



**Asia-Pacific
Economic Cooperation**

**REPORT ON
COMPARISON OF ENERGY MANAGEMENT
SYSTEM STANDARDS**

APEC Energy Working Group

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1. OVERVIEW

1.1 Introduction

In 2007, the American National Standards Institute (ANSI, United States of America) and Associação Brasileira de Normas Técnicas (ABNT, Brazil) partnered to submit a proposal to the International Organization for Standards (ISO), which was for new work to develop an international standard on energy management system (EnMS). The application was approved by ISO's Technical Management Board (TMB). In 2008, ISO Project Committee, PC 242 was established to focus on developing an ISO standard on EnMS numbered as ISO 50001. ISO/PC242 now has 42 P-members and 12 O-members and ISO 50001 is going to be issued in 2011.

This report is based on an Aisa-Pacific Economic Cooperation (APEC) supported project, namely as "Capacity Development Workshop — Facilitation of International Harmonization of Standards for Energy Management in APEC", formed through APEC expert group on energy efficiency and conservation (EGEE&C) under the APEC energy working group (EWG).

In October 2010, APEC with the Standardization Administration of China (SAC) was sponsoring a workshop in Dezhou, China to facilitate discussion on harmonization of EnMS standards and the implimentation and utilization of EnMS.

1.2 Purpose

This document, Summary Comparison of Energy Management Standards, is a condensed version of a very detailed comparison that was developed by the China National Institute of Standardization (CNIS). This document was prepared based on the existing 12 different EnMS standards from ISO and other different region and countries, and also based on the Dezhou workshop discussion. Through the comparison based on all important elements, the level of agreement of different standards is recommended and some of key findings are discribed in this report. This document is intended to highlight all the important differences of the EnMS standards from 8 countries.

These 8 countries standards are not an exhaustive representation of EnMS national standards but do represent those that were most widely available at the time of this writing. This comparison also includes the ISO EnMS standard, ISO DIS 50001, the quality standard, ISO 9001:2000, the environmental standard, ISO 14001:2004, and the European standard, EN 16001.

The workshop, sponsored by APEC in Dezhou, was attended by representatives from the countries that have national energy standards and a stake in the international standard. The discussion in the Dezhou workshop allowed many countries to understand the

similarities and differences of the standards and to frame the issues requiring resolution. This will give the harmonization effort a great support before the coming of ISO 50001 in the middle of 2011.

1.3 Methodology

This document presents a comparative analysis of the elements or requirements in the EnMS standards. The many tables in this summary document are organized around the common framework for management system standard design – the Plan-Do-Check-Act (PDCA) continual improvement cycle. This allows the elements of all the standards to be broadly grouped into six categories providing an order for the 26 elements and their corresponding tables (see Section 3 Methodology for more details).

1.4 Key Findings

Most of the management standard elements that focus on management system best practices (ie. Policy, internal audits, corrective and preventive action, management review, document control, training, communication, etc.) show a high degree of similarity and agreement. However, among the more technical elements of the standards, there are significant differences that will require considerable effort to achieve harmonization.

Those elements that have the lowest level of agreement are in the “PLAN” and “DO” phases of the continual improvement cycle. These elements, which present the greatest hurdles to harmonization, are generally technical aspects of energy management, such as purchasing, design, and use of energy data and information in planning. Specifically, those elements that showed the lowest level of agreement are,

- Management commitment
- Strategic planning
- Energy data management / energy profile / energy aspects
- Purchasing
- Design
- Energy project implementation
- Contingency Planning

Section 5 Conclusions goes into greater detail on each of the elements listed above.

2. INTRODUCTION

In 2007, the American National Standards Institute (ANSI, United States of America) and Associação Brasileira de Normas Técnicas (ABNT, Brazil) partnered to submit a proposal to the International Organization for Standards (ISO), which was for new work to develop an international standard on energy management system (EnMS). The application was approved by ISO's Technical Management Board (TMB). In 2008, ISO Project Committee, PC 242 was established to focus on developing an ISO standard on EnMS numbered as ISO 50001. ISO/PC242 now has 42 P-members and 12 O-members and ISO 50001 is going to be issued in 2011.

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In October 2010, APEC with the Standardization Administration of China (SAC) was sponsoring a workshop in Dezhou, China to facilitate discussion on harmonization of EnMS standards and the implementation and utilization of EnMS.

Below is a list of the management system standards that formed the basis for this report. ISO 9001-2000 and ISO 14001-2004 were also included in the analysis because they form the basis for many of the national management standards for energy. The standards included are:

1. ISO DIS 50001
2. ISO 9001- 2000
3. ISO 14001-2004
4. U.S. Standard MSE 2000:2008
5. European Union Standard CEN 16001
6. Chinese Standard GB/T 23331-2009
7. Swedish Standard SS 62 77 50: 2003
8. Irish Standard IS 393:2005
9. Danish Standard DS 2403 E:2001
10. Netherlands Standard SenterNovem 2004
11. Korean Standard KSA 400:2007
12. United Kingdom Standard PAS 99:2006

These standards were included because they were readily available at the time of this report. This is not an exhaustive list. There are several other countries that have recently completed standards or are in the process of developing standards, including Spain and Thailand. The standards included in this comparison represent most typical approaches to management system standard development.

3. METHODOLOGY

One of the methods used for comparison is the Six Thinking Hats of decision making, created by Edward de Bono. 'Six Thinking Hats' is a powerful technique for looking at important decisions from a number of different perspectives. It leads to better decisions by pushing individuals to move outside their habitual ways of thinking. As such, it contributes to understanding the full complexity of the decision, identifying issues and opportunities which might otherwise be overlooked. The 'Six Thinking Hats' are typically defined as follows:

- The White Hat calls for information known or needed. "The facts, just the facts."
- The Yellow Hat symbolizes brightness and optimism. Under this hat an investigator explores the unique additions that only a minority of the standards included to look for the positives and probe for value and benefit
- The Black Hat is judgment – significant differences or trends. Under this hat an investigator spots the difficulties and dangers; where things might go wrong. Probably the most powerful and useful of the Hats but a problem if overused.
- The Red Hat denotes differences. When using this hat an investigator expresses differences and issues that need resolution.
- The Green Hat focuses on creativity; unique additions, possibilities, alternatives, and new ideas. Under this hat an investigator has an opportunity to express new concepts and new perceptions.
- The Blue Hat is used to manage the thinking process. Under this hat, an investigator has the opportunity to harmonize terminology. Terminology is a key place for discussion and harmonization so this represents a control point in the process of the six hats.

For this summary comparison, only the black hat and the red hat analyses are presented to accentuate the differences; the detailed analysis presents all six hats. The red hat presents the perceived differences and the black hat signifies significant differences that present the greatest difficulties and dangers for harmonization. The black hat analyses are in bold text and yellow highlighting, to quickly identify areas requiring further dialogue. The Red Hat thoughts are not.

The table topics are organized around a common MSS framework. They employ a plan-do-check-act continual improvement cycle to management system design and utilize either ISO 9001 and/or ISO 14001 as a basis. This results in the standards having many similar elements. Though the title of the elements in each standard varies, and some standards include sections that others do not, they can all be grouped according to the following broad categories:

- Scope and Definitions
- General Requirements, Documents and Records
- “Planning” elements
- “Doing” elements
- “Checking” elements
- “Acting” elements

In Section 4 of this report, separate tables for each of the elements under these broad categories is displayed with a column for comparative analysis (red hats and black hats) and another for discussion questions. In addition, the level of agreement between the standards for each element is graded and shown in the heading for that table. The grading levels are low, medium, and high. These levels are based on the following criteria:

- High ($\lambda > 8$) – strong agreement, eight (8) or more of the twelve (12) standards agreed
- Medium ($6 < \lambda < 8$) – six (6) to eight (8) of the twelve (12) standards agreed
- Low ($\lambda < 5$) – five (5) or less of the twelve (12) standards agreed

4. COMPARISONS

The table below contains links to each of the management system elements. This table will help the reader to navigate the more than 20 pages of comparison contents in this document. In the last column of the navigation table, the grade (low, medium, or high) of similarity is listed.

Categories	Elements	Level of agreement
Scope and definitions	Scope	Medium
	Definitions	Medium
General Requirements	General Requirements	High
	Documentation	High
	Records	High
“Planning” elements	Management commitment	Low
	Energy Policy	High
	Responsibility and authority	Medium
	Strategic planning	Low
	Energy data management	Low
	Energy Profile (aspects)	Medium
	Legal and other	High
Goals, targets and projects	High	
“Doing” elements	Purchasing	Low
	Design	Low
	Communication	High
	Competency, training and awareness	High
	Equipment, systems, and process control	Medium
	Energy project implementation	Low
	Calibration	Medium
Contingency planning	Low	
“Checking” elements	Monitoring and measurement	Medium
	Evaluation of legal and other requirements	High
	Internal audits	Medium
	Nonconforming, corrective action, preventive action	High
“Acting” elements	Management review	High

4.1 Scope and definitions

4.1.1 Scope

Level of agreement: Medium

Comparative analysis

Three of the energy standards support the limitation of the scope. The EN 16001 supports the control and influence of energy it can monitor. The Swedish standard supports the policy, and conditions under which the organization operates. The Korean standard supports the consideration of the policy, activities, products and services, the status of the organization and its operating conditions.

Detail analysis

- Inclusion of what the system includes such as primary and secondary energy sources.
- The US standard and ISO/DIS 50001 present the purpose of the management system to control and reduce costs, and energy related environmental impacts. The Chinese standard indicates that the purpose is to reduce energy consumption and increase energy efficiency.
- The CEN, Irish, and Danish standards include improving energy performance in a systemic way as a purpose of the system.
- The CEN and Swedish Irish standards include the purpose of the system is to increase the use of renewable energy and/or increased energy exchange with the rest of society. The Irish standard states it is to have a more efficient and sustainable use of energy.
- Only the Korean standard indicates the specification contains legal requirements.

4.1.2 Definitions

Level of agreement: Medium

Comparative analysis

◆ The basic definition of energy is significantly different between the standards. The US definition includes both primary and secondary energy and represents the most inclusive definition. Secondary energy is not addressed by the CEN, Swedish, Irish or Danish standards. Only the US standard addresses water as a part of the energy system.

◆ Energy aspect is defined by CEN, Sweden, and Ireland in terms of what can affect energy usage, where Denmark and the Netherlands define it in terms of energy consumption. Korea defines it in terms of influencing energy. This demonstrates a significant discrepancy in the use of the term aspect.

◆ Energy Target or Target – The Chinese standard, and the current version of the US standard (not the draft) require targets to be measurable. CEN, Ireland, and Denmark only require they be quantifiable. China also requires that targets be set

to reduce energy consumption. Sweden suggests a connection to significant energy aspects when possible but does not require a connection – similar to ISO 14001.

◆ -Top Management – Swedish, Irish, and Danish standards specifically define top management in terms of those who control the PART of the organization under the energy management system. The US and CEN standards use the current management system definition – direct the organization at the highest level.

Detail analysis

- Action Area – this definition only appears in two of the standards the Irish and the Danish. It allows for the system to be applied in a very limited area of the organization.
- Aspect is used routinely in many of the standards but it is only defined in the PAS document.
- Audit is only defined in the CEN standard. The definition of the term Audit does specifically use the term independent which is not compatible with the current versions of the other management system standards. The current definitions in the other management system standards allow for audits as long as the auditor is objective. The term independent could introduce the concept of “certification/verification” audits – beyond the management system requirements. It also introduces a point of divergence from existing management system standards. ISO standard defines Management System Audit.
- Benchmarks for energy management are only defined in the China standard. The comparison can be historical or it could be an index. This does not provide for clear comparisons over time against changing circumstances.
- Commissioning and Continuous Commissioning are only defined in the US standard. The benefits of this process relate to new buildings and energy systems and on the measuring and monitoring value.
- Contingency Planning is only defined in the PAS standard but is not addressed in any of the energy standards.
- Continual improvement is a term that has several different definitions. The CEN, Irish, and Danish standards use the same definition and indicate that the activity that provides greater efficiency should be performed continuously by the organization. The ISO, US, Swedish and Korean standards reference continual improvement in terms of improvement in overall energy performance. This definition is more in alignment with the current definition in management system standards.
- Effectiveness is only defined in the Korean Standard.
- Efficiency is only defined in the Korean Standard.
- Energy Assessment is only defined in the US standard.
- Energy baseline are defined in the US and Chinese standards.
- Energy Efficiency is defined the same way in the CEN and Irish standards. The Korean standard provides a definition in terms of an index or ratio.

- Energy Goal is only defined in the Korean Standard.
- Energy Management is defined in the Dutch standard, but is based on minimizing energy consumption.
- Energy Management Projects/Programs are defined in the US and Dutch standards.
- Energy Objective – the CEN and Irish standards have the same definition but the Chinese standard defines it in terms of reduction of energy consumption. The ISO/DIS 50001 defines it in terms of output or achievement related to improved energy performance. The Swedish definition includes a note that provides examples of objectives such as use of renewable energy, and exchange with the rest of society- this is not necessarily addressed by other standards. There is similarity between the use of the terms objective and goal.
- Energy Performance/Energy Performance Indicator (EnPI) is defined in ISO/DIS 50001 as the important term related to energy use and energy consumption.
- Energy Profile (Key Figures) – defined in the US standard as the profile and as key figures in the Irish standard.
- Energy quality – only defined in the Korean standard.
- Energy related Environmental Impact – defined by Korean standard; makes the connection between energy, global warming, and green house gases.
- Energy System- defined by the US and Korea.
- Major energy aspect – only defined by Korea.
- Organization – is defined by 9 standards. There is disagreement on the entire organization versus part of an organization, which would significantly impact scope of an energy management system.
- Primary Energy Resource- the use of this term is not consistent across the standards and what it does and does not include is not consistent across the standards for example China's definition does not include electricity.
- Re-commissioning – only presented by the US standard.
- Secondary Energy resource – there is not a consistent approach to the use of this term including what is and is not included for example China includes electricity as a secondary source.
- Significant energy aspect- is presented by three standards. The CEN standard considers an aspect significant if it can affect a significant total of energy use. The Swedish standard considers it significant if it can affect a significant part of the energy use, has potential for more efficient use or increased energy exchange. Denmark considers an aspect significant if it can impact a large portion of energy use and offers considerable potential for conservation.
- Significant energy use – this represents an alternative approach to significant aspects. The US standard basis it on the energy profile, ISO/DIS 50001 and CEN to total energy use, and Ireland if it is a large portion and offers considerable potential for conservation.

- Strategic Planning – is only defined by Korea
- Supplier - is defined by the US and Korean standards.
- Sustainable use of energy – only defined by Ireland.

4.2 General requirements, documentation and records

4.2.1 General requirements

Level of agreement: High

Comparative analysis

This section of the standard provides a starting point for the discussion for ordering elements in the standard.

- **What belongs in the planning part of the standard?**
- **What belongs in the doing part of the standard?**
- **Do outsourced processes need to be considered?**
- **Where does document control fit into the standard?**
- **Does strategic planning belong in the standard?**

The Chinese standard includes a general requirement to have a mechanism to adopt energy saving technologies and products.

Detail analysis

- There is opportunity to complete the discussion on scope. The ISO/DIS50001, U.S and Swedish standards ask for defining any exclusion to the scope.
- There is opportunity to discuss a requirement to address outsourcing as a general requirement - this is an issue for quality systems but many organizations are outsourcing energy services. The US Standard does allow for this to be addressed through the purchasing requirements of the EnMS.
- The Quality, Korean and PAS standard require the organizations to identify their processes needed for energy management.
- The Quality, Korean and PAS standard require the organizations to determine the sequence and interaction of the processes related to energy management.
- The Quality, Chinese, Korean, and PAS standards include a general requirement to determine the criteria for operational control. The Chinese standard focuses on reduction of energy consumption.
- The Quality, Korean, and PAS standards have a general requirement to ensure the availability of resources for the EnMS.
- The Quality, Korean, and PAS standards have a general requirement to monitor and measure the processes identified

4.2.2 Documentation

Level of agreement: High

Comparative analysis

The CEN standard combines documents and records. Documents and records are presented as separate issues in this analysis, since only one of the eleven standards took this approach. Requirements related to records are not included in this analysis.

The Swedish standard raises the question about the inclusion of information/data and how it should be controlled. Energy information or data could be seen as competitive information; and it may not be a record so how it is addressed by the system is unclear.

Detail analysis

- The Chinese standard adds the need for work instructions when necessary to ensure proper operation.
- ISO 9001 and ISO 14001 standards mention the difference between a document and a record. None of the energy standards mention this difference.
- Two of the energy standards and the two MSS standards mention control of records in this section but reference the user to another section of the standard.
- Five of the standards include a requirement that documents can be located – this generally applies to records and availability or distribution generally applies to documents.

4.2.3 Records

Level of agreement: High

Comparative analysis

There are no significant differences.

Detail analysis

- Nine of the standards include the requirement to establish, maintain records to demonstrate the requirements of the standard
- Nine of the standards include the requirement that the records demonstrate the performance or effectiveness of the system
- Seven of the standards specifically require a records procedure. The Netherlands requires that the records system be described.
- There is general agreement that the procedure should address identification, storage, protection, retrieval, retention and disposal of records. It is interesting to note that the US, Korea, China, PAS 99 and current MSS separate out the requirements for records control and document control while the European standards, with the exception of Denmark, combine it with document control.
- Nine of the standards agree that records should be legible, identifiable, and traceable.

4.3 Planning requirements



4.3.1 Management commitment

Level of agreement: Low

Comparative analysis

There is not a consensus to include this requirement in the energy management standard. At issue is whether management commitment should be identified as a separate requirement or whether inclusion in the section on roles, responsibilities and authorities is enough. As a point of reference in the discussion, the Quality standard includes this section as an important part of the process and the Environmental standard does not- because it uses roles, responsibilities, and authorities to address these issues.

4.3.2 Energy policy

Level of agreement: High

Comparative analysis

The policy requirements did not present any significant questions or trends.

Detail analysis

- The US and Korea include a requirement that the policy be consistent with other policies.
- The Dutch standard includes a commitment to energy efficiency and prevention of unnecessary energy consumption.
- The CEN, Irish, Danish, and Dutch standards add the statement in the form of improved energy efficiency to the commitment of continual improvement.
- Five standards (ISO/DIS 50001, quality, China, CEN, and PAS99) include a requirement that the policy is reviewed for continuing suitability.

- The Chinese standard adds a requirement to commit to carry out appropriate projects measures and adopt best workable technologies and good operation criteria
- The Danish standards adds a commitment to cover products, processes and other activities that have an influence on the significant energy uses
- The Korean and U.S standards add a requirement to consider energy related environmental impacts when developing the policy.
- The ISO/DIS 50001 and U.S standard require the organization considers the available alternative sources of energy.
- The US requires the organization considers the level of quality and appropriateness of sources and the effect on operations.
- The Danish standard adds the requirement that the organization commits to identifying the voluntary requirements related to energy to which the organization voluntarily subscribes.
- The Chinese standard requires a commitment to a reduction of energy consumption
- The Chinese standard adds to the legal and other commitment a statement that includes applied energy management, implement advanced energy conservation standards and marks
- The Quality standard and the Korean standard indicate that the policy is intended for employees of the organization, whereas the other standards indicate it applies to those who work both for and on behalf of the organization.

4.3.3 Responsibility and authority

Level of agreement: Medium

Comparative analysis

- ◆ **Should resources be considered as a part of these requirements or in a separate section?**
- ◆ **Should the structure of the management system require the use of teams or Top Management committees? There is a requirement for teams in sector standards but not in most MSS.**

Detail analysis

- The Quality and Chinese standards include a requirement that the management representative act as a liaison
- The Quality standard includes a requirement for the management representative to promoting awareness
- The US and Korean standard include requirements for the management representative to organize and appoint the team members for the energy team.
- The Korean standard includes a requirement that the management representative take action on items from management review.
- The Chinese standard introduces the concept that management representative may

work full or part time.

- Three standards raise the idea of a team (ISO/DIS 50001, US and Korea). The team is formed by the management representative and membership approved by top management. The team members come from a variety of staff that is affected by the management system for energy and may include external stakeholders.
- The team is responsible for the goals/objectives
- Korea includes responsibilities of the team for:
 - Periodic energy aspect analysis
 - Periodic management system performance evaluations
 - Establishing and executing the projects.

4.3.4 Strategic planning

Level of agreement: Low

Comparative analysis

Only two of the twelve standards included this topic as a requirement. There is significant disagreement on whether to include this element.

4.3.5 Energy data analysis, energy profile

Level of agreement: Low, Medium

Comparative analysis

For determining the focus for the improvement in the system there are two basic approaches. One is data driven, based on the energy profile – from which projects are chosen and implemented. The other addresses the operational controls for the significant energy aspects and programs chosen that consider significant energy users.

Detail analysis

- The Korean standard adds a requirement that the information is updated through data collection at least once per year. Among other standards, there is disagreement about an annual requirement rather than requiring dynamic monitoring and measurement of the system.
- There is limited agreement in what should or should not be included in the profile/review.
- The ISO/DIS 50001 and US standard include a specific list of items for the energy profile as well as what is included by each of those items. This level of detail is not represented by the other standards.
- The US and Chinese standards encourage the use of a baseline and a comparison to the baseline. However, it also indicates that the baseline should not be changed except under specific conditions.

- The criteria for selection of projects varies between the standards, each provides some value which should and should not be included is a good point of discussion.
- Four of the standards agree that the timeframe for the projects should be documented. (US standard, Chinese, Danish and Dutch)
- The Dutch standard includes a requirement to consider energy in investments and product development.
- The US standard standard includes a requirement that the data is used to measure performance against energy goals, targets, and baseline.
- China adds a requirement that the information on energy objectives and targets include information about the adoption of new technologies, renewable energy and potential of energy conservation.
- The Korean standard includes a requirement that goals be expressed in numerical values.
- The Korean standard includes a requirement that the data required is controlled and confirmed where necessary for key performance indicators, cost, consumption and efficiency.

4.3.6 Legal and other

Level of agreement: High

Comparative analysis

There are no significant differences; however, the level of regulation varies greatly among the countries represented.

Detail analysis

- Four of the standards (environmental, Chinese, CEN and Irish) include a requirement to determine how these requirements apply to the organization.
- China adds a requirement to update the legal requirements.
- Only the environmental standard requires the evaluation of other requirements.
- Inclusion of Note – other requirements may include: certification system for energy savings products, energy efficiency label, energy audit system elimination system of high energy consuming products standards good operation criteria etc.

4.3.7 Goals, targets and projects

Level of agreement: High

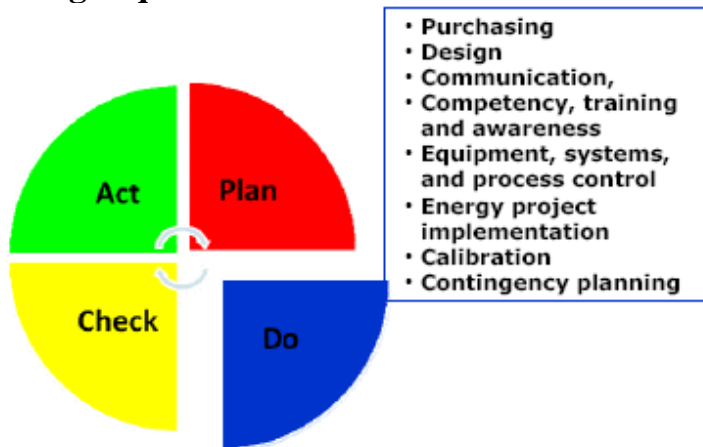
Comparative analysis

All of the standards require action taken to achieve goal, objectives, and targets. However, some standards require projects and other programs. This terminology difference will have to be resolved.

Detail analysis

- All of the standards require goals that are consistent with the energy policy. Several use the term objectives instead of goals. The U.S also requires consistency with the strategic plan. The Dutch and Korean standards require both short term and longer term goals/objectives.
- Five of the standards require the goals / objectives to be measurable.
- Seven of the standards require that targets are established for the goals/objectives.
- All of the standards (except Quality) require that projects or programs are established to meet the objectives, goals, and targets of the organization.
- The consideration for developing goals/objectives varies with some requiring consideration of legal requirements, other standards including finances, as well as the expected energy and environmental considerations.

4.4 Doing requirements



4.4.1 Purchase

Level of agreement: Low

Comparative analysis

Purchasing represents a technical aspect of energy management. It is not clear that the full nature of this technical aspect is addressed in the standards other than the US and China.

Detail analysis

- Six of the standards (ISO/DIS 50001, US, China, Sweden, and Denmark) require a procedure for purchasing.
- Five of the standards (ISO/DIS 50001, US, Quality, China and Korea – not the same as the list for required procedure)
- Korea adds the requirement that the organization shall select the equipment, facilities,

and systems with high energy efficiency and low energy consumption.

- The US requires that the organization review and approve energy purchasing specifications such as RFP and RFQ for adequacy prior to release.
- The US standard requirements specify the types of specification on energy, including:
 - Energy quality (US and China)
 - Availability (US and China)
 - Capacity
 - Variation over time (US and China)
 - Billing parameters
 - Environmental Impact
- The quality standard (ISO 9001) includes a general purchasing requirement on the approval of product, procedures, processes and equipment.
- The quality standard (ISO 9001) includes a general purchasing requirement on personnel and services.
- The quality and Chinese standard both include a requirement to ensure the specifications are reviewed for adequacy prior to providing them to a supplier.
- The US standard includes a requirement that the criteria for suppliers include reliability and financial risk to the organization. The Chinese standard includes consideration of risks and energy quality considerations. The US 2005 version includes a requirement to approve equipment and systems based on a series of criteria including efficiency, recyclability, durability, etc.
- Five standards (ISO/DIS50001, US, Quality, China, and Denmark) require the organization to evaluate and select suppliers on their ability to meet requirements. The Danish extend the requirement to add that the suppliers are partly evaluated on the basis of energy consumption.
- When communicating with suppliers there are several unique limitations:
 - Environmental standard limits to goods and services related to significant aspects
 - China to items that are important energy conservation factors
 - CEN to equipment and raw materials
 - Sweden to equipment and raw materials with impacts on significant energy aspects
 - Denmark to energy consuming equipment and raw materials having a significant impact on energy consumption
- The Chinese standard adds the requirement that the organization testify the products provided by energy suppliers.
- The ISO/DIS50001, U.S and Quality standards require records of the supplier evaluations.
- The US and Chinese standards require the evaluation of bids, offers, and tariffs.

- The US and Chinese standards require the review, evaluation and records of contracts.
- The US and Korea agree that the controls on outsourced processes should be documented.
- Korea also requires records on the controls of outsourced processes.
- Korea requires records of purchase related processes.
- The US requires the organization to consider products that can have a reduced effect on humans or the environment.
- There is a note in the US standard that states the use of environmentally preferable purchasing guidelines is recommended.

4.4.2 Design

Level of agreement: Low

Comparative analysis

Although the concept of design is present in most of the standards at some level, it is primarily considered to be a part of operational control and not separated out as a separate section.

Detail analysis

- Six standards (ISO/DIS50001, US, Chinese, CEN, Swedish, and Korean) address the need for energy efficiency in the design process.
- Design systems are limited by the US standard to the design of new facilities or major modifications or expansions. The Danish scope of design is similar but includes renovations.
- The US standard includes a requirement to record the decisions and update the energy profile as necessary.
- The US standard introduces a separate requirement related to the selection process for purchases of equipment related to significant energy uses and what should be considered.
- The US standard adds additional considerations for equipment including: operations and maintenance cost, suitability for recycling, durability, reusability, recycled content, disassembly potential, and legal and other requirements.
- The US standard adds a requirement that addresses the commissioning, recommissioning or continuous commissioning of new and existing facilities, plants, or systems.
- The Quality and Chinese standards add a consideration of safety and quality.
- There is not agreement on the items that should be included in the design considerations.

4.4.3 Communication

Level of agreement: High

Comparative analysis

The ISO 9001 system focuses on internal communication; the customer process for communication being separate. The environmental and energy standards focus on the combination of internal and external communication processes.

Detail analysis

- The Korean and PAS standards add a requirement to receive records and respond to relevant external communication.
- The CEN, Irish, and Danish standards add a requirement that internal communication includes those working on behalf of the organization.

4.4.4 Competency, Training and awareness

Level of agreement: High

Comparative analysis

There are no significant differences other than the minor ones listed in the Red Hat Thinking.

Detail analysis

- The ISO/DIS50001, U.S, environmental, and PAS 99 standards state that competency applies to personnel working on behalf of the organization, whereas the Quality, Chinese, CEN, Irish, Danish, Dutch, and Korean standards limit this to employees of the organization.
- The Quality standard includes the requirement to determine the competencies for personnel.
- The US standard, Quality, Environmental, Chinese and Korean standards require records of competency.
- The ISO/DIS50001, U.S and Environmental standards include a requirement to maintain records of training needs.
- The Quality and PAS 99 standards add a requirement to evaluate the effectiveness of the actions taken.
- The ISO/DIS50001 and Environmental standards expand the awareness requirement beyond the employees to those working on behalf of the organization.
- Four standards (ISO/DIS50001, US, Quality and Korean) include a requirement to make employees aware of energy goals, targets.
- China adds the requirement that employees are aware of benefits of reduced energy consumption and increased energy efficiency and energy management.
- Six of the standards (ISO/DIS50001, US, Environmental, Irish, Danish, and PAS 99) include a requirement that employees be aware of the importance of conformance

with the management system.

- Four of the standards (Environmental, Chinese, Swedish, and Korean) include a requirement that the employee be aware of the consequences of departing from the procedures.
- China and CEN include a requirement that those employees whose work is related to the control, purchase, storage, use or treatment of energy will be specially trained.

4.4.6 Equipment, Systems and process control

Level of agreement: Medium

Comparative analysis

- ◆ **The current MSS have moved to the term criteria from work instructions to allow a more flexible approach to documentation. For example, criteria may be provided in a form or through a computer system or drawing and not necessarily in a procedure or work instruction.**
- ◆ **The measuring and monitoring of processes is included under measuring and monitoring in other MSS to provide consistency and clarity. Consideration to integration issues and the location of measuring and monitoring of processes should be discussed.**
- ◆ **Records and the use of those records in data analysis are not clear in these requirements. Appropriate connections to required records and any data analysis or use in management review need to be considered.**

Detail analysis

- The controls included by the standards have considerable variation, creating an opportunity for discussion.
- The Irish standard includes a broad range of controls in this section that address the topics of purchasing, design, and maintenance.
- The Dutch standard starts the section with the statement that the organization documents insight into energy consumption of significant energy consumers and the behavior and/or technology with which these are managed.
- The PAS 99 standard links the controls to conditions necessary to meet the policies, objectives and legal requirements of the system.
- Korea adds facilities in with equipment.
- The ISO/DIS 50001, US and Quality standards include measuring and monitoring requirements as an operational control.
- The Quality standard adds in the requirement for a process that defines the review and approval of the criteria, equipment and personnel.
- China identifies several items in control not otherwise addressed these include requirements for:
 - Reduction of energy consumption
 - Energy efficiency given priority in approval of equipment

- Identification of best workable technology
- Managing necessary infrastructure and environment
- Research of new technologies
- Adoption of new energy and renewable energy
- Records requirements are added by quality and Korea.
- Restoration considerations are added by CEN, Sweden and Korea.

4.4.7 Energy project implement action

Level of agreement: Low

Comparative analysis

This topic is not widely addressed in the standards compared. This requirement provided the “doing” connection within the standards that address energy projects.

4.4.8 Calibration

Level of agreement: Medium

Comparative analysis

- ◆ **There are two basic approaches to calibration. As a point for comparison :**
 - **The Quality MSS includes requirements due to the importance of calibration in meeting customer requirements.**
 - **The Environmental standard does not include the detailed requirements due to the nature of the items used, such as pH paper in environmental measuring and monitoring.**
- ◆ **The location of the calibration requirements also varies. Some of the standards place it in the DO section of the PDCA cycle. Others place it in the ACT section of the PDCA cycle. Some standards have a separate section for calibration while others include it either in operational controls or measuring and monitoring.**

Detail analysis

- The organization shall identify what needs to be calibrated is added by the quality MSS.
- The organization shall acquire or retain the appropriate equipment is added by the Korean standard.
- The Korean and Quality standard add a requirement to ensure valid results.
- The Quality standard adds a requirement to calibrate against traceable standards.
- The Quality and Korean standard add the requirement to adjust the calibration as appropriate.
- The Quality standard adds the requirement to identify the calibration status.
- The Quality and Korean standards add a requirement to safeguard and protect the

devices.

- The Korean standard adds the requirement that calibration requirements be followed even when the measuring and monitoring activities are consigned.

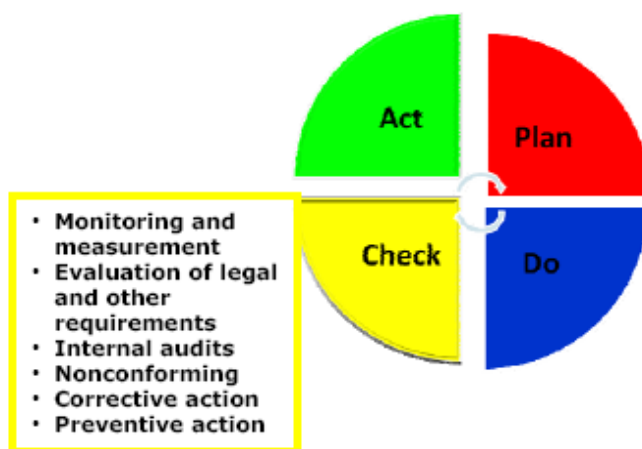
4.4.9 Contingency planning

Level of agreement: Low

Comparative analysis

Other than PAS 99 this topic is not addressed.

4.5 Checking requirements



4.5.1 Monitoring and measurement

Level of agreement: Medium

Comparative analysis

There is a significant amount of variation in what information should be measured and monitored to demonstrate an effective system, or effective processes.

Detail analysis

- The Quality standard begins the measuring and monitoring section with a statement that the organization shall plan and implement measuring and monitoring to accomplish three items. Then follows with requirements related to those three items (process, product, continual improvement).
- The US standard adds in the requirement that where available standard measurement and verification protocols be used.
- The US standard adds in a requirement to use cost data to verify performance and savings from commissioning are achieved.
- China adds a requirement that energy measurement and verification to include energy consumption of products, condition of equipment that day, procedures of

energy purchase, storage, usage and treatment, adoption of new technologies and new energy, and potential of energy conservation.

- China adds the requirement that measurement, collection, cleaning and use of energy data and information shall be carried out according to requirement on calculation of total production energy consumption, energy balance of enterprise, energy conservation surveillance technologies, energy conservation products evaluation, enterprise energy audit technologies, etc.

4.5.2 Evaluation of legal and other requirements

Level of agreement: High

Comparative analysis

The Chinese, CEN, Swedish, Danish and Dutch standards include a connection to legal and other requirements commitment in the policy. They require that the organization periodically evaluate compliance.

4.5.3 Internal audits

Level of agreement: Medium

Comparative analysis

Although the standards agree that audits should be based on importance and previous results, they do not agree on the focus for importance. The US Standard uses energy status as the focus, the Chinese uses the influence of energy efficiency, the CEN, Irish and Danish use importance of the processes and areas (no reference to energy), the Swedish use the significant energy aspects, and the Koreans use the impact of energy.

Detail analysis

- The CEN, Irish, Danish and Korean standards have a requirement to document the audit. In the case of the Korean standard it is specifically referencing a required audit checklist which is a document that would be controlled by the ENMS. In the case of the CEN, Irish, and Danish standard it is in reference to audit results. These are treated as records by the other standards and not as documents. The issue of record vs. document was noted in the document and records requirement review. This is a specific example within the standard.
- A checklist that addresses specific topics is a requirement of the Korean standard.
- The CEN standard stated that “a) conforms to the energy policy, objectives, programs, and all other requirements of this standard” to provide emphasis on the planning part of the PDCA cycle.
- The ISO/DIS 50001, US, CEN, Chinese, and Korean standards add the requirement that auditors shall not audit their own work; this is in alignment with current MSS

trends.

- The US adds the requirement that the procedure address the retaining of records, the Chinese add the requirement that the procedure include the criteria for the audit.
- The ISO/DIS50001, US, China, Korea, and the Quality standard require that the internal audit results be brought to the attention of persons who can take corrective action. The Korean and US standard add the connection requirement that internal audits be reported to management review.
- The Dutch and the Korean standard include a requirement that the audits be conducted at least once per year.
- (Connection to Nonconformance, corrective and preventive action) Should a note be added here to address the intent that internal audit finding require a corrective action. Recall note in nonconformance section that allows organizations to determine the need for action.

4.5.4 Nonconforming, corrective action, preventive action

Level of agreement: High

Comparative analysis

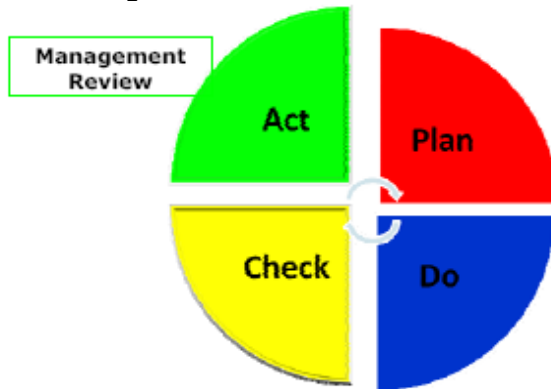
- ◆ **Several standards combine nonconforming, corrective and preventive action.**
- ◆ **Several standards separate nonconforming (identifying the problem), corrective (solving the problem), and preventive (responding to trends in data analysis).**
- ◆ **Several standards allow the corrective and preventive processes to be combined.**
- ◆ **A few of the energy standards do not address nonconforming.**

Detail analysis

- The US, environmental and Korean standards introduce the concept of actual or potential nonconformities.
- The CEN, Irish and Danish standards require that the organization take action within a specified time limit.
- Customer complaints and communication from external parties is a requirement of existing MSS.
- Responsibility for addressing nonconforming is a requirement of the Quality, Swedish, and Dutch standards.
- Ensuring control of the nonconforming materials and appropriate handling is a requirement of the quality MSS standard.
- Mitigation (an environmental term relative to clean up actions) is included in the US, Korean, PAS, and Environmental standards.
- The connection to management review for corrective and preventive action is not clearly agreed to in the requirements, but in most cases it is an input to management review – this appears to be a disconnection.

- Does the note on organization deciding when nonconformity requires action conflict with the intent that internal audit findings must have a corrective action response?

4.6 Act requirements



4.6.1 Management review

Level of Agreement: High

Comparative analysis

The standards agree on the requirements for management review. There were several minor differences identified in the red hat section but there were no significant differences noted.

Detail analysis

- The ISO/DIS 50001, US, Swedish, and Korean standards require that the necessary information for the management review be collected and presented. The US standard assigns the responsibility for this to the energy coordinator (management representative).
- The Korean standard adds a requirement to carry out corrective and preventive actions based on the management review.
- Five standards state a requirement that the review consider the need for changes to the management system including changes in the policy, objectives and targets.
- The US and Korean standards have a requirement to include changes to key performance indicators as an input to management review.
- The Korean standard includes two additional inputs one for evaluation of the degree of accomplishment of energy performance for each department or process and other matters that relate to the EnMS.
- It is interesting to note that only four of the standards (ISO/DIS 50001, China, CEN, and Irish) that include requirements on legal requirements include compliance audits or legal information as inputs into management review.
- The inclusion of energy aspects in the inputs for management review is addressed currently by two standards (CEN and Irish) but is not included by the other standards

that use energy aspects.

- The inclusion of the requirement that communication with external parties, including any complaints be included in the input to management review.
- The US and Korean standards include a requirement for the outputs to address any changes to key performance indicators.
- The ISO/DIS 50001, US, Quality, Chinese, Korean and PAS 99 standards include the requirement that outputs should include allocation of resources.
- The inclusion of the requirement that outputs should include improvements related to interested party requirements or improvement of the product is included in the quality and environmental standards.

5 CONCLUSIONS

As expected, most of the elements that focus on management system best practices (i.e. Policy, internal audits, corrective and preventive action, management review, document control, training, communication, etc.) show a high degree of similarity and agreement. However, among the more technical elements of the standards, there are significant differences that will require considerable effort to achieve harmonization. Illustrating these differences on a very basic level is the definition of energy and energy performance which varies widely between the standards. Other terms and definitions will also require considerable effort to achieve harmonization.

The requirements/elements that have the lowest level of agreement are in the “PLAN” and “DO” phases of the continual improvement cycle. These elements, which present the greatest hurdles to harmonization, are generally technical aspects of energy management, such as purchasing, design, and use of energy data and information in planning. Specifically, those elements that showed the lowest level of agreement are:

- Management commitment
- Strategic planning
- Energy data management / energy profile / energy aspects
- Purchasing
- Design
- Energy project implementation
- Contingency Planning

5.1 Management commitment

For those standards that are a derivative of ISO 14001 (many of the European standards), the commitment of the organization’s management is limited and covered under the section on roles, responsibilities and authorities. For those standard’s that utilize ISO 9001 as a basis, management commitment is called out in a separate element in order to provide emphasis on the role of top management. Only four standards (US, Quality, China, Korea) have this separate element. All the standards, however, agree that top management commitment is needed to support the energy management system.

5.2 Strategic planning

Only two standards (US, Korea) included this topic as a requirement. In these standards, energy considerations are elevated to the level of an organization’s strategic planning activity. The strategic plan has limited connections to other parts of the standard. This requirement represents a creative opportunity within the international MSS to improve connectivity with the strategic decision making process.

5.3 Energy data management / energy profile / energy aspects

All of the standards (except quality) require the development of energy information to help with the planning process. Seven of the standards include a requirement for a procedure to develop energy data information (US, Environmental, Chinese, CEN, Irish, Danish, Dutch and PAS 99), however the method to be used is not specified. The US standard uses the term “profile” to label this energy data document. The Korean standard addresses a more limited version referred to as “consumption and other data”. The CEN draft and other standards patterned after ISO 14001 require that “energy aspects” of an organization’s operations be documented. However, only the PAS standard defines aspect as “characteristic of an activity, product, or service that has or can have an impact”. These approaches lead to some interesting differences in how the standards manage energy information, how it affects the planning process and leads to improvement in energy performance.

The US approach, the “energy profile”, is data driven. The components of the profile are very specific and include regular utility tracking, an energy baseline, significant energy uses and key performance indicators (KPI). The use of normalized KPIs provides a means to compare results across time, addressing seasonal variations and typical production swings. The results of regular energy assessments which highlight opportunities for energy efficiency improvements are also part of the energy profile. This information is used to develop goals, targets, and project plans. Implemented projects then lead to continual improvement in energy performance which is measured by changes to the key performance indicators and to the energy baseline, all of which are developed from the profile data. China calls for evaluation of performance based on industrial energy use benchmarks whereas Korea calls for a comparison to the key performance indicators or “consumption efficiency” which are both associated with the targets. The use of normalized metrics, KPI, to manage the system, not just the current projects, is unique to the US standard.

The “energy aspects” approach gives organization flexibility in developing its energy information document. A review process is established that looks at energy use data, projected energy use and other parameters, along with opportunities for energy conservation. This review feeds the identification of “energy aspects” and significant energy uses. Opportunities for improvement are identified. A program plan is then developed with goals and objectives to achieve greater energy efficiency. The program is the means to improve organizational energy performance.

The energy profile and energy aspects approaches have a couple of significant differences. The energy profile is a dynamic data approach that requires at least monthly updates to the profile. The energy aspects approach looks at reviews of current energy use and projected energy use over longer periods of time. The energy profile also includes energy performance measurement based on changes to key performance indicators and the energy baseline. The energy aspect approach demonstrates performance improvement

through meeting goals and objectives.

Finally, the US uses the concept of energy projects to achieve energy conservation improvements while the energy aspects approach uses the programs to control significant energy uses and deploy energy conservation activities.

5.4 Purchasing

Most of the standards address a requirement for purchasing of products and equipment that are energy efficient. Only China and the US use this element to also address the purchase of energy resources. Only the US standard includes developing supply purchasing requirements to be used for proposals and evaluation of bids and contracts. This is because the US supply marketplace is very complex and many organizations have multiple energy suppliers with varying rates and tariffs. In response, the US standard is designed to help organizations control energy costs as well as manage energy use. This dual focus promotes organizational communication that facilitates optimization of energy management, which is particularly important when organizations face multiple supply options.

5.5 Design

Although the concept of design is present in eight of the standards at some level, it is primarily considered to be a part of operational control and not called out as a separate element. In these instances, the design process for an organization requires energy efficiency considerations to be included. Two of the standards (US, Danish) limit the scope of design to new facilities and major upgrades, with the Danish specifically calling out renovations and the US calling out significant energy uses. The scope for applying energy efficient design varies significantly among the standards.

5.6 Energy project implementation

This topic is not widely addressed in the standards compared. Where it is included, it provides the “DO” connection within the standards that address energy projects. It also provides a mechanism for the implementing organizations to modify project plans in order to maximize the potential of continual improvement.

5.7 Contingency planning

Contingency planning was only included in one standard, PAS 99:2006, and presents an opportunity to address connections to emergency issues that organizations may face.