alternatively the level of accuracy required by the company's capex or opex process may be applied.

NOTE: Refer to Appendix H, Paragraph H7.

5.2 Audited object

Subject of the energy audit, which may include site(s), building(s), equipment, system(s), process(es), transport systems or service(s).

[Source: ISO 50002, modified.]

* To be published.

5.3 Benchmarking

The use of energy performance indicators (EnPIs) and other suitable data to compare the energy consumption and/or intensity of the site or systems under review with similar sized sites or systems performing the same function and, thus, establishing whether energy consumption is high, in the typical range or comparatively efficient.

NOTES:

- 1 Better energy performance relative to other systems does not imply best practice.
- 2 Refer to Appendix H, Paragraph H4.4 and Appendix I, Paragraph I5 for additional guidance.

5.4 Boundary

Physical or site limits and/or organizational limits as defined by the organization.

NOTE: The boundary of energy audit could be different to the boundary of an energy management system and may include the base building, tenancies or both.

[Source: ISO 50004*, note modified]

5.5 Energy

Electricity, fuels, steam, heat, compressed air, and other like media.

NOTES:

- 1 For the purposes of this Standard, energy refers to the various forms of energy, including renewable, which can be extracted, purchased, stored, treated, used in equipment or in a process, or recovered.
- 2 Examples of other like media include chilled or hot water, steam or intermediate products or by-products such as waste heat or biogas.

[Source: ISO 50001, with changes to Note 1 and a new Note 2]

5.6 Energy audit

Systematic analysis of energy use and energy consumption of audited objects, in order to assess current energy use and identify, quantify and report on the opportunities for improved energy performance.

NOTE: The terms 'energy audit' and 'energy assessment' are often used interchangeably.

5.7 Energy auditor

Individual, group of people or body conducting an energy audit.

NOTE: A group or body can include subcontractors.

[Source: ISO 50002]

5.8 Energy balance

A systematic accounting for energy flows, and transformations in a system, covering all energy sources either instantaneously or over a defined period of time. This enables energy recovery options to be quantified.

NOTES:

- 1 The theoretical basis for the energy balance is the first law of thermodynamics. Specifically, the change in energy for a system equals the heat transferred into the system minus the work done by the system plus the net energy input associated with mass flows. Mass flows carry enthalpy, kinetic and potential energies.
- 2 A system can be described by a single balance because all forms of energy are additive—energy cannot be created or destroyed.
- 3 A balance will typically include all energy flows, though the amount of energy that can be converted into useful work will be reduced by unrecoverable losses (known as irreversibilities). An energy balance may be represented by a Sankey diagram.
- 4 Refer to Appendix H, Paragraph H2.

* To be published.

5.9 Energy baseline

Quantitative reference(s) providing a basis for comparison of energy performance.

NOTES:

- 1 An energy baseline reflects a specified period of time.
- 2 An energy baseline can be normalized using variables which affect energy use and/or consumption, e.g. occupancy, ambient temperature, humidity, degree days, etc.
- 3 The energy baseline is also used for calculation of energy savings, as a reference before and after implementation of energy performance improvement actions.

[Source: ISO 50001, with changes to Note 2]

5.10 Energy consumption

Quantity of energy applied.

[Source: ISO 50001]

5.11 Energy efficiency

Ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy (e.g. conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate).

NOTE: Both input and output need to be clearly specified in quantity and quality, and be measurable.

[Source: ISO 50001]

5.12 Energy end use breakdown

An account of energy inputs showing how much of an energy source is consumed by or allocated to each end use, such as motors, pumps, lighting or air compressors, over a defined period of time.

NOTE: An energy end-use breakdown is not an energy balance.

5.13 Energy intensity

Ratio of energy consumption to a measure of the activity carried out by an entity, e.g. production levels, total floor space, number of employees, financial turnover etc.

NOTE: Energy consumption related to production levels is also referred to as 'specific consumption'.

[Source: ISO 50004]*

5.14 Energy management system (EnMS)

Set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those objectives.

[Source: ISO 50001]

5.15 Energy monitoring

The regular recording and review of energy consumption and cost, and the principal variables that could affect these, such as production rates, occupancy or climatic conditions.

* To be published.

5.16 Energy performance

Measurable results related to energy efficiency, energy use and energy consumption.

NOTES:

- 1 In the context of energy management systems, results can be measured against the organization's energy policy, objectives, targets and other energy performance requirements.
- 2 Energy performance is one component of the performance of the energy management system.

[Source: ISO 50001]

5.17 Energy performance indicator (EnPI)

Quantitative value or measure of energy performance, as defined by the organization.

NOTES:

- 1 This could be expressed as a simple metric, ratio or a more complex model.
- 2 Effective energy intensity measures should enable comparison between different buildings (such as the National Australian Built Environment Rating System (NABERS) or other building energy rating), processes, geographical locations and performance trends over time.
- 3 Refer to Appendix H, Paragraph H4.5.

[Source: ISO 50001, with changes to Note 2]

5.18 Energy savings

The direct energy and energy cost savings arising from energy performance improvement actions, including GHG emissions savings and costs where applicable.

5.19 Energy use

Manner or kind of application of energy (e.g. ventilation, lighting, heating, cooling, transportation, processes, production lines).

NOTE: Energy end-use' is an alternative term.

[Source: ISO 50001, Note added]

5.20 HVAC system

Heating, ventilation and air conditioning system

5.21 ICT

Information and communications technologies

5.22 National Australian Built Environment Rating System (NABERS)

Rating system that measures the energy efficiency, water usage, waste management and indoor environment quality of a building or tenancy and its impact on the environment.

5.23 Mass balance

An account of the mass of material inflows, transformations and outflows.

NOTES:

- 1 Examples of transformations include phase changes and chemical reactions and other physical transformations or separations.
- 2 Mass balances are mostly applicable to industrial processes.

5.24 Non-energy savings

The financial value of indirect benefits such as maintenance savings, improved productivity or quality, etc. arising from energy performance improvement actions.

5.25 Organization

Company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration and that has the authority to control its energy use and consumption.

NOTE: An organization can be a person or a group of people.

[Source: ISO 50001]

5.26 Relevant variable

Quantifiable parameter impacting energy consumption.

NOTE: Also known as 'adjustment factors' [e.g. weather conditions, operating parameters (indoor temperature, light level) working hours, production throughput, etc.].

[Source: ISO 50002, with changes to the note]

6 WHEN TO UNDERTAKE AUDITS

An audit of an appropriate type should be undertaken every 3 to 5 years or whenever there are—

- (a) proposed and recent significant changes in site use, such as systems, tenancies, changes to fuel systems or processes;
- (b) site developments or refurbishments;
- (c) proposed and recent revisions of working practices;
- (d) substantial changes in energy costs or availability;
- (e) significant changes in the energy performance indicator (EnPI) for the site or audited object;
- (f) proposed and recent changes in technology; or
- (g) regulatory or other requirements to do so.

7 ENERGY AUDIT REQUIREMENTS

7.1 General

A rigorous energy audit follows five fundamental requirements as outlined in Clause 7.2. The application of these requirements helps to make the energy audit an effective and reliable tool in support of management decisions and controls, by providing information on which an organization can act in order to improve its energy performance.

Adherence to these requirements is a prerequisite for providing an effective energy audit and for enabling energy auditor(s), working independently from one another, to reach consistent conclusions in similar circumstances.

7.2 Requirements

An energy audit shall—

- (a) be consistent with the agreed scope, boundary and objective (see Paragraph B2);
- (b) involve measurement and observation that is appropriate to energy uses and consumption;
- (c) collect and utilize energy performance data that is representative and accurate;
- (d) employ a traceable process for collecting and analysing data; and
- (e) provide energy performance improvement opportunities, based on financial analysis, that are appropriate for the chosen type of audit.

Appendix B specifies requirements for performing an energy audit.

8 ENERGY AUDITOR REQUIREMENTS

8.1 Competency

8.1.1 General

Application of the following principles by the energy auditor is fundamental to the success of the energy audit.

The energy auditor shall have the knowledge and skills necessary to complete the defined energy audit scope. Competence can be shown by:

- (a) appropriate education, skills, experience and/or training considering local or national guidelines and recommendations;
- (b) relevant technical skills specific to the energy uses, scope, boundaries and audit objective;
- (c) knowledge of appropriate legal and other requirements;
- (d) familiarity with the energy uses being audited;
- (e) knowledge of the requirements of this Standard;
- (f) (for a team member designated as lead energy auditor) having the skills to manage and provide leadership to the energy audit team; a lead auditor should have managerial, professional and leadership skills in order to manage a team.

NOTES:

- 1 Where there is a single auditor, he/she is considered to be the lead auditor.
- 2 Where a national or local energy auditor certification scheme, or equivalent, is available, certified energy auditors can be considered. Some schemes can be technology specific.
- 3 The energy auditor is encouraged to demonstrate continual professional development to maintain and improve auditing knowledge, technical skills and personal attributes. Continual professional development could be achieved through means such as attendance at meetings, seminars, conferences, technical training, work experience, self-study, coaching, or other relevant activities.

For Type 1 audits, the auditor's competencies should encompass all energy uses that contribute 20% or more of the energy consumption of the building systems that are within the scope of the audit.

Any required auditor accreditation or industry standards applicable to the relevant jurisdiction should be considered, along with the type of audit and the audited object.

NOTE: See Appendix E for guidance on auditor competencies.

8.1.2 Additional competencies for Type 2 and Type 3 audits

Audits of Type 2 and Type 3 require higher competency levels than Type 1 audits due to the increased level of detail and analysis involved.

Type 2 and Type 3 audits should be undertaken by auditors with appropriate technical, project management and professional experience and skills, and familiarity with the energy uses being audited, to analyse detailed energy and process data to identify and evaluate opportunities.

As Type 3 audits involve measurement and acquisition of data the auditors should have knowledge of energy data acquisition and measurement.

8.2 Confidentiality

The energy auditor shall exercise discretion in the use and protection of data and other information acquired in the course of their duties. Energy audit information shall not be used inappropriately for personal gain by the energy auditor or the organization, or in a manner detrimental to the legitimate interest of the organization. This requirement includes the proper handling of sensitive or confidential information in consultation with the organization.

8.3 Objectivity

The energy auditor shall act independently and in an impartial manner. Conflicts of interest, personal, financial or other, shall be identified and disclosed to the organization in a timely manner.

NOTE: A conflict of interest occurs when an individual or organization is involved in multiple interests, one of which could possibly compromise the motivation for action in another.

The energy auditor shall ensure that their claims for performance of products, provision of services and expertise are accurate, substantive and independently verifiable.

If the organization intends to carry out an energy audit using internal personnel, it may not be possible for energy auditor(s) to be fully independent of the audited object(s), but every effort should be made to remove bias and encourage objectivity.

9 ORGANIZATION'S ENGAGEMENT WITH THE AUDIT

9.1 General

The degree to which the organization engages with the audit process is critical to the success of the audit and the achievement of the objectives of the audit.

Energy audits and energy saving opportunities identified in audits are best implemented in the context of an energy management system (EnMS), such as one consistent with ISO 50001.

Whether or not an organization has an energy management system in place, organizations are more likely to achieve the intended outcomes of an audit when senior management supports audit objectives and provides sufficient resources for the audit process and for post-audit activities.

NOTE: See Appendix G for an example of an audit process flow chart.

9.2 Pre-audit activities

9.2.1 Scope of the audit

The scope of the audit shall align with the business objectives of the organization. In so far as the scope of the audit is encapsulated in the type of audit and in the boundaries of the object to be audited, the scope shall reflect the following:

- (a) Specific business and operational issues to be addressed by the audit.
- (b) Availability of the data and information required for the chosen type of audit.
- (c) Availability of organizational representatives to facilitate the chosen type of audit.
- (d) Complexity of the building and the energy uses at the site.
- (e) Total energy expenditure.
- (f) Total greenhouse gas emissions arising from the use of energy in the building.
- (g) Budget available for the audit process.

NOTE: Implementation of low cost, easily implemented projects may provide funding for the implementation of additional efficiency projects.

- (h) Relevant legislative requirements for the organization.

Organizations need to be aware that the scope of the audit and the requirements for analysis can have a marked effect on the cost of the audit. Factors that might affect audit costs include the following:

- (i) The level of accuracy.
- (ii) The extent to which longer payback opportunities are investigated.
- (iii) The scope/boundaries of the audit.
- (iv) The availability of data—both energy performance data and equipment-related data.
- (v) The availability of previous energy audit reports/studies.
- (vi) The complexity of the building and whether processes and equipment are unusual or custom designed.

Organizations should discuss the scope of the audit with the auditor to ensure that the audit is cost effective for the organization, noting the cost considerations in Clause 9.2.2.

9.2.2 *Quotations for capital costs*

An audit is not intended to deliver a works specification, and should not be considered sufficient for the purpose of obtaining quotes for larger capital works identified as energy audit improvement opportunities. Quotes are only sufficient as a cost estimate for simple works where no support, design or planning are required. A full pricing for capital works is to some extent context dependent (i.e. it may vary dependent upon the timing of works relative to other works) and may need to consider the following costs:

- (a) Site establishment costs.
- (b) Scaffolding and craneage.
- (c) Works by other trades (e.g. demolition, asbestos removal, builder's works).
- (d) Builder's margins.
- (e) Design fees.
- (f) Project management fees.
- (g) Commissioning costs (often not fully allowed for under quotations).
- (h) Cost impact of having to conduct work after hours.
- (i) Demolition, disposal and clean-up costs.
- (j) Development approval costs and authority fees.
- (k) Latent defects in the existing plant.

Site or company-specific factors that should be considered include costs of integrating new equipment with existing equipment and structures. This includes costs due to incompatible sizes of old and new equipment (e.g. mix of metric and imperial units), and costs due to existing equipment being designed according to superseded standards. There may be a need to modify existing equipment if capital investment involves an increase in output or system loads.

For some projects there may be flow on effects of compliance with revised or updated standards in areas such as occupational health and safety, other standards, codes or regulations. There may also be a need to confirm the structural integrity of existing structures and evaluate the need to upgrade/strengthen the structure to support new equipment.

9.2.3 *Selection of auditors*

When carrying out any energy audit in accordance with this Standard, organizations shall select an auditor with demonstrated experience, relevant to the characteristics of the audited object and the type of audit to be undertaken. If an audit is being conducted externally, the process outlined in AS 4121 (or other appropriate procurement processes) should be used to select the energy auditor.

The auditor shall nominate one or more competent individuals who will be responsible for conducting the audit. The work shall be performed by, or under the direct supervision of, the nominated individual or individuals. Nominated individual(s) should be suitably qualified and recognized by appropriate industry associations or other organizations.

9.2.4 *Information to be provided*

As part of the energy audit planning process, the organization outlines the desired audit outcomes. In view of these outcomes, the auditor shall specify the minimum information needed to conduct an audit of the appropriate type in compliance with this Standard. The role of the organization is to supply the information specified in the data collection plan to the auditor according to the timeframe specified in the plan.

NOTES:

- 1 The data collection plan should be agreed between the organization and the auditor.
- 2 The data collection plan may be amended by agreement.

The monitored data that is maintained by the organization should be presented in its original form and in the form requested by the energy auditor or in another easily assimilated form (e.g. spreadsheets that reveal changes of energy use over time).

NOTE: As part of good energy management practice the data should be reviewed regularly and any change in the pattern of energy consumption over time should be investigated, possibly by an energy audit.

Original data should be made available to the auditor as well as summaries made by the organization to ensure that errors in data extraction do not compromise the audit.

9.2.5 *Pre-audit checklist for the organization*

NOTE: Appendix F presents an example pre-audit checklist for an organization.

9.3 **During the audit**

The organization shall arrange for appropriate site access, occupational health and safety briefings, provision of additional information and meetings with key personnel as required by the auditor and agreed by the organization.

The availability of organization personnel to assist with the audit and supply data may influence the cost and quality of the audit.

9.4 **Post audit**

The role of the organization does not end with the handover of the audit report.

In order to realize the business objectives of the audit the organization should carry out the following post-audit activities after the final report has been submitted:

- (a) If the business requirement of the audit was to assess the feasibility of a more detailed study, the organization should review the outcomes of the audit and make a decision on whether to undertake a more comprehensive or detailed audit.
- (b) Develop an action plan that outlines and prioritizes the tasks and costs involved in implementing each measure, task allocations and the implementation timetable.
- (c) Present the appropriate level of management with any recommendations to implement energy performance improvement actions, and document these decisions.

- (d) Develop and submit investment approval documentation for those opportunities which are to proceed to implementation.
- (e) Ensure that decisions on implementation of recommendations under (c) and (d) are made and documented.
- (f) Implement the energy performance improvement actions approved under (c) and (d).
- (g) Regularly monitor the results of implemented measures and review the audit action plan as required.
- (h) If recommended in the audit report, consider any additional data collection or analysis that is required to manage energy consumption or to quantify opportunities more accurately.
- (i) Assign a suitable management representative to oversee post-audit activities.
- (j) Communicate the outcomes of the audit, including energy performance improvements and non-energy benefits, to relevant staff in the organization.

10 AUDIT TYPES

10.1 General

There are three types of audit, described in Clauses 10.3 to 10.5, which are based on the level of detail and focus required. Clause 11 specifies the minimum requirements for each defined type of audit.

NOTE: See Appendix H for guidance.

Auditors and organizations should note that Type 1 represents the minimum level of detail required to comply with this Standard.

10.2 Selection of audit type

The appropriate focus and level of detail required for an audit depends on the audited object, the energy uses and energy consumption, and the resources available for the audit. As a preliminary audit activity, the organization and the energy auditor should establish the availability of data for the energy audit and determine whether or not the data is sufficient to enable this type of audit.

If additional measurement is required, the organization and the auditor should typically agree on the likely extent of required measurements before undertaking the audit. For audits of Type 2 or 3, it is advisable for the organization and the auditor to agree on appropriate energy prices to be used in the analysis.

Clauses 10.3 to 10.5 provide summaries of audit Types 1–3. Selection of the audit type shall be based on the detailed requirements for each audit type in Clause 11.

10.3 Type 1: Basic energy audit

Type 1 audits provide a quantitative overview that is typically suitable for smaller sites with lower energy expenditures, or as a scoping audit for larger sites. Type 1 defines the minimum level of detail for an audit required to comply with this Standard. Type 1 audits provide a quantitative overview of energy performance and identify no-cost and low-cost opportunities with payback periods of up to 2 years. The accuracy of costs and benefits would generally only be sufficient for low cost operational expenditures or as a method for prioritizing opportunities for more detailed assessment.

Type 1 audits provide indicative or typical savings calculated using rules of thumb or industry acceptable benchmarks, with indicative costs used to provide a simple payback. Costs and energy savings are therefore to a broad estimate level, see Clause 5.1(a).

10.4 Type 2: Detailed energy audit

Type 2 audits provide detailed analysis of energy performance to quantify the full range of opportunities for a site. Type 2 defines a detailed level of audit involving a comprehensive review and analysis of equipment, systems, and operational characteristics of the whole building to enable quantified energy savings recommendations. Type 2 audits are required to include financial analysis of recommended energy performance improvement actions based on agreed financial criteria to rank opportunities (see Paragraph B2). The accuracy of costs and savings should generally be sufficient for operational expenditures or medium-scale capital investments, and should be commensurate with organization's approval processes for expenditures at those levels.

Type 2 audits may include on-site measurements but would not normally involve the installation of additional monitoring equipment.

As a result, some major projects or opportunities may require further investigation beyond the scope of the audit to fully quantify the energy performance improvements, costs and benefits. Such work may become the brief for a Type 3 audit as described in Clause 10.5.

Type 2 audits calculate energy savings by reconciling against the end-use breakdown, considering daily energy consumption profiles. Costs of implementation are based on a build-up of both capital and labour items including site, internal and project management costs. Type 2 audit requirements provide costs and benefits to a medium level of accuracy [see Clause 5.1(b)].

10.5 Type 3: Precision subsystem audit

Type 3 audits are detailed audits of specific subsystems, with additional data gathering and measurement to provide a higher level of accuracy, see Clause 5.1(c). Audits of this type are typically focused on a process or subsystem level, such as for HVAC, building management systems, compressed air or lighting, rather than the whole building. Type 3 audits involve onsite measurements to monitor energy data over a period long enough to capture the various operating conditions and relevant variables which require their own set of measurements in order to quantify the business case for energy saving measures more accurately than is possible under a Type 2 audit.

Audits of this type would normally involve representatives from the organization in the development of cost estimates, to provide the level of accuracy required by the company's capital expenditure processes.

Type 3 audits calculate energy savings by reconciling against the detailed energy end use breakdown, considering the additional measurements taken during the audit. Costs of implementation are based on a build-up of both capital and labour items including site internal and project management costs, to the level of accuracy required by the company's capital expenditure process. Type 3 audit requirements provide costs and benefits to a higher level of accuracy, developed with input from the organization.

NOTE: Type 3 audits could also be undertaken for two or more systems at a site, either separately or in parallel, as part of the implementation of an energy management system. In these cases audits would typically be undertaken over a period of time sufficient to measure data, perform the analysis (including analysis of interactions between significant energy uses) and quantify the business cases. This means that Type 3 audits covering major systems at a site would typically extend beyond the scope of a single contract and would require significant involvement from the organization.

11 DETAILED REQUIREMENTS FOR AUDIT TYPES

11.1 Audit types

This Clause specifies requirements for the three audit types; Type 1 (see Clause 11.4), Type 2 (see Clause 11.5) and Type 3 (see Clause 11.6).

Type 1 represents the minimum level of detail required for an energy audit to comply with this Standard. Each type defines the minimum actions that are required to complete an audit that complies with the requirements of that defined type.

The aim is to meet the business needs and achieve the specified outcomes with a process that effectively supports management decisions and is sufficiently rigorous and repeatable.

Each of the nominated requirements is a minimum for each type. In some cases it may be appropriate to go beyond the level of detail outlined for each type, as agreed between the organization and the auditor.

11.2 Specific audit type requirements

11.2.1 General

This Standard aims to be sufficiently specific to ensure responses of comparable quality to organizations issuing requests for proposals for energy audits.

In order to be of value, energy audits need to identify specific, measurable and implementable energy savings opportunities.

To comply with this Standard, energy audits are required to quantify energy savings measures, rather than simply provide recommendations for further investigation. Therefore, audits should be consistent in terms of quality and cost.

11.2.2 Variations from the defined audit types

The organization and the auditor may agree to vary an audit from the defined type and remain compliant with the Standard. In such instances a schedule containing the information specified in Appendix A shall be used.

11.3 Summary of audit types

NOTE: Appendix D presents a tabulated comparison of requirements for the three defined types of audit for information only. For normative requirements refer to Clause 11.

11.4 Type 1

11.4.1 General

Typical applications for a Type 1 audit include the following:

- (a) Initial scoping investigation of a site.
- (b) Lower cost study for the identification of short payback measures.

11.4.2 Outcomes and business needs

A Type 1 audit shall include the following outcomes to address business needs:

- (a) Overview of energy consumption and energy intensity at a site level, relative to industry benchmarks.
- (b) Overview of energy costs and the potential benefits of managing energy, with estimated greenhouse gas emissions and any associated costs if required by the organization.
- (c) Identification and basic evaluation of low cost opportunities that can be easily implemented.
- (d) Overview of the extent of more capital intensive opportunities.
- (e) Indication of potential savings and benefits from undertaking more detailed investigations such as a Type 2 or Type 3 energy audit.

The data collection and analysis, opportunity identification and evaluation and reporting requirements in Clauses 11.4.3 to 11.4.6 are focused on achieving these outcomes.

11.4.3 *Data collection*

Data collection to be outlined in a Type 1 audit report shall include the following:

- (a) Clear identification of the audited object and identification of boundaries applied.
- (b) Summary description of the audited object and all end uses consuming greater than 20% of total energy consumption.
- (c) Historic energy use, including available load profiles for at least the last 12 months (recommended 24 months) to identify anomalies.
- (d) Appropriate activity data to establish overall EnPIs.
- (e) Summary of energy consumption and costs.
- (f) Table of average price for each energy source. Nomination of energy cost used in calculations if not equal to this average.
- (g) Summary of published energy tariffs and peak demand charges.
- (h) Greenhouse gas emissions factors for each energy source, if required by the organization.

11.4.4 *Analysis*

Analysis to be outlined in a Type 1 audit report shall include the following:

- (a) Annual energy end-use breakdown including consumption of all identified end uses greater than 20% of total energy cost or consumption.
NOTE: Remaining energy use need only be quantified as 'other'.
- (b) Determination of greenhouse gas emissions for each energy source, if required by the organization.
- (c) High-level review of daily profiles to identify anomalies, where readily available.
- (d) Establishment of EnPIs.
- (e) Comparison of EnPIs with known benchmarks and best practice targets.
- (f) Provision of a brief comment on any recommended improvements to the organization's management practices in relation to energy consumption, including—
 - (i) monitoring practices;
 - (ii) processes for energy efficiency investment;
 - (iii) procurement policies and their impact on energy performance;
 - (iv) existing site energy efficiency activity; and
 - (v) maintenance.

11.4.5 *Opportunity identification*

The opportunity identification to be outlined in a Type 1 audit report shall include the following:

- (a) Site visit to inspect site and plant and to interview key staff members and supervisors so as to understand energy consumption under different circumstances.
- (b) Identification and quantification of low-cost and easily quantifiable savings.
- (c) Identification of more capital intensive measures at a generic or specific level but not required to be taken through to technical resolution.

11.4.6 Opportunity evaluation

The opportunity evaluation to be outlined in a Type 1 audit report shall include the following:

- (a) Indicative or typical savings calculated using rules of thumb, reconciled to energy end-use breakdown.
- (b) Nomination of typical payback periods for the identified opportunities.
- (c) A list of saving opportunities with simple paybacks of less than 2 years. This list shall include the following:
 - (i) At least 80% of the identified energy savings shall be quantified to a broad estimate level.
 - (ii) Cost savings shall include both the energy savings and non-energy savings expected from implementing the recommendation, including greenhouse gas (GHG) emissions savings, where applicable.
NOTE: Non-energy gains may not always be quantifiable within the scope of the audit.
 - (iii) Return on investment (ROI) for each recommendation shall be expressed as simple payback.
 - (iv) An outline of the steps that are necessary to generate specific actions that can be implemented.
- (d) A list of the remaining saving opportunities, including the following:
 - (i) At least half of the recommendations shall be quantified to a broad estimate level.
 - (ii) The remainder of the opportunities shall be listed and qualitatively described.
 - (iii) A level of accuracy shall be stated for each recommendation (broad estimate, medium or higher accuracy).
 - (iv) Any measures requiring additional data/investigation shall be identified.
- (e) Summary table of measures specifying measure identifier, measure cost, cost savings, energy savings and payback, with indicative GHG and peak demand savings where applicable.
- (f) Review of tariff savings for sites on scheduled rather than contract tariffs.
- (g) Qualitative assessment of potential savings from reduced peak demand costs where a peak demand tariff is present.
- (h) Identification of measures where additional data/investigation are required to improve or clarify energy savings, costs or benefits.

11.5 Type 2

11.5.1 General

Typical applications for a Type 2 audit include the following:

- (a) Detailed energy audit for the identification of a full suite of energy efficiency measures.
- (b) Suitable for most sites.

NOTE: Type 2 audits may not be cost effective for organizations with smaller energy budgets.

11.5.2 Outcomes and business needs

A Type 2 audit shall include the following outcomes to address business needs:

- (a) Detailed analysis of energy consumption and use.
- (b) Data for energy review/monitoring purposes.
- (c) Identification and evaluation of a range of coherent and specific opportunities with specific costs and benefits.
- (d) Identification of opportunities for which further or more detailed investigation involving measurement is required.
- (e) Examination of metering systems and recommendations to address data gaps.

The data collection and analysis, opportunity identification and evaluation and reporting requirements below are focused on achieving these business outcomes.

11.5.3 Data collection

Data collection to be outlined in a Type 2 audit report shall include the following:

- (a) Clear identification of the audited object and identification of boundaries applied. Summary description of audited object and all end uses consuming greater than 10% of total energy consumption.
- (b) Historic energy use including load profiles for at least the last 12 months (recommended 24 months).
- (c) Sub-meter data, evaluated down to load profile level for significant meters where available.
- (d) Appropriate data to establish EnPIs for significant energy uses.
- (e) Summary of energy consumption and costs.
- (f) Tabulation of tariff structure for each energy type. Nomination of simplified rates used in savings calculations (typically 2–3 averaged daily energy cost figures plus a separate demand cost figure).

NOTE: Costs should reflect the variation of energy costs depending on the load and time of the day when the equipment is used.

- (g) Additional energy data and information to be analysed in the audit, as appropriate, shall include—
 - (i) detailed data on energy consuming systems, processes and equipment, including known relevant variables;
 - (ii) monitoring equipment configuration, and analysis information;
 - (iii) design, operation and maintenance documents;
 - (iv) energy audits or previous studies related to energy and energy performance; and
 - (v) future plans that affect energy use.

11.5.4 Analysis

Analysis to be outlined in a Type 2 audit report shall include the following:

- (a) Analysis of historic energy use including normalization for known variables such as occupancy levels or climatic conditions (such as degree days and humidity).

NOTE: Data frequency should be sufficient to account for the variability of the systems and processes being analysed.

- (b) The annual end-use breakdown for each energy source.

- (c) Determination of greenhouse gas emissions for each energy source, if required by the organization.
- (d) Detailed energy balance including consumption of all end uses greater than 10% of total energy cost or consumption including—
 - (i) identification and calculation or estimation of energy losses in generation, and distribution and services;
 - (ii) remaining energy consumption may be quantified as ‘other’, or further analysed as agreed with the organization.
- (e) Establishment of EnPIs and analysis of typical variation.
- (f) Comparison of EnPIs with known benchmarks and best practice targets.
NOTE: EnPIs should be normalized where appropriate, e.g. to account for seasonal variations in occupancy levels, business activity, climatic variations etc..
- (g) Presentation of separate 24-hour time-of-use power profile for each energy source and each energy end use across typical operating and non-operating days and for different periods (e.g. different seasons or major operating modes) where time-of-use data for energy consumption is available;
NOTE: Where only tariff period information is available, the typical profiles should at least include energy end use breakdowns across these tariff periods.
- (h) Analysis of potential savings from reduced tariff/peak demand costs, where the tariff includes a cost component based on peak demand.
- (i) Assessment of tariff savings for sites on scheduled rather than contract tariffs, with commentary on potential impacts of measures on contract tariffs.
- (j) Comparisons of energy consumption in different operating regimes, including seasonal, shift by shift, business hours and after hours as applicable.
- (k) Electrical power factor review where power factor is relevant to energy cost.
- (l) Consideration of the design and configuration options to address the system needs.
- (m) Provide comment and recommendations on the organization’s energy management practices including—
 - (i) energy efficiency goals and policy;
 - (ii) energy management accountabilities;
 - (iii) monitoring practices;
 - (iv) reporting practices (both internal and external);
 - (v) site documentation;
 - (vi) awareness, education and training;
 - (vii) processes for energy efficiency investment;
 - (viii) existing site energy efficiency activity;
 - (ix) maintenance; and
 - (x) procurement policies.

11.5.5 Opportunity identification

The opportunity identification to be outlined in a Type 2 audit report shall include the following:

- (a) Site visit to inspect site and plant and to interview key staff members and supervisors so as to understand energy consumption under different circumstances.