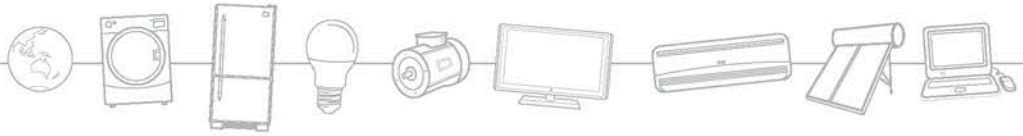
E3
Equipment Energy Efficiency

Implementation update: Refrigerated display and storage cabinets

May 2018



A joint initiative of Australian, State and Territory and New Zealand Governments.

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Introduction

Background

This paper provides an update on the implementation of the proposals for refrigerated display and storage cabinets, gelato scooping cabinets and small (<=500 litre) ice-cream freezers, following approval by the Council of Australian Governments (COAG) Energy Ministers of the Decision Regulatory Impact Statement on 24 November 2017.

It also updates stakeholders and industry on developments since they were consulted on the recommendations of the trans-Tasman Technical Working Group in August 2017. The proposed implementation date for all proposals is 1 December 2019.

Technical Working Group recommendations

In August 2017, industry stakeholders were consulted on the following recommendations of the Technical Working Group (TWG):

- **Recommendation 1:** Adoption of EU efficiency levels for refrigerated display cabinets, with adjustments to one cabinet category
- **Recommendation 2:** Adoption of EU efficiency levels for refrigerated storage cabinets, gelato scooping cabinets and small ice-cream freezers
- **Recommendation 3:** A registration scheme encompassing single model registrations, family model registrations and deemed to comply registrations (for low production volume/bespoke cabinets unable to be tested in a standard testing facility)
- **Recommendation 4:** Voluntary online labelling, with cabinet efficiency characteristics provided in a standardised star rating format.[1]
- **Recommendation 5:** Adoption of the European Standard ISO 23953 for refrigerated display cabinets, with minor amendments to wording and one cabinet category.
- **Recommendation 6:** Adoption of ISO 23953.1 (Vocabulary) – concerning groups of cabinets as classified by type.

[1] The transition to a star rating system would require an algorithm (developed by regulators), to be published prior to implementation of the new efficiency levels.

- **Recommendation 7:** Adoption of ISO 23953.2 (Refrigerated Display Cabinets – Classifications, Requirements and Test Conditions) with minor amendments.
- **Recommendation 8:** Adoption of the European test method EN 16825:2016 (Refrigerated Storage Cabinets and Counters for Professional Use) with minor amendments.
- **Recommendation 9:** Adoption of EN 16901:2016 (Ice-Cream Freezers – Classifications, Requirements and Test Conditions) with minor changes.
- **Recommendation 10:** Exclusion of EN 16902 (Commercial Beverage Coolers – Classifications, Requirements and Test Conditions) - ISO 23953 to be used as the test Standard for beverage coolers.
- **Recommendation 11:** Adoption of EN 16838:2016 (Refrigerated Display Scooping Cabinets for Gelato – Classification, Requirements and Test Conditions).
- **Recommendation 12:** Refrigerants are out of scope.

Two submitters responded to the TWG consultation paper: a NZ based supplier proposed increasing the MEPS level recommended under option 4, the other (from a small Australian based importer) recommended all regulation be abandoned and the European CE mark to be accepted as compliance. Otherwise, there was cross-industry consensus on the recommendations made.

The consultation paper containing the full TWG recommendations (and the Technical Appendix to that paper) are published on the Energy Rating website at:

http://energyrating.gov.au/document/industry-update-refrigerated-display-and-storage-cabinets-technical-working-group.

Decision Regulatory Impact Statement

The Decision Regulatory Impact Statement (Decision RIS), prepared by EECA on behalf of the trans-Tasman Equipment Energy Efficiency (E3) programme, subsequently proposed that the best option (to address problems within the refrigerated display and storage cabinet market and current regulations), was to align with the European approach, as recommended by the TWG:

- Adoption of ISO 23953 for refrigerated display cabinets and beverage cabinets and EN 16825 for refrigerated storage cabinets.
- Adoption of EN16838 for gelato scooping cabinets and EN16901 for small ice-cream freezers (<=500 litre).
- Adoption of EU efficiency levels for all of these cabinet class/groups (see **Attachment A**).
- Introducing voluntary star rating information, to be displayed online.

It is proposed that all measures will be implemented no earlier than 1 December 2019. Australian and New Zealand regulators are now taking steps to implement the

recommended regulatory measures. EECA has sought further technical advice from TWG members on how these measures will work in practice, including how the European Energy Efficiency Index (EEI) methodology applies to existing registrations, whether the calculations proposed to be used correctly represent current performance, and how the proposed new star rating information will be displayed online.

Key Implementation Steps

Aligning with European Standards, Test Methods and EC Efficiency Levels

The EU Standards, test methods and EC efficiency (EEI/MEPS) levels will be adopted for refrigerated display cabinets, storage cabinets, gelato scooping cabinets and small ice cream freezers - see **Table 1** below.

Table 1: Published and draft EN Standards and EC MEPS levels (and the parts which are not currently being considered for adoption in Australia and New Zealand).

European Standards	Standards Published	EC MEPS Levels Published	Parts of standards or regulations that are not being considered by current proposals
ISO 23953 Refrigerated Display Cabinets and commercial beverage coolers	**Published**	Draft	Beverage vending machines
EN 16825 Refrigerated storage cabinets and counters for professional use	**Published**	**Published**	Blast cabinets, condensing units and process chillers
EN 16901 Small (<= 500 litre) ice-cream freezers	**Published**	Draft	
EN 16838 Refrigerated display scooping cabinets for gelato (soft scoop)	**Published**	**Published**	

In accordance with the TWG recommendations, minor variations have been made to the relevant European Standards so the EU methodology is suitable for local consumption (see **Attachment B** for the full technical details of the proposed variations).[2]

While EC MEPS levels for Refrigerated Display Cabinets remain in draft, they are currently being finalised with a view to legislation being adopted in the EC by the end of 2018. Any minor and non-consequential variations to the EC MEPS levels that are published during the period before the proposed trans-Tasman 1 December 2019 implementation date will be incorporated into the final Determination and New Zealand regulations, to achieve the intended alignment with EC MEPS.

[2] The proposed variations refer to minor amendments required to adapt/adopt the Standards and methodologies to the local market.

In line with TWG recommendations, the specific standard applying to commercial beverage coolers will not be adopted as it is not currently fit for purpose in a trans-Tasman context.[3] EN 16902 Commercial Beverage Coolers was developed to address the need for carbonated beverages to be chilled to a certain temperature at the point of sale – which does not apply to cabinets that could contain perishable foodstuffs. In Australia and New Zealand the majority of beverage coolers are suitable as display cabinets for both perishable foodstuffs and non-perishable beverages.

Also, from a technical perspective, EN 16902 is about pull down rather than testing for energy efficiency. It promotes a less onerous test, meaning that lower efficiency cabinets could enter the market. The ISO 23953 Standard will therefore be used for all Refrigerated Display Cabinets including beverage coolers.

Energy Efficiency Index

Efficiency levels, based on the European Energy Efficiency Index (EEI), will apply to specific refrigerated display cabinets and to refrigerated storage cabinets from the implementation date (no earlier than 1 December 2019), as set out in **Table 2** and **Table 3** below.

Table 2: Proposed energy efficiency level for refrigerated display cabinets from implementation date

Proposed energy efficiency level for refrigerated display cabinets	
Introduction	Specific refrigerated display cabinets
No earlier than 1 December 2019	EEI < 130

Table 3: Proposed energy efficiency level for refrigerated storage cabinets from implementation date

Proposed energy efficiency level for refrigerated storage cabinets		
Introduction	Refrigerated storage cabinets Light and Normal Duty	Refrigerated storage cabinets Heavy duty cabinets
No earlier than 1 December 2019	EEI < 95	EEI < 115

See **Attachment B** for a table detailing the new EU based class groups, descriptions and efficiency requirements.

[3] See the TWG consultation paper for the full details of the TWG recommendations (Recommendation 10).

EECA, in conjunction with TWG members, has applied the EEI methodology to currently registered cabinets to assess how they would perform under the proposed new regime. An EEI level has been calculated for each cabinet type so the current performance of registered models could be assessed against the new criteria. The veracity of claimed performance was validated by obtaining and auditing test reports.

The process for calculating the EEI for low production volume/bespoke cabinets has also been determined. This calculation applies to cabinets that are unable to be tested in a standard testing facility or do not meet the criteria for other cabinet groups.

See **Attachment C** for details of the EEI methodology and calculations used for each group or class of cabinet, including low production volume/bespoke cabinets.

Star Rating

The EEI methodology incorporates an assessment of how the current registrations will rate within a star rating index. An algorithm has been developed which provides the basis for calculating a star rating for each cabinet model.

The algorithm compares the ratio of the measured energy consumption with the standard energy consumption for that product and then applies a factor for the reduction of each Star. The following algorithm can be used to determine the Star Rating Index or SRI of a product as a whole number or fraction such as that for a half star.

$$SRI = 1 + \left[\frac{\log_e\left(\frac{CEC}{BEC}\right)}{\log_e(1 - ERF)} \right]$$

Where:

- SRI is the star rating index;
- CEC is the comparative energy consumption;
- BEC is the base energy consumption – the equation for a product with an SRI of 1.0;
- ERF is the energy reduction factor – reduction in CEC for each additional star (effectively the % energy reduction per star).

Online star rating information will be available for all products, with all products grouped into star bands according to their EEI level. The star rating sits within an index which equates with a number of stars and allows online comparison of the energy efficiency of

different models. See **Table 4** below for the proposed star rating scale which will be used to allocate a number of stars to different cabinet models depending on their EEI level.[4]

Table 4: Proposed Star Rating Index

Star range	EEI
1 Star	100-130
2 Star	77 - 100
3 Star	60 - 77
4 Star	45 - 60
5 Star	35 - 45
6 Star	27 - 35
7 Star	21 - 27
8 Star	16 - 21
9 Star	12 - 16
10 Star <	12 - 0

The proposal to provide labelling has been modified in the implementation phase so that the information will be available online but it will not be provided in the form of a physical label. This reflects industry feedback on the Consultation RIS that physical labels were of little value when making a purchasing decision or product comparison about refrigerated commercial cabinets (which generally does not occur in a showroom). Online energy rating information will, however, provide a basis for product comparison using an Energy Rating icon (see below) which is readily identifiable by consumers. The icon will be able to be available for use in accordance with E3 programme guidelines.

[4] The TWG had little comment to make about this scale, with one member commenting that the bands failed to incentivise higher performing models (< 100 EEI) and requesting narrower bands at the top of the range.

Registration system

The online registration system will be upgraded by making enhancements to the existing online registration process for refrigerated display cabinets. Any changes will be implemented by the Department of the Environment and Energy (DEE) in conjunction with EECA.

The upgrades to the E3 Energy Rating Product Registration system will include new registration pages for refrigerated display and storage cabinets, gelato scooping cabinets and small ice-cream freezers. These upgrades will incorporate the EEI and star rating calculations, and the low production volume/bespoke and family model methodologies. Existing family functionality will be modified to accommodate the revised parameters.

Transitional arrangements will be in place before the proposed 1 December 2019 implementation date to ensure suitably efficient model registrations can be validated and rolled over.[5]

Registration channels

Any new registrations or re-registration will be via one of two main channels:[6]

- Single model registrations, which will require a certified performance test report.
- Low production volume/bespoke registrations[7] – an alternative registration method reserved for custom units that are unable to be tested in a standard testing facility, with prescribed technical information required at the point of registration. See **Attachment D** for more information about the process, including examples of the type of documentation that will be required to support an application under this channel.

In addition to single model registrations, both the single or low production volume/bespoke channels will allow families of models to be registered, whereby the maximum energy consumption and minimum energy performance will be evidenced by a certified

[5] Registration valid until expiry date.

[6] The TWG consultation paper referred to three defined registration channels – the same channels are referred to here but the family of models option will apply to both the single model and low production volume/bespoke channels.

[7] This has previously been referred to as the deemed to comply channel.

performance test report conducted on the worst performing 'parent' cabinet model, with certain conditions to be met at the point of registration.

To register using the single model channel or family of models option (under either channel), applicants will need to respond to specific questions in an online registration form. Provision of test data supporting onscreen EEI calculations will be mandatory. There will be an increase in the maximum permitted units for family registrations, from 10 to 25. See **Table 5** below for a comparison of the current and new requirements under the single model registration channel.

Table 5: Standard/Single channel: comparison of old and new requirements

	Single	Family
Single model registrations current requirements	1 unit	Maximum 10 units
Single model registrations new requirements	1 unit	Maximum 25 units

For the new low production volume/bespoke channel, whether for single or family models, similar efficiency requirements will apply using the same EEI methodology. However, there will be additional inputs required to meet the registration criteria. Applicants will need to use a software package which enables the Carnot calculation to be validated.[8] If the required inputs are not provided, there will be a default back to the single model/family registration channel. See **Table 6** below for the maximum permitted units for single models and families of models under the low production volume/bespoke channel.

Table 6: Low Production Volume/Bespoke Channel: new requirements [9]

Single	Family
Maximum of 10 identical units per annum[10]	Maximum of 25 units (including parent model)

[8] Note: the Carnot calculation includes application of a 15% performance penalty to registrations in the low production volume/bespoke category.

[9] This channel was formerly referred to as Deemed to Comply.

[10] There will be a sales reporting requirement for single models, whereby an email will be generated by the Energy Rating website asking for confirmation of the number of units sold per annum.

See **Attachment D** for more information as to the process involved in using this channel and the documentation required to be submitted on application.

See the **Attachment E** flowchart which shows how the new registration channels and options will work.

Commercial Beverage Coolers

A common theme from discussions with TWG members was the treatment of IVC4 models that can be used for beverage only or beverage and perishable goods. Suppliers wish to avoid double registrations for what may physically be the same model used in slightly different applications.

It is now proposed that there will be two different registration processes for IVC4 models, one for models capable of use for perishable foodstuffs and the other for models which can be used for non-perishable beverages only (including smaller domestic use beverage coolers).[11]

Each of these registration processes will involve different coefficients and EEI calculations – the EEI calculation method for beverages only models will be available only for cabinets that cannot be used for perishable goods. See **Attachment A** for the coefficients and EEI levels applying to these two categories.

Transitional arrangements prior to implementation date

Transitional arrangements will apply in both New Zealand and Australia prior to the implementation date. It is intended that the GEMS Determination (Determination) will be published and come into voluntary effect from 1 December 2018. The implementation date for the Determination in Australia and the regulatory changes in New Zealand will be no earlier than 1 December 2019.

Industry will be kept informed of all relevant developments, including any changes to the dates or timeframes.

[11] The ICV4 class criteria incorporates commercial and domestic applications, including smaller volume units that are suitable for domestic use. Please note that the door opening requirements of the ISO 23953 test are considered impractical for domestic appliances and it is recommended these procedures not be required for domestic models.

Australia

The following transitional arrangements will apply in Australia prior to the proposed implementation date:[12]

- Suppliers will be able to register products from 1 December 2018 until 1 December 2019, using either the old Determination or the new Determination.
- Existing/compliant registrations will be converted to EEI registrations, free of charge. This process will be based on existing information held within the registration system.
- Existing registrations can be upgraded to EEI registrations between 1 December 2018 and 30 November 2019. A $250 upgrade/variation fee will apply. Validated test data to the new requirements will need to be provided. Upgraded registrations will be valid until the original expiry date of the registration (a maximum of five years).
- Formal rollover of existing registrations that are compliant with the new requirements will occur at the point the Determination takes effect, namely on the implementation date.
- Suppliers with existing/non-compliant registrations will be notified as part of a one-off exercise prior to the new Determination coming into effect. Suppliers will be notified of the registrations that will not be rolled over and given the opportunity to arrange new test data to support an upgrade if they disagree with the result.
- All new registrations (irrespective of when) submitted from 1 December 2018 will involve payment of a full registration fee of approximately $700 - $800. Validated test data to the appropriate European Standard will also be required.

The assessment of whether a registration is rolled over will be Pass or Fail. If the methodology shows an EEI of <130, the registration should be rolled over. If the registrant disagrees with a fail result, they can upgrade the registration providing EN/ISO test report.

Fees for new registrations in Australia are under review with the aim of making GEMS registrations fully cost-recoverable, however the fees are likely to remain approximately $700 - $800 for this product class.

[12] Under the GEMS Act the requirements to be met by specified product classes are set out in a Determination, which may specify Australian or Australian/New Zealand standards either by reference or by incorporating the requirements directly within the Determination.

New Zealand

Suppliers will be encouraged to update existing registrations from 1 December 2018, when it is intended the Determination will come into voluntary effect, until the implementation date. This process will allow registrants to demonstrate performance under the new rating system prior to the new regulations coming into effect.

Suppliers will be able to voluntarily register compliant products to the new test standards once the registration system has been upgraded. Registrations that are upgraded to the new standards will be clearly identified on the Energy Rating database. The database will be updated as new registrations are received.

Registrants will be notified of the cabinet models that meet the new requirements and can be rolled over. They will also be notified of the models that do not meet the new requirements and given the opportunity to arrange new test data to support an upgrade.

The following EEI range definitions show how the proposed rollover process for upgraded registrations will work in New Zealand:[13]

Definitions of ranges	EEI
More information needed (evidence of performance)	<100
Pass - Low Range (inclusive) Rollover if performance evidence provided	100-117
Marginal – Low/High Range (inclusive) Rollover if performance evidence provided	117-130
Fail Does not meet new MEPS (evidence of performance required to re-register)	>130

[13] More information is needed to support New Zealand registrations given that they do not expire.

Transitional arrangements after implementation date

The proposed implementation date of 1 December 2019 is considered to provide sufficient lead in time for compliance with the new requirements.

All classes of cabinet would be required to comply by that date, with no exceptions. Test reports using the new test methods will be required in order to register cabinets from the implementation date.

In Australia, once the changes are in force:

- Suppliers will be able to register products for a period of 12 months from the date the new Determination is made (1 December 2018), using either the old or the new Determination. At the end of the 12 month period (30 November 2019), registrations to the old Determination will not be possible.
- Registration under the new Determination will be required for existing newly regulated product types that meet the new requirements. A test report will be required.
- Registered cabinets imported or manufactured prior to the law change that do not meet the new requirements may still be supplied until stock is depleted. Their registrations would be grandfathered (status changed to "Superseded" in the registration system). Import or manufacture of these cabinets from the date of the law change would not be permitted.
- Suppliers wishing to import or manufacture models that are not already registered, but meet the new requirements, will need to complete a registration application, pay the registration fee and lodge the application with the GEMS Regulator. A test report will be mandatory.

In New Zealand, once the changes are in force:

- Registered cabinets imported or manufactured prior to the law change that do not meet the new requirements may only be sold until stock is depleted. New import or manufacture of these cabinets will not be permitted.
- Registered cabinets imported or manufactured prior to the law change that already meet the new requirements, may continue to be supplied. Registrations will be re-validated and updated. A new test report will be required.
- Suppliers wishing to import or manufacture models that are not already registered, but meet the new requirements, will need to complete a registration application and lodge it with the New Zealand Regulator (EECA). A test report will be mandatory.
- Unregistered cabinets that fall within the scope of the new legal requirements, will not be permitted to be supplied or used for any commercial purpose at any time.

- Focused compliance activities will be undertaken in both NZ and Australia at the point of importation and in field to ensure all cabinets meets the requirements of the new Determination/Regulations.

Regulatory Process

The regulatory processes required to adopt the new requirements are separated out by country. In Australia, the Department of Environment and Energy (DEE), is in the process of drafting a Determination. In New Zealand, EECA is leading the implementation of the required regulatory amendments, on behalf of the Ministry of Business, Innovation and Employment (MBIE) who is responsible for administering the Regulations.

Australia

Australia's energy efficiency regime is regulated by the *Greenhouse and Energy Minimum Standards Act 2012* (GEMS Act). Under the GEMS Act the requirements to be met by specified product classes are set out in a Determination, which may specify Australian or Australian/New Zealand standards either by reference or by incorporating the requirements directly within the Determination.

The current standards for Refrigerated Display Cabinets are prescribed in Australia by the *Greenhouse and Energy Minimum Standards (Refrigerated Display Cabinets) Determination 2012*. A Determination is currently being drafted by DEE for Refrigerated Display Cabinets and Refrigerated Storage Cabinets. This replacement Determination will reference the various ISO and EN test methodologies, incorporating the variations agreed with the TWG. The MEPS/ EEI levels will be directly written into the Determination.

It is proposed that an exposure draft of the Determination will be released to stakeholders.

Following stakeholder consultation, the replacement Determination will be finalised for approval by the Commonwealth Minister for the Environment and Energy. It is proposed that the replacement Determination will be published on 1 December 2018 and will come into force no earlier than 1 December 2019.

New Zealand

In New Zealand, the standards and MEPS for Refrigerated Display Cabinets are currently prescribed by the *Energy Efficiency (Energy Using Products) Regulations 2002* (the Regulations). The new requirements will be incorporated by amendment to these Regulations, and will apply to Refrigerated Display Cabinets and Refrigerated Storage Cabinets.

Following COAG approval of the RIS, policy approval is now required from the New Zealand Cabinet, which is due in May 2018.

Any amendment to the Regulations must go through the regulation-making process. Cabinet approval is required before amendments to the Regulations can be drafted. Once drafted, the amendments are then subject to further scrutiny by the Cabinet Legislative Committee before requiring final Cabinet approval. A six month notice period then applies before any regulatory amendments can come into force.

The regulation-making process will be completed with a view to it being implemented at the same time as the Determination is adopted into the GEMS legislation in Australia.

Next Steps and Key Dates

The next implementation steps, and their proposed timeframes, are listed below:

- The implementation date for all new requirements will be no earlier than 1 December 2019.
- Following the Decision RIS being approved by COAG ministers on 24 November 2017, both countries will continue to take steps to implement the Decision RIS proposals.
- The New Zealand Cabinet is due to consider the Decision RIS in May 2018.
- Industry will be formally notified of any upcoming regulatory requirements.
- The registration system will be upgraded and operational by 1 December 2018:
    - New registration pages (with updated inputs reflecting EEI methodology and alternative registration pathways) will be available and will allow product upgrades.
    - The process for transitioning existing registrations to the new requirements will be in place, including a rollover process for those which meet the new criteria.
    - From the implementation date all new registrations will require a test report to the new Standards.
- An exposure draft of the Determination will be released to stakeholders in mid 2018.
- In Australia, the Commonwealth Minister for the Environment and Energy will approve the final Determination following agreement by COAG Energy Ministers.
- The Determination will come into force in Australia no earlier than 1 December 2019, incorporating any technical inputs and the various ISO and EN test methodologies for refrigerated display cabinets and refrigerated storage cabinets.
- In New Zealand the *Energy Efficiency (Energy Using Products) Regulations 2002* will be amended to incorporate the new standards and efficiency levels into the Regulations, subject to Cabinet approval. The final implementation date should coincide with the date the Determination comes into force.
- From the implementation date the Energy Rating Website will display star rating information online for all registered products. Selected registration data will also be available as a downloadable CSV file.

Feedback on implementation

Feedback on implementation recommendations and decisions is invited by **25 May 2018** via email to: regs@eeca.govt.nz.

Note: Submissions will be published, as will the names of all stakeholders who have made submissions. If you do not want your submission to be published, please confirm in your covering email that you wish the submission to be treated as confidential.

Attachment A – Efficiency limits per cabinet

See the Table on pages 23 and 24

REFRIGERATED CABINETS - CLASS GROUPS, DESCRIPTIONS and EFFICIENCY

Class abbreviation	Class description	Application	Temperature	Configuration	Type for Testing	Type description	Efficiency Limit EEI	Coefficient M	Coefficient N
IRH	Integral Refrigerated Horizontal Cabinets	Integral Refrigerated Display Cabinets	Refrigerator	Horizontal	IHC1	Chilled, serve-over counter, open service access	130	3.7	3.5
					IHC2	Chilled, serve-over counter with integrated storage, open service access			
					IHC3	Chilled, open wall site			
					IHC4	Chilled, open island			
					IHC5	Chilled, glass lid, wall site			
					IHC6	Chilled, glass lid, island			
					IHC7	Chilled, serve over counter, closed service access			
					IHC8	Chilled, serve over counter with integrated storage, closed service access			
IRV	Integral Refrigerated Vertical Cabinets			Vertical	IVC1	Chilled, semi-vertical	130	9.1	9.1
					IVC2	Chilled, multi-deck			
					IVC3	Chilled, roll in			
					IVC4	Chilled, vertical glass door (perishable foodstuffs)			
					IYC1	Chilled, open top, open bottom			
					IYC2	Chilled, open top, glass lid bottom			
					IYC3	Chilled, glass lid top, open bottom			
					IYC4	Chilled, glass door top, glass lid bottom (perishable foodstuffs)			
IRV-4	Integral Refrigerated Vertical Glass Door Cabinet intended for display of non-perishable beverages			Vertical	IVC4M2	Chilled, vertical glass door (non-perishable beverages)	130	0.69	5.97
					IYC4M2	Chilled, glass door top, glass lid bottom (non-perishable beverages)			
IFH	Integral Freezer Horizontal		Freezer	Horizontal	IHF1	Frozen, serve-over counter, open service access	130	4.2	9.8
					IHF3	Frozen, open wall site			
					IHF4	Frozen, open, island			
					IHF7	Frozen serve over counter, closed service access			
IFH-5	Integral Freezer Horizontal with Lid. Small Ice-cream freezer.			Horizontal $V_N \leq 500$ l	IHF5	Frozen, glass lid, wall site	130	1	0.009
					IHF6	Frozen, glass lid, island			
IFV	Integral Freezer Vertical			Vertical	IVF1	Frozen, semi-vertical	130	1.6	19.1
					IVF2	Frozen, multi-deck			
					IVF4	Frozen, glass door			
					IYF1	Frozen, open top, open bottom			
					IYF2	Frozen, open top, glass lid bottom			
					IYF3	Frozen, glass door top, open bottom			
					IYF4	Frozen, glass door top, glass lid bottom			

REFRIGERATED CABINETS - CLASS GROUPS, DESCRIPTIONS and EFFICIENCY

Class abbreviation	Class description	Application	Temperature	Configuration	Type for Testing	Type description	Efficiency Limit EEI	Coefficient M	Coefficient N
RRH	Remote Refrigerated Horizontal Cabinets	Remote Refrigerated Display Cabinets	Refrigerator	Horizontal	RHC1	Chilled, serve-over counter, open service access	130	3.7	3.5
					RHC2	Chilled, serve-over counter with integrated storage, open service access			
					RHC3	Chilled, open wall site			
					RHC4	Chilled, open island			
					RHC5	Chilled, glass lid, wall site			
					RHC6	Chilled, glass lid, island			
					RHC7	Chilled, serve over counter, closed service access			
					RHC8	Chilled, serve over counter with integrated storage, closed service access			
RRV	Remote Refrigerated Vertical Cabinets			Vertical	RVC1	Chilled, semi-vertical	130	9.1	9.1
					RVC3	Chilled, roll in			
					RVC4	Chilled, glass door			
					RYC1	Chilled, open top, open bottom			
					RYC2	Chilled, open top, glass lid bottom			
					RYC3	Chilled, glass lid top, open bottom			
					RYC4	Chilled, glass door top, glass lid bottom			
RRV-2	Remote Refrigerated Vertical Cabinet, open, medium temp			Vertical	RVC2	Chilled, multi-deck	130	9.1	9.1
RFH	Remote Freezer Horizontal		Freezer	Horizontal	RHF1	Frozen, serve-over counter, open service access	130	4.2	9.8
					RHF3	Frozen, open wall site			
					RHF4	Frozen, open, island			
					RHF5	Frozen, glass lid, wall site			
					RHF6	Frozen, glass lid, island			
					RHF7	Frozen serve over counter, closed service access			
RFV	Remote Freezer Vertical			Vertical	RVF1	Frozen, semi-vertical	130	1.6	19.1
					RVF2	Frozen, multi-deck			
					RVF4	Frozen, glass door			
					RYF1	Frozen, open top, open bottom			
					RYF2	Frozen, open top, glass lid bottom			
					RYF3	Frozen, glass door top, open bottom			
					RYF4	Frozen, glass door top, glass lid bottom			
GSC	Gelato Scooping Cabinet	Refrigerated Display Cabinets	Freezer	Horizontal	GF1	Gelato Scooping Cabinet	130	10.4	30.4
					GF2	Gelato Scooping Cabinet with storage section			
					GF3	Gelato Pozetti Scooping Cabinet			
ISC	Ice-cream Scooping Cabinet			Horizontal	IC1	Ice-cream Scooping Cabinet	130	10.4	30.4
					IC2	Ice-cream scooping cabinet with storage section			
SRH	Storage Refrigerator Horizontal	Integral Refrigerated Storage Cabinets	Refrigerator	Horizontal	LD	Light duty	95	2.555	1790
					ND	Normal duty			
					HD	Heavy Duty	115		
SRV	Storage Refrigerator Vertical			Vertical	LD	Light duty	95	1.643	609
					ND	Normal duty			
					HD	Heavy Duty	115		
SFH	Storage Freezer Horizontal		Freezer	Horizontal	LD	Light duty	95	5.84	2380
					ND	Normal duty			
					HD	Heavy Duty	115		
SFV	Storage Freezer Horizontal			Vertical	LD	Light duty	95	4.928	1472
					ND	Normal duty			
					HD	Heavy Duty	115		

Attachment B – Minor Amendments to EU Standards

Variations to ISO 23953-2:2015[14]

ISO 23953.2 adoption includes minor amendments to various clauses:[15]

(1) Clauses 5.3.2.7 and 5.3.2.8 (requirements for cabinet lighting controls) are as stated in the standard. However, cabinets from Europe always contain a switch. To ensure the full interpretation of the ISO standard, an automatic switch is able to be fitted. In addition, cabinets without controls are required to be tested with the lighting operating continuously during the test.

(2) Clause 5.3.2.3.2 (loading heights of closed cabinets), varies to use half-height loading of test packages.

(3) Clause 5.3.3.2 (closed refrigerated cabinets). Closed cabinets must maintain the specified temperature when subject to door openings.

(4) The ISO sneeze guard dimensional limit of not less than 1500mm is not appropriate for all types. Specific dimensions may be authorised in certain jurisdictions on application to the respective Australia/NZ regulator.

(5) Annex A is as provided in the standard, which removes the light transmission factor.

(6) Annex D is varied to permit the ability to substitute components and calculate the difference using the technical standard methodology.

(7) Substitute M-Package temperature classifications are referred to in **Table 7** (over page), with cabinets required to comply with one of the defined classifications:

[14] The Determination will specify the changes that apply but will not vary the Standards.

[15] The relevant amendments to the standards are summarised in this appendix. See the Technical Appendix to the consultation paper on the Technical Working Group recommendations for full details of the required modifications to the relevant standards: http://energyrating.gov.au/document/industry-update-refrigerated-display-and-storage-cabinets-technical-working-group.

Table 7: ISO 23953-2 M-Package temperature classes (modified)

Temperature Class	**Highest temperature, θah, of warmest M-package colder than or equal to**	**Lowest temperature, θb, of coldest M-package warmer than or equal to**	**Highest minimum temperature, θal, of all M-package colder than or equal to**
L1	-15	-	-18
L2	-12	-	-18
L3	-12	-	-15
M0	+4	-1	-
M*	6	-1	
M1	+5	-1	-
M2	+7	-1	-
H1	+10	+1	-
H2	+10	-1	-
S	Special Classification		
*For Class M, the highest temperature of warmest package θah colder than or equal to 6,1 °C but the average of the warmest M package colder than or equal to 5 °C.			

See also the substitute climate classifications specified in the table below:

Table 8: ISO 23953-2:2015 climate classifications (modified)

Test Room climate class	Dry bulb temperature Celsius	Relative humidity %	Dew point Celsius	Water vapour mass in dry air g/kg
0	20	50	9.3	7.3
1	16	80	12.6	9.1
8	23.9	55	14.3	10.2
2	22	65	15.2	10.8
3	25	60	16.7	12
4	30	55	20	14.8
6	27	70	21.1	15.8
5	40	40	23.9	18.8
7	35	75	30	27.3
Note: The water vapour mass in the dry air is one of the main points influencing the performance and the energy consumption of cabinets. Therefore, the table is arranged in order of water vapour mass in dry air. See also ISO 23952 -2:2015, ANNEX B to compare lab and store conditions.				

Variations to EN 16825:2016

(1) Light duty cabinet are to be tested at Climate Class 3, and the efficiency value is multiplied by an Adjustment Factor of 1.2 (stated in Annex IV 2 (b), Page L177/36) to normalise the efficiency rating at Climate Class 4.

(2) Heavy duty cabinet Climate Classes:

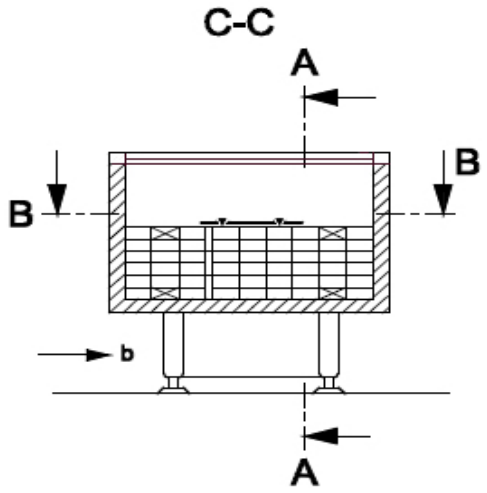
1. Climate Class 5 is to be used to validate that the cabinet can be operated at these conditions.
2. Climate Class 4 is for efficiency ratings.
3. Climate Class 7 is to measure water vapour condensation.

Alternative Australian/NZ test filler packages can be used (as specified in ISO 23953-2:2015).

Variations to EN 16901:2016

(1) Clause 3.3.6 Add abbreviation under description of term V_N

(2) Replace the cross section C-C in Figure 6 with the following diagram:



Attachment C – Energy Efficiency Index Calculations

Energy Efficiency calculations

1) Energy Efficiency Index (EEI) – Refrigerated Display Cabinet categories

Calculation of the Energy Efficiency Index (EEI) of an Integral Refrigerated Display Cabinet,

Group/Class IRV (example).

A vertical refrigerated display cabinet (Type IVC2) with a Total Display Area (TDA) of 0.754 m^2 when tested has a measured energy consumption per day ($E_{24}h$) of 16.6 kWh.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) AEC = E24h × 365
= 16.6 x 365
= 6059 kWh/year.

The Standard Annual Energy Consumption (SAEC) is then calculated using the coefficients for Group/Class IRV being, M = 9.1 and N = 9.1; and Y (TDA) = 0.754:

(b) SAEC = (M + N x Y) x 365
= (9.1 + (9.1 x 0.754)) x 365
= 5825.9 kWh/year.

(c) To calculate the EEI:

Where from the above step (a) AEC = 6058 and (b) SAEC = 5825.9

EEI = (AEC/SAEC) × 100
= 6059/5825.9 x 100
= 104.0

(Note – in this example, the efficiency of this model cabinet is better than the maximum permitted EEI level of <130 and therefore would be compliant with respect to efficiency)

2) Energy Efficiency Index (EEI) – Refrigerated Display Cabinet categories

Calculation of the Energy Efficiency Index (EEI) of an Integral Refrigerated Display Cabinet with a glass door intended for the display of non-perishable beverages,

Group/Class IRV-4 (example)

An integral vertical refrigerated display cabinet (Type IVC4) with a Total Display Area (TDA) of 0.604 m^2 when tested has a measured energy consumption per day ($E_{24}h$) of 4.9 kWh.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) AEC = E24h × 365
= 4.9 x 365
= 1788.5 kWh/year.

The Standard Annual Energy Consumption (SAEC) is then calculated using the coefficients for Group/Class IRV-4 being, M = 0.69 and N = 5.97; and Y (TDA) = 0.604:

(b) SAEC = (M + N x Y) x 365
= (0.69 + (5.97 x 0.604)) x 365
= 1568 kWh/year.

(c) To calculate the EEI:

Where from the above step (a) AEC = 1788.5 and (b) SAEC = 1568

EEI = (AEC/SAEC) × 100
= 1788.5/1568 x 100
= 114.06

(Note – in this example, the efficiency of this model cabinet is better than the maximum permitted EEI level of <130 and therefore would be compliant with respect to efficiency)

3) Energy Efficiency Index (EEI) – Refrigerated Storage Cabinet categories

Calculation of the Energy Efficiency Index (EEI) of a Refrigerated Storage Cabinet, Group/Class SRV (example).

A normal duty vertical refrigerated storage cabinet (SRV) with a Net Volume (V_N) of 0.590 m^3 (590 litres) when tested has a measured energy consumption per day ($E_{24}h$) of 3.6 kWh.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) AEC = E24h × *af* x 365 (*af* being the adjustment factor for light duty cabinets and not required in this instance, being a Normal Duty cabinet)
= 3.6 x 365
= 1,314 kWh/year.

The Standard Annual Energy Consumption (SAEC) is then calculated using the coefficients for Class SRV being, M = 1.643, N = 609; and V_N = 590 litres:

(b) SAEC = M x V_N + N
= (1.643 x 590) + 609
= 1578.4 kWh/year.

(c) To calculate the EEI:

Where from the above step (a) AEC = 1314 and (b) SAEC = 1578.4

EEI = (AEC/SAEC) × 100
= 1314/1578.4 x 100
= 83.25

(Note – in this example, the efficiency of this model cabinet is better than the maximum permitted EEI level of <95 and therefore would be compliant with respect to efficiency)

4) Energy Efficiency Index (EEI) – Small Ice-cream Freezer

Calculation of the Energy Efficiency Index (EEI) of a small Ice-cream freezer,

Group/Class IFH-5 (example)

A small refrigerated ice-cream freezer (Type IFH5) with a Net Volume (V_N) of 480 litres when tested has a measured energy consumption per day ($E_{24}h$) of 3.8 kWh.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) AEC = E24h × 365
= 3.8 x 365
= 1387 kWh/year.

The Standard Annual Energy Consumption (SAEC) is then calculated using the coefficients for Group/Class IFH-5, being M = 1.0 and N = 0.009; and Y (V_N) = 480 litres:

(b) SAEC = (M + N x Y) x 365
= (1.0 + (0.009 x 480)) x 365
= 1941.8 kWh/year.

(c) To calculate the EEI:

Where from the above step (a) AEC = 1387 and (b) SAEC = 1941.8

EEI = (AEC/SAEC) × 100
= 1387/1941.8 x 100
= 71.43

(Note – in this example, the efficiency of this model cabinet is better than the maximum permitted EEI level of <130 and therefore would be compliant with respect to efficiency)

5) Energy Efficiency Index (EEI) – Ice Cream and Gelato Scooping Cabinet categories

Calculation of the Energy Efficiency Index (EEI) of a Gelato Scooping Cabinet,

Group/Class GSC (example).

An integral gelato scooping cabinet (Type GF1) with a Total Display Area (TDA) of 1.12 m^2 when tested has a measured energy consumption per day ($E_{24}h$) of 38.6 kWh.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) AEC = E24h × 365
= 38.6 x 365
= 14089 kWh/year.

The Standard Annual Energy Consumption (SAEC) is then calculated using the coefficients for Group/Class GSC being M = 10.4 and N = 30.4; and Y (TDA) = 0.932:

(b) SAEC = (M + N x Y) x 365
= (10.4 + (30.4 x 0.932)) x 365
= 14137.4 kWh/year.

(c) To calculate the EEI:

Where from the above step (a) AEC = 9344 and (b) SAEC = 16223.5

EEI = (AEC/SAEC) × 100
= 14089/14137.4 x 100
= 99.65

(Note – in this example, the efficiency of this model cabinet is better than the maximum permitted EEI level of <130 and therefore would be compliant with respect to efficiency)

6) Energy Efficiency Index (EEI) – Low Production Volume/Bespoke Cabinets

Calculation of the Energy Efficiency Index (EEI).

A custom built refrigerated display cabinet with an incorporated condenser unit is test run to verify the temperature operation and measure the electrical energy consumption.

When tested, the cabinet has a measured electrical energy consumption, not including the compressor, per day of 7.84 kWh. The average heat extraction rate of the compressor was measured at 3.451 kW.

The Annual Energy Consumption (AEC) would be calculated using the formula:

(a) $AEC = E_{24h} \times 365$

The measured energy consumption per day E_{24h} = TEC = REC + DEC where the total daily electrical energy consumption (TEC) expressed in kWh/24 h is the sum of REC which is the refrigeration electrical energy consumption in kWh/24h, and DEC which is the direct electrical energy consumption in kWh/24h:

DEC in this example has been measured at 7.84 kWh. REC for a cabinet operating with a compression type system is calculated from the following formula taken from ISO 23953.2:2015 Clause 5.3.6.3.3:

$$REC = (24h - t_{deft}) \times \emptyset_{24-deft} \times \frac{(T_c - T_{mrun})}{(0.34 \times T_{mrun})} = Q_{tot} \frac{(T_c - T_{mrun})}{(0.34 \times T_{mrun})}$$

Where:

- t_{deft} is the defrost time within 24 h when the compressor is not running (or solenoid valve is closed)
- $\emptyset_{24-deft}$ is the average hourly heat extraction rate during a whole day excepting defrost time in kilowatts
- Θ_{mrun} is the arithmetic average of evaporator-saturated temperature obtained from measuring pressure and referring to table of saturated properties for refrigerant in use, during t_{run}, in degrees Celsius. Refrigerant pressure at cabinet outlet, in Pascals.
- T_c = 308.15K = constant condensing temperature of 35°C
- T_{mrun} = Θ_{mrun} + 273.15 in Kelvin
- Q_{tot} is the Total Heat Extraction

Example using: t_{deft} = 3.15, $\emptyset_{24-deft}$ = 3.451 rounded to 3.45, Θ_{mrun} = -10.7°C, Tc = 308.15, $T_{mrun} = \Theta_{mrun} + 273.15 = 262.45K$.

$$REC = (24 - 3.15) \times 3.45 \times \frac{(308.15 - 262.45)}{(0.34 \times 262.45)}$$

$$= 36.84 \text{ kWh/24h}$$

Therefore TEC = REC + DEC = 36.84 + 7.84 = 44.68 kWh/24 and

AEC = E_{24h} x 365
= 44.68 x 365
= <u>16,308.2 kWh/year</u>.

The Standard Annual Energy Consumption (SAEC) is then calculated for the same cabinet using energy efficiency components. (i.e. fans motors and lighting).

As a result the electrical energy consumption of the cabinet, not including the compressor, is calculated to be 5.36 kWh/24.

(b) SAEC = (REC + DEC) x 365
= (36.84 + 5.36) x 365
= 42.2 x 365
= <u>15403 kWh/year</u>

(c) To calculate the EEI:

EEI= (AEC/SAEC) x 100

Where: AEC is the estimated Annual Energy Consumption of the DTC custom cabinet, and

SAEC is the calculated Standard Annual Energy Consumption of the same cabinet when fitted with energy efficient components.

From the above steps (a) AEC = 16308.2 and (b) = 15403

EEI= (AEC/SAEC) x 100
= 16308.2/15403 x 100
= <u>105.8</u>

(Note in this example the efficiency of this cabinet is higher than the maximum permitted EEI level of < 100 and therefore would not be compliant (energy efficiency fans and lighting would be required to make the cabinet compliant).

Calculated Direct Electrical Energy Consumption (DEC) of cabinet - not including compressor											
Formula ISO 23953	Term	Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	50	-	-	2.4
			Fan output power	Pfo	35%	2	24	-	17.5	2.4	-
		Fans - Condenser	Fan input power	Pfi	-	1	16	100	-	-	1.60
			Fan output power	Pfo	35%	1	16	-	35	1.60	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	80	-	0.96	0.96
		Lights -External	Total light input power	Pli	100%	0	0	0	-	0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75	-	1.8	1.8
D.7	DFEC	Defrost Heaters	Defrost heater input power	Pd	100%	0	0	0	-	0.00	0.00
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45	-	1.08	1.08
D.3	DEC	Cabinet Direct Electrical Energy Consumption								7.84	7.84

""

Calculated Direct Electrical Energy Consumption (DEC) of an efficient cabinet - not including compressor											
Formula ISO 23953	Term	Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	26.8	-	-	1.29
			Fan output power	Pfo	65%	2	24	-	17.5	1.29	-
		Fans - Condenser	Fan input power	Pfi	-	1	12	54	-	-	0.65
			Fan output power	Pfo	65%	1	12	-	35	0.65	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	45		0.54	0.54
		Lights -External	Total light input power	Pli	100%	0	0	0		0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75		1.8	1.8
D.7	DFEC	Defrost Heaters	Defrost heater input power	Pd	100%	0	0	0		0.00	0.00
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45		1.08	1.08
D.3	DEC	Cabinet Direct Electrical Energy Consumption								5.36	5.35

Attachment D – Low Production Volume/ Bespoke Registration Channel

Applications using Low Production Volume/Bespoke channel

The Energy Efficiency Index (EEI) of a cabinet being approved using the low volume/bespoke registration channel is found by comparing the energy usage of the cabinet as 'measured in practice' with that of a cabinet fitted with best practice energy efficient components.

For a successful application, it is necessary to demonstrate that a cabinet betters the minimum efficiency levels of a similar class of product by approximately 15%.

The process can be applied to cabinets built as very low production volume cabinets or one off custom-built cabinets. There will be a maximum of 10 permitted unit sales per annum for single model registrations. There will be a requirement to provide annual sales data for units registered under this channel. This will be a new requirement for Australian registrants. Compliance steps, which may include revoking registration, will be taken if 10 unit sales is exceeded.

Generally fan motors, cabinet lighting and compressors are available as energy efficient electrical components but other methods, such as controls may be used providing it is demonstrated that they achieve the desired efficiency outcome.

In the case of self-contained (integral) equipment the Total Daily Electrical Energy Consumption (TEC) of the cabinet as a whole is measured and the energy consumption of each individual electrical component is either measured or calculated using the established methods set out in Annex D of ISO 23953-2:2015 *Refrigerated Display Cabinets – Part 2: Classification, requirements and test conditions.*

For cabinets that are intended to be connected to a remote condenser unit, the Total Direct Daily Electrical Energy Consumption (DEC) of the cabinet (only) is measured, and the energy consumption of each individual component is either measured or calculated using the established methods set out in Annex D of ISO 23953-2 and this is added to this theoretical energy used by the system -refrigeration electrical energy consumption (REC) as determined using the method also set out in Annex D and in particular Formula (9) of Clause 5.3.6.3.3.

These results are compared with those of a theoretical cabinet of the same design/construction but fitted with efficient fan motors, lighting system, compressor etc. To account for variations in the method of evaluation compared with actual practice the energy efficiency index EEI must be 15% better than that for a similar class of mass produced

cabinet. For example, if the maximum permitted EEI is 130 then a cabinet approved under the low production volume/bespoke channel must be better than 115.

Documentation required

In addition to providing a declaration as to the accuracy of the information provided during the registration process, the following documentation will be required to be submitted with all applications:

A **Cabinet Specification** containing information on type of cabinet, cabinet construction, operating characteristics and physical characteristics (see the **example** below).

CABINET SPECIFICATION

Type of cabinet:				
Cabinet Class:			Class Maximum EEI :	
Open/Closed	Doors		Type of door	
			Number of doors	
		4.1 (ISO 23953.2)	Total Display Area (m^2)	
Dimensions	External	5.2.2 (ISO 23953.2)	Height - H - (mm)	
			Depth - D - (mm)	
			Length - L - (mm)	
	Internal		Height (mm)	
			Depth (mm)	
			Length (mm)	
	Capacity	4.9 (ISO 23953.2)	Gross Volume (m^3)	
		6.1 (EN 16825)	Net Volume - V_N - (m^3)	
		3.7 (EN 16825)	Shelf area (m^2)	
Operating conditions		Table 3 (ISO 23953.2)	Climate Class	
		Table 1 (ISO 23953.2)	Storage Temperature	
Operating duty			Continuous	
			Part time (hrs on/hrs off)	
		3.1.5 (EN 16825)	Light Duty	
		3.1.6 (EN 16825)	Normal Duty	
		3.1.7 (EN 16825)	Heavy Duty	
Insulation material		4.1.3.1 (ISO 23953.2)	Description	
			Thickness: Minimum (mm)	
			Average (mm)	
			R Value	
Lighting control			Manually switched	
			Automatic control	
Refrigeration system			Refrigerant/quantity	
			Integral/Remote	
Controls	Thermostat		Mechanical	
			Electronic	
	Energy Management Device		Yes/ No	
	Defrost system		Type	
			Defrost frequency	

Electrical Data containing electrical data and information on the energy using components in the cabinet (see the **example** below):

ELECTRICAL DATA (Example)

Electrical Characteristics of Energy using components							
Component	Type	Model Number	Voltage (V)	Power (Watts)	Quantity	Efficiency	Estimated Duty
Evaporator Fan Motor	ECM	XGR-56	230	35	3	38%	100%
Condenser Fan Motor	ECM	XHR -78	230	60	1	38%	75%
Compressor	Hermetic	GCD 8	230	485	1	74%	75%
Lighting	LED	SL10	230	10	4	100%	50%
Defrost heating element	Tubular heating element	DHE 1100	230	300	1	100%	15%
Auxillary heating elements	Door Frame heaters	DFH 215	230	120	2	100%	100%
	Cabinet Heater	CHW 275	230	75	2	100%	100%
	Glass heating film	GHF 105	230	72	2	100%	100%
	Mullion heating	MHW 675	230	25	1	100%	100%
Evaporator Pan Heater	Tubular heating element	EPH 45	230	45	1	100%	17%

A **Calculation Sheet** showing the calculations/measurements of key efficiency metrics and the resultant energy efficiency index factor.

This may be the output of a proprietary software report (see the below **examples**).

CALCULATION SHEET

Self-contained/Integral Cabinet.

Example with standard fan motors and lighting

Actual Total Daily Electrical Energy Consumption (TEC) of a Self-contained (Integral) Cabinet as built.												
Formula ISO 23953		Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	50	-	-	2.4
			Fan output power	Pfo	35%	2	24	-	17.5	2.4	-
		Fans - Condenser	Fan input power	Pfi	-	1	16	100	-	-	1.60
			Fan output power	Pfo	35%	1	16	-	35	1.60	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	80	-	0.96	0.96
		Lights -External	Total light input power	Pli	100%	0	0	0	-	0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75	-	1.8	1.8
D.7	DFEC	Defrost Heaters	Defrost heater input power	Pd	100%	0	0	0	-	0.00	0.00
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45	-	1.08	1.08
D.15	CEC	Compressor	Measured average input power	Pcpr	-	1	16	580	-	9.28	9.28
$D.4.2_{Actual}$	TEC	Actual Total Energy Consumption (kWh/24h)								17.12	17.12

Example with theoretical substitution of fan motors and lighting with efficient components

Standard Total Daily Electrical Energy Consumption (TEC) of a Self-contained (Integral) Cabinet with efficient components.											
Formula ISO 23953		Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	26.8	-	-	1.29
			Fan output power	Pfo	65%	2	24	-	17.5	1.29	-
		Fans - Condenser	Fan input power	Pfi	-	1	16	54	-	-	0.86
			Fan output power	Pfo	65%	1	16	-	35	0.86	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	45		0.54	0.54
		Lights -External	Total light input power	Pli	100%	0	0	0		0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75		1.8	1.8
D.7	DFEC	Defrost Heaters	Defrost heater input power	Pd	100%	0	0	0		0.00	0.00
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45		1.08	1.08
D.15	CEC	Compressor	Measured average input power	Pcpr	-	1	16	580	-	9.28	9.28
$D.4.2_{Standard}$	TEC	Standard Total Energy Consumption (kWh/24h)								14.85	14.85

CALCULATION SHEET

Remote cabinet

Example with standard fan motors and lighting

Actual Total Direct Electrical Energy Consumption (DEC) of remote cabinet - not including condenser unit.											
Formula ISO 23953	Term	Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	50	-	-	2.4
			Fan output power	Pfo	35%	2	24	-	17.5	2.4	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	80	-	0.96	0.96
		Lights -External	Total light input power	Pli	100%	0	0	0	-	0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75	-	1.8	1.8
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45	-	1.08	1.08
$D.3_{Actual}$	DEC	Actual Cabinet Direct Electrical Energy Consumption (kWh/24h)								6.24	6.24

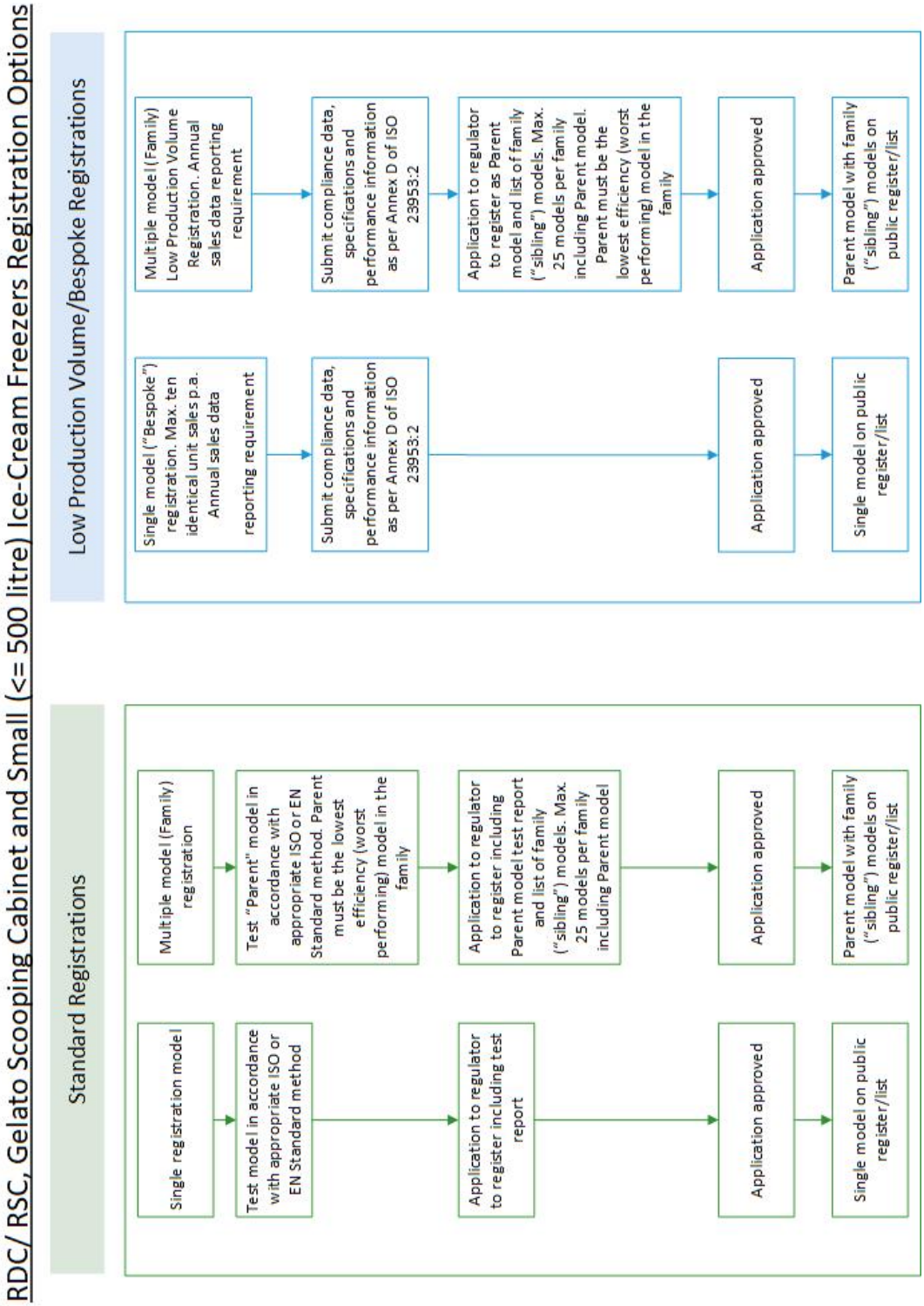
Example with theoretical substitution of fan motors and lighting with efficient components

Standard Total Direct Electrical Energy Consumption (DEC) of an efficient cabinet - not including condenser unit.											
ISO 23953-2	Term	Component	Basis of calculation		Efficiency (*hm*) %	Quantity Number (*n*)	Run time (*t*) h/24h	Power Input (Watts)	Power Output (Watts)	Sub-total	
D.4	FEC	Fans - Evaporator	Fan input power	Pfi	-	2	24	26.8	-	-	1.29
			Fan output power	Pfo	65%	2	24	-	17.5	1.29	-
D.5	LEC	Lights - Internal	Total light input power	Pli	100%	1	12	45		0.54	0.54
		Lights -External	Total light input power	Pli	100%	0	0	0		0	0
D.6	AEC	Anti-condensation	Anti-condensation heater input power	Pai	100%	1	24	75		1.8	1.8
D.8	PEC	Pan Heaters	Evaporator pan heater input power	Pc	100%	1	24	45		1.08	1.08
$D.3_{Standard}$	DEC	Standard Cabinet Direct Electrical Energy Consumption (kWh/24h)								4.71	4.71

Example of calculation of refrigeration energy consumption using Carnot formula.

Calculation of Refrigeration Electrical Energy Consumption (REC)				
ISO 23953-2				
D.3.3 5.3.6.3.3	$REC = (24h - t_{defr}) \times \Phi_{24-defr} \times \frac{(T_c - T_{mrun})}{(0.34 \times T_{mrun})} = Q_{tot} \frac{(T_c - T_{mrun})}{(0.34 \times T_{mrun})}$ Formula (9)			
	Term	Abbreviated description	Example data	Using the example data:
3.1	t_{defr}	Defrost time (h)	3.15	$REC = (24 - 3.15) \times 3.45 \times \frac{(308.15 - 262.45)}{(0.34 \times 262.45)}$
	$\Phi_{24-defr}$	Heat extraction rate (kilowatts)	3.45	
3.2	Θ_{mrun}	Ave Evaporator saturated temperature (°C)	-10.70	
	T_c	= 308.15K - Condensing temperature of 35°C	308.15	
	T_{mrun}	= Θ_{mrun} + 273.15 in Kelvin (K)	262.45	
	Q_{tot}	Total Heat extraction = REC		
D.3.3	REC	Refrigeration Electrical Energy Consumption	By calculation from Formula (9) (kWh/24h)	36.84

Attachment E – Registration Flowchart



Implementation update:

Refrigerated display and storage cabinets

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