Japan – Brazil Cooperation on Energy Conservation

METI/ECCJ

Program-1- Improvement in Standard and Labelling of Electrical Appliances

Training as the first training of trainers (TOT)

Country Report

Conclusion

Ministry of Mines and Energy- MME
Secretary of Energy Planning and Development- SPE
Department of Energy Development- DDE

Electrical Power Research Center - CEPEL
Fundão Laboratory Department - DLF
Refrigeration Laboratory - MA7

National Institute of Metrology, Quality and Technology- INMETRO
Compliance Assessment Department

Brazilian Electricity Centers S.A. - Eletrobrás
National Program of Energy Conservation- Procel

Brazilian Electricity Centers S.A. - Eletrobrás
Eletricity Research Center- CEPEL

PROCEL PROGRAMA NACIONAL DE CONSERVAÇÃO DE ENERGIA ELÉTRICA
Eletrobras
MINISTÉRIO DE MINAS E ENERGIA
PÁTRIA AMADA BRASIL GOVERNO FEDERAL
INMETRO

1 Participants

	Family	Middle	First	Organization	Present position
1	dos Santos	Januário Neris	Marx Sangirardi	LG Electronics	HA Certification Supervisor
2	Lisboa	de Abreu	Pablo	Electric Energy Research Center - CEPEL	Researcher Engineer
3	Capella	da Silva	PAULO	ELECTRIC ENERGY RESEARCH CENTER - CEPEL	RESEARCHER
4	dos Santos		Paulo	ELECTRIC ENERGY RESEARCH CENTER - CEPEL	RESEARCHER
5	Anders Brasil		Davi	Inmetro	Researcher
6	Amaral Kyriazis		Gregory	Inmetro	Senior researcher
7	Monteiro	Tiago	Felipe	Inmetro	Technologist Researcher
8	Da Silva Souza		Hercules Antonio	Inmetro	Technologist Researcher
9	Mianes	Leão	Rodrigo	labelo- PUCRS	Technical manager
10	Wesche nfelder		Leandro José	labelo-pucrs	laboratory coordinator
11	Oliveira	de Sousa	Bruno	labelo-pucrs	technician
12	João	de Andrea	Leonardo	labelo-pucrs	laboratory analyst
13	Santos	Moreira Duarte	Samuel	Eletrobras	Mechanical Engineer
14	da Cunha	Alvarenga	Elisete	Eletrobras	architect analyst
15	de Mello	Neiva	Estefânia	Eletrobras	architect analyst
16	Fonseca	Zidan	Victor	Eletrobras	Mechanical Engineer
17	Rocha	Soares	Marcello	Eletrobras	electrical engineer
18	Maciel	Albuquerque	Alexandra	Ministry of Mines and Energy	Infrastructure analyst
19	SEVERO KLUWE		CLAUDIO HENRIQUE	MIDEA CARRIER	R&D MANAGER
20	Moraes Lourenço		Leandro	Daikin McQuay Ar Condicionado Brasil Ltda.	Product Engineering Manager
21	Pazinato		Luiz Carlos	Electrolux do Brazil	Techinical representant at Eletros association

2 Training period

From the 29th of October to the 18th of November.

3 Training Summary

3.1 J01 - Program Guidance

The lecturer detailed the main Project which comprises two programs:

Program-1 - Improvement in standard and labeling of electrical appliances and Program-2 - Energy efficiency and conservation (EE&C) promotion in the energy intensive industry by the "benchmark approach" under the energy management system (EnMS).

The time schedule of Program-1 related to air conditioners will match the enforcement schedule of the ordinance No. 234 on introduction of ISO16358-1 so that seasonal aspects are taken into account in the evaluation of the EE&C of such appliances in Brazil.

Program-1 comprises the following activities related to air conditioners:

a) Training for Trainers (TOT) to introduce ISO16358-1 CSPF;
b) Improvement in laboratories to introduce Cooling Seasonal Performance Factor (CSPF);
c) Development of a roadmap to introduce CSPF - Studies to improve the standardization and labeling system.

Details about the TOTs:

a) 1st TOT (BEC BR6 - STEP-1) - Remote training - Lectures and advisory discussion;
b) 1st TOT (BEC BR6 - STEP-2) - Training in Japan - Testing practice with master air conditioner;
c) 2nd and 3rd TOT - as per the plan developed.

3.2 J02 - Points and Requirements to Introduce ISO 16358-1 (CSPF)

Main contents of the lecture:

a) Outline of ISO 16358-1 (CSPF);
b) Situation of CSPF adoption;
c) CSPF calculation process.

ISO 16358-1 provides the means for calculating the Seasonal Performance Factor (SPF), namely the coefficient to evaluate the energy efficiency of air conditioners in actual use conditions. ISO 5151 should be consulted for test methods, conditions and requirements.

Differences between Energy Efficiency Ratio (EER) / Coefficient of Performance (COP) as stated in ISO 5151 and Cooling Seasonal Performance Factor (CSPF) and Heating Seasonal Performance Factor (HSPF) as stated in ISO 16358-1. The performance of air conditioners varies greatly depending on the conditions. Watt-hour (Wh) is more appropriate.

The unique point evaluated by ISO 5151 is the rated point (full load capacity) at 35 degrees Celsius. But partial load operation is much more frequent in actual use. In addition, most of the histogram of annual temperatures is located below 35 degrees Celsius. A new efficiency evaluation index is desired that takes into account both issues.

The seasonal energy efficiency is calculated by considering the air conditioner operating efficiency at each outside temperature. The seasonal energy efficiency is the mean of those air conditioner operating efficiencies weighted by the frequency of occurrence of each outside temperature. The overall efficiency is closest to actual use.

A historical account of ISO 16358-1 was given where it was pointed out that the regulation by one evaluation performance criteria without classification between fixed and inverter-type air conditioners will contribute to the reduction of electric consumption. CSPF can evaluate the performance in actual use and can evaluate all types of air conditioners.

CSPF is the ratio between Cooling Seasonal Total Load (CSTL) in Wh and Cooling Seasonal Energy Consumption (CSEC) in Wh. CSTL is calculated by multiplying the cooling load in W for each outdoor temperature by the histogram of temperatures in bin hours.

CSEC calculation depends on the type of air conditioner being obtained by multiplying the power input at each temperature by the histogram.

The calculation tool for CSPF is attached to ISO 16358-1/Ammendment 1: 2019. A spreadsheet is provided. But it seems easy for everyone to elaborate another spreadsheet based on the equations provided in ISO 16358-1 and in the lecture. However, the use of the standard spreadsheet is recommended.

3.3 J03 - Key Points of Testing Work for Air Conditioners

Main contents of the lecture:

a) Overview of testing standards and basic workflow of the air conditioner capacity test;
b) Capacity test application, acceptance, unpacking check and test preparation;
c) Capacity test.

The main written standards for cooling are: ISO 5151:2017 (valid for all types of air conditioners), ISO 16358-1:2013 and ISO 17025:2017. Testing standards are not enough for proper testing work. A testing manual describing their own specific procedures based on the testing standards should be elaborated by each testing laboratory.

The capacity test workflow was described. The test application, acceptance and unpacking involves a service application sheet, a questionnaire on capacity test, Equipment Under Test (EUT) reception check sheet, and EUT appearance check sheet.

The weight of the outdoor unit should be measured. The test preparation workflow was described. The unit should be installed according to the requirements of ISO 5151. If split-type air conditioner, there is a workflow for the refrigerant tube connection which was detailed. The air sampler installation was then described. The test facility setup and operation was then described with a final checklist.

Details concerning the EUT operation were given and an example of the questionnaire on capacity test was provided. The capacity test main workflow was described. It is simpler for cooling where only a steady-state test is required. The main flow of the steady-state test was described including data selection and test tolerances.

The workflow after the end of the test was described. It is simpler for fixed-type air conditioner. The procedure for split-type air conditioner was detailed and involves the refrigerant pump down, the refrigerant tubes handling, the drying of the EUT, weight measurement, and packing of the EUT.

3.4 J04 - Requirements of ISO/IEC 17025

Main contents of the lecture:

a. Outline of ISO/IEC 17025;

b. Key points of the requirements;
c. Reference materials.

A historical account of ISO/IEC 17025 was given showing the main reasons for its revision in 2017. In particular, its change from prescriptive to performance-type requirements. Some other major changes were also described. A comparison of the contents between the 2005 and 2017 editions was tabled for easy reference.

The key points of the requirements were detailed for each item of the standard. In item 4, the need of risk management and legally binding confidentiality. In item 5, the procedures should be documented only to the extent necessary, and no longer the need of formal management. In item 6, the resource requirements were commented. In item 6, the need for periodic monitoring the personnel competence (not only training and education but clear criteria). The need for calibrating equipment and evaluating uncertainty of measurement and other traceability issues were stressed in the new version. There is no more any distinction between calibration and testing labs.

In item 7, there should be good communication between customer and testing laboratory concerning the work to be performed. Updated documentation and appropriate methods should be used for selection, verification and validation of results. The lab shall have procedures for handling of test and calibration items. Amendments for technical records shall be able to be tracked. Laboratories shall identify the contributions to measurement uncertainty. The laboratory shall have a procedure for ensuring the validity of results. Several examples for monitoring the validity of test results for air conditioners were presented as an illustration of this item. The procedure for reporting the results was detailed. In particular, the need of documenting the decision rule employed, taking into account the risk level (when this is needed), when providing a statement of conformity with a given specification. Personnel authorization is a requirement to provide legally binding reports.

4 Training evaluation

The Ministry of Mines and Energy have received feedback of 15 participants regarding three main topics:

- General evaluation (videos and training material)
- Applicability of the acquired knowledge
- Suggestions for improvement

4.1 General evaluation

In general, the participants observed that the training has managed to approach, with good quality and didactic, all the proposed topics.

It was observed that the J01 and J02 videos could achieve more participants, regarding their different expertise, and the J03 and J04 videos were better evaluated by the participants with activities directly related to laboratory tests.

The J02 video was highly praised for presenting the technical aspects of energy consumption assessments, explaining in detail the reasons and procedure for each type of

equipment. This knowledge also helped in the understanding of the operation of air conditioning equipment.

There was a very good approval of the remote format, in which each participant could manage their own time to study the material and the videos. The translation in Portuguese was also very well evaluated.

4.2 Applicability of the acquired knowledge

The applicability will occur in the management of the planned revisions, both in the improvement of the air conditioning programs and other equipment regulated by the energy efficiency labelling program, as well as in the review of the energy efficiency indexes of these programs. It will also take place in activities related to market surveillance actions foreseen by such regulations, in the interface with regulated entities (laboratories and industry), training of the regulation area team and provision of information to society in general regarding the Brazilian labelling program, which includes air conditioners.

Given the review of the air conditioner label by INMETRO and the subsequent review of the criteria for the concession of the Procel Seal and the creation of the Procel Gold Seal, the training provides important information. The adoption of ISO 16358 was the basis for this regulatory review, therefore, knowing in detail the calculations of the standard, the air conditioner testing process itself and the specification of laboratories is fundamental to align the knowledge among the various agents that operate in the sector.

With the training it was possible to improve the skills of how to evaluate seasonal performance factors and its role to energy conservation of electrical appliances, contributing to disseminate the need for the seasonal performance factor evaluation for air conditioners. As a consequence, it will contribute to the enforcement of Brazilian Ordinance No. 234, and help on the improvement of test procedures in Brazilian laboratories.

4.3 Suggestions for improvement

Most participants have suggested that in future trainings ECCJ could consider the possibility of using subtitles or simultaneous translation in order to save time for the videos.

Another suggestion would be that in the training, demonstrative videos were added to facilitate the understanding of the explanation of the operations presented by JATL technicians, also inserting more practical examples of the approaches involving the certifications through the ISO / IEC 17025 and ISO 9001 standards.

Considering that the videos are not accessible after the training and that the support slides do not allow to cover the large amount of information presented, it is suggested that support texts could follow the slides, so that the information is not lost.

Future training topics were also suggested, such as specific training on the balanced calorimeter method and the enthalpy method discussed in ISO 5151. For the practical training provided, a script with the main questions related to laboratory and documentary aspects could be elaborated to be used as a reference material during the tests to be carried out.

5 Main findings

The standards for air conditioning testing (ISO 5151, ISO 13253 and ISO 15042) that define minimum conditions for testing are not sufficient to perform high performance tests. New rules must be defined in a test manual, as JATL did, to address this situation. Procedures must be followed to obtain information from the customer, the product, how the tests are carried out, checking the product and identifying problems with it. The use of proper devices to establish the connections with the air conditioning and the monitoring of environmental conditions as well as its correct positioning, control and verification are essential to guarantee the reproducibility and reliability of the tests. Another important point cited was the data acquisition period defined in a technical standard to prevent initial instabilities in both the environment and the instrument from interfering with the test data and all products can be evaluated in a stable interval.

Finally, the ISO / IEC 17025 standard and its modifications that impact the laboratory's actions, decisions and structure were briefly presented. Efforts are aimed at balancing it with the ISO 9001 standard that works with performance optimization. Thus, some items of the standard have been relieved in order to provide better service to the laboratories while others have been intensified to prevent external interference from impairing performance and better laboratory management.

The CEPEL and LABELO laboratories, according to the information provided in the course, have a structure similar to that of JATL, but specific situation indicators are still used (ISO 5151 - EER). New test points will be necessary since the use at half capacity is used in the calculation of the CSPF, in the case of inverter air conditioners and possibly others. For this, it will be necessary to recondition the laboratories so that the control of the room also reaches this condition or any other required by the client. The sensors and measuring instruments must be evaluated and, if necessary, recalibrated at the necessary points or replaced with suitable ones. JATL provided examples of materials and devices that they developed for installation and testing. It is worth evaluating the adoption of these same procedures for manufacturing or whether it is better to acquire them from specialized companies.

Amendment 1 of ISO 16358 was cited, which provides a spreadsheet for calculating the CSPF. It would be interesting to acquire this amendment and there is also the possibility of developing your own calculation since the formulas were provided together with examples described in the training. Accreditation by CEPEL will also be necessary since LABELO already has it. Therefore, the laboratory must be adapted to the standards and submitted to the competent body for obtaining it.

For the implementation of the CSPF, it will be necessary to access the country's annual temperature database. There is a problem with the continental extent of Brazil and temperature extremes. One possibility would be the implementation of regional labeling. For example, the CSPF for the southeast region will be one value, for the northeast region another and consequent labeling. The regions can be grouped by similarity of temperature (perhaps this does not coincide with the delimited regions - north, northeast, midwest, southeast and south). For this case, there is also the possibility of grouping states or even that it is individual by state and a database provided to the consumer by the regulatory agency. The label, for this situation, must state the status for which this label is valid and if used in another region, consult a specific website.

There is a plan to adopt the CSPF and its classification (from A to F) by the end of 2022. Companies must adapt, if necessary, in order to improve their products in terms of energy efficiency. The case of Japan is very interesting, the "Top runner" program predicts that the lower limit of energy efficiency in the target year will be the maximum of the current condition. Manufacturers will have to adapt to at least achieve the most efficient product efficiency today. This approach, while aggressive, can be very effective if the government creates ways for cutting-edge technologies to be accessible to more modest companies. It is a case to be considered for the Brazilian reality.

The examples of procedures and applications carried out at JATL also provide material for the classification of energy risks and also for safety. Classifications may insert new items for safety testing and risk assessment. In order to move the Brazilian economy, laboratories that intend to acquire certification to carry out tests on electrical equipment that have an energy impact can seek the competent bodies for advice on how to proceed. The knowledge acquired in training enables this relationship. The growth in the number of qualified laboratories can relieve CEPEL and LABELO of the burden of receiving too much equipment for testing and labeling and fosters the market.

6 Final conclusions

In conclusion the course allowed the comprehension of the importance of improving our performance evaluation capacity, with the objective of promoting and conserving energy in the industrial sphere. At first, the focus on methods of evaluating the performance of air conditioners, makes it possible to achieve and replicate practices for other appliances that participate in the national labeling program, such as refrigerators.

Labelo (Laboratories Specialized in Electro-electronics) and Cepel (Electric Energy Research Center) will be the key laboratories in Brazil in this process. The training objectives were to present improvements in the Brazilian labeling program (PBE), through the insertion of ISO 16358.

The calculation methodology of ISO 16358, although more complex than ISO 5151, can achieve results in performance evaluation more faithful to reality. Each country has its particularities in the climate, and considering it in the assessment is of fundamental importance. Through the introduction of Bins Hours, the evaluation method will consider the annual temperature averages, thus it is possible to adapt the calculations in the analysis of the performance of air conditioners to the Brazilian reality.

Thus, this training was of fundamental importance for the new policies and regulations of the national energy conservation program, which aims to implement in the coming years indices that demand increasingly efficient devices.