Scottish and Southern
Energy
Power Distribution

New Thames Valley Vision

SSET203

LCNF Tier 2 SDRC 9.8(a) Part 4 Report
Cold Thermal LV Network Energy Storage

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1. Introduction

1.1. Successful Delivery Reward Criteria

This report meets the requirements of the New Thames Valley Vision (NTVV) Full Bid Submission [Ref. 01] and the associated change control documentation that was formally agreed by Ofgem [Ref. 02] for Successful Delivery Reward Criteria (SDRC) 9.8(a) Cold Thermal LV Network Energy Storage .

Cold thermal storage technology has been installed at three commercial premises and relevant information relating installation requirement(s), permissions, unit costs, safety considerations and associated time scales for this technology have been included within this report.

Trials of the three cold thermal storage devices have been completed following the installation and commissioning of the devices in July 2015. Data from the devices has been transmitted from the Ice Energy web portal and analysed to understand the effects of the units on the Low Voltage (LV) network. The data collated as part of the cold thermal storage technology trials has enabled the project team to assess the technology and outline how the learning from the trials could influence future deployment.

The information presented within this report delivers the learning applicable to cold thermal storage as outlined in Learning Outcome 4 [Ref. 01 – the bid] as the learning presented within this report provides an understanding of both: 1) the effect of deployment on the LV network within different customer premises, in technical, geographical and in turn climatic conditions not previously trialled; and 2) the value to commercial customers in terms of energy savings and economic payback.

Successful Delivery Reward Criteria 9.8 (a)

Criterion:

Prepare final reports on the trials carried out on the subjects listed in "Evidence 9.8" with reference to Change Request 002, Modification to the deployment of cold thermal storage. As well as an end of project report.

Evidence:

(4) LV Network Energy Storage

(Method 4, Learning Outcome 4.1)

- Installation (requirements, permissions, unit costs, safety considerations, timescales)
- Benchmark the battery and thermal storage methods
- Ice Energy Storage (demand shifting from individual and aggregated operation, commercial arrangements and customer feedback)
- Thermal Energy storage (assess additional generation permitted within existing network, management of network voltage, thermal)

Battery storage and the use of hot thermal storage are not included in this report, and have been detailed in separate reports.

It is confirmed under evidence ‘Installation’ that:

- 3 commercial customers have had a Cold Thermal Storage device fitted at their facilities, during July 2015.
- This report clearly details the installation requirement(s), permissions, unit costs, safety considerations and associated time scales.

It is confirmed under evidence ‘Benchmark the thermal storage methods’ that:

- 3 installed Units, by 28th July 2015, have been operating and providing data for analysis.
- The data has been transmitted by the Ice Energy web portal and analysed to understand the effects of the Units on the LV network.
- The outcome of learning points from each analysis stage has been described in terms of its influence on the optimisation of future deployments.

It is confirmed under evidence ‘Thermal Energy Storage’ that:

- All of the units will be re-visited by SSEPD’s approved domestic electrical contractor, who has carried out routine checks on the unit and confirm its operational status.

- The NTVV project team has performed in depth analysis, on the received data, performed trending and cross referencing of all to LV network feeder cable(s) level, by individual participant addresses. Section 2.5 details 3 installed Units cross referenced to substations, including substation ID's, and individual LV feeders to the participants' addresses.
- The NTVV project team has performed cross referencing on the received data, to identify remote monitoring to individual substation level, and hence internal monitoring systems to understand the effects of the installed units on the LV network.
- The outcome of learning points from each analysis stage has been described in terms of its influence on the optimisation of future unit deployments.

1.2. Background

NTVV is a Low Carbon Network Fund Tier 2 project selected during the 2011 funding round. This five year project is focussed on the LV network and aims to demonstrate how electricity distribution networks can better serve their customers by understanding, anticipating and supporting their energy use as they move towards low carbon technologies. The project explores a mixture of analytic, technological and commercial solutions.

The NTVV project explores energy storage solutions, including hot thermal, cold thermal and battery storage. The cold thermal storage part of this project involves the installation of Cold Thermal Storage devices within the study area. This will help Scottish and Southern Energy Power Distribution (SSEPD) and other Distribution Network Operators (DNOs) understand the benefits to network operation that these units could bring. Under this project, cold thermal (Ice Bear) units have been installed to shift the operation of commercial Air Conditioning (AC) condensing units from on-peak periods to off-peak periods on the LV network. Energy storage has the potential to reduce electric system demand, improve electric system load factor, reduce the amount of investments needed in the network, and improve the overall electric system efficiency and power quality. Customers can also benefit from lower off-peak rates for electricity for the majority of energy consumed in cooling their premises.

The Ice Bear units deployed in NTVV are, at their most basic, a large thermal storage tank that attaches directly to an existing building AC system.

The Ice Bear operates in two modes. During programmed off-peak periods, the unit activates ice charge mode, whereby a self-contained system uses refrigerant, pumped around a configuration of copper coils to freeze water inside an insulated tank. Once this process of freezing is complete, the condensing unit turns off; storing energy until cooling is required.

As temperatures rise the unit replaces the energy intensive compressor of the buildings air conditioning unit. Fully charged from the off-peak, the unit switches to ice cooling mode, using ice, rather than the AC units compressor to cool hot refrigerant. This in turn melts the ice depleting the charge.

Following the six hours of cooling programmed to cover peak loads, any additional cooling will then be covered by switching back to the AC unit. During the off-peak, ice charge mode is activated again and the entire cycle repeats [Ref 03].

Since the project started, a material change in circumstances resulted in a change in SEPD's delivery of cold thermal storage as set out in the full submission. The original submission looked to deploy *"50 ice cooling storage units to demonstrate the extent to which thermal storage can increase the available 'controllable' load within a home or business"* [Ref 01 p. 7]. At project development stage, based on initial review of US and Australian experience, where this technology was largely deployed, it was envisaged that in the UK these units would be installed and funded by customers who wished to participate in a naturally occurring demand response market (with the project incentivising customers within the study area, encouraging use of cold thermal storage to improve network performance). However given a comprehensive study of 194 buildings in the study area, of which 95 direct reviews were held, it was concluded that no buildings had existing cold thermal. In turn meetings with the 3 most supportive customers, identified (social, community and operational) advantages, nonetheless customers could not quantify sufficient tangible economic benefits.

The changed approach does not rely on customer funding or market forces to encourage uptake but rather, focuses on DNO requirements to position larger scale units at critical points on the electricity network. Having identified the network locations, a third party recruitment and installation expert worked on behalf of the supplier to install units at customer premises. These units are funded by the DNO to provide cold thermal storage to regularly shift the electrical demand of refrigeration plant to times of low network demand; customers elected to receive the cold thermal storage and to routinely use it in return for new air-conditioning refrigeration plant. The key benefits of this approach are defined in the change control document [Ref.02].

This report was established to acknowledge the clear focus given to the optimisation of cold thermal storage, both in terms of quantity and location. In particular, the project has sought to:

- Deploy the required cold thermal storage hardware in a cost effective manner, hence providing the maximum ultimate benefit to customers and the network.
- Keep to legal and environmental procedures in accordance with EU regulation on Fluorinated Greenhouse Gas(F Gas), the Data Protection Act and Waste Electrical and Electronic Equipment Directive.
- Review the data from the units via an online portal, to confirm satisfactory ongoing operation, understand the effects on demand reduction across ice cooling periods and how this may affect future deployments.
- Review with customers their experience of the cold thermal storage unit and that the unit continues to meet expectations.

1.3. Link to Methods and Learning Outcomes

Method 4 as defined for NTVV [Ref 01] proposed the development of electrical energy storage on the low voltage network in the Thames Valley area to provide a better understanding of the effects of loads on the LV network, provide the ability to buffer the effects and reduce the need for network reinforcement using traditional methods, whilst meeting the needs of new low carbon technologies.

This report looks at the ability of 3 cold thermal storage units to divert the bulk of commercial AC condensing energy usage to off-peak periods through the use of cold thermal storage, as per Method 4, meets Learning Outcome 4.4.

Successful completion of Learning Outcome 4.4, applicable to cold thermal storage, requires an understanding of the effect of deployment on the LV network within different customer premises, in technical, geographical and in turn climatic conditions not previously trialled, as well as the value to commercial customers in terms of energy savings and economic payback.

1.4. Report Structure

The structure of this report is as follows:

- **Section 2 - Cold Thermal Storage:** Provides an overview of the technology;
- **Section 3 - Installation:** Summarises learning from the installation of the technology;
- **Section 4 -Trial Set Up and Operation:** Summarises key information from the trials;
- **Section 5 - Stakeholder Engagement:** Summarises the learning from engaging with stakeholders;
- **Section 6 - Commercial Arrangements:** provides an overview of the commercial arrangements that were developed with trial participants;
- **Section 7 - Benchmarking:** Benchmarks cold thermal storage against traditional forms of reinforcement on the distribution network;
- **Section 8 - Future Applications:** outlines potential applications for the technology; and
- **Section 9 - Conclusions:** Summarises the findings of the cold thermal storage trials.

2. Cold Thermal Storage

2.1. Introduction

A contract with the US based company Ice Energy was placed, to deliver 3 cold thermal storage units, or Ice Bears, to commercial premises across Bracknell. Five companies were reviewed to trial cold thermal storage in a UK context. It was concluded that Ice Energy were the only company with an appropriate product and scale to fit NTVV project learning outcomes. Resultantly the supplier was engaged directly for project participation.

The Ice Bear differs from its competitors in the cold thermal storage market due to its development, specifically for small to mid-sized commercial buildings. As such the Ice Bear is designed to work in conjunction with commercial DX air-conditioning systems- specifically in US SMEs, with 2-10 kW systems most typical in commercial buildings. With more efficient ductless air-conditioning units this will typically be towards the lower end of this scale.

Ice Energy has a targeted business model that looks specifically to add value and benefits to a utility driven approach in rolling out these devices as a means of network management. As such this proven approach was deemed a best fit for the DNO operated approach being trialled as a part of NTVV. Nonetheless the Ice Bear is installed behind the meter, allowing customers to benefit from potential savings made through efficiencies in the device and through shifting consumption to the off-peak.

Case-Study: Glendale Water and Power- California

One example of a utility led approach, where Ice Bears have been used in a project looking to “lay the groundwork for a city run on entirely smart, sustainable energy” is in California [Ref 04]. In this case study an amalgamation of energy storage and off-peak generation were deemed a central enabler in facilitating effective and reliable integration of renewable technologies such as wind and solar.

Glendale Water and Power (GWP) carried out their energy storage and Heating Ventilation and Air Conditioning (HVAC) replacement program in two phases. Phase one looked to replace over 80 inefficient HVAC units (on 25+ buildings) with new higher efficiency units simultaneously with Ice Bears. As a result, daily peak demand was calculated as being reduced by 1.5MW.

The second phase involved “the deployment of an additional 2 MW of Ice Energy distributed energy storage units on commercial and industrial customer sites throughout GWP’s service territory” [Ref 04].

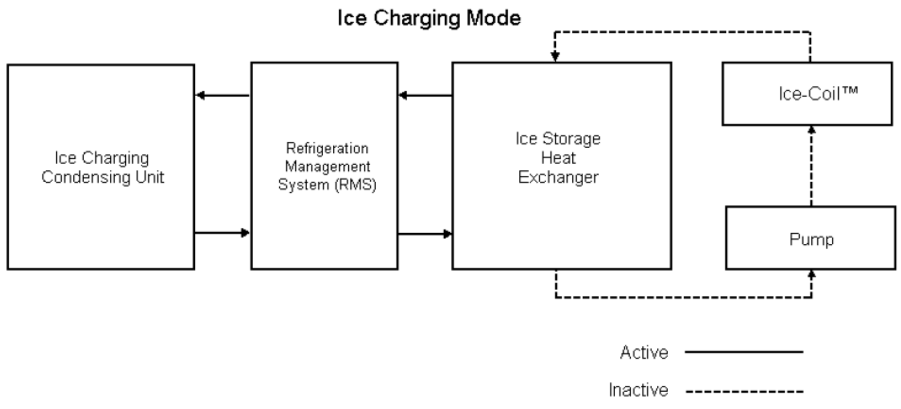
2.2. Operation

The Ice Bear 30, being trialled under NTVV is currently Ice Energy’s only cold thermal storage product. The following subsections of this report detail how the Ice Bear is set up to run over a typical 24 hour period.

2.2.1. Ice Charging mode

During ice charge mode the condensing unit inside the device provides low temperature refrigerant (R410A and miscible oil) to the units Refrigerant Management System (RMS). On the secondary side of the RMS, a separate oil free R410A automatically circulates through a heat exchanger until the water freezes into a solid block of ice (ice does not form around the outside of the tank)[Ref 05] This is shown in **Error! Reference source not found.** below:

Figure 1: Ice Charging Mode

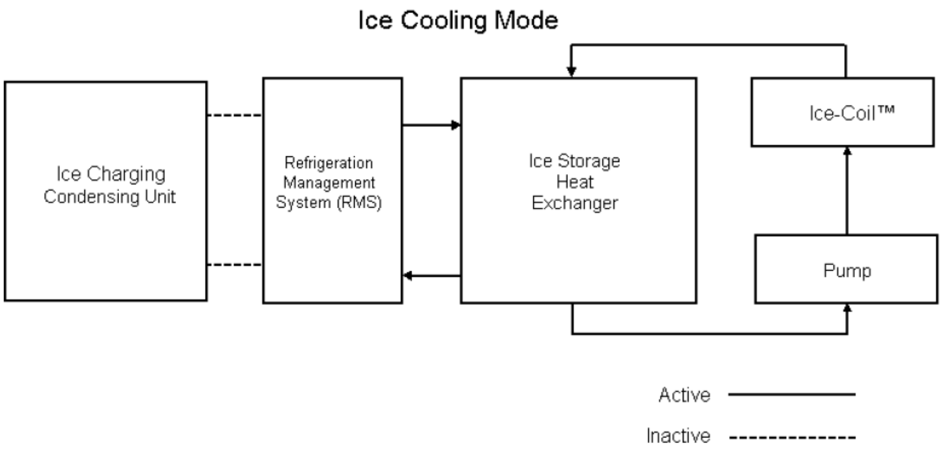


Following around 10 hours of charging (across off-peak periods) the Ice Bear will be fully charged ready to provide approximately 35kWh of cooling [Ref 06] when called upon.

2.2.2. Ice Cooling mode

When cooling is required, the integral Ice Bear condensing unit is switched off and typically one condensing coil on the existing Direct Expansion (DX) air-con system will be locked out. The ice cooling circuit (including: an ice-on-coil heat exchanger, a refrigerant pump, and Ice Coil - a flooded evaporator coil) is isolated from the Ice Charging circuit by a unique receiver/separator. When cooling is required / requested a small highly efficient pump circulates the oil-free refrigerant through the liquid supply line to a redundant ice-coil located in the air stream. Typically this Ice Coil is installed in a packaged unit or a slab coil mounted in the air supply duct. A fan then circulates warm air in the enclosed space across this ice-coil carrying the refrigerant; this in turn evaporates the liquid part of the refrigerant, turning it to vapour, whilst cooling the circulating air lowering the temperature of the room being supplied as required (this is controlled through a thermostat in the same manner as a conventional DX system). "The vapour return line returns vaporised (or mixed phase) refrigerant to the Ice Bear units ice-on-coil heat exchanger where it melts ice and is condensed back to its liquid state" [Ref 05]. The frozen water in the ice bear effectively does the job of the (traditionally energy intensive) compressor where hot vapour is cooled and condensed into a liquid form.

Figure 2: Ice Cooling Mode

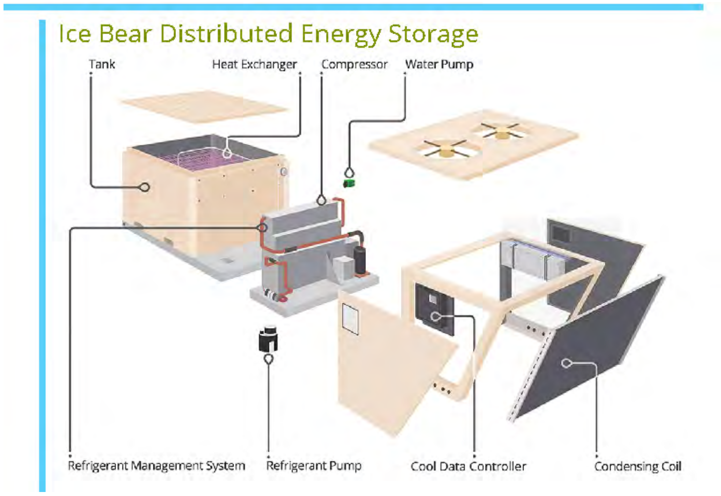


The Ice Bear can be set-up on a 2 stage thermostat to allow the Ice Bear and an additional system to provide cooling at the same time.
Given the cooling requirements in the UK and relatively small extremes in temperature this was deemed superfluous to requirements. The UK Ice Bears are set-up on single stage thermostats.

2.3. Ice Bear Specifications

The product specification(s) can be found in Appendix 1; however a few key considerations are detailed below. **Error! Reference source not found.** details the framework for an Ice Bear noting the location of each internal component.

Figure 3: Ice Bear



At times of on-peak demand the Ice Bear is rated to use around 300 watts on a typical installation, as such the Ice Bear claims to be able to reduce peak-demand by up to 7kW at generation source, (accounting for line losses and degradation of generation on a peak day). This amount of reduction is dependant upon the Seasonal Energy Efficiency Rating (SEER) of the device, ambient peak day temperature and the size of the HVAC unit(s) connected to. Given the 6 hours of cooling provided, an Ice Bear might be expected to shift a theoretical maximum of 42kWh of cooling to the off-peak.

Ice Energy however note this figure is unlikely to succeed 35 kWh given the output would unlikely be able to achieve a consistent rate of 7kW for 6 hours [Ref 06].

The compressor used during Ice Charge mode will operate at approximately 3.470kW (at 33.9°C) for 10-11.5 hours depending on ambient temperatures. [Ref 07]

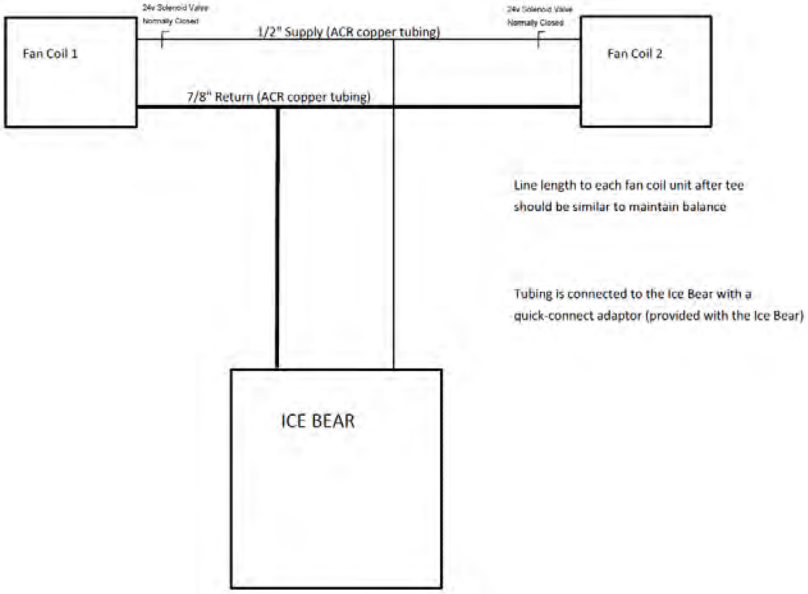
The Ice Bear 'cooldata controller' also has the capability to provide demand response capabilities by shutting down another device in response to a remote command through the same dashboard as used to monitor the Ice Bears. A typical application of demand response would occur on a site whereby the Ice Bear is connected to an existing AC unit which could then be controlled remotely. The dashboard then has parameters programmed into it (event duration, maximum number of events a year, maximum number of events per day) that limit the demand response usage depending on the commercial agreement with a given customer. Ice Energy claim their demand response capabilities may double or even triple the peak-demand reduction capacity of the Ice Bear [Ref 08]

Each of the 3 UK customers elected to receive an Ice Bear were already enrolled onto the NTVV's Automated Demand Response (ADR) programme. As such the features were already in place to accomplish this and enabling it within the Ice Bear would have had no value and could have even had a negative impact on customer experience through unnecessary confusion and crossover.

2.4. Trial Participants

The set-up of each of the Ice Bears is shown in Figure 4 and Figure 5. Figure 4 represents the set-up for Customers A and G. Figure 5 shows the set up for Customer D.

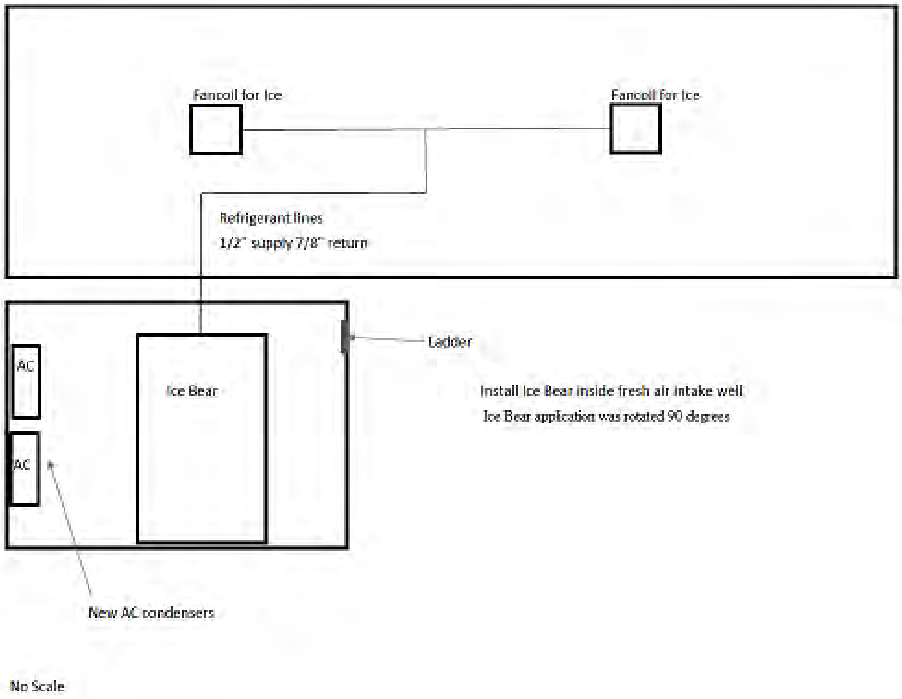
Figure 4: Ice Bear configuration on Customers A and G



Line length to each fan coil unit after tee should be similar to maintain balance

Tubing is connected to the Ice Bear with a quick-connect adaptor (provided with the Ice Bear)

Figure 5: Ice Bear configuration on Customer D



Install Ice Bear inside fresh air intake well

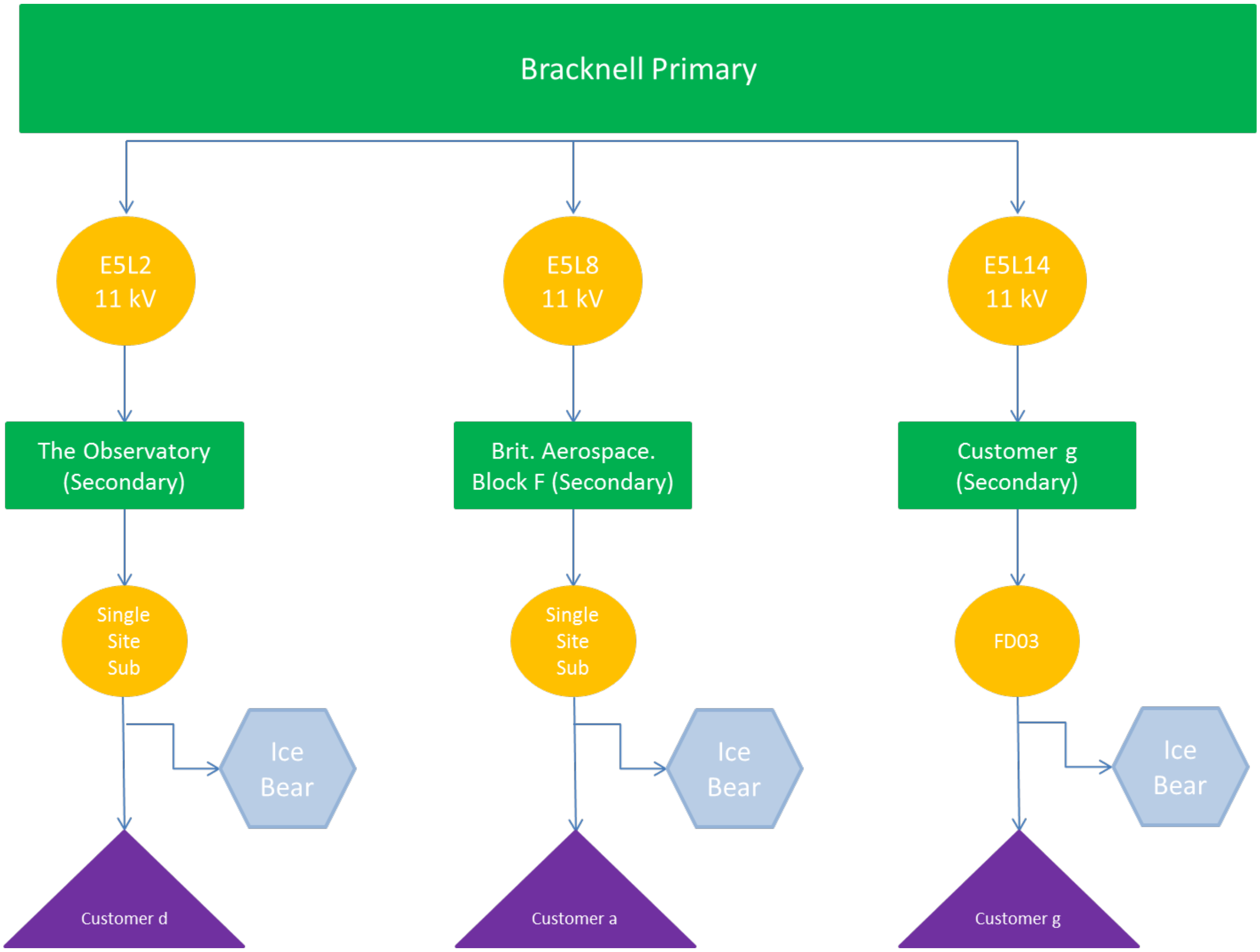
Ice Bear application was rotated 90 degrees

No Scale

2.5. Network Connectivity

Figure 6 below details the location of each Ice Bear and the associated customer on Bracknell's distribution network. This starts with the primary substation, of which all 3 Ice Bears are aggregated on Bracknell Primary, traveling down the network via the relevant 11kV feeder to where it joins the associated secondary substation. For both customers A and D these substations are single customer sites and hence only have one feeder which supplies that commercial premise alone. Customer G however is supplied by a 3 feeder sub, of which the Ice Bear sits on the part of the building supplied by feeder 3.

Figure 6: Network Connectivity



2.6. UK Context

Given the infrastructural and climatic differences between the UK and US certain agreements were implemented for successful, timely and cost-effective Ice Bear delivery.

Initial engagement with Ice Energy looked to address network differences between UK and US, namely voltage levels and frequency. Given the UK is run at 50Hz, whilst the US is run at 60Hz, it was ensured that a compressor was used within the Ice Bear that could run at both 60Hz and 50Hz. In addition given the UK voltage level of 415 on the three phase network, it was agreed with Ice Energy that their 460V model was a best fit for the UK market. As a result it is anticipated that the Ice Bear would take longer to charge than the 10 hours seen in US case studies.

In turn the network structure within the UK means that whilst a vertically integrated network operator may see benefits from the demand-side accrue through distribution, transmission and generation; within the UK the financial benefits from demand-side reductions will be seen individually by each sector of the electricity market. Resultantly roll-out by the DNO alone is unlikely be as cost-effective as would be accrued in vertically integrated markets.

Customer engagement throughout project delivery revealed a second key learning for the NTVV project team and Ice Energy alike, that is; in the US most air-conditioning systems are ducted systems which are largely regarded as less efficient than the ductless alternative primarily adopted in the UK. Given the relative inefficiency of ducted systems, when compared to ductless systems, it can be expected that the level of energy savings from the Ice Bear in a lot of UK applications may be less than in otherwise comparative US applications.

Finally (and most apparently) due to temperature differences between the UK (Bracknell’s average high temperature is 23^{o}C in August [Ref. 13]) and California where high densities of Ice Bears have previously been installed (Redding, California’s average high temperature is 37^{o}C in July) ([Ref 09] it would be a reasonable assumption that the Ice Bear could be more efficient in a UK market.

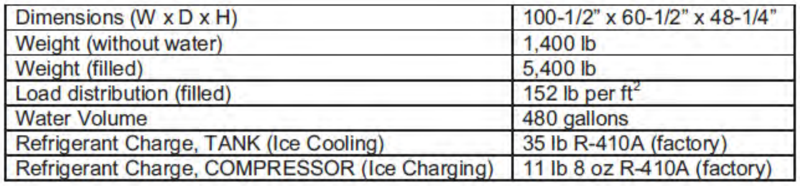
This will test one of the Ice Bears unique design features that claims cooling performance is not impeded by ambient temperature. In addition the level of cooling in terms of kWh per annum will likely be lower in the UK because the demand for cooling will mainly be across a far shorter seasonal time-span than the 8 months of the year typical in California.

3. Installation

3.1. Physical Requirements

The Ice Bear unit requires 3.5 meters (2.6 meters in length and 0.9 meters clearance) by 3.35 meters (1.55 meters in width and 0.9 meters clearance either side); with a structure able to facilitate 2450 Kg (see Figure 7). Within the NTVV project the size of the unit was only an issue on 1/7 of the customers surveyed, no rooftop applications were trialled; given the units weight in future applications this would require a structural survey.

Figure 7: Physical Requirements



Dimensions (W x D x H)	100-1/2" x 60-1/2" x 48-1/4"
Weight (without water)	1,400 lb
Weight (filled)	5,400 lb
Load distribution (filled)	152 lb per ft^2
Water Volume	480 gallons
Refrigerant Charge, TANK (Ice Cooling)	35 lb R-410A (factory)
Refrigerant Charge, COMPRESSOR (Ice Charging)	11 lb 8 oz R-410A (factory)

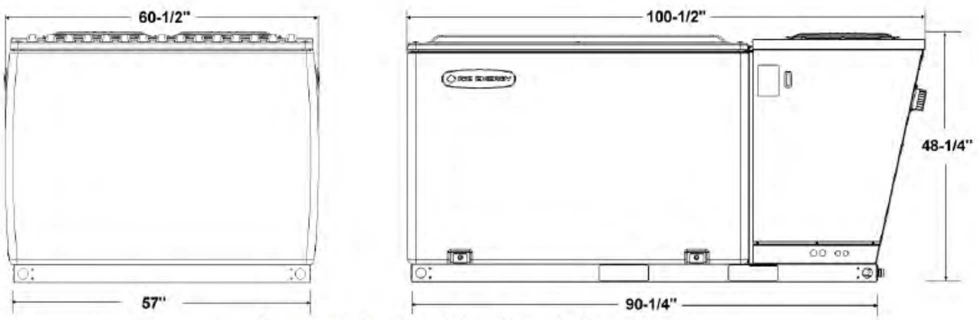


Figure 41 – Ice Bear® Unit Rear & Side Views

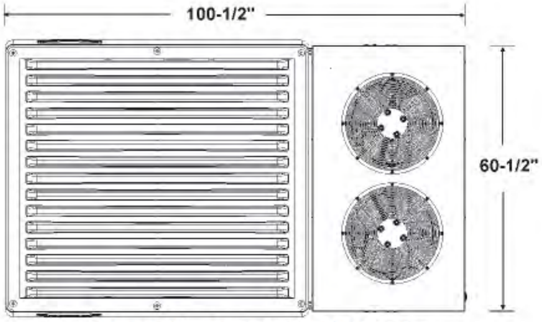


Figure 42 – Ice Bear® Unit Top View

Prior to any installations the NTVV project team undertook comprehensive analysis of the network, participant engagement and a site survey (detailed in Section 3.2) to understand if a commercial premises was suitable for the installation of an Ice Bear. Given the short list of minimum requirements (see Figure 8) and the tangible benefits to customers through the project trial, the majority of customers passed site survey and were willing to progress with Ice Bear installation.

Figure 8: Ice Bear Requirements

1. (Ground or roof) space enough to accommodate the Ice Bear
2. A room with the appropriate load on it (2-10kW being an ideal application) that the ice-bear could be used to provide cooling- no further than 46 meters (150ft) from the unit itself.
3. Power Supply for the unit
4. Sufficient drainage for the unit

Ice Energy are working to expand the range (size kW) of DX cooling systems they could connect to.

3.2. Installation Process and Permissions

The initial customer engagement to assess the market for Ice Bears and customers feedback concluded that there were no buildings within the target area with cold thermal storage and that although there were operational benefits as well as social/community reasons for considering the technology the tangible economic benefits were not sufficient as the payback period is greater than 3 years. Given the DNO funded approach and subsequent change control, this barrier was removed.[Ref 02]

The following section details a timeline of 8 stages relevant for completing successful installation of an Ice Bear.

3.2.1. Stage 1- Customer Engagement

From the initial engagement approach, the customers who registered an interest in both the cold thermal storage trials and the NTVV project were contacted to take part in the trial. These 10 customers were each contacted initially via e-mail, outlining the cold thermal storage trial and providing additional information in an attached leaflet (outlined in Appendix 2). Where required this was followed up with a phone conversation.

3.2.2. Stage 2- Initial Site Survey

Each of these 10 customers responded positively; however as a result of timescales to maximise the learning from the Ice Bears trials across summer 2015, 3 were unable to meet for site surveys. Meetings were arranged with the facilities departments of each of these commercial customers to coincide with Ice Energy's UK visit. Ice Energy accompanied by SSEPD visited each of the remaining 7 customers to further discuss the Ice Bear, detail requirements and perform a site survey to establish the applicability of installation. Each of the customers were reported on individually- a summary is detailed below in Figure 9

Figure 9: Customer Site Survey

Customer A (Financial Firm)	Customer B (School/College)	Customer C (Data Centre)	Customer D (Offices)	Customer E (Offices)	Customer F (Offices)	Customer G (School)
• Best application in the gymnasium • Exhisting concerete pad large enough for Ice Bear with proximate power • Refrigerant line length is within tolerance but approaching maximum length. • This application requires installing a parallel ductless system that is to connect to the Ice Bear.	• One potential application • Tight for space • Undesirable location of Ice Bear • Refrigerant line at maximum length	• 2 potential fits • There is a ground application for the Ice Bear • Owner reluctant to lock out cooling as vital- Ice Bear would add cooling and leave current system running with higher set points, hence acting as an insurance • Ice Energy have experience of this working well in US	• Good application on ground floor work area that is currently planned to have cooling systems installed • Adequate outside space for the Ice Bear unit.	• No workable application identified	• Best application in the gymnasium • One 20 kW system, one 25kW the 20kW system would be preferable • Space outside for the Ice Bear, would need approval and expansion of exhisting fencing	• Best application on glass fronted south facing IT suite • Previous plans for cooling system installations • Good application for a standalone Ice Cooling system • Ice should cover large enough time-period to cover cooling needs • Occupancy during summer months may not meet trial needs.

During the site survey Ice Energy outlined the Ice Bear and its network value using a short video (http://www.ice-energy.com/technology/). They also talked through and answered any questions the customer had, before surveying the site and identifying appropriate Ice Bear locations and rooms to be cooled.

Of the 7 customers only one was not suitable for installation, due to space requirements, the other 6 were discussed between Ice Energy and the NTVV project team to select the most relevant sites. This was determined by applicability of install, envisaged load shifted and variance in learning (type of install, site to be cooled and type of customer). It was concluded that the 3 first choice sites would be: customer A (Financial Firm) - gymnasium, customer C (Data Centre) - data room and customer D (Office space) - IT training room with large data storage. However due to land ownership and project time restrictions, customer C was obliged to drop-out (the ice bear would have required increasing the boundaries of the company premises). Whilst this was potentially feasible, the timescales to proceed with the property landlords were deemed to damage project learning. Given this, it was decided that customer G was the next best application. It is determined that customer G will give a different insight into where Ice Bears may be deployed instead of conventional air-conditioning units to mitigate against potential network overloading.

3.2.3. Stage 3- End-user agreements

Taking on board learning from the NTVV ADR trials it was made an early priority to issue each customer the relevant contracts to progress through the relevant legal departments, this allowed adequate time for revisions before install. A skeleton of this contract is detailed in Appendix 6

3.2.4. Stage 4- Detailed Site Survey

Ice Energy engaged with UK based contractors to carry out the necessary works within Bracknell. Responsibilities included: site assessments, install and maintenance of the Ice Bears. The contractors were first familiarised with the Ice Bear and its requirements before carrying out survey on each commercial customer.

From this survey it was intended that the contractors could confirm the suitability of the application site and put together a quote for the works (the requirements of these surveys as detailed by Ice Energy can be found in Appendix 4). In summary this looked to:

- Identify the location of the Ice Bear/space availability;
- Assess below Ground Drainage;
- Confirm the power source; and
- Determine the best fan coil given the application (matched with existing ac units where applicable).

The area identified during the initial site survey at customer G was altered due to drainage issues and to avoid unwanted attention. There was also suggestion of a new location for the Ice Bear at customer D, within the office car park, as opposed to the vacant walled off space initially suggested; this alteration was purely for simplicity and cost-effective install. This was progressed, but later reverted back to the original area due to internal parking constraints (final location shown in Figure 10 below)

Figure 10: Ice Bear location- Customer D

3.2.5. Stage 5- Shipping and Customs

To aid with the shipping process customs brokers were engaged in both the UK and US, this ensured smooth transit, customs clearance and legal compliance. Prior to shipping of the Ice Bears a timetable was devised to ensure that the devices were compatible and compliant with the relevant UK electrical standards.

In discussion of the substances used within the Ice Bear it was noted that the refrigerant R410a is used within the unit, further research determined this to be an F Gas, class 2.2, marked UN 2857 (Appendix 3) and as such required a dangerous goods note upon shipping as well as a regular checking procedure upon installation.

From first discussions with Ice Energy it was noted that CE marking (Appendix 3) for the unit as well as Low Voltage Directives (LVD) and Electromagnetic Compatibility (EMC) directives were necessary to progress the project, these were also finalised prior to shipping the units to the UK.

It was agreed that the 3 units would be shipped full container load (FCL) onto a 40’ container, this necessitated that they were unloaded with a bay/ramp. It was devised that this was best performed at a depot in Southampton prior to collecting the units to store at a local depot.

Throughout the shipping process, the Ice Bears progress was tracked using the bill of lading, allowing for an accurate ETA for arrival in Southampton, customs clearance, collection from the depot in Southampton and in turn a strategy to progress installation swiftly and effectively.

3.2.6. Safety Considerations

Prior to installation it was confirmed that the Ice Bears were CE marked, and met relevant health and safety regulations (Appendix 3).

As the units were installed within commercial premises, one of which was a school, and involved connections to an LV distribution board, safety was paramount throughout the entire process.

The installation of the 3 units was carried out by a contracts engineer with customer management, project management and technical support by SSEPD and Ice Energy staff. Prior to the installation of the units, the contracts engineer discussed their process and requirements with Ice Energy who produced manufacturer's drawings and an installation, maintenance and operating manual. SSEPD also requested and reviewed a safe system of work (method statement), primary risk assessment, with secondary risk assessments required daily. The contracts engineer was tasked with keeping these documents with him throughout each install in the form of a site job pack. These sites specific Risk Assessment and Method Statements (RAMS) were then re-visited and amended where necessary during the Ice Energy commissioning process to ensure any further risks were identified and mitigated and to act as an effective refresher exercise.

All installations were performed by qualified engineers given the technical and mechanical nature of the install. Periodical maintenance or revisits are required in order to check gas volumes / temperatures (notably of the refrigerant R410a mentioned previously); this will be performed by the original installation operatives ensuring familiarity with the unit and provides continuity therefore mitigating against any inherent risks associated with the maintenance programme.

3.2.7. Stage 6- Install

Installation of the Ice Bears took between 2-4 weeks depending upon site specifics, customer availability and weather. The install at customer A took longest given the distance of piping (50m) with Inoac trunking installed from the Ice Bear to the room being cooled. Before any installation could take place contractors were required to carry out a final site survey and identify site preparation prior to Ice Bear delivery. Mechanical, electrical and civil works were largely exclusive of each other and hence could occur independently to one another. Given that the concrete plinth required for an Ice Bear took 4-7 days to set, these works often took principal attention; where necessary requiring diverting of underground services prior to laying the plinth.

Whilst the plinth dried it was most time-effective to carry out electrical and mechanical works. Mechanical works took on average 5 days and included interconnecting refrigerant ductwork, AC installation including pipework and condensating drains. Electrical work took around 2 and a half days, requiring, electrical controls wiring and excavating a route for power.

Given the time for the plinth to dry, the Ice Bear was often landed whilst electrical and mechanical works were taking place to allow relevant connections to be made. Finally commissioning by Ice Energy took 1-2 days before the units became operational.

Table 1 below shows a delay between work starting on customers A and D and commissioning. This was largely due to delays in civil works starting on customer G as the school did not want children present whilst the concrete plinth was setting. As a result electrical and mechanical works took place in mid-July to pre-empt the civil works starting in line with school holidays. All 3 units were required to be fully installed before commissioning could begin due to the geography between Ice Energy and SSEPD.

Table 1- Install timeline

Customer	Civil Works Start	Mechanical Works Start	Ice Bear land	Electrical Works Start	Commissioning Start	Operational
Customer A	02-Jul	07-Jul	05-Jul	11-Jul	24-Jul	28-Jul
Customer D	30-Jun	02-Jul	03-Jul	06-Jul	24-Jul	27-Jul
Customer G	18-Jul	13-Jul	22-Jul	13-Jul	24-Jul	27-Jul

3.2.8. Stage 7- Commissioning

Commissioning of the units was the only part of the installation process that required a physical presence by Ice Energy. Ice Energy were in the UK for two weeks to complete the commissioning process and train contractors in maintenance of the Ice Bears. It was estimated that commissioning on each site should take between 1 and 2 working days.

This gave ample leeway for unplanned additional works, customer engagement and to monitor the units as they came online.

The commissioning process required Ice Energy with the support of an electrical contractor to:

1. Install current sensors to monitor power consumption on the existing DX condensing units;
2. Install and configure wireless communication equipment on the Ice Bear;
3. Configure the Ice Bear for the application; and
4. Perform start-up and verification of the Ice Bear and calibrate the current sensors.

However, following day 1 on site there were delays due to power requirements at indoor units being overlooked, this was quickly corrected with minimal delay to commissioning timescales.

3.2.9. Stage 8- Customer Engagement and Maintenance strategy

Upon their UK commissioning, Ice Energy were required to liaise with their contractors to train them in operation and maintenance of the Ice Bear. In attendance it was detailed that the Ice Bear be checked and recorded every 12 months to abide with European F Gas Regulation (EC Regulation 842/2006).

Following the Ice Bears becoming operational customers were engaged to determine their perceived peak consumption, off-peak/on-peak tariffs and preferred times of Ice Bear operation in both Ice Charging and Ice Cooling mode.

3.3. Timescales

From initial customer engagement starting March 2015, all 3 Ice Bears arrived in the UK on 9th June 2015 and were operational 28th July 2015. The 3 installed Ice Bears can be seen in figures 11-16 below. In the right hand pictures the arrows point to the room(s) that the Ice Bear provides cooling to.

The timescales for this project were relatively short; given the maturity of the product, the item could effectively be purchased with minimal alterations and applied to the UK market. The main mitigation to an immediate install is customer engagement and building accessibility.

Figure 11: Customer A

Figure 12: Customer A (2)

Figure 13: Customer D

Figure 14: Customer D (2)

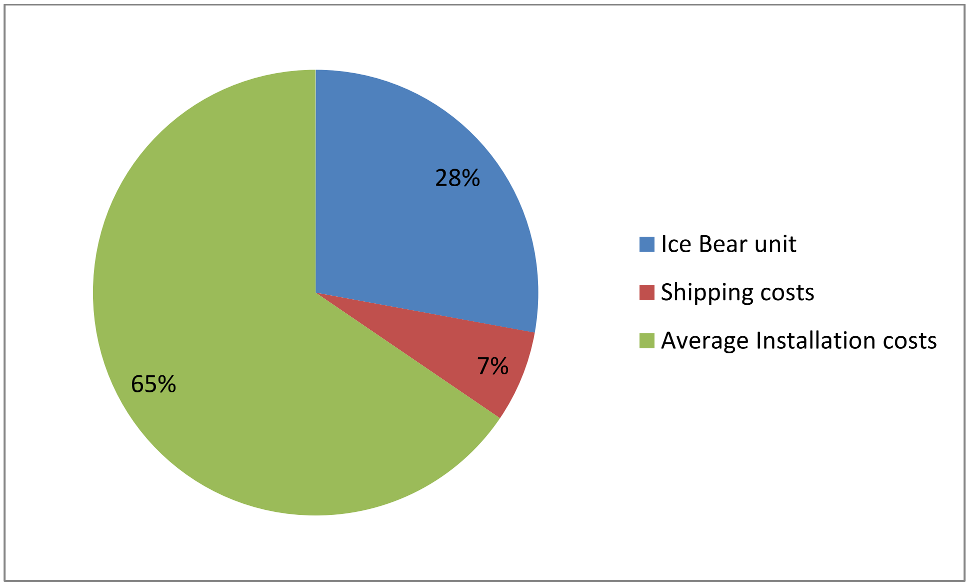
Figure 15: Customer G

Figure 16: Customer G (2)

3.4. Unit Costs

The cost breakdown of delivering operational Ice Bears is detailed in Figure 17 below. It is noted that these figures are an average, given costs variation in installation cost between applications.

Figure 17: Ice Bear Delivery Costs



It is apparent that installation makes up a major proportion of the cost of the Ice Bears with the units themselves only accounting for 28% of the cost on average. Through discussion with the contractors responsible for installing the Ice Bears, they estimated costs could be reduced through a better understanding of the system and its operation.

This could bring the percentage of total cost represented by installation to approximately 60% of total cost.

Each Ice Bear was installed over a series of consecutive days for minimal disruption to the customer. The time for an install varied between the 3 sites and reduced as the installation engineers became more familiar with the installation process. Two contracted engineers were required for approximately 11 days to install an Ice Bear (2 days for civils, 2 days for electrical, 5 days mechanical and 2 days commissioning). It could therefore be estimated that 165 man hours were required to install each Ice Bear. Resultant costs for installation were estimated at 5% electrical, 45% mechanical, 5% haulage and 45% civil works.

In the US, Ice Energy's contracts will often look to include all marketing, customer surveys, site acquisition, design services, construction and start-up services on an Ice Bear. As such they will price MW scale utility projects based on \$/kW (converted to £/kW) whereby the utility owns and operates the equipment. This price can vary depending on the percentage of thermal energy storage capacity to the percentage of demand response capacity, and the number of air conditioners being replaced as part of the programme which can drive a £/kW range of between £960-£1600 (\$1500-\$2500; based on a conversion rate of 1GBP = 1.57USD on 26/8). On top of this, ongoing annual mechanical and remote monitoring as well as dispatch services to control the Ice Bears and Demand Response switches will range from 1.5 to 2% of the total project price per annum.

4. Trial Set Up and Operation

4.1. Trial Locations & Set Up

Each of the sites trialled on NTVV have been chosen to maximise learning from the Ice Bear devices and their associates set-ups. As a result, the level (and hence period) of cooling that each unit will demand, will be site specific as is detailed throughout section 4.

On both customers A and D, air-con units were already in operation and hence the framework of ductless systems with accompanying fan coils was already established. For this reason the Ice Bear was connected to the fan coil units in each of these buildings to create a parallel cooling system. Through literature review into the existing air-conditioning units it is estimated that the two condensing units on customer A consume 2.4kW each, whilst on customer D the two units are estimated at 3kW each. Given the estimated 0.3kW cooling cycle that the Ice Bear operates within, it is predicted that at times of peak consumption customers A and D will alleviate (2.4 x 2 - 0.3) 4.5kW and (3 x 2 - 0.3) 5.7kW respectively; which are both within the Ice Bears previously quoted capability of reducing load of up to 7kW.

On customer G however no cooling system was previously connected as the Ice Bear was implemented as an alternative to putting conventional air conditioning in. As a result 2 fan coil systems were installed (one to each room) to be connected to the Ice Bear to provide cooling.

The data analysis in the following sections looks at the first months testing on each of the Ice Bears. During this time the data has been relayed to the NTVV team via Ice Energy's online portal, the 'Cooldata control network'. Over the August period, the devices have been contributing towards active LV management and providing cooling throughout. Given US experience, the Ice Bear devices are usually able to provide around 6 hours of cooling at up to 7 kW, this is of course dependant upon external (weather / temperature) and internal (amount / level of cooling required) variables.

This cooling can be programmed to operate in a block of 6 hours or in periods, i.e. for 2 hours at a time, 3 times a day.

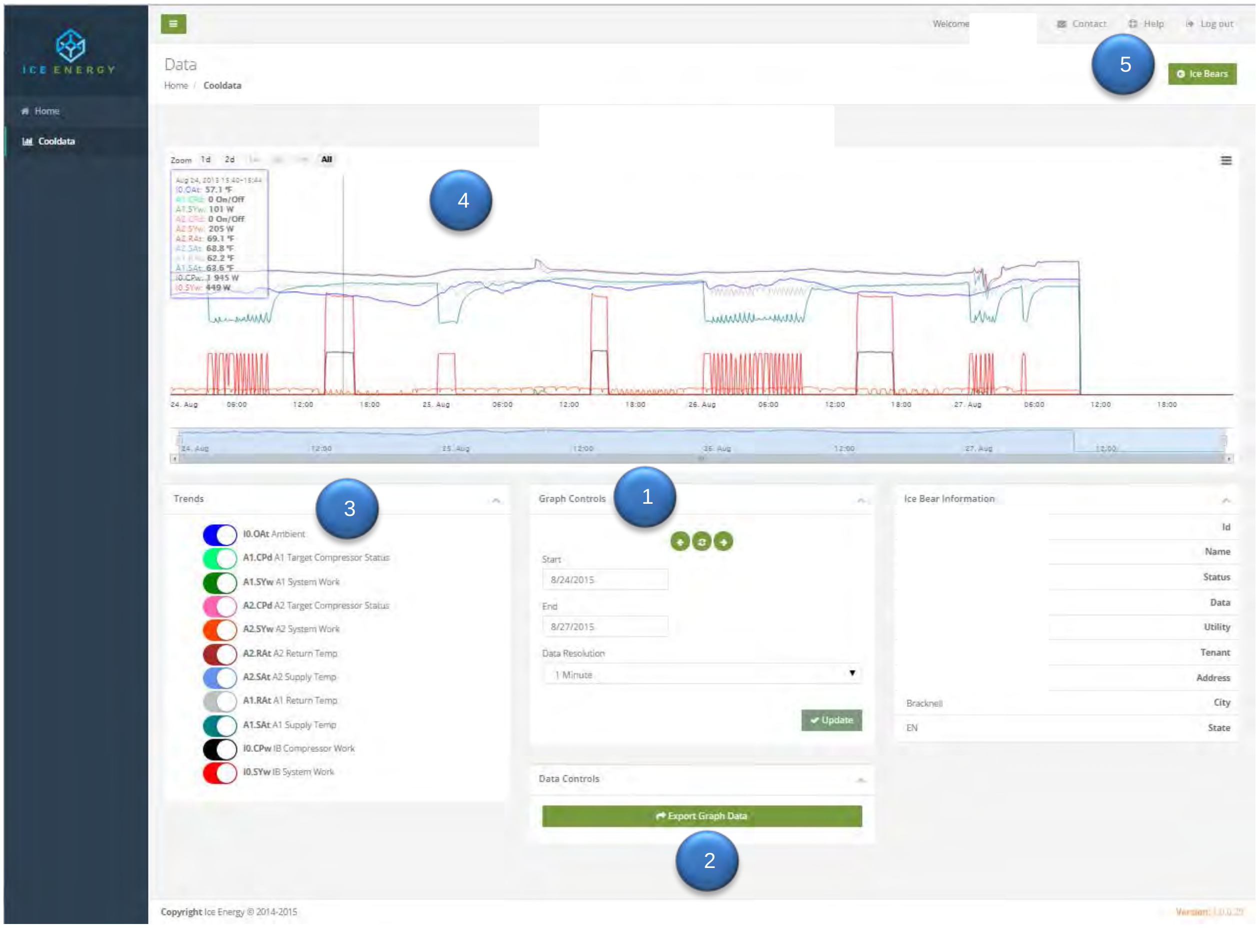
Before the formal trials started the devices were run in each participant's premises, to determine the amount of cooling required by each building and in turn the average duration through which the Ice Bear could provide cooling for and would require to fully charge. This was done by using the data from customers half-hourly meters, monitored secondary substations and the related primary substations, visualising and correlating their peaks and troughs in consumption whilst simultaneously accounting for the estimated hours of cooling an Ice Bear might deliver (over 6-10 hours) and the estimated charge time (10-12 hours, assuming all the ice has been depleted). These time periods were estimated following advice from Ice Energy's engineers and data analysis following the first few days of operation.

4.2. Ice Energy Cooldata Portal

Information from the Ice Bears is relayed from the units to the Cooldata online portal through which customers are able to log-in and view real-time and historic data relating to an Ice Bear install. The portal layout is simple and effective with each Ice Bear clearly detailed in order to analyse that units data.

When selecting an Ice Bear an intuitive graph is displayed showing a date range and the relevant variables across that period. An annotated screenshot of this display is provided in Figure 18.

Figure 18: Ice Energy Portal



Aug 24, 2015 15:40-15:44
I0.OAt: 57.1 °F
A1.CPd: 0 On/Off
A1.SYw: 101 W
A2.CPd: 0 On/Off
A2.SYw: 205 W
A2.RAt: 69.1 °F
A2.SAt: 68.8 °F
A1.RAt: 62.2 °F
A1.SAt: 63.6 °F
I0.CPw: 1 945 W
I0.SYw: 449 W

Trends

- **I0.OAt** Ambient
- **A1.CPd** A1 Target Compressor Status
- **A1.SYw** A1 System Work
- **A2.CPd** A2 Target Compressor Status
- **A2.SYw** A2 System Work
- **A2.RAt** A2 Return Temp
- **A2.SAt** A2 Supply Temp
- **A1.RAt** A1 Return Temp
- **A1.SAt** A1 Supply Temp
- **I0.CPw** IB Compressor Work
- **I0.SYw** IB System Work

Graph Controls

Start: 8/24/2015
End: 8/27/2015
Data Resolution: 1 Minute

Ice Bear Information

	Id
	Name
	Status
	Data
	Utility
	Tenant
	Address
Bracknell	**City**
EN	**State**

1. Graph Controls- within this section of the portal it is possible to amend the date range displayed within the graph; this can show a longer or a shorter date range from the Ice Bear becoming operational until the current day. The resolution of the data can also be amended within this section from 1 minute up to 1 hour resolution.
    a. The graph can also be controlled using a scroll bar option at the bottom of the graph by amending the date dimensions highlighted.
2. Export graph data- this option will pull the data displayed on the graph at the top into an excel format at the given data resolution selected.
3. Trends- This gives options as to what variables are displayed on the Ice Energy graph. These variables are described in table 1 below. Each of these variables will be displayed on the graph coloured to match the key relating to that variable.

These can be switched on or off using a swipe option. Through turning an option off it will be removed from the graph and the export function described in (2).

Table 2: Ice Bear Portal meanings

Trend	Description
I0.OAt Ambient	Outdoor temperature measured at the Ice Bear
A1.SYw A1 System Work	First existing AC condensing unit power consumption
A2.SYw A2 System Work	Second existing AC condensing unit power consumption
A2.RAt A2 Return Temp	Air Intake at fan coil unit zone 2
A2.SAt A2 Supply Temp	Air Discharge at fan coil unit zone 2
A1.RAt A1 Return Temp	Air Intake at fan coil unit zone 1
A1.SAt A1 Supply Temp	Air Discharge at fan coil unit zone 1
I0.CPw IB Compressor Work	Power consumption for Ice Bear make compressor
I0.SYw IB System Work	Power consumption by all other components on Ice Bear (refrigerant and water pump during melt, condenser fans during Ice Charge)

4. Ice Energy Graph- This gives a visual representation of how the Ice Bear is interacting with its surroundings. Given the range of variables displayed here there is no y axis; the x-axis displays time. By using the mouse to hover over a given point in time it is possible to see values for each variable switched on, displayed on the graph at that point (the box on the left hand side of the graph details this). Alternately the data can be exported.
5. Ice Bears/Options- By clicking the Ice Bear button here you can view and switch to other Ice Bears. Contact and Help buttons are also available.

4.2.1. Scheduling

The Ice Energy portal displayed above is a software upgrade that Ice Energy has recently enabled. Resultantly the Control centre for the Ice Bear is accessed through an alternative system. Ice Energy will be developing their software to provide both these functions in the one portal shown above in Figure 18. The Ice Bear control centre is set up to allow scheduling of Ice Charge and Ice Cool modes on each client as well as in order to schedule Demand Response (DR) events. Figure 19 and Figure 20 show the Ice Bear scheduling and DR screen.

Figure 19: Ice Bear Scheduling Screen

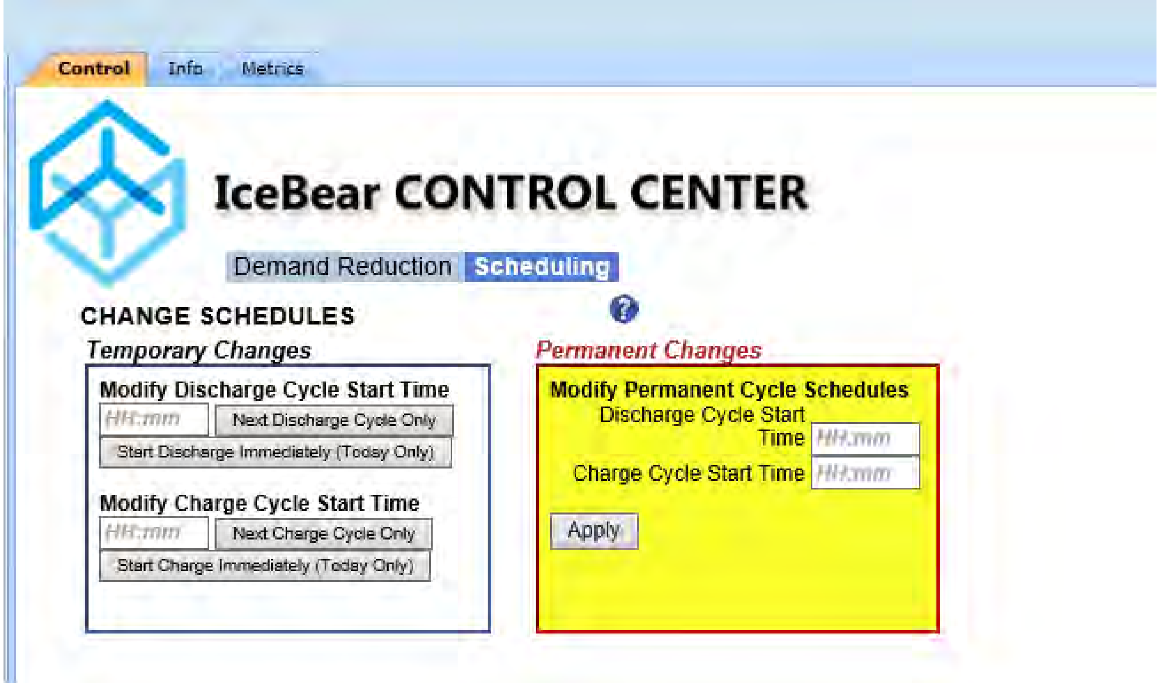
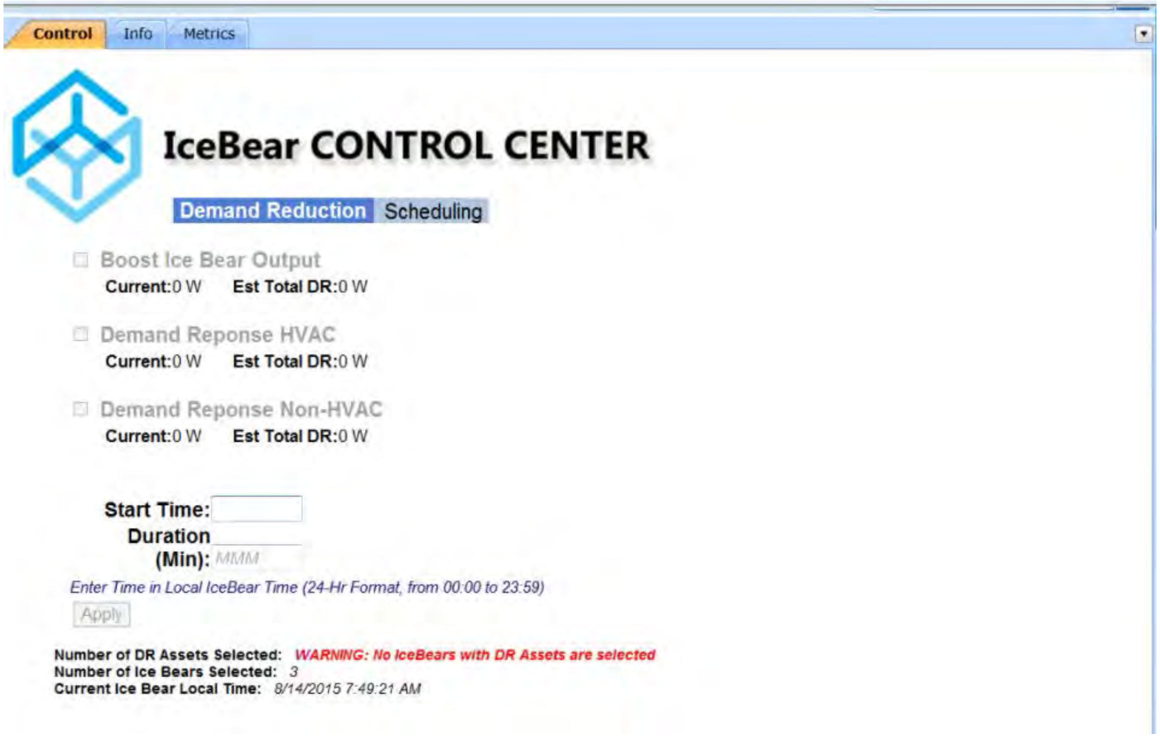


Figure 19 above shows the system used to schedule an Ice Bear. To enter this screen one or more Ice Bears may be selected and then changes may be applied to the unit(s).

Two options are available here, on the right hand side, the yellow box, will allow a permanent change to be made to a device. Here it is possible to determine the time through which Ice Charge and Ice Cool mode will begin. Within this application Ice Charge will operate until the unit is fully charged or Ice Cool begins. Likewise Ice Cool will run until the ice is depleted (depending on building demand) or Ice Charge is activated. Ice Energy must be engaged in order to make more detailed changes such as limits to the time periods for charge and cool mode and intervals of cooling throughout the day, i.e. 3 hours in the morning and 3 in the evening.

On the left side an Ice Bear(s) may be programmed with a changed charge and discharge mode for a given day. This tool is useful to a DNO if a large spike in demand has been modelled/predicted at an abnormal time of day (i.e. world cup half-time) to provide a demand response capability from the Ice Bear.

Figure 20: Demand Response Scheduling Screen



☐ Boost Ice Bear Output
Current:0 W **Est Total DR:**0 W

☐ Demand Reponse HVAC
Current:0 W **Est Total DR:**0 W

☐ Demand Reponse Non-HVAC
Current:0 W **Est Total DR:**0 W

Start Time:
Duration (Min): MMM

Enter Time in Local IceBear Time (24-Hr Format, from 00:00 to 23:59)

Number of DR Assets Selected: *WARNING: No IceBears with DR Assets are selected*
Number of Ice Bears Selected: *3*
Current Ice Bear Local Time: *8/14/2015 7:49:21 AM*

Figure 20 displays the DR screen. Here a set amount of Ice Bears can be selected (3 in this case) and as a result the number of assets set up for load-shed will be detailed. Start time and duration are entered manually to organise a load-shed. Above the start time box shows what each DR asset is currently consuming and it's estimated load-shed.

4.3. Trial Planning

During the initial program each Ice Bear was scheduled to deliver a full make cycle followed by a full melt cycle over a 2 day period. This was intended to determine what the melt and make durations were for each specific site.

Figure 21: Melt and Make Cycles

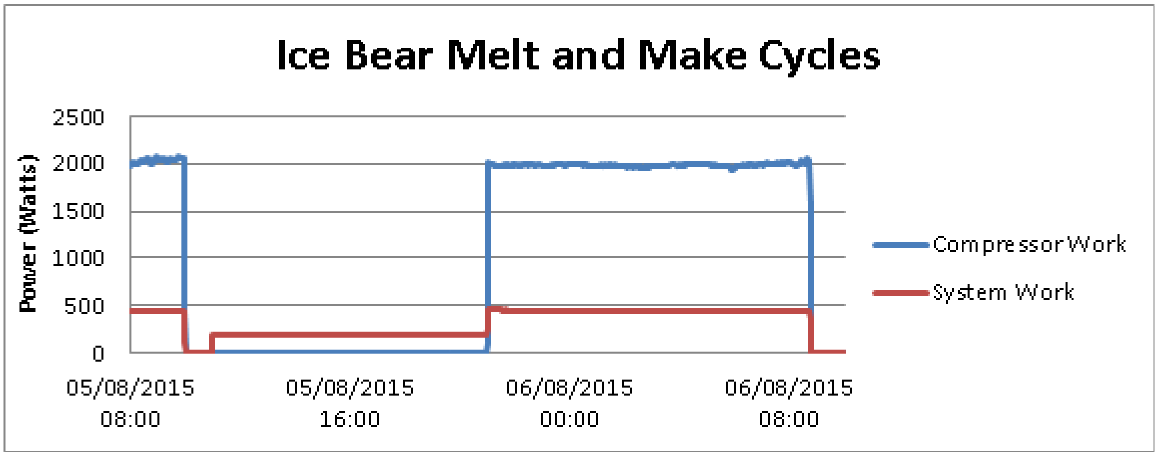


Figure 21 above shows an example from Customer A, detailing the length of the melt and make cycles. When Compressor Work is at its peak, it is creating ice. When the System Work has a value individually, then the Ice Bear is cooling the building. The consumption on the unit can be calculated as the sum of compressor work and system work. Thus, during Ice Charge (make) mode the Ice Bear is consuming approximately 2.5kW, whereas during Ice Cooling (melt) the units consumption is just 200W.

The following Melt and Make cycles were determined:

Table 3: Ice Bear Schedule

Site	Melt Length (hours)	Make Length (hours)
Customer A	9	6
Customer D	9	6
Customer G	9	6

Throughout testing on the Ice Bears the make cycle emerged at just 6 hours as opposed to the 10 hours estimated by Ice Energy. This was presumed largely due to the ice not being exhausted as a result of the cooler than expected climate during trial periods. On discussions with Ice Energy, the decision was made to plan for a longer making cycle than the 6 hours seen through testing, as such the units were programmed to run for a total of 9 hours to ensure that the unit had enough time to fully recharge.

To decide which time periods would be most appropriate for the make and melt period data was collated detailing each sites energy usage, the corresponding primary substation ampere usage, and the kW values from the secondary substation where possible.

As Customer A and D are both served by their own dedicated single site substation, an assumption was made that their half hourly power (kW) reading, would be double that of the sites half hourly kWh usage. Where substation monitoring was not available within these single site substations, this has enabled the substation load to be estimated. The substation and customer peaks and troughs, as well as the times identified by facilities managers as being highest occupancy and cooling requirements are detailed in Appendix 5.

Figure 22: Electricity Consumption

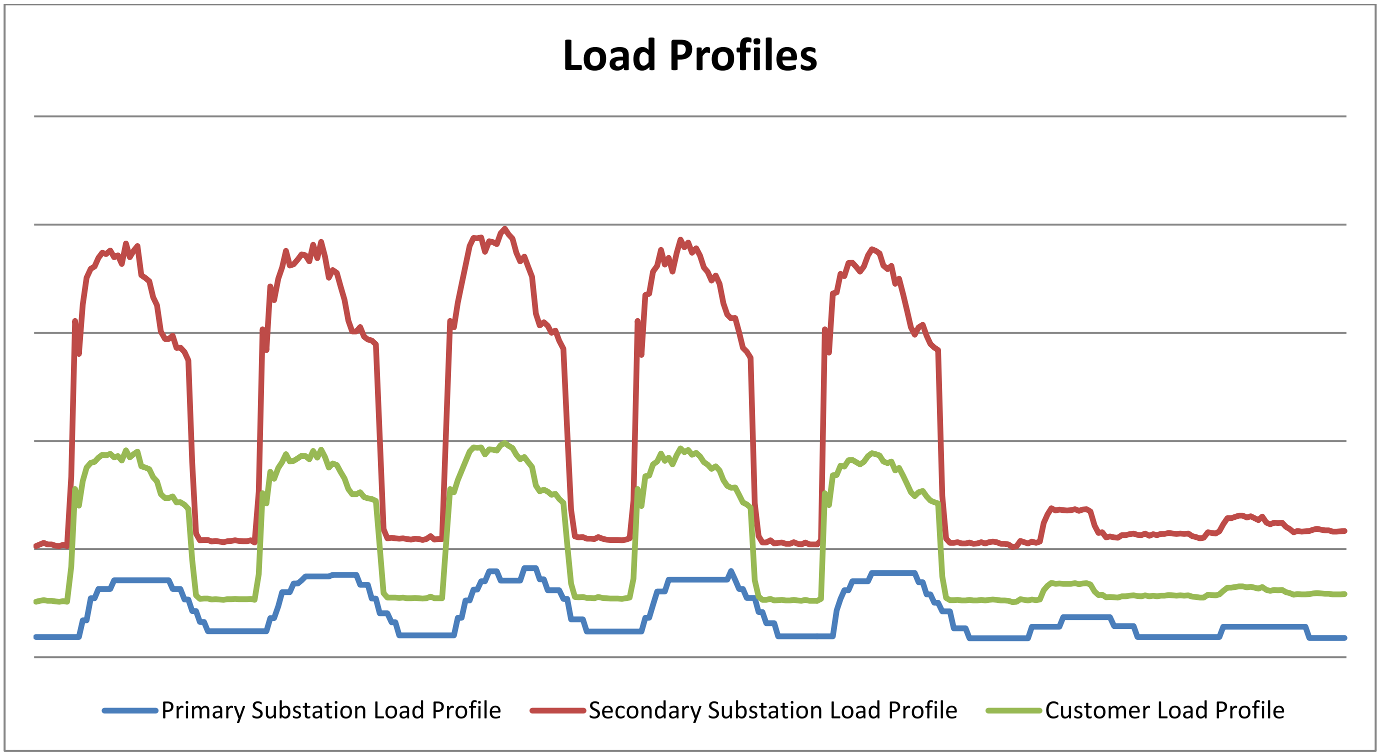


Figure 22 above shows what an average week for Customer A looks like. As this looks at a graphical comparison of peaks, the peaks of the participants usage were compared with the peaks of the substations to find ideal make and melt times for each site as shown Table 4.

Table 4: Ice Bear Daily Schedule

Site	Melt Time	Make Time
Customer A	08:00 - 17:00	21:00 - 06:00
Customer D	08:00 - 17:00	21:00 - 06:00
Customer G	07:00 - 16:00	22:00 - 07:00

4.4. Trial Results

Throughout the analysis that follows on customers A, D and G it has been assumed that the pre-existing air conditioning unit, would be running at full power for the duration of the 'melt' cycle to enable direct comparison. As a result, the data shows output levels higher than that expected by Ice Energy. Once more data is available, these calculations will be amended to show true curtailment, rather than theoretical.

Customer A

The room being cooled in Customer A is a gym in an office building. The buildings peak energy usage is between 04:30 and 20:30, Monday to Friday. The room has a separate, pre-existing thermostat. This has proved a challenge, as despite communications sent to the customer, it appears as though this thermostat has been used at some points. This has resulted in the air conditioning unit blowing air constantly throughout a period of several days. This is not normal behaviour for the building, nor for what an Ice Bear Unit is designed. Evolution of Cold Thermal Storage to integrate with a central BMS might alleviate these issues.

From 28/07/2015 until 31/08/2015, the Ice Bear unit has been cooling for 80 hour periods, and curtailed a total of 374kWh. Weather has been erratic over this trial period, so it is difficult to state what an average day's curtailment should be for this customer at this early stage.

The Ice Bear unit has a power rating of 30 - 300 watts during the 'melt' cycle. If compared to the original air condition unit, which uses 4.8kW, the theoretical curtailment of the Ice Bear is between 4.5 – 4.77kW during cooling.

On days where the Ice Bear has been cooling as expected, it has been doing so for between 5 and 10 hours. If this were to be generalised as a standard weekdays use, then the Ice Bear would be curtailing between 22.5 and 47.7 kWh each day. Ice Energy has previously noted a maximum energy curtailment of 35kWh, so as the trial continues, these figures will be revisited.

Figure 23: Customer A Melt Cycle

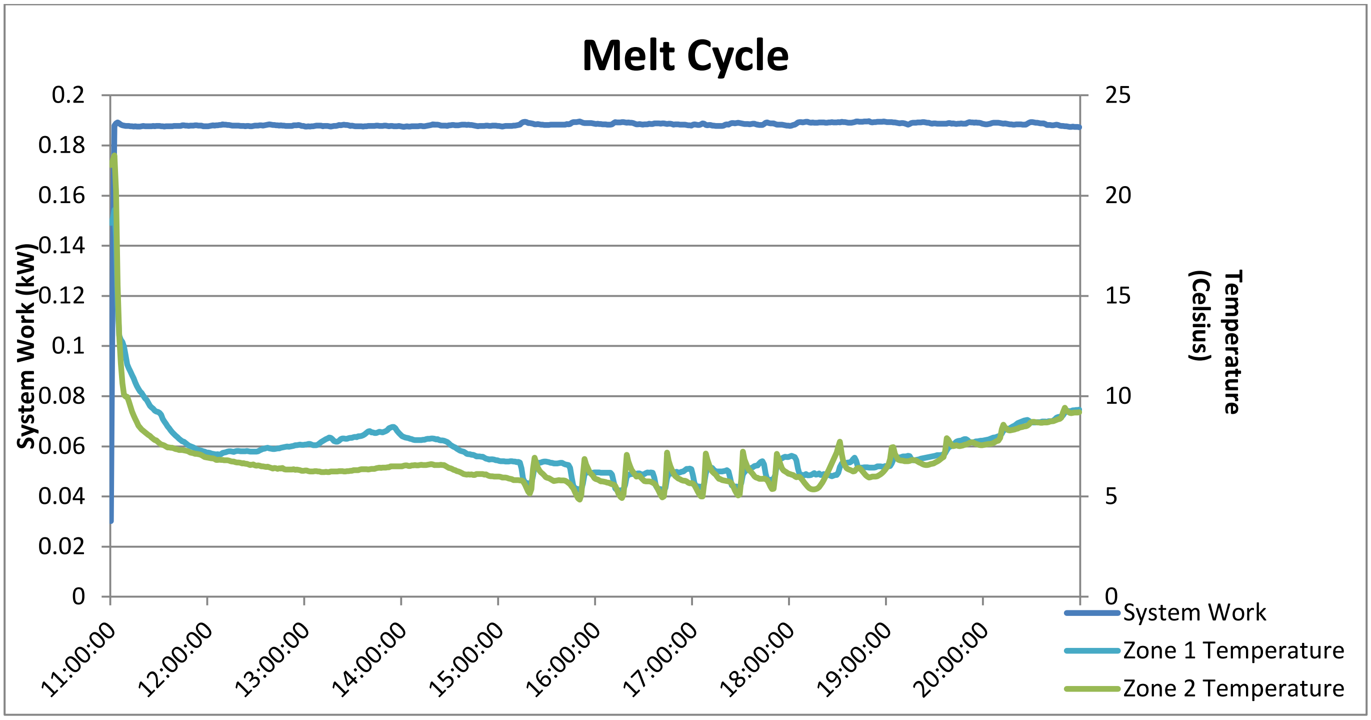


Figure 23 shows a successful melting cycle, over a 10 hour period. Zone 1 and Zone 2 refer to different rooms within the cooling area of the Ice Bear. The maximum ambient temperature was 22.3°C.

Figure 24: Customer A Make Cycle

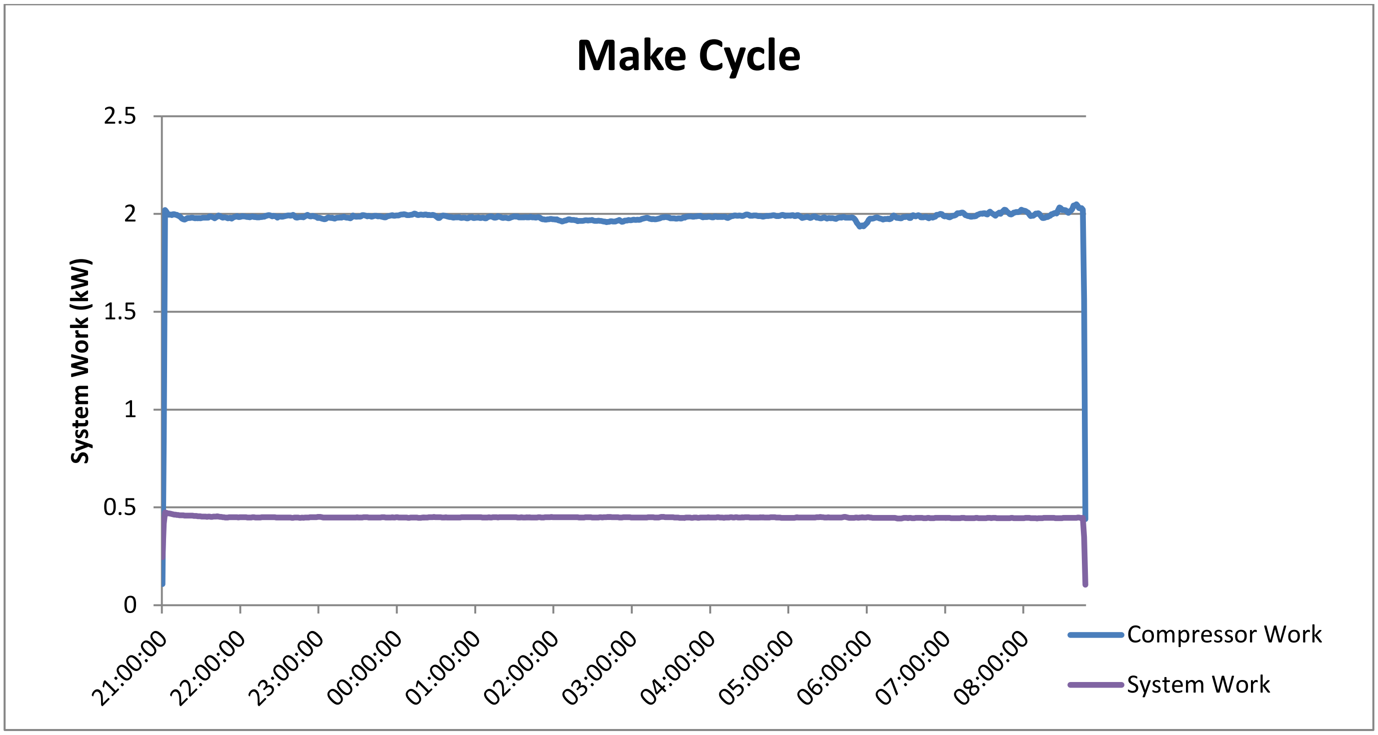


Figure 24 shows a successful make cycle for customer A.

Customer D

The room being cooled on Customer D is an IT and data room within an office building with peak energy consumption between 06:00 and 17:30. Similarly to customer A, there has been use of the pre-existing thermostat. This has resulted in air conditioning circulating air during parts of the day that should not be circulating air. Discussion has been arranged between Ice Energy and the customer to resolve this problem.

From 27/07/2015 to 31/08/2015, the Ice Bear unit has been cooling for 120 hour periods. Given the assumptions made previously this would translate to a maximum curtailment of 712.55kWh. Weather has been erratic over this trial period, so it is difficult to state what an average day's curtailment should be for this customer at this early stage.

The Ice Bear unit has been cooling at a power rating of 30 – 300 watts during the 'melt' cycle. Comparing this to the original air conditioning unit, which uses 6kW, the theoretical curtailment may be between 5.7 – 5.97kW during the Ice Bears cooling.

Across days where the Ice Bear has been cooling as expected, it has been doing so for around 8 - 10 hours. If this were to be generalised as a standard weekdays use, then the Ice Bear would be curtailing between 45.6 - 60kWh each day. As with customer A, this is above the 35kWh curtailment noted by Ice Energy. This shows current limitations in the theoretical models, in essence that the Ice Bear is not providing cooling in parallel to the 6kW capacity of the previous units within the customer premises.

Figure 25: customer D Melt Cycle

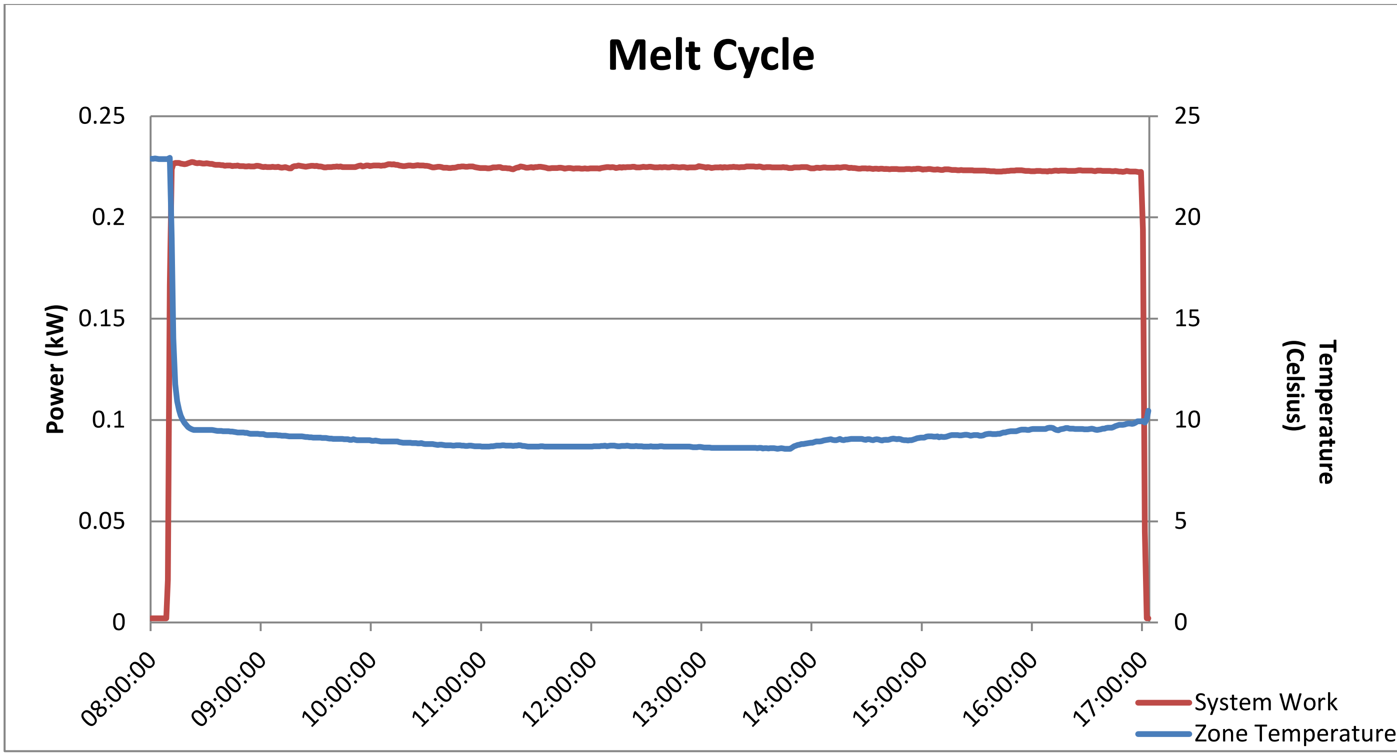


Figure 25 shows a successful melting cycle, over a 10 hour period. The maximum ambient temperature was 27.4°C.

Figure 26: customer D Make Cycle

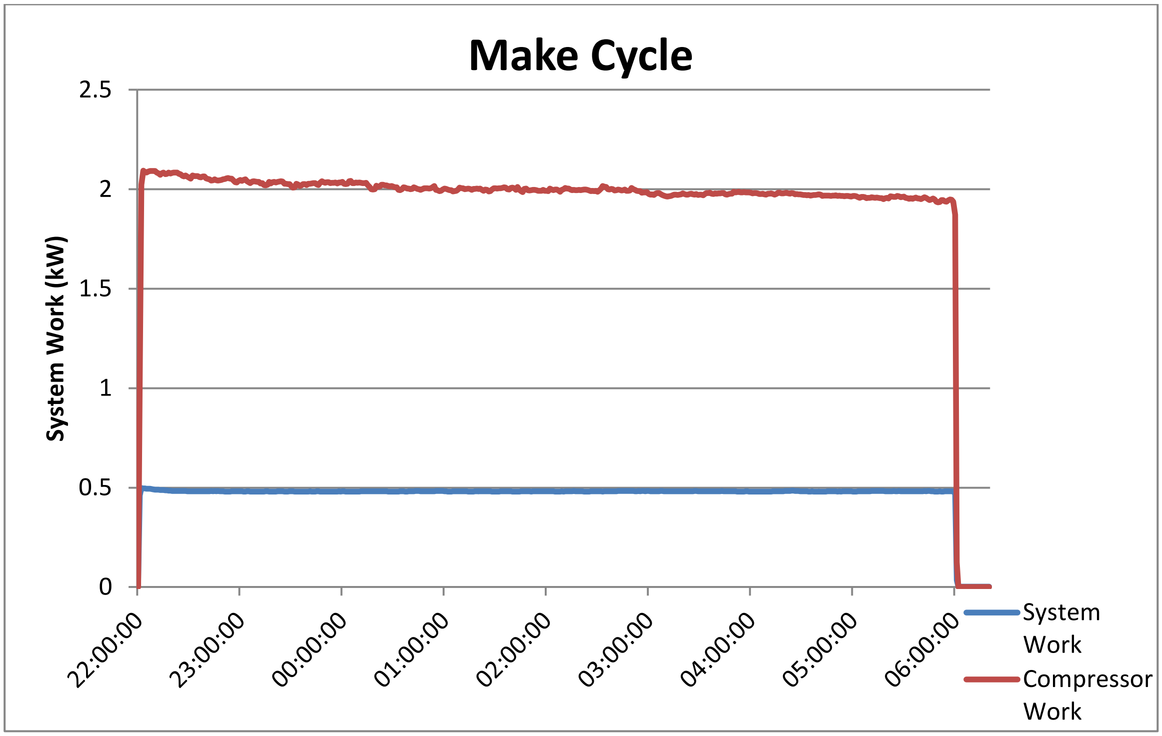


Figure 26 shows a successful make cycle for customer D.

Customer G

Customer G is a school IT suite with its primary energy usage between the times of 07:00 – 16:00. For the trial period, the building had less occupation, due to it being the summer holidays. This has enabled a better view of how the Ice Bear unit was operating, as there is less involvement and interruption of other energy using devices, such as computers and lighting.

For a comparative view, the assumption was made that if customer G were to have an air conditioning unit installed, other than the Ice Bear Unit, that it would be similar in specification to the existing air conditioning unit at customer A, and be running at full power for the duration of the ‘melt’ cycle to enable direct comparison. As a result output levels are higher than expected. Once more data is available, these calculations will be amended to show true curtailment, rather than theoretical.

From 27/07/2015 to 31/08/2015, the Ice Bear unit has been cooling for 107 hour periods, and curtailed a total of 503kWh. Due to the trial period currently being within the school holidays, we cannot say for certain whether this will be the normal consumption of the Ice Bear unit during term time. The room may get warmer with more computers switched on, or more people within the rooms, and as a result the Ice Bear may melt quicker. The Ice Bear will continue to be trialled until the end of summer 2016, so further learning points are still to be discovered.

The Ice Bear unit has been cooling at a power rating of 30 – 300 watts during the 'melt' cycle. If we compare that to the original air conditioning unit, which uses 4.8kW, we are theoretically seeing curtailment of 4.5 – 4.77kW during the Ice Bears cooling.

On days where the Ice Bear has been cooling as expected, it has been doing so for between 3 – 10 hours. If these were to be generalised as a standard weekdays use, regardless of term times, then the Ice Bear would be curtailing between 13.5 – 47.7kWh each day. Again these figures will be revisited.

Figure 27: customer G Melt Cycle

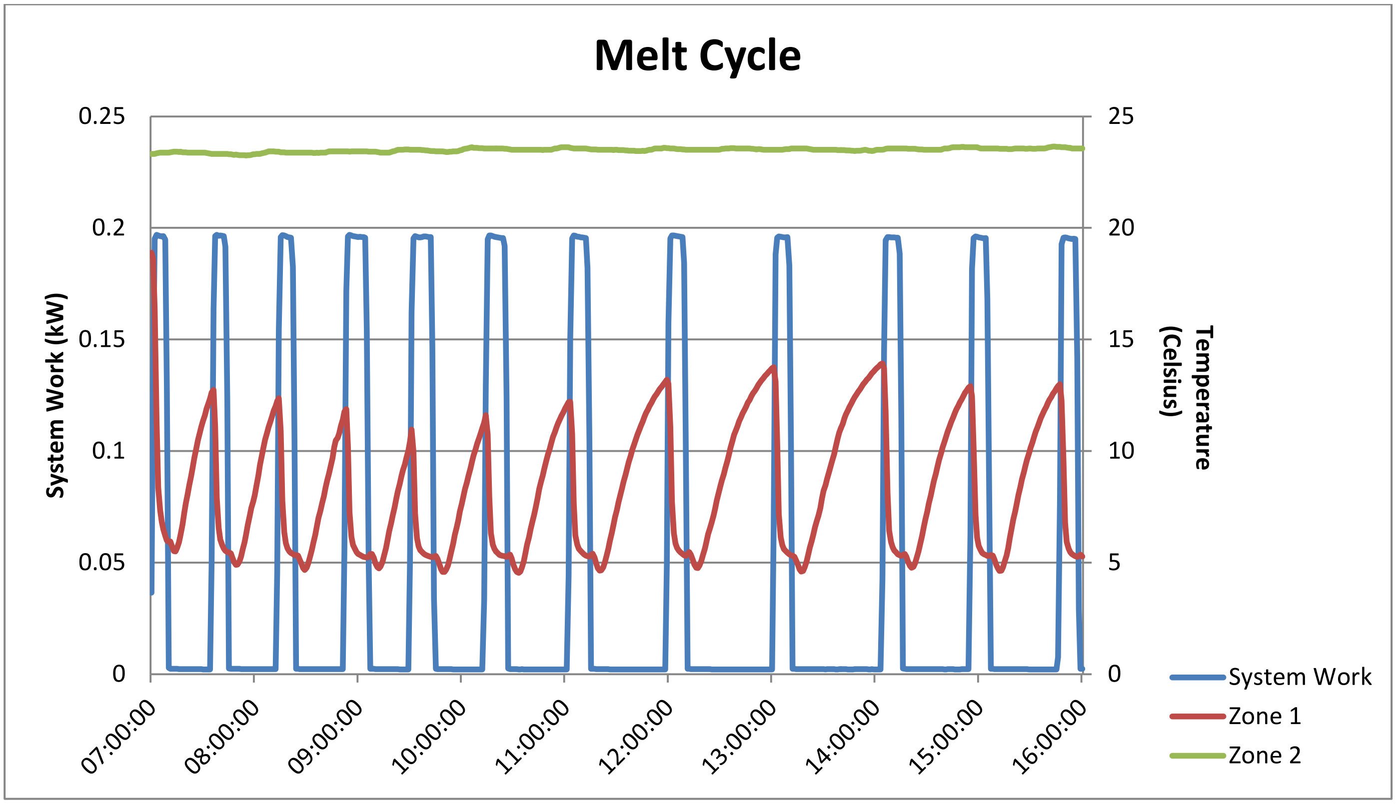
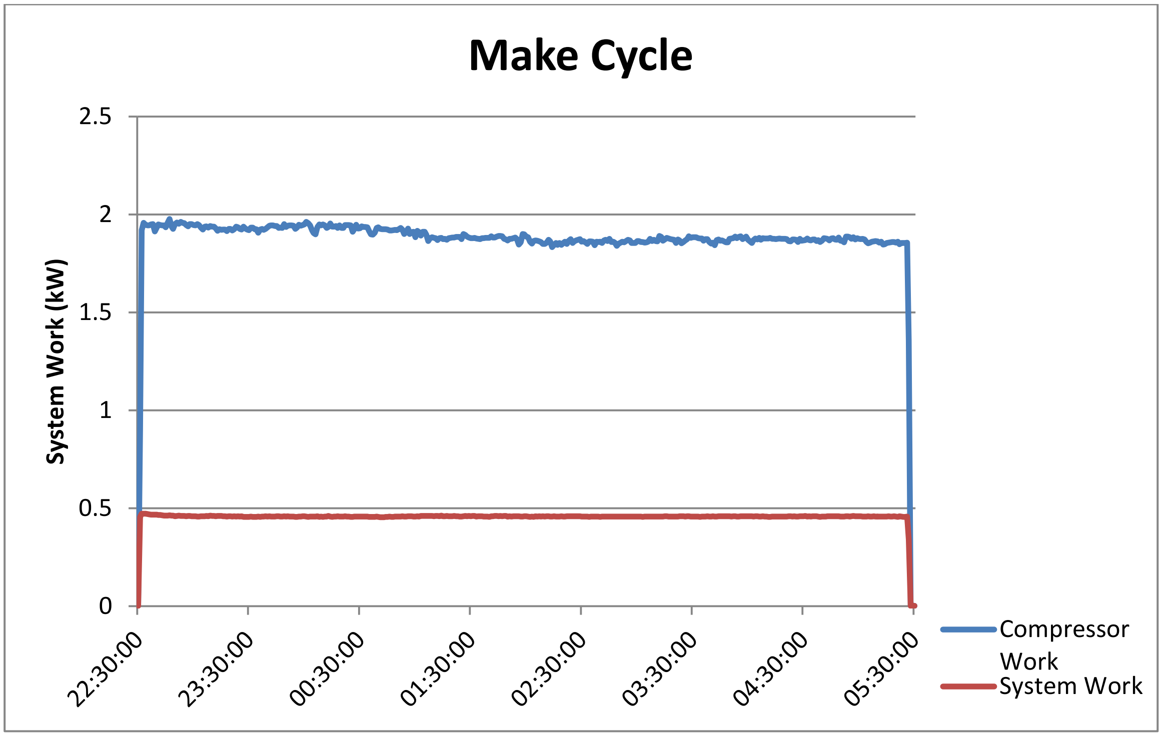


Figure 27 is showing a typical melt cycle for customer G. Zone 1 and Zone 2 refer to different rooms within the Ice Bears cooling area. The Ice Bear is being used ‘off and on’, which is in contrast to the other two sites. However this days usage clearly depicts the Ice Bears cooling power given demand on Zone 1 (it would appear zone 2 was unoccupied this day). The maximum ambient temperature for this day was 22.2°C.

Figure 28: Customer G Make Cycle



4.4.1. Summary

Weather has been an important factor in these trials, and unfortunately August has not provided the continued heat that would stipulate a high air-conditioning demand. Therefore the Ice Bears have struggled to output all of their cooling potential every day. As a result of this, theoretical models have been developed above as an insight into the Ice Bears potential demand shifting capabilities. However at this stage it has not been possible to accurately generalise what an Ice Bear unit could save a customer over a year, and what demand it could possibly curtail against the network.

Nonetheless it is apparent that the Ice Bear is operating at below expected consumption levels during both Ice Cool (expected consumption 300W) and Ice Charge (expected consumption 3kW).

This has been reviewed with Ice Energy and is expected to be as a result of ambient conditions, the Ice Bear doesn’t have to work as hard to reject heat to cooler air; and the lower frequency of the network being operated on (50Hz rather than 60Hz).

A further insight that can be drawn from the above is that when multiplying the potential demand shifting of an Ice Bear by their period of operation to see the total kWh shifted, it seems likely (given by the high kWh value seen in case studies above) that the Ice Bear is not required to operate at maximum capacity to cool the buildings trialled. It is therefore an important point that in future UK applications there may be value found in applying Ice Bears to buildings with either a constant high level of air-conditioning consumption (i.e. a data centre) or may be best applied to larger air-conditioning units allowing for better utilisation of the full ‘Ice Charge’ within an Ice Bear and allowing for existing AC units to deliver any excess cooling demand when necessary.

5. Stakeholder Engagement

Following the original customer engagement taken by SSEPD that superseded the change request, and the feedback following the site surveys performed throughout the customer recruitment phase of the project, it was determined that a more detailed customer engagement approach would be of value in addressing potential barriers to the uptake of Cold Thermal Storage.

This actioned engagement with UK HVAC specialists and facilities / energy managers across the Thames Valley area, with the guidance and assistance of project partners DNV GL consisted of six semi-structured interviews during the two weeks whilst Ice Energy were in the UK commissioning the Ice Bears. Four of these were with company representatives who had a broad knowledge of different buildings and facilities across their site / organisation. The other two were held with industry experts in order to understand the wider UK HVAC market. Section 5.1 details the learning from this engagement.

5.1. Workshop results

Information below documents the proceedings of a workshop held following the six semi-structured interviews held by SSEPD and Ice Energy. The workshop was designed to capture and discuss the results of the semi-structured interviews conducted as the first stage of an appraisal of the UK commercial potential for ICE energy's cold thermal distributed energy storage technology. Present at the meeting were:

- Senior Consultant, DNV GL – Energy
- Customer Project Manager, SSEPD
- Regional Operations Manager, ICE Energy

5.1.1. Interview questions and respondents

Suitable representatives of organisations in the Thames Valley area which own or operate buildings with significant assumed cooling load were the primary interview targets.

These included an HVAC contractor and an Original Equipment Manufacturer (OEM) (Mitsubishi) for a general discussion on the technology and its applications. As well as potential Ice Bear customers, detailed in Table 5.

Table 5: Interviewee Demographics

Energy and Carbon Manager-University Facilities/location: *Offices, Lecture Theatres, Sports Facilities, Data Centres* Building Occupancy: *3,000* Usage Profile: *Daytime*	**Park services manager, Science Park** Facilities/locations: *Offices managed and let* Building occupancy: *2,500 across 60 units* Usage profile: *Daytime*
Engineering Services Managers, multinational information and communication technology (ICT) company Facilities/locations: *Offices and data centres* Building occupancy: U*nknown* Usage profile: *Daytime*	**Representative, multinational technology company** Facilities/locations: *Offices and manufacturing* Building occupancy: U*nknown* Usage profile: *Daytime*

The interviews were carried out by ICE energy and SSEPD. The interviews centred on seven questions; drafted ahead of the interviews and designed with the objectives of the study in mind. They were used to guide the interviews but scope was given for the interviews to cover topics outside the list of questions:

- What kind of smart technology or low carbon technology have you installed or considered installing?
- How familiar are you with cold thermal technology?
- Are there any potential barriers for the adoption of cold thermal units?
- What are the potential benefits you foresee?
- What are your organisations policy regarding investment and payback periods?

- What's the process you normally use when conducting refurbishment works to your housing stock? What are the key principal costs in this process?
- Time permitting: tour of facilities to identify potential of cold thermal and of unit locations

5.1.2. Responses

The following sections provide a summary of the responses given to the questions shown above.

5.1.2.1. Smart or low carbon technology installation

All respondents had implemented some form of low-carbon technology on the buildings that they owned or managed, albeit generally at a low level. One customer cited the only reason they had made such investments was because they were obliged to under policy. Most common was the relatively low-cost option of LED lighting and solar PV generation technology. The University has the most diverse portfolio of technologies with solar PV, solar thermal, LED lighting, Combined Cooling, Heating and Power CCHP and some demand management technologies installed.

5.1.2.2. Familiarity with cold thermal technology

All of the respondents were aware of the technology at a shallow, conceptual level but only one had a meaningful technical understanding of the technology. They had a good experience on a defunct building with a 50kW (14 ton) auxiliary cold storage unit supplied by an OEM called Baltimore Air Coil. It was rarely used as the system was a back-up for power failures, however was noted to have worked well when it was used.

5.1.2.3. Barriers to the adoption of cold thermal units

Several different types of barrier were discussed which can be divided into six themes:

<u>Economic barriers</u>

Cost effectiveness – all interviewees were keen to understand the business case and some were sceptical that it would "add up".

Lack of carbon credit – the technology's focus on load shifting, rather than energy saving, means that it may not be supported by policy such as carbon credits.

Contractual barriers

DNO/end user problem – interviewees were concerned that the benefit of the technology is seen by the DNO rather than the consumer who may bear some of the risk or cost.

Landlord/tenant problem – interviewees pointed out that, as with other energy efficient technology, a landlord has little if any incentive to adopt.

Availability of after-sales support – some interviewees were concerned about the maintenance of a new technology from a foreign supplier.

Technical barriers (installation)

Weight of the unit when roof mounted – the Ice Bear, in operation, weighs more than 2,000kg. There was concern that this may present problems with older or specialist buildings.

Size of the unit when ground mounted – the size of the unit could present a challenge, especially in the lettings sector where real-estate area is the main driver of revenue.

Retro-fit issues – the complexity and extent of the structural, mechanical and electrical works needed to install the units was a concern.

Technical barriers (operation)

Noise during off-peak periods – the fact that the main chilling activity is overnight could cause noise pollution if installed in close proximity to residences.

Flexibility to meet needs (unit control etc.) – the controllability of the unit to ensure adequate cooling through the day was a concern to some.

Uncertainty around unfamiliar technology – some interviewees felt uncomfortable about the reliability of an unknown product.

Product specification

UK market dominated by "ductless" technology – the UK’s dominant approach to space conditioning is different from that widely used in the US. As noted earlier, already more efficient, ductless units reduce the potential peak-shifting that an Ice Bear may deliver.

No process cooling option at present – the focus on environmental cooling at the expense of industrial process cooling may limit applications.

External/policy barriers

Trust in innovative environmental technology damaged by unstable government policy - some interviewees were nervous about new technology and the government "pulling the rug out” at a later date.

Speed of obsolescence in 'smart' technologies - some interviewees felt that the pace of change in the smart energy space could mean that a technology is superseded before the end of payback period.

5.1.2.4. Potential benefits of cold thermal storage

Cost savings were generally seen by respondents as the most visible benefit of the technology. One company stressed the value of Corporate Social Responsibility (CSR) within their organisation as the main selling point; however this did not translate across other interviews. Carbon abatement benefits were not considered relevant and neither was the reduction of the likelihood of future network upgrades. A general interest in innovative technology was cited as a possible reason for pursuing cold thermal energy storage and the performance/cost implications for data centre applications were of interest to interviewees with that kind of facility.

5.1.2.5. Investment and payback periods

University: Generally less than 5 years but possibly longer if access to longer term finance is available through an energy performance contract.

Science Park: Depends on the tenant: 2-3 years typical for larger businesses and up to 10 years for smaller firms. But smaller ones are less likely to be able to take on technology risk.

ICT Company: approximately 5 years depending on the lease on the building.

Technology Company: 2 years maximum.

5.1.2.6. Typical refurbishment process

University: Would have to prove technology before wide roll-out.

Science Park: Do not undertake refurbishment works while building is tenanted. All improvements should last at least one tenancy (typically 10 years).

ICT Company: Must prove the tech on one building for up to 5 years before rolling out to others. Decisions are generally ad-hoc with few portfolio wide practices.

Technology Company: N/A

5.1.2.7. Site visits

Of four locations visited only one was surveyed- the university campus. Here only one site, a computer room at the university, was deemed a potential application for the technology. The main limitation was the size of the unit when ground-mounted.

5.2. The model user

There are several user characteristics which appear to influence the applicability of the technology.

Tenure: As discussed in Section **Error! Reference source not found.**, the economic case for a user to adopt the technology is substantially reduced in situations where buildings are tenanted, leading to concerns about the ability to design a suitable contracting arrangement that rewards the investing party.

Air-conditioning system type: The interviews raised some questions about the applicability of the technology to the UK context. In particular the fact that the Ice-Bear product has been optimised for ‘packaged’ rather than the more prevalent ‘ductless’ air conditioning could severely limit the scale of any future roll-out.

Non-financial value of the technology: The lack of interest in innovative or environmental technology by some interviewees may increase the relative investment hurdle for certain customers while for others the ability to been seen to lead may have real value.

5.3. Summary

It is clear from the interviews and accompanying analysis that the primary benefits of installing the technology are systemic and tend to accrue to the network owner/operator rather than to the energy consumer. Nevertheless there are two types of benefit that the customer could gain from an installation. Firstly there are economic benefits such as reduced energy expenditure as a result of reduced peak-time consumption and in some cases the ability to defer or avoid grid connection upgrade charges that may result from increasing peak demand. Secondly there are reputational and CSR benefits that accrue from an organisation’s visible commitment to the improving the environmental and operational performance of the electricity system. At this stage it appears unlikely that any of the customer groups interviewed could assemble a business case to invest in an Ice-Bear unit without some form of additional financial or other benefit or subsidy from the DNO[1] or other party.

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[1] Although more detailed analysis may show otherwise

The two key messages to take away from the interview process are as follows:

- The allocation of cost, risk and benefit between tenant, landlord and network owner are unclear which makes appraisal of the commercial viability challenging. A straw-man business model could be a good way to start the conversation about the best approach although the long-term regulatory implications are yet to be understood; and
- More experience with the technology in the UK context is needed to build up case-studies to demonstrate the technology’s applicability. The current demonstration sites are an important step in this process.

6. Commercial Arrangements

6.1. Trials

In procuring an agreement between SSEPD (Company) and Ice Energy (Supplier) it was outlined that the supplier would supply 3 Ice Bears on a turnkey basis. This includes peak demand reduction by Thermal Energy Storage, demand response as applicable, warranty, remote control and monitoring and maintenance until September 1st, 2016. It is noted that the payment from the Company to the Supplier covers the price of the Ice Bear units, shipment costs and costs of a Delivery at Place (DAP) HVAC contractor and/or installation site. Within this agreement also outlined is rigour in data protection and Safety, Health and Environment (SHE) requirements.

Within the context of the NTVV project, a three way license agreement was reached between the supplier (SSEPD), manufacturer (Ice Energy) and the customer (Licensor). The basis for this agreement outlined the premise of the project and legal jurisdictions around the trial. Whilst independences were mutually agreed across customers the construction of the agreements were built upon a mutual framework. A skeleton template is provided in Appendix 6.

The agreements key aspects outlined that the Ice Bear was made available at no-cost to the customer; as a result the Ice Bear is a SSEPD owned asset and will be maintained by Ice Energy until September 1st 2016. Any request to inspect/repair the unit will be at no cost to the customer, assuming it is within the scope of the Ice Bear project. SSEPD and Ice Energy do not warrant the Ice Bear or its performance in any way.

Obligations on the customer under the contract detail the requirement to grant access with regards to construction, installation, operating maintenance, replacing, upgrading and/or removing the Ice Bear. Once commissioned the customer is given the right of utilisation of the equipment during the term of the license to shift electrical demand and reduce electrical bills.

7. Benchmarking

This section will benchmark cold thermal storage against traditional forms of reinforcement on the distribution network. This will detail the cost of releasing capacity on a system in terms of £/kW. It is proposed that the marginal cost of cold thermal storage (given a theoretical kW reduction) is slightly higher but of the same order of magnitude as traditional reinforcement. “This comparison is expected to become more favourable with a) the benefit of economies of scale and b) recognition of additional capacity released at higher voltages. Typically, the increased capacity from installing a new asset can only be realised at the voltage level it is associated with; whereas peak demand reduction measures benefit all voltage levels at the point of connection and above.” [Ref 02]

7.1. Scalability of Cold Thermal Storage

Before assessing the value of Ice Bears in avoiding traditional reinforcement within the UK, it is first appropriate to determine that there is significant enough market to accommodate such units. Using Elexon profile classes (classes 4-8) to identify potentially applicable commercial customers across Bracknell; 168 matches were noted. It is common in the US that a site may have multiple Ice Bear applications across it; this should be noted when scaling Cold Thermal Storage deployment.

7.2. Network reinforcement costs

In order to address the value of an Ice Bear in avoiding/deferring conventional network reinforcement, case studies were analysed and modelled in Table 6 below. These figures are calculated based on reinforcement costs from SSEPD’s statement of methodology and charges for connection as well as case-studies of reinforcements within the Thames Valley area (detailed in Appendix 7).

Table 6: Network Costs

	min £/kW	max £/kW	Demand Reduction Adjusted for Diversity[2] and Losses
LV Network	168.2	348.8	1
33 kV Network	44.7	95.2	0.6
132 kV Network	17.5	263.2	0.57

The costs above show the marginal cost of reinforcement as can be presumed typical within the Thames Valley. It can be seen from the above that network reinforcement costs can vary enormously. Taking the figures shown above as typical local max and min reinforcement costs it becomes applicable to benchmark the cost of an Ice Bear in terms of £/kW against traditional reinforcement mechanisms.

As mentioned previously, in the US, when bought at scale Ice Bears are available at between £960-£1600 per kW (depending upon the application and the level of demand response). Given the assumed costs of reinforcement in Table 6, an Ice Bear as an interdependent system would not be cost-effective to a DNO at 132kV, 33kV or 11kV level.

Nonetheless, the figures above taken alone do not build a picture of an interconnected network; rather they assume that demand reductions at the customer level are targeted and accrued at just one part of the network. This is not representative of an electricity distribution network whereby a demand reduction at the bottom may have benefits at each level of the network from LV up to EHV. In addition, we have presumed that there is no diversity and losses at the LV level, however as we move up the network diversity and losses mitigate the impact of demand reduction at customer level. As such to achieve 1kW of demand reduction at 33kV level we actually need to achieve (1kW/0.6 =)

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[2] Assumes unitary power factor so kva=kW.

Estimated LV network costs: [Ref 12]

1.66kW demand reduction at the customer level. Equally to achieve 1kW reduction at 132kV level we need to reduce demand by (1kW/0.57) = 1.75kW.

In an ideal scenario, Ice Bears may be deployed on an area of the network with constraints throughout each level of the network. Deploying Ice Bears within this scenario would therefore avoid marginal costs across each level and can be benchmarked as the aggregated avoided costs (per kW in this scenario) of reinforcement at each level of the network.

A case study based on the above assumption has been devised below based on 1MW of demand reduction through cold thermal units being deployed. The figures for LV network reinforcement have been adjusted to account for the demand reduction adjusted for diversity and losses.

Table 7: Ice Bear against Traditional Reinforcement

	Min £/MW	Max £/MW
LV Network	£168,200	£348,800
33 kV Network	£26,820	£57,120
132 kV Network	£9,975	£150,024
Sum of Deferred reinforcement	**£204,995**	**£555,944**
Ice Bear Demand Reduction[3]	**£960,000**	**£1,600,000**

Table 7 above shows that even given the higher boundary of reinforcement costs seen/predicted within Bracknell and assuming that the cost of Ice Bears are towards the lower boundary of that commonly found in the US, the Ice Bears are less cost-effective when compared to traditional reinforcement techniques.

The limitations to such a simplified model should not be overlooked. Primarily these calculations are based on a ‘perfect world’ scenario whereby we assume there will be applications for Ice Bear deployment for a DNO at areas of constrained network.

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[3] Shipping costs not accounted for in this calculation

Taking this assumption away, for a DNO to alleviate 1MW on a 33kV Primary Substation (assuming diversity 0.6, therefore 1.66MW needed at customer level) from Cold Thermal Storage, could need between 140 and 280 Ice Bears (depending on level of reduction and demand response capabilities). Such scale may be more viable within Urban areas with higher densities of commercial buildings, however £/sq.m would likely be of more value in such environments, hence finding potential participants for Cold Thermal Storage may more difficult.

Additionally calculations within the model above are based on average costs from a limited number of case studies within Bracknell. Moreover there are of course other externalities, both positive and negative that can accrue to traditional reinforcement or using Ice Bears across the network. For example as well as contributing to KVA capacity, network reinforcements can also be of value to voltage control, fault level and security enhancement. On the flip-side however, there are also heavy social costs associated with reinforcement (disruption) and benefits that could be accrued from Cold Thermal Storage at policy, generation, transmission and customer levels that could add weight to cases for Ice Bear deployment.

7.3. Transfer to Business as Usual

7.3.1. Key Considerations

This section looks to outline the potential cost of an Ice Bear, monetary savings to the customer and the appetite for Ice Bears within the UK market.

Cost

As noted by Ice Energy, the costing of Ice Bears in a BaU scenario would likely be in the region of £960-£1600 per kW. These costs have the potential to reduce further with economies of scale, as familiarity of the technology brings required man hours down and mitigates against potential risk; as well as technological improvements that may accrue.

Customer Value

The value to a customer should be assessed on a site-by-site basis. Nonetheless a theoretical model is devised below, assuming the Ice Bear shifts 35kWh [Ref 06].

We assume a typical commercial tariff might be: 8.4p/kWh during off peak and 15.7p/kWh during the peak [Ref 10]. Potential savings could therefore be in the region of (15.7-8.4)*(35)=£2.56 per day. This can be translated to a saving of £2.56 *80 working days (16 weeks * 5 days a week) = £204.40 per customer, per annum.

However the savings that we have seen through our analysis in section 4 is not a consistent enough reduction to warrant this level of value of reduction to the customer.

This may be partly due to already more efficient ductless air-con systems in the UK, temperature differences and the applications tested through the NTVV project. Given a more consistent warm climate than that seen over the trial period or an application with a consistent demand for cooling (i.e. data centre) values are more likely to be similar to those seen in the theoretical model described above.

Stakeholder Feedback

From section 5 it is apparent that in the vast majority of cases the installation of an Ice Bear hinges on the financial viability of the product, namely its payback period. There are a few cases whereby CSR or university learning may favour the product, however these would again likely only be in individual trial cases or within a particular sub-category of customers.

It therefore seems appropriate to assume that if the only motivation for a company is monetary, the typical pay-back period a business would accept as ascertained in section 5.1.2.5 may be between 3 and 5 years.

This does not translate through in monetary value to customers calculated above and supports the approach of a DNO supported/funded deployment of Cold Thermal Storage.

7.3.2. A DNO led model

Guidelines for a alternative approach to the fully DNO funded approach trialled under NTVV may look to consider several other factors. Firstly the required level of the subsidy should be estimated to reflect the appropriate allocation of the cost between the DNO and the user. This exercise could be based on a cash-flow model capable of calculating the Present Value (PV) of an installation’s cash-flow based on:

- Upfront cost;
- Payback period;
- An estimate of Weighted Average Cost of Capital (WACC) and,
- Economic benefits (savings due to time-of-day pricing, possible connection cost savings).

The model could be used in the first instance to indicate the scale of the subsidy required which could possibly be compared to the expected savings by the DNO during the investment period to ensure that there is an economic case even with subsidy. Secondly the basis of the potential arrangement needs to be considered. The main options are: i.) a co-investment (or capital grant) in which the up-front cost seen by the user is reduced and ii.) a model which sees some of the DNO operational savings passed on to the user on a monthly or annual basis. The decision of which one to opt for is a function of the commercial preferences of both parties. The concerns about the ‘newness’ of the technology reported during the interviews probably indicates that a co-investment approach would likely be the most productive overall.

8. Future Applications

8.1. UK Applications

Given the learning reported in sections 2.6 and 4 within this report, several other outcomes should be considered when looking to benchmark Ice Bears. Firstly the seasonality of the demand reduction when targeting air-conditioning load needs to be considered. Given the UK climate, the vast majority of Ice Bear applications would be a valuable tool in mitigating against summer peak loading when cable ratings are at their lowest due to the heat. However in most applications the Ice Bear would be of no/little value during winter peaks in consumption. Given the unpredictability of the UK weather, the curtailment power of an Ice Bear unit cannot be relied on in the same way it could be in the US (California). There are of course applications, such as a data centre, whereby Cold Thermal Storage could provide year round cooling. It is forecasted that given the technology intensive architecture of all 3 rooms being trialled through NTVV that the Ice Bears may provide some winter load-shedding.

The analysis in sections 4 is based on a month long trial period whilst average maximum ambient temperature in Bracknell was 21^{o}C; it gives evidence that on days of cooling demand the Ice Bear may alleviate close to the theoretical values (existing air-con units minus 300W). These days are likely to be the warmest days of the year whereby constraints on the network are mostly likely to materialise. Given the best theoretical application on customer D, presumed as the most likely business as usual (BaU) application, it is reasonable to assume a 5.7kW reduction at peak times. With demand response capabilities effectively doubling the peak demand reduction of the Ice Bear [Ref 08]. If it were possible to solely target these applications, it is likely costs of an Ice Bear would be towards the lower end of the £/kW cost detailed in this report.

8.2. An alternate application

None of the Ice Bears trialled under NTVV were implemented with demand response due to the buildings already having these capabilities as another element of the NTVV trial.

In the US Ice Energy claim that around 25% of their applications have demand response capabilities on them that can double or even triple peak demand reduction capacity of the Ice Bear [Ref 08].

In turn, discussion with Ice Energy brought to the fore a model they have adopted with some customers in the US whereby instead of providing cooling over 6 hours they can effectively cool a larger load over a shorter amount of time. Whilst the Ice Bear does not run as efficiently as it does at the optimum level of 6 hours of cooling, it has been found to maintain reasonable efficiency by providing 12kW of cooling over 3 hours. This would require the Ice Bear to be attached to two approximately 6kW+ HVAC compressors, rather than two 3kW as is typical in the installation completed in this trial.

Given these alternate/additional applications the feasibility case for Ice Bears may be amplified depending on the nature of the loading on a given substation. Both demand response capabilities and the shorter cooling model obviously better suit a network characterised by large short-term peaks. For instance taking our case study earlier and applying the assumption that three hours cooling would cover constraint issues at all levels of the network, it is reasonable to half the costs of the Ice Bear (twice as much cooling= half as many Ice Bears required) to a minimum of £480,000 and a maximum of £800,000 per MW. Given the more expensive network reinforcement costs stated in this report and on a given application how many levels of the network the Ice Bear may be able to accrue benefits to, there could in this scenario be a business case for cold thermal storage.

Finally, through discussion between Ice Energy and the OEM (detailed in section 5), a way of modifying a fan coil and incorporating another DX coil to serve the Ice Bear and integrating all the required controls at the same time materialised. This would mean that only one fan coil would need to be installed which could provide an improved application for the UK market. Nonetheless it would be necessary to do further market analysis to determine whether this was the best approach for Ice Energy to take within the UK.

9. Conclusions

This report has compiled one month's evidence to assess the applicability of installing cold thermal storage devices and suggests that, whilst currently the units may not be a cost-effective approach to managing the electricity network, they do provide a level of cooling as anticipated. Resultantly within particular case-studies or as unit costs come down, Cold Thermal Storage may develop to be a cost-effective solution.

As detailed earlier the technical integration of Ice Bears within the UK market can largely apply the approach that Ice Energy adopt in the US, given the 'off the shelf' nature of the product. For this reason, the time to install an Ice Bear is relatively minimal, it is customer engagement and determining a site that are likely to be the largest barriers to deployment.

Each of the 3 locations, for Ice Bears, trialled within this report show different applications, cooling a variety of spaces. It is apparent from the evidence in previous sections that given a constant, high demand for cooling, an Ice Bear can effectively shift 1-10kW to an off-peak time. The applications trialled in the UK rarely show this constant high demand for cooling and hence value is limited. Applications such as data centres may still have value due to their consistent high demand for cooling and as such an Ice Bear could provide reliable year round benefits.

As previously assessed, the market for Ice Bears given a customer led approach to deployment is almost non-existent, the benefits from the technology that accrue to the customer are largely regarded as <10%. Given a DNO led approach, there emerged a healthy appetite for Cold Thermal Storage, this assumed a model whereby the technology would be provided effectively free to the customer and was run and operated by the DNO. As such a three-way agreement between Ice Energy, the customer and the DNO, as determined within the report above, was an effective approach for managing the roll-out of Ice Bears to trial participants.

Through engaging customers, there also emerged mitigations in line with the space requirements for the Ice Bear, tenant/landlord complications and in proving the technology. As such the model user would have a large demand for air-conditioning, ideally year round such as a data centre, on owner occupied property with ample space for either ground or more likely roof mounted (given a secure structure) Ice Bear units. These factors are likely to limit the potential applications for Ice Bears identified in section 8.1 and as such reduce the scale at which Ice Bears could be deployed. Nonetheless as air-conditioning demand is likely to grow in the UK to around 40% of commercial floor space by 2020, up from 10% in 1994 [Ref 11] these limits on the number of potential applications are expected to reduce.

Whilst benchmarking of cold thermal storage does not, in the case studies above, provide clear cost savings at the time of writing within the UK; there may be situations where the technology does give a viable business case across the wider electricity market. This said further benefits from Ice Bears (largely external to the DNO) should be accounted for, namely the technologies value in supporting transition to a low-carbon economy. In addition to this there may be specific case-studies whereby Ice Bears do have a viable business model, for example an area of the network may be: particularly costly to reinforce, denoted by a high density of commercial customers and with a significant (preferably summer) peaking in demand of approximately 3 hours or less (it would then be possible for an Ice Bear to shift approximately double the kW value(s) stated throughout this report, over this shorter time period, still delivering a similar kWh reduction) giving a cost-effective, sustainable solution to traditional network reinforcement.

10 References

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11 Appendices

Appendix 1- Ice Bear Product Specifications (Ice Energy, 2013b)

Appendix 2- NTVV Customer Handout

Appendix 3- CE Marking and Dangerous Goods Notice

Appendix 4- Customer Surveys

Appendix 5- Customer Consumption Profiles

Appendix 6- End-user License

Appendix 7- Estimated Reinforcement Costs

Product Sheet

ICE ENERGY®
INTELLIGENT STORAGE AT WORK.™

IceBear®
ENERGY STORAGE

Product Specifications

Ice Energy's Ice Bear distributed energy storage system enables a powerful change in how – and, more importantly, when – energy is consumed for air conditioning, without sacrificing consumer comfort.

Using thermally efficient, off-peak power to produce and store energy for use by air conditioners the next day, the Ice Bear uses a fraction of the peak energy required by conventional systems. It requires no modification to existing ductwork or structure, and integrates seamlessly with standard rooftop and split-system air conditioners.

The Ice Bear unit creates and stores cooling energy at night by freezing water in an insulated storage tank. It cools during the day by circulating chilled refrigerant from that tank to the conventional air conditioning system, eliminating the need to run the energy-intensive compressor during peak daytime hours.

During off-peak hours, the conventional HVAC system operates as usual. Together, this unique hybrid system surpasses the overall efficiency and performance of conventional equipment alone.

Key Benefits

For Utilities

- Cost-effective Alternative to New Peaking Generation
- Permanently Shifts Peak Demand
- Uses Cleaner, More Efficient Off-Peak Power
- Improves System Efficiency & Grid Reliability
- Relieves Congestion on Peak
- Enables Reliable Integration of Renewables
- Reduces Greenhouse Gas Emissions
- Easy, Rapid Deployment at a Multi-Megawatt Scale

For Commercial Energy Consumers

- Reduces the Building's Carbon Footprint by 10% or More
- Reduces Building Energy Consumption on Peak
- Delivers Superior Cooling Comfort for Customers and Employees
- Improves Building Energy Performance
- No Cost Under Utility-Sponsored Programs
- Utility Pays for Equipment, Installation and Maintenance

Key Features

High Reliability

- 25-year design life
- Cooling mode uses two long-life pumps
- Extends compressor life by eliminating stop-start operation during hottest hours of the day

Widely Compatible

- For commercial rooftop and split systems from 4 to 20 Tons, and ductless units from 3 to 5 Tons
- Each Ice Bear unit can be applied to a 3-5 Ton system, or a single 5-ton stage of a 7.5-20-Ton system
- 30 Ton-hours of cooling at a load of up to 5 Tons
- Easy Installation
- Can be installed on the roof or ground by an Ice Energy certified local HVAC contractor
- CoolData® Controller programmed for utility savings
- Low Maintenance
- Simple 1 hour annual maintenance procedure

Technical Specifications

Cooling Capability

- Maximum Cooling Load .... 5 Tons
- Total Storage Module Capacity .... 30 Ton-hours

Daytime Peak Power Reduction

- On-Peak Demand Reduction .... Up to 7kW
- On-Peak Electric Demand .... 300 watts
- On-Peak Energy Efficiency .... ffi200 EER
- Energy Shifted to Off-Peak .... 35 kWh

Nightime Ice Make

- Copeland Scroll Compressor .... 4.3 Ton
- Ice Make Time (full make) @ 55° F .... 10 hours
- Ice Make Time (full make) @ 75° F .... 11.5 hours

Line Set Restrictions

- Length (Ice Bear to airside coil) .... 150 feet
- Height (Ice Bear to coil above/max) ...... 35 feet
- Height (Ice Bear to coil below/max) ...... 20 feet

Ice Storage Section

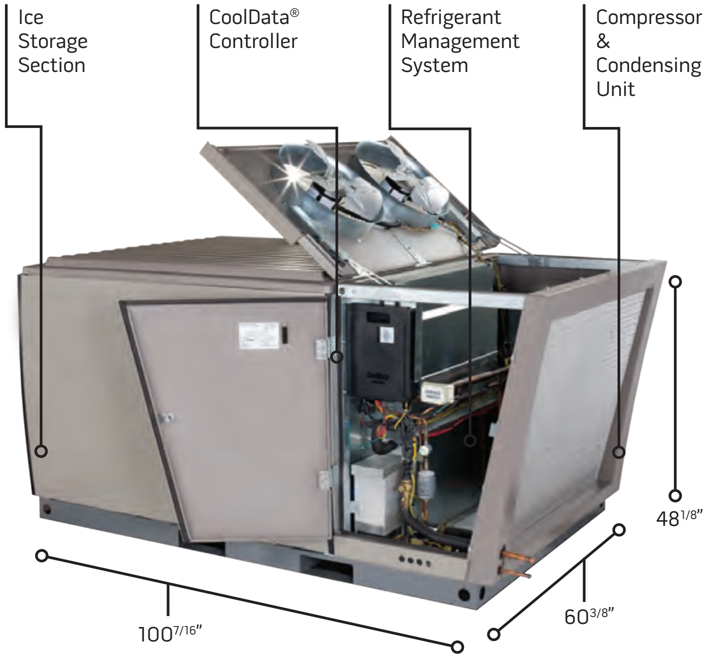
- Tank Capacity (tap water) .... 480 gallons
- Thermal Storage Capacity (latent) .... 360,000 BTU

Refrigerant Management System (RMS) & Compressor

- Refrigerant R-410A

CoolData® SmartGrid Controller

- Built-In Web Server & Data Logging
- NI LabVIEW On-Board Application Lay.. NATIONAL INSTRUMENTS
- Historian .... OSIsoft.
- 1-Wire Dallas Sensor Network .... MAXIM



Physical Properties

- Size ....100$^{7/16}$" W x 60$^{3/8}$"D x 48$^{1/8}$" H
- Weight (dry) ....1,400 lb. (approx.)
- Weight (filled) ....5,400 lb. (approx.)
- Load Distribution (filled) ....152 lbs. per sq.ft

Electrical Requirements (by model #)

- #IB30A-521: 208/230 VAC, 1 Φ, ...50A min. service
- #IB30A-523: 208/230 VAC, 3 Φ, ...30A min. service
- #IB30A-543: 460 VAC, 3 Φ, ...20A min. service

Warranty

Ice Energy products are warranted to be free from defects in workmanship and materials under normal use and service per the terms below. See full warranty for details.

- Tank & Ice Heat Exchanger......................5 years
- Compressor...5 years
- Condensing Unit Heat Exchanger ....5 years
- Other Components.....................................1 year

Support

For assistance with technical or sales support questions contact your Ice Energy representative, call us at 877-542-3232 or visit us online at www.ice-energy.com.

ICE ENERGY®

Manufactured under the following U.S. Patents: 5,647,225 - 7,124,594 - 7,162,878 - 5,255,526 -D501,490 - 7,363,772 - D540,452 - D538,412. Additional patents pending.

9351 Eastman Park Drive, Windsor CO 80550 970-545-3630 *ice-energy.com*

Thames Valley Vision

Cold thermal storage Trial
March 2015

A cool way to potentially reduce your electricity costs and protect the environment!

Ice Bear for your AC units!

3 Ice Bear units available!

FREE TRIAL!

Pay low night time rates for daytime air conditioning

Ice Bear for your AC units

The Ice Bear system is a distributed energy storage solution that works in conjunction with commercial direct expansion (DX) air conditioning systems, specifically refrigerant based systems that are common to most small to mid-sized commercial buildings.

The system stores energy at night, when electricity generation is cleaner, more efficient and less expensive, and delivers that energy during the peak of the day to provide cooling to the building.

How the Ice Bear works?

At its most basic, the Ice Bear consists of a large thermal storage tank that attaches directly to a building's existing roof top air-conditioning system.

The Ice Bear energy storage unit operates in two basic modes, ice charging to store cooling energy overnight, and ice cooling to deliver that energy the following day.

During Ice Charge mode, a self-contained charging system freezes water in the Ice Bear's insulated tank by pumping refrigerant through a configuration of copper coils within it. The condensing unit then turns off, storing energy until cooling is needed.

As daytime temperatures rise the Ice Bear unit replaces the energy intensive compressor of the building's air conditioning unit. The Ice Bear, fully charged from the night before, switches to Ice Cooling mode. The Ice Bear uses the ice, rather than the AC unit's compressor, to cool the hot refrigerant, slowing melting the ice as it travels through a series of copper coils.

Once the 6 hours of ice cooling is used, programmed to cover midday peak loads, the Ice Bear transfers the job of cooling back to the building's AC unit to provide cooling as needed. During the cool of the night, the Ice Charge mode is again activated and the entire cycle begins again.

Ice Bear for your AC units!

3 Ice Bear units to available!

How is it installed?

Ice bear unit is fitted either at the ground floor or the rooftop near your AC units by one of SSEPD's approved installers. Installation is relatively quick and SSEPD will make sure to minimise any disruption.

Does my organisation qualify for an Ice Bear unit?

Our initial assessment suggests that your facilities are likely to qualify for installation of Ice Bear units. However, a detailed on site survey will be needed to ensure compatibility.

How can my organisation get it?

If your facilities fulfill the technical requirements our team will process your request and will get back to you as soon as possible.

Will my organisation have to pay for the Ice Bear unit?

No! The Ice Bear unit for the TVV project would be totally free to you. We will procure, install and maintain for the life of the project.

How much will Ice Bear save my organisation?

Potential savings depend on the operating hours of your AC system and your electricity tariff. Savings result from paying lower night time rate to charge the Ice Bear unit, reducing cooling loads during the day.

What other benefits can Ice Bear provide?

Power generation is cleaner, more efficient process at periods of low demand and thus at night. Because the Ice Bear unit primarily consumes power at night rather than the day, it can result in significantly lower CO_2 emissions. This could also help with corporate social responsibility (CSR) targets.

The Ice Bear unit can also improve the performance and value of clean technologies such as solar PV and wind, improving their viability of renewable technologies.

How will my organisation contribute to the project?

Daytime energy demand from air conditioning can be reduced significantly through the implementation of an Ice bear unit. When aggregated and deployed at scale, we will shift the operation of commercial AC condensing units from on-peak periods to off-peak periods, reducing electric system demand, improving electric system load factor, reducing the amount of investments needed in the network, and improving overall electric system efficiency and power quality.

We would like you to come along with us on this journey to explore the potential benefits of the cold thermal storage both for your organisation and the network.

www.thamesvalleyvision.co.uk

Southern Electric Power
Distribution plc Registered in
England & Wales No.
04094290 having its
Registered Office at 55
Vastern Road Reading
Berkshire RG1 8BU which
are members of the SSE
Group

www.ssepd.co.uk

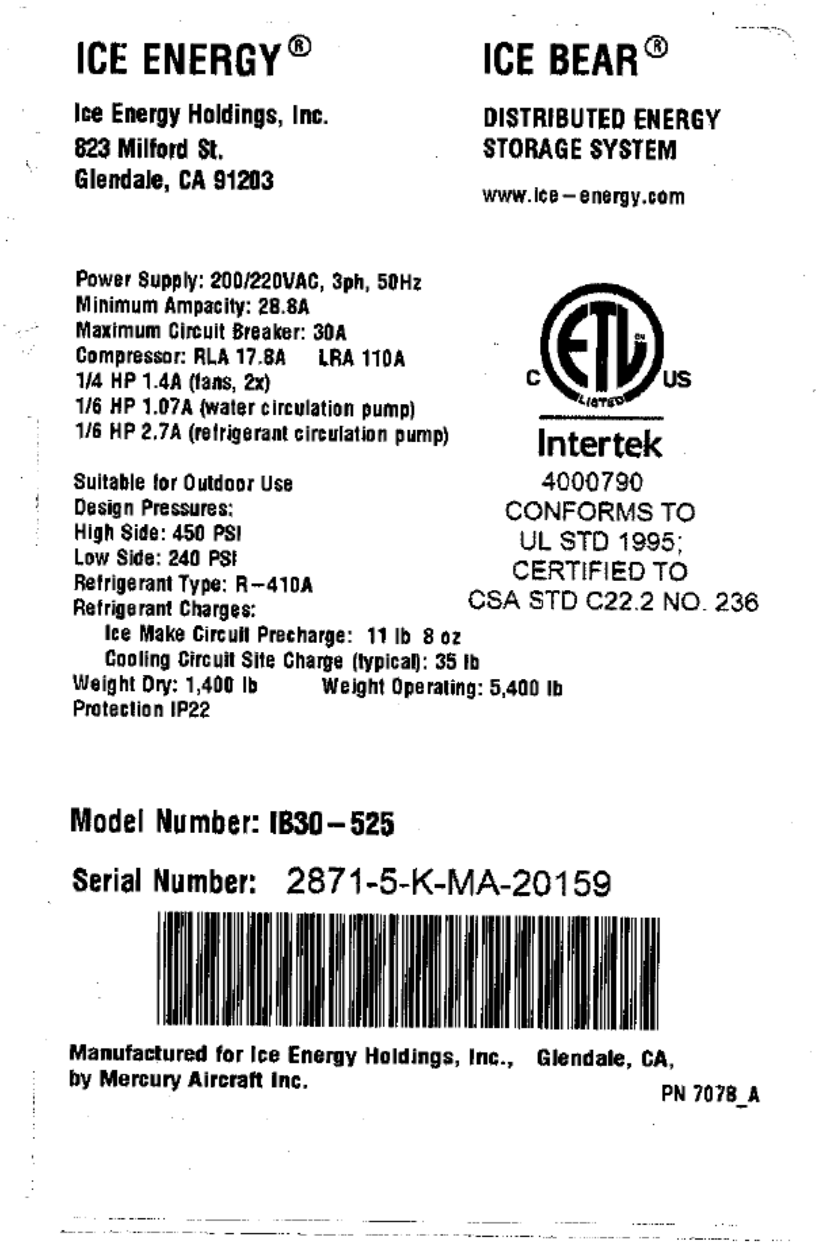
Test Report issued under the responsibility of:
Intertek Testing Services
3933 US Route 11
Cortland, NY 13045

TEST REPORT
IEC/EN 60335-1 & IEC/EN 60335-2-40
Safety of household and similar electrical appliances
Part 1: General Requirements
Part 2: Particular requirements for electrical heat pumps, air conditioners and dehumidifiers

Report Reference No.......................:	101539146CRT-001	
Tested by (name + signature) ....:	Thomas J. Holt	Thomas J Holt
Approved by (name + signature)......:	Wayne Niggli	Niggli
Date of issue.....................................:	05/1/2015	
Testing Laboratory.........................:	Intertek Testing Services	
Address ....:	3933 US Route 11, Cortland, NY 13045	
Testing location / procedure.............:	CBTL ☐ RMT ☐ SMT ☐ WMT ☐ TMP ☒	
Testing location / address ....:	Mercury Aircraft, Inc. 8126 Pleasant Valley Rd. Hammondsport, NY 14840	
Applicant's name............................:	Ice Energy Holdings, Inc.	
Address ....:	823 Milford Street Glendale, CA 91203	
Test specification:		
Standard ....:	IEC 60335-2-40:2005, used in conjunction with IEC 60335-1:2010	
Test procedure ....:	CCA Scheme	
Non-standard test method…………..:	N/A	

Test item description ....:	Condensing Unit Air Conditioners	
Trade Mark ....:	Ice Energy / Ice Bear	
Manufacturer ....:	Ice Energy, Inc.	
Model and/or Type reference ....:	**IB30-521, IB30-523, and IB30-543**	
Rating(s) ....:	IB30-521	208/230VAC, 50Hz., 1 Phase
	IB30-523	208/230VAC, 50Hz., 3-Phase
	IB30-543	460VAC, 50Hz., 3-Phase

Copy of marking plate –



ICE ENERGY®

Ice Energy Holdings, Inc.
823 Milford St.
Glendale, CA 91203

ICE BEAR®

DISTRIBUTED ENERGY
STORAGE SYSTEM

www.ice–energy.com

Power Supply: 200/220VAC, 3ph, 50Hz
Minimum Ampacity: 28.8A
Maximum Circuit Breaker: 30A
Compressor: RLA 17.8A LRA 110A
1/4 HP 1.4A (fans, 2x)
1/6 HP 1.07A (water circulation pump)
1/6 HP 2.7A (refrigerant circulation pump)

Intertek
4000790
CONFORMS TO
UL STD 1995;
CERTIFIED TO
CSA STD C22.2 NO. 236

Suitable for Outdoor Use
Design Pressures:
High Side: 450 PSI
Low Side: 240 PSI
Refrigerant Type: R–410A
Refrigerant Charges:
Ice Make Circuit Precharge: 11 lb 8 oz
Cooling Circuit Site Charge (typical): 35 lb
Weight Dry: 1,400 lb Weight Operating: 5,400 lb
Protection IP22

Model Number: IB30–525

Serial Number: 2871-5-K-MA-20159

Manufactured for Ice Energy Holdings, Inc., Glendale, CA,
by Mercury Aircraft Inc.

PN 7078_A

Summary of testing:

The Air Conditioning Unit Model No. IB30-523 went through the following tests with no failures:

- Input Test
- Cooling Operation Test (Temperature and Pressure)
- Condenser Water Failure Test
- Dielectric Voltage Withstand Test

Test item particulars ....:	
Serial Number ....:	2871-1-H-MA-20676
Additional information:	
Supply connection ....:	Permanently Connected
Type of mounting ....:	Floor Mounted
PTC heating element ....:	None
Pressure relief device...:	Pressure switches and brazed joints used for pressure relief.
Possible test case verdicts:	
- test case does not apply to the test object ....:	N/A
- test object does meet the requirement.......................:	P(Pass)
- test object does not meet the requirement.................:	F(Fail)
Testing ....:	
Date of receipt of test item ....:	5/13/2014
Date(s) of performance of tests ....:	5/13/2014 – 5/16/2014

General product information:

This model IB30-523 is a 3-phase Condensing Unit Air Conditioner rated for 208/230V, at a frequency of 50 Hz. The only difference between the models offered in this family are the compressor and electrical components necessary for the models' rated voltage, as this unit is also offered in a single phase 208/230V, and 3-phase 460V Models.

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
5	GENERAL CONDITIONS FOR THE TESTS		——
5.1	Tests according to this standard are type tests.	Informative	Info
5.2	If the test of Annex D has to be carried out, an additional appliance may be used. (IEC 60335-1/A1)	Not applicable for this CE evaluation.	N/A
5.3	Tests are to be carried out in order of the clauses.	No testing required.	N/A
5.4	When testing appliances that are also supplied by other energies such as gas, the influence of their consumption has to be taken into account.	Unit does not use any gas in its application.	N/A
5.5	Tests are carried out with the appliance in its most unfavorable position that may occur during normal use.	Unit was floor mounted and in the most unfavorable position during testing.	P
5.6	Appliances provided with controls or switching devices are tested with these controls or devices adjusted to their most unfavorable setting, if the setting can be altered by the user.	No controls or switching devices can be adjusted while the unit is operating as intended.	N/A
	Any controls which regulate the temperature or humidity of the conditioned space are rendered inoperative during the test. (IEC 60335-2-40:2005)	Controls were rendered inoperative during testing.	P
5.7	Tests to be carried out in drought-free location.	See test data.	P
5.8.1	Appliances for a.c. only to be tested with a.c. at rated frequency. (IEC 60335-1:2010)	Unit was tested at 50 Hz.	P
5.8.2	Appliances having more than one rated voltage are tested on the basis of the most unfavorable settings.	See test data.	P
5.8.3	For heating appliances and combined appliances, when no factor is specified for the rated power input range, the power input is the most unfavorable within the rated power input range.	This Condensing Unit Air Conditioner is not considered a Heating appliance or Combined appliance.	N/A
5.8.4	When a factor is not specified, the power input corresponds to the power input at the most unfavorable voltage within the rated voltage range.	See test data.	P
5.9	When alternative heating elements or accessories are made available by the appliance manufacturer, the appliance is tested with those elements or accessories which give the most unfavorable results.	No heating elements are used in this unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
5.10	The tests are carried out on the appliance as supplied. However, an appliance constructed as a single appliance but supplied in a number of units is tested after assembly in accordance with the instructions provided with the appliance.	Informative	N/A
	For split-package units, the refrigerant lines shall be installed in accordance with the installation instructions. The refrigerant line length shall be the maximum length stated in the installation instructions or 7.5 m, whichever is the shorter. The thermal insulation of the refrigerant lines shall be applied in accordance with the installation instructions. (IEC 60335-2-40:2005)	These units are not considered to be a split-package unit.	N/A
5.11	Appliances intended to be connected to fixed wiring by means of a flexible cord are tested with the appropriate flexible cord connected to the appliance.	All intended fixed wiring for its application was used during testing.	P
5.12	For heating appliances and combined appliances, when it is specified that the appliance has to operate at a power input multiplied by a factor, this applies only to heating elements without appreciable positive temperature coefficient of resistance.	No heating elements are used in this unit.	N/A
5.13	The tests for appliances with PTC heating elements are carried out at a voltage corresponding to the specified power input.	No heating elements are used in this unit.	N/A
5.14	NOTE: Guidance is given in Annex P for enhanced requirements that may be used to ensure an acceptable level of protection against electrical and thermal hazards for particular types of appliances used in an installation without a protective earthing conductor in countries that have warm damp equable climates. (IEC 60335-1:2010)	Not Applicable	N/A
5.15	If appliances have parts operating at safety extra-low voltage, such parts are checked for compliance with the appropriate requirements specified for class III construction.	This unit is not a class III construction.	N/A
5.16	When testing electronic circuits, the supply is to be free from perturbations from external sources that can influence the results of the tests.	No outside influences affected the results of the tests.	P
5.17	Appliances powered by rechargeable batteries are tested in accordance with annex B.	No rechargeable batteries are used in this unit.	N/A
5.18	If linear and angular dimensions are specified without a tolerance, ISO 2768-1 is applicable.	Not applicable for this review.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
5.19	If a component or part of the appliance has both a self resetting feature and a nonself-resetting feature and if the non-self-resetting feature is not required in order to comply with the standard, then appliances incorporating such a component or part shall be tested with the non-self-resetting feature rendered inoperative. (IEC 60335-1:2010)	No components or parts used in this condensing unit air conditioner utilize a self-resetting feature and a non-self-resetting feature.	N/A
5.101	Motor-compressor comply with IEC 60335-2-34 (IEC 60335-2-40:2005)	Compressor is properly marked and is CE compliant.	P
	Motor-compressor subjected to the relevant test (IEC 60335-2-40:2005)	Compressor is marked and is CE compliant.	P

6	CLASSIFICATION		——
6.1	Protection against electric shock: Class I, II, III (IEC 60335-2-40:2005)	This unit is a class 1 appliance, as it does not only rely on the basic insulation for protection against electric shock, but also relies upon the ground at the supply for protection.	P
6.2	Protection against harmful ingress of water, IP degree in accordance with IEC 60529 (IEC 60335-2-40:2005)	Unit is for outdoor use only and has sufficient protection against ingress of water.	P
	Appliance for outdoor use shall be at least IPX4 (IEC 60335-2-40:2005)	Used for outdoor use and has sufficient IP ratings.	P
	Appliances intended only for indoor use (excluding laundry rooms) may be IPX0 (IEC 60335-2-40:2005)	This unit is not intended for indoor use.	N/A
	Appliances intended to be used in laundry rooms shall be at least IPX1 (IEC 60335-2-40:2005)	This unit is not intended for use in laundry rooms.	N/A
6.101	Degree of accessibility (accessible/not accessible to the general public) (IEC 60335-2-40:2005)	This air conditioner is not intended to be accessible to the general public.	N/A

7	MARKING AND INSTRUCTIONS		——
7.1	Rated voltage or voltage range (V)	Rated voltage of 208/230VAC is marked.	P
	Symbol for nature of supply including number of phases, unless for single phase operation (IEC 60335-2-40:2005)..	3-Phase is marked on the unit nameplate.	P
	Rated frequency (Hz)	Appliance is marked at 50Hz	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Rated power input (W)	Appliance is not marked with Watts, it is not required.	N/A
	Rated current (A)	Appliance is marked with Amperage.	P
	Manufacturer's or responsible vendor's name, trademark or identification mark..........................	Appliance is marked with the responsible vendor.	P
	Model or type reference	Appliance is marked with model number.	P
	Symbol 5172 of IEC 60417, for Class II appliances	Not a class II appliance	N/A
	IP number according to degree of protection against ingress of water, other than IPX0	IP number is provided on the unit nameplate.	P
	symbol IEC 60417-5180 (2003-02), for class III appliances. This marking is not necessary for appliances that are operated only by batteries (primary batteries or secondary batteries that are recharged outside of the appliance). (IEC 60335-1:2010)	Not a class III appliance	N/A
	Mass of the refrigerant or of each refrigerant in a blend (except for azeotropic type) (IEC 60335-2-40:2005):	Unit is marked properly with the mass of the refrigerant required.	P
	Refrigerant identification (IEC 60335-2-40:2005)	Marked to use R-410A refrigerant.	P
	Permissible excessive operating pressure for sanitary hot water heat pumps (IEC 60335-2-40:2005):	This unit is not a sanitary hot water heat pump.	N/A
	The maximum operating pressure for the heat exchanger for hydronic fan coil/air handling units	The maximum operating pressures are provided on the unit nameplate.	P
	Excessive operating pressure of the refrigerant circuit for suction and discharge, if they differ (IEC 60335-2-40:2005)	Refrigerant circuit for different suction and discharge are provided.	P
	Symbol for degree of protection against ingress of water, other than IPX0 (IEC 60335-2-40:2005):	IP rating is provided on the unit nameplate.	P
	Separate marking of the appliances with all the rated characteristics of the supplementary heaters (IEC 60335-2-40:2005):	No electric heaters are used.	N/A
	Marking of the direction of the fluid flow (IEC 60335-2-40:2005):	Direction of fluid flow marking is provided.	P
	Flammable refrigerant	No flammable refrigerant is used.	N/A
7.2	Warning for stationary appliances for multiple supply	Unit not to be connected to multiple supply.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Warning placed in vicinity of terminal cover	Unit not to be connected to multiple supply.	N/A
7.3	Range of rated values marked with the lower and upper limits separated by a hyphen	Voltage range markings are separated by an oblique stroke on the appliance.	N/A
	Different rated values marked with the values separated by an oblique stroke	Markings provided with an oblique stroke and mean that it is only for use at 208V or 230V.	P
7.4	Appliances adjustable for different rated voltages, the voltage setting is clearly discernible	This unit does not utilize controls for adjusting the voltage range.	N/A
7.5	Appliances with more than one rated voltage or one or more rated voltage ranges, marked with rated input or rated current for each rated voltage or range.	Proper voltage markings are shown on the nameplate.	P
	the power input is related to the mean value of the rated voltage range	Proper voltage markings are shown on the nameplate.	P
	Relation between marking for upper and lower limits of rated power input or rated current and voltage is clear	Proper voltage markings are shown on the nameplate.	P
7.6	Correct symbols used	Correct symbols are used throughout the unit.	P
7.7	Connection diagram fixed to appliances to be connected to more than two supply conductors and appliances for multiple supply	Not to be connected to two or more power supply conductors.	N/A
7.8	Except for type Z attachment, terminals for connection to the supply mains indicated as follows:		——
	- marking of terminals exclusively for the neutral conductor (N)	Terminals are marked properly.	P
	- marking of protective earthing terminals (symbol 5019 of IEC 60417)	Earthing terminal lug is used in this unit.	P
	- marking not placed on removable parts	No terminal markings placed on removable parts.	P
7.9	Marking or placing of switches which may cause a hazard	No switches used on this unit.	N/A
7.10	Indications of switches on stationary appliances and controls on all appliances by use of figures, letters or other visual means	No switches used on this unit.	N/A
	This requirement also applies to switches which are part of a control. (IEC 60335-1 2010):	No switches used on this unit.	N/A
	The figure 0 indicates only OFF position, unless no confusion with the OFF position	No switches used on this unit.	N/A

IEC / EN 60335-1 & 60335-2-40

Clause	Requirement – Test	Result	Verdict
7.11	Indication for direction of adjustment of controls	No switches used on this unit.	N/A
7.12	Instructions for safe use provided	Installation & Operating Manual was provided.	P
	The instructions for appliances having a part of class III construction supplied from a detachable power supply unit shall state that the appliance is only to be used with the power supply unit provided with the appliance.	Unit is not considered to have a class III construction.	N/A
	The instructions for class III appliances shall state that it must only be supplied at safety extra low voltage corresponding to the marking on the appliance. This instruction is not necessary for battery-operated appliances if the battery is a primary battery or secondary battery charged outside of the appliance.	Not a class III appliance.	N/A
	Classification of 6.101 included, for appliances not accessible to general public (IEC 60335-2-40:2005)	Unit is not intended to be accessible to the general public.	P
7.12.1	Sufficient details for installation or maintenance supplied (IEC 60335-2-40:2005):		——
	If an appliance is intended to be permanently connected to the water mains and not connected by a hose-set, this shall be stated. (IEC 60335-1:2010):	This unit is not intended to be connected to water mains.	N/A
	- national wiring regulations for installation (IEC 60335-2-40:2005):	Info provided is acceptable.	P
	- dimensions of space for installation (IEC 60335-2-40:2005):	Info provided is acceptable.	P
	- minimum clearance from appliances with supplementary heaters to combustible surfaces (IEC 60335-2-40:2005):	No electric heat is used.	N/A
	- wiring diagram (IEC 60335-2-40:2005):	Wiring diagram is provided.	P
	- range of external static pressures (only heat pumps and appliances with electric resistance heaters) (IEC 60335-2-40:2005):	This unit is not a heat pump nor uses electric resistance heaters.	N/A
	- method of connection to the electrical supply and interconnection of separate components (IEC 60335-2-40:2005):	Provided in Installation & Operating manual.	P
	- indication of suitable parts for outdoor use (IEC 60335-2-40:2005):	Overall unit is used for outdoor use.	N/A
	- type and rated characteristics of fuses (IEC 60335-2-40:2005):	Fuse markings are provided.	P
	- details of supplementary heating elements, including fitting instructions (IEC 60335-2-40:2005):	No heating elements used.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	- maximum and minimum water or brine operating temperatures (IEC 60335-2-40:2005):	Maximum and minimum water operating temperature markings are provided.	P
	- maximum and minimum water or brine operating pressures (IEC 60335-2-40:2005-07):	Maximum and minimum water operating pressure markings are provided.	P
	- indication of open water storage tanks (IEC 60335-2-40:2005-07):	Not applicable	N/A
7.12.2	Stationary appliances not fitted with means for disconnection from the supply mains having a contact separation in all poles that provide full disconnection under overvoltage category III, the instructions state that means for disconnection must be incorporated in the fixed wiring in accordance with the wiring rules	Unit is to be permanently connected in the field.	P
7.12.3	Insulation of the fixed wiring in contact with parts exceeding 50 K during clause 11; instructions stating that the fixed wiring must be protected	No parts to exceed 50K during testing.	N/A
7.12.4	Instructions for built-in appliances:		——
	- dimensions of space	Not a built in appliance.	N/A
	- dimensions and position of supporting means	Not a built in appliance.	N/A
	- distances between parts and surrounding structure	Not a built in appliance.	N/A
	- dimensions of ventilation openings and arrangement	Not a built in appliance.	N/A
	- connection to supply mains and interconnection of separate components	Not a built in appliance.	N/A
	- allow disconnection of the appliance after installation, by accessible plug or a switch in the fixed wiring, unless	Not a built in appliance.	N/A
	- a switch complying with 24.3	Not a built in appliance.	N/A
	The disconnection may be achieved by having the plug accessible or by incorporating a switch in the fixed wiring in accordance with the wiring rules.	Not a built in appliance.	N/A
7.12.5	Replacement cord instructions, type X attachment with a specially prepared cord	Not a cord-connected unit.	N/A
	Replacement cord instructions, type Y attachment	Not a cord-connected unit.	N/A
	Replacement cord instructions, type Z attachment	Not a cord-connected unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
7.12.6	Caution in the instructions for heating appliances with a non-self resetting thermal cut-out	Not Applicable	N/A
7.12.7	Instructions for fixed appliances stating how the appliance is to be fixed	This unit is a floor-supported unit that does not require instructions on how it is to be supported.	N/A
7.12.8	Instructions for appliances connected to the water mains:		——
	The instructions for appliances connected to the water mains shall state – the maximum inlet water pressure, in pascals; – the minimum inlet water pressure, in pascals, if this is necessary for the correct operation of the appliance.	This unit is not intended to be connected to the water mains.	N/A
	The instructions for appliances connected to the water mains by detachable hose-sets shall state that the new hose-sets supplied with the appliance are to be used and that old hose-sets should not be reused.	This unit is not intended to be connected to the water mains.	N/A
7.13	Instructions and other texts in an official language	Instructions will be provided in the language of the country to which the unit is sold.	P
7.14	Marking clearly legible and durable	Markings are clear and legible.	P
7.15	Marking on a main part		
	Marking clearly discernible from the outside, if necessary after removal of a cover	Markings are clearly discernible from the outside of the unit.	P
	For portable appliances, cover can be removed or opened without a tool	Not a portable appliance.	N/A
	For stationary appliances, name, trademark or identification mark and model or type reference visible after installation	Name and trademark will be visible after installation.	P
	For fixed appliances, name, trademark or identification mark and model or type reference visible after installation according to the instructions	Name and trademark will be visible after installation.	P
	Indications for switches and controls placed on or near the components. Marking not on parts which can be positioned or repositioned in such a way that the marking is misleading	No switches used within the unit.	N/A
	Marking on panel allowed, provided panel in place for intended operation of appliance (IEC 60335-2-40:2005)	Nameplate marking will not be on the removal panel, but trademark will be visible on removal panel.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
7.101	Marking of fuses and overload protective devices, if replaceable (IEC 60335-2-40:2005):		——
	- fuse rated current in amperes, type and rated voltage (IEC 60335-2-40:2005)	The fuse rating in amperes is provided.	P
	- manufacturer and model of the overload protective device (IEC 60335-2-40:2005)	The manufacturer and model of the overload protective device is provided.	P
7.102	Marking for connection with aluminium wire, if necessary (IEC 60335-2-40:2005)	Use copper supply marking is provided, so this does not apply.	N/A

8	PROTECTION AGAINST ACCESS TO LIVE PARTS		——
8.1	Adequate protection against accidental contact with live parts	Appliance is constructed so that there is no accidental contact to live parts.	P
8.1.1	Requirement applies for all positions, detachable parts removed		
	Insertion or removal of lamps, protection against contact with live parts of the lamp cap	No lamps used.	N/A
	Use of test probe B of IEC 61032: no contact with live parts	No lamps and no detachable parts are on this unit.	N/A
8.1.2	Use of test probe 13 of IEC 61032 through openings in class 0 appliances and class II appliances/ constructions: no contact with live parts	Unit is not Class 0 or a Class II appliance.	N/A
	Test probe 13 also applied through openings in earthed metal enclosures having a non-conductive coating: no contact with live parts	Unit is not Class 0 or a Class II appliance.	N/A
8.1.3	For appliances other than class II, use of test probe 41 of IEC 61032: no contact with live parts of visible glowing heating elements	No heating elements used.	N/A
8.1.4	Accessible part not considered live if:		——
	- safety extra-low a.c. voltage: peak value not exceeding 42.4 V	No safety extra-low voltage parts are accessible without the removal of the access panel.	N/A
	- safety extra-low d.c. voltage: not exceeding 42.4 V	Not Applicable	N/A
	- or separated from live parts by protective impedance	Not Applicable	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	If protective impedance: d.c. current not exceeding 2 mA, and	Not Applicable	N/A
	a.c. peak value not exceeding 0.7 mA	No safety extra-low voltage parts are accessible without the removal of the access panel.	N/A
	- for peak values over 42.4 V up to and including 450 V, capacitance not exceeding 0,1 µF	No safety extra-low voltage parts are accessible without the removal of the access panel.	N/A
	- for peak values over 450 V up to and including 15 kV, discharge not exceeding 45 µC	No safety extra-low voltage parts are accessible without the removal of the access panel.	N/A
	The quantity of electricity in the discharge is measured using a resistor having a nominal non-inductive resistance of 2 000 Ω (IEC 60335-1/A1)	Not Applicable	N/A
8.1.5	Live parts protected at least by basic insulation before installation or assembly:		——
	- built-in appliances	No built in appliances in this unit.	N/A
	- fixed appliances	Fixed appliances are protected by basic insulation.	P
	- appliances delivered in separate units	No appliances are delivered in a separate unit.	N/A
8.2	Class II appliances and constructions constructed so that there is adequate protection against accidental contact with basic insulation and metal parts separated from live parts by basic insulation only	Unit is not a class II appliance.	N/A
	Only possible to touch parts separated from live parts by double or reinforced insulation	Unit is not class II appliance.	N/A

9	STARTING OF MOTOR-OPERATED APPLIANCES		——
	Not applicable (IEC 60335-2-40:2005)	Not applicable	N/A

10	POWER INPUT AND CURRENT		——
10.1	Power input at normal operating temperature, rated voltage and normal operation not deviating from rated power input by more than shown in table 1	Unit is rated at 200-220V, so Input Test was completed at 200V and Temperature Tests was completed at 220V. See test data.	P
10.2	Current at normal operating temperature, rated voltage and normal operation not deviating from rated current by more than shown in table 2	Unit was not deviated from its rated current. See test data.	P

11	HEATING		——
11.1	No excessive temperatures in normal use (IEC 60335-2-40:2005)	See test data.	P
	Compliance is checked by the tests of Annex C, if (IEC 60335-2-40:2005):		——
	- temperature of motor winding exceeds values shown in Table 3 (IEC 60335-2-40:2005)	See test data.	P
	- there is no doubt about the classification of the insulation system of the motor (IEC 60335-2-40:2005)	This is a Class I appliance.	P
11.2	Placing and mounting of appliance (IEC 60335-2-40:2005):		——
	- clearances to adjacent surfaces	Acceptable spacings were provided	P
	- flows	Acceptable flows were measured during testing.	P
	- adjustable limit controls set at the maximum cut-out setting and the minimum differential	This unit does not utilize any adjustable limit controls.	N/A
	For appliances with supplementary heaters, use test casing of 11.9 (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
11.2.1	For appliances with supplementary heaters, an inlet duct is connected to the inlet air opening (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
11.2.2	Air outlet duct if necessary (IEC 60335-2-40:2005)	No air outlet duct required with this condensing unit air conditioner.	N/A
11.3	Temperatures determined by thermocouples or resistance method (IEC 60335-2-40:2005)	Temperatures were determined by thermocouples.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
11.4	Test performed at supply voltage between 0.94 and 1.06 times the rated voltage (IEC 60335-2-40:2005)	Tests were performed at supply voltage between 0.94 and 1.06 times the rated voltage	P
	Heating appliances operated under normal operation at 1.15 times rated power input (IEC 60335-2-40:2005)	Heating elements were not used in this unit.	N/A
11.5	Test conducted in the heating mode and in the cooling mode, if both exist (IEC 60335-2-40:2005)	Tests were conducted in the cooling mode only.	P
	All supplementary heating elements operative simultaneously (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
11.6	Defrost test in the most unfavourable conditions, if needed (IEC 60335-2-40:2005)	This unit does not utilize a defrost facility.	N/A
11.7	Appliances operated continuously until steady conditions except for defrost tests (IEC 60335-2-40:2005)	Appliances operated adequately and continuously until steady conditions were met.	P
11.8	Monitored temperatures not exceeding the values of Table 3 (IEC 60335-2-40:2005)	(See appended table)	P
	Protective devices do not operate (IEC 60335-2-40:2005)	Protective devices did not operate.	P
11.9	Test casing and installation of the rest of the appliances in accordance with the manufacturer's instructions (IEC 60335-2-40:2005)	No test casing used for testing.	N/A
	Glass fibre insulation for appliances without indication of minimum clearances according to the manufacturer; the thermocouple in contact with the enclosure (IEC 60335-2-40:2005)	No glass fibre used for insulation	N/A

13	LEAKAGE CURRENT AND ELECTRIC STRENGTH AT OPERATING TEMPERATURE		——
13.1	Leakage current not excessive and electric strength adequate	Not Applicable	N/A
	Heating appliances operated at 1.15 times rated power input:	Not Applicable	N/A
	Motor-operated appliances and combined appliances supplied at 1.06 times rated voltage .	Not Applicable	N/A
	Protective impedance and radio interference filters disconnected before carrying out the tests	Not Applicable	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
13.2	Leakage current measured by means of the circuit described in figure 4 of IEC 60990	Not Applicable	N/A
	Leakage current measurements	Not Applicable	N/A
13.3	The appliance is disconnected from the supply and the insulation is immediately subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min, in accordance with IEC 61180-1. (IEC 60335-1/A1)	Not Applicable	N/A
	The high-voltage source used for the test is to be capable of supplying a short circuit current Is between the output terminals after the output voltage has been adjusted to the appropriate test voltage. (IEC 60335-1/A1)	Not Applicable	N/A
	The overload release of the circuit is not to be operated by any current below the tripping current Ir. The values of Is and Ir are given in Table 5 for various high-voltage sources. (IEC 60335-1/A1)	Not Applicable	N/A
	No breakdown during the tests	Not Applicable	N/A

14	TRANSIENT OVERVOLTAGES		——
	Appliances withstand the transient overvoltages to which they may be subjected	Not Applicable	N/A
	Clearances having a value less than specified in table 16 subjected to an impulse voltage test, the test voltage specified in table 6	Not Applicable	N/A
	No flashover during the test, unless of functional insulation	Not Applicable	N/A
	In case of flashover of functional insulation, the appliance complies with clause 19 with the clearance short circuited	Not Applicable	N/A

15	MOISTURE RESISTANCE		——
15.1	Electrical components of appliances shall be protected against the ingress of water (rain, overflow from the drain pan or defrosting, tests of 15.2, 15.3, 11.6 and Cl. 16) (IEC 60335-2-40:2005)	All electrical components are protected against the ingress of water.	P
	After test, water inside the enclosure has not reduced the creepage distances and clearances below the values of Cl. 29 (IEC 60335-2-40:2005)	No water will penetrate the electrical enclosure.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Motor-compressor not operated during 15.2 and 15.3 (IEC 60335-2-40:2005)	Not Applicable	N/A
15.2	Tests in accordance with IEC 60529 in appliances other than IPX0, as specified (IEC 60335-2-40:2005)	Not Applicable	N/A
15.3	Drain pan filled to brim and subjected to continuous overflow and fan(s) switched on (IEC 60335-2-40:2005)	No drain pan required.	N/A
15.101	Spillage test for floor units or wall mounted units accessible to the general public. (IEC 60335-2-40:2005)	No test required as this is not an indoor unit.	N/A

16	LEAKAGE CURRENT AND ELECTRIC STRENGTH		——
16.1	Leakage current not excessive and electric strength adequate	No Testing Required.	N/A
	Protective impedance disconnected from live parts before carrying out the tests	No Testing Required.	N/A
16.2	Single-phase appliances: test voltage 1.06 times rated voltage	No Testing Required.	N/A
	Three-phase appliances: test voltage 1.06 times rated voltage divided by √3	No Testing Required.	N/A
	Leakage current measurements	No Testing Required.	N/A
16.3	Electric strength tests according to table 7	No Testing Required.	N/A
	No breakdown during the tests	No Testing Required.	N/A

17	OVERLOAD PROTECTION OF TRANSFORMERS AND ASSOCIATED CIRCUITS		——
	No excessive temperatures in transformer or associated circuits in event of short-circuits likely to occur in normal use	Not Applicable	N/A
	Appliance supplied with 1.06 or 0.94 times rated voltage and the most unfavourable short-circuit or overload likely to occur in normal use applied...	Not Applicable	N/A
	Temperature rise of insulation of the conductors of safety extra-low voltage circuits not exceeding the relevant value specified in table 3 by more than 15 K	Not Applicable	N/A
	Temperature of the winding not exceeding the value specified in table 8,	Not Applicable	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	however limits do not apply to fail-safe transformers complying with sub-clause 15.5 of IEC 61558-1	Not Applicable	N/A

18	ENDURANCE		——
	Not applicable (IEC 60335-2-40:2005)	Not applicable	N/A

19	ABNORMAL OPERATION		——
19.1	The risk of fire or mechanical damage under abnormal or careless operation obviated (tests 19.2-19.13) (IEC 60335-2-40:2005)	The appliances are constructed to not result in a hazard from careless operation.	P
	Electronic circuits so designed and applied that a fault will not render the appliance unsafe (electric shock, fire or mechanical hazard, dangerous malfunction) (test 19.11 and 19.12) (IEC 60335-2-40:2005)	Electronic circuits are designed to not render the appliance unsafe.	P
19.2	Test of appliance with motor rotors, other than motor-compressors, operated for 15 days (360h) or until a protection device opens the circuit (IEC 60335-2-40:2005)	No testing required.	N/A
	Insulation of motor windings (IEC 60335-2-40:2005)	No testing required.	N/A
	Temperature of enclosure does not exceed (°C) (IEC 60335-2-40:2005):	No testing required.	N/A
	Temperature of the windings does not exceed the values shown in the table ; temperature (°C) (IEC 60335-2-40:2005):	No testing required.	N/A
	Electric strength test as specified in 16.3, 72h after the beginning of the test (IEC 60335-2-40:2005)	No testing required.	N/A
	A 30mA residual current device does not open (IEC 60335-2-40:2005)	No testing required.	N/A
	At the end, the leakage current between the windings and the enclosure does not exceed 2mA (IEC 60335-2-40:2005)	No testing required.	N/A
19.3	Motor-compressor complies with IEC 60335-2-34 (IEC 60335-2-40:2005):	Motor-compressor is provided with CE marking.	P
	Test of the motor-compressor with the rotor locked as specified in 19.101 of IEC 60335-2-34 (IEC 60335-2-40:2005)	Motor-compressor Is provided with CE marking.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
19.4	Test of three-phase motors operated under the conditions of Cl. 11 with one phase disconnected until steady conditions (IEC 60335-2-40:2005)	Unit will not operate if one phase is disconnected.	P
19.5	Test of appliance with heat transfer medium flow of the outdoor heat exchanger restricted or shut off when reaching steady conditions (IEC 60335-2-40:2005)	See test data.	P
	Test of appliance with heat transfer flow of the indoor heat exchanger restricted or shut off when reaching steady conditions (IEC 60335-2-40:2005)	See test data.	P
	Disconnection of the motor common to both the outdoor and the indoor heat exchangers when reaching steady conditions (IEC 60335-2-40:2005)	See test data.	P
19.6	Test of appliances using water as heat transfer medium (IEC 60335-2-40:2005)	No indoor heat exchanger within this unit.	N/A
19.7	The test of air to air appliances at rated voltage or at the upper limit of the rated voltage range. The dry-bulb temperature is 5K below the values specified by the manufacturer (IEC 60335-2-40:2005)	No test required.	N/A
	Test with the dry-bulb temperature 10K over the values specified by the manufacturer (IEC 60335-2-40:2005)	No test required.	P
19.8	Test of appliances with supplementary electric heaters (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
19.9	Test at a temperature permitting continuous operation of the motor-compressor and the electric heating elements at the same time (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
19.10	Test of the appliance with any defect which may be expected during normal use (IEC 60335-2-40:2005)	No testing required.	N/A
19.10.1	Test of 19.10 is repeated on class 01 and class 1 appliances incorporating tubular sheathed or embedded heating elements. Controls are not short-circuited but one end of the element is connected to the sheath of the heating element.	No supplementary heaters are used.	N/A
19.10.101	Test of 19.10 is repeated on class 01 and class 1 appliances incorporating tubular sheathed or embedded heating elements. Controls are not short-circuited but one end of the element is connected to the sheath of the heating element.	No supplementary heaters are used.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
19.11	Electronic circuits, compliance checked by evaluation of the fault conditions specified in 19.11.2 for all circuits or parts of circuits, unless they comply with the conditions specified in 19.11.1 (IEC 60335-2-40:2005)	Electronic circuits comply to fault conditions specified in 19.11.2	P
	Appliances incorporating a protective electronic circuit are subjected to the tests of 19.11.3 and 19.11.4. (IEC 60335-1:2010)	Tests not required.	N/A
19.11.1	Before applying the fault conditions a) to f) in 19.11.2, it is checked if circuits or parts of circuit meet both of the following conditions (IEC 60335-2-40:2005):		——
	- the electronic circuit is a low-power circuit, that is, the maximum power at low-power points does not exceed 15W according to the tests specified (IEC 60335-2-40:2005)	Not Applicable	N/A
	- the protection against electric shock, fire hazard, mechanical hazard or dangerous malfunction in other parts of the appliance does not rely on the correct functioning of the electronic circuit (IEC 60335-2-40:2005)	Not Applicable	N/A
19.11.2	Fault conditions applied one at a time, the appliance operated under conditions specified in Cl.11, but supplied at rated voltage, the duration of the tests as specified (IEC 60335-2-40:2005-07):		——
	a) short circuit of creepage distances and clearances between live parts of different potential, if these distances are less than the values specified in 29.1, unless the relevant part is adequately encapsulated (IEC 60335-2-40:2005)	Distances are not less than values specified in 29.1	N/A
	b) open circuit at the terminals of any component (IEC 60335-2-40:2005)	No open circuits at terminals	N/A
	c) short circuit if capacitors, unless they comply with IEC 60384-14 (IEC 60335-2-40:2005)	No short circuits in capacitors	N/A
	d) short circuit of any two terminals of an electronic component, other than integrated circuits. This fault condition is not applied between the circuits of an optocoupler (IEC 60335-2-40:2005)	No circuits of any two terminals.	N/A
	e) failure of triacs in the diode mode (IEC 60335-2-40:2005)	No failures of triacs in the diode mode.	N/A
	f) failure of an integrated circuit. (IEC 60335-1:2010)	No failure of an integrated circuit.	N/A
	Short-circuit of low-power circuits (IEC 60335-2-40:2005)	No short circuit of low-power circuits	N/A
	In each case, the test is ended if a non-self-resetting interruption of the supply occurs within the appliance. (IEC 60335-1:2010)	No interruptions of supply occurred within the appliance.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	The duration of the tests (IEC 60335-2-40:2005):		——
	- as specified in 11.7 but only for one operating cycle (in case the fault cannot be recognized by user) (IEC 60335-2-40:2005)	Not Applicable	N/A
	- as specified in 19.2, if fault can be recognized by user (IEC 60335-2-40:2005)	Not Applicable	N/A
	- until steady conditions are established (IEC 60335-2-40:2005)	Not Applicable	N/A
	Test ended if interruption of supply occurs within the appliance (IEC 60335-2-40:2005)	Not Applicable	N/A
	Fault condition f) applied to encapsulated or similar components (IEC 60335-2-40:2005)	Not Applicable	N/A
	PTC’s, NTC’s and VDR’s resistors not short-circuited if used as specified by manufacturer (IEC 60335-2-40:2005)	Not Applicable	N/A
19.11.3	Appliance that incorporates a protective electronic circuit which operates to ensure compliance with Clause 19, the relevant tests are repeated as indicated in Clause 19.11.2 a) – f)	Not Applicable	N/A
19.11.4	Appliances having a switch with an off position obtained by electronic disconnection, or a switch that can be placed in the stand-by mode, are subjected to the tests of 9.11.4.1 to 19.11.4.7. The tests are carried out with the appliance supplied at rated voltage, the switch being set in the off position or in the stand-by mode. (IEC 60335-1:2010)	No on/off switch on this unit.	N/A
	Appliances incorporating a protective electronic circuit are subjected to the tests of 19.11.4.1 to 19.11.4.7. The tests are carried out after the protective electronic circuit has operated during the relevant tests of Clause 19 except 19.2, 19.6 and 19.11.3. However, appliances that are operated for 30 s or 5 min during the test of 19.7 are not subjected to the tests for electromagnetic phenomena. (IEC 60335-1:2010)	Tests not required.	N/A
	The tests are carried out with surge arresters disconnected, unless they incorporate spark gaps (IEC 60335-1:2010)	Tests not required.	N/A
19.11.4.1	The appliance is subjected to electrostatic discharges in accordance with IEC 61000-4-2, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity are applied at each preselected point (IEC 60335-1:2010)	Tests not required.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
19.11.4.2	The appliance is subjected to radiated fields in accordance with IEC 61000-4-3, test level 3 being applicable. (IEC 60335-1:2010)	Tests not required.	N/A
19.11.4.3	The appliance is subjected to fast transient bursts in accordance with IEC 61000-4-4. Test level 3 s applicable for signal and control lines. Test level 4 is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity (IEC 60335-1:2010)	Tests not required.	N/A
19.11.4.4	The power supply terminals of the appliance are subjected to voltage surges in accordance with IEC 61000-4-5, five positive impulses and five negative impulses being applied at the selected points. Test level 3 is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 Ω being used. Test level 4 is applicable for the line-to-earth coupling mode, a generator having a source impedance of 12 Ω being used. (IEC 60335-1:2010)	Tests not required.	N/A
	Earthed heating elements in class I appliances are disconnected during this test (IEC 60335-1:2010)	No heating elements used.	N/A
	For appliances having surge arresters incorporating spark gaps, the test is repeated at a level that is 95 % of the flashover voltage (IEC 60335-1:2010)	Not required.	N/A
19.11.4.5	The appliance is subjected to injected currents in accordance with IEC 61000-4-6, test level 3 being applicable. During the test, all frequencies between 0.15 MHz to 80 MHz are covered. (IEC 60335-1:2010)	Test not required.	N/A
19.11.4.6	The appliance is subjected to voltage dips and interruptions in accordance with IEC 61000-4-11. The durations specified in Table 1 of IEC 61000-4-11 are applied to each test level, the dips and interruptions being applied at zero crossing of the supply voltage (IEC 60335-1:2010)	Test not required.	N/A
19.11.4.7	The appliance is subjected to mains signals in accordance with IEC 61000-4-13, test level class 2 being applicable (IEC 60335-1:2010)	Test not required.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
19.11.4.8	The appliance is supplied at rated voltage and operated under normal operation. The voltage is then reduced to a value of approximately 10 % less than the recorded voltage. It is held at this value for approximately 60 s and then increased to rated voltage. The rate of decrease and increase of the power supply voltage is to be approximately 10 V/s. The appliance shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart it.	Test not required.	N/A
19.12	If the safety of the appliance for any of the fault conditions specified in 19.11.2 depends on the operation of a miniature fuse-link complying with IEC 60127, the test is repeated but with fuse-link replaced by an ammeter (IEC 60335-2-40:2005)	Test not required.	N/A
	Current ≤ 2,1 times rated current of fuse-link, circuit not adequately protected (fuse-link short-circuited) (IEC 60335-2-40:2005)	Test not required.	N/A
	Current ≥ 2,75 times rated current of fuse-link, circuit adequately protected (IEC 60335-2-40:2005)	Test not required.	N/A
	Current ≥ 2,1 and ≤ 2,75 times rated current, fuse-link short-circuited and test carried out during specified time (IEC 60335-2-40:2005)	Test not required.	N/A
19.13	Test of appliances with PTC heating elements (IEC 60335-2-40:2005)	No heating elements are used.	N/A
19.14	No flames, molten metal, poisonous or ignitable gas or deformed enclosures (IEC 60335-2-40:2005)	No deformed enclosures during testing.	N/A
19.101	Appliances provided with supplementary heaters and with free air discharge are subjected to the testing in each mode of operation.	No supplementary heaters are used.	N/A

20	STABILITY AND MECHANICAL HAZARDS		——
20.1	Adequate stability		
	Tilting test through an angle of 10° (appliance placed on an inclined plane/horizontal plane); appliance does not overturn	Floor supported unit that cannot be tested at an angle.	N/A
	Tilting test repeated on appliances with heating elements, angle of inclination increased to 15°	Floor supported unit that cannot be tested at an angle.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Possible heating test in overturned position; temperature rise does not exceed values shown in table 9	Floor supported unit that cannot be tested at an angle.	N/A
20.2	Moving parts adequately arranged or enclosed as to provide protection against personal injury	All moving parts are properly contained within the enclosures.	P
	Protective enclosures, guards and similar parts are non-detachable	Protective guards of enclosure can not be removed without use of tools.	P
	Adequate mechanical strength and fixing of protective enclosures	Protective enclosures have adequate strength.	P
	Self-resetting thermal cut-outs and overcurrent protective devices not causing a hazard, by unexpected reclosure	Self-resetting thermal cut-outs and overcurrent protective devices will not cause a hazard by unexpected reclosure.	P
	Not possible to touch dangerous moving parts with test probe	Test probe can not penetrate enclosure walls to contact dangerous moving parts.	P

21	MECHANICAL STRENGTH		——
21.1	Appliance has adequate mechanical strength and is constructed as to withstand rough handling	Appliance has sufficient mechanical strength to withstand rough handling.	P
	Checked by applying blows to the appliance in accordance with test Ehb of IEC 60068-2-75, spring hammer test, impact energy 0.5J (IEC 60335-1:2010)	No tests required.	N/A
	If necessary, supplementary or reinforced insulation subjected to the electric strength test of 16.3	No tests required.	N/A
	If necessary, repetition of groups of three blows on a new sample	No tests required.	N/A
	Safety requirements specified in ISO 5149 shall apply. (IEC 60335-2-40:2005)	See test data.	P
21.2	Accessible parts of solid insulation shall have sufficient strength to prevent penetration by sharp implements. (IEC 60335-1:2010)	All accessible parts will prevent penetration by sharp implements.	P
	Compliance is checked by subjecting the insulation to the following test, unless the thickness of supplementary insulation is at least 1 mm and that of reinforced insulation is at least 2 mm. (IEC 60335-1:2010)	No testing required.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	The insulation is raised to the temperature measured during the test of Clause 11. (IEC 60335-1:2010)	No test required.	N/A
	The surface of the insulation is then scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0,25 mm ± 0,02 mm. (IEC 60335-1:2010)	No testing required.	N/A
	The pin is held at an angle of 80°- 85°to the horizontal and loaded so that the force exerted along its axis is 10 N ± 0,5 N. (IEC 60335-1:2010)	No testing required.	N/A
	The scratches are made by drawing the pin along the surface of the insulation at a speed of approximately 20 mm/s. Two parallel scratches are made. (IEC 60335-1:2010)	No testing required.	N/A
	They are spaced sufficiently apart so that they are not affected by each other, their length covering approximately 25 % of the length of the insulation. (IEC 60335-1:2010)	No testing required.	N/A
	Two similar scratches are made at 90°to the first pair without crossing them. (IEC 60335-1:2010)	No testing required.	N/A
	The test fingernail of Figure 7 is then applied to the scratched surface with a force of approximately 10 N. No further damage, such as separation of the material, shall occur. The insulation shall then withstand the electric strength test of 16.3. (IEC 60335-1:2010)	No testing required.	N/A
	The hardened steel pin is then applied perpendicularly with a force of 30 N ±0.5 N to an unscratched part of the surface. The insulation shall then withstand the electric strength test of 16.3 with the pin still applied and used as one of the electrodes. (IEC 60335-1:2010)	No testing required.	N/A

22	CONSTRUCTION		——
22.1	Appliance marked with the first numeral of the IP system, relevant requirements of IEC 60529 are fulfilled	IP marking is provided on the unit nameplate.	P
22.2	Stationary appliance: means to provide all-pole disconnection from the supply provided, the following means being available:		——
	- a supply cord fitted with a plug	Not a cord-connected unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	- a switch complying with 24.3	No switches used.	N/A
	- a statement in the instruction sheet that a disconnection incorporated in the fixed wiring is to be provided	Information was provided in the instructions.	P
	- an appliance inlet	Not Applicable	N/A
	Single-pole switches and single-pole protective devices for the disconnection of heating elements in single-phase permanently connected class I appliances, connected to the phase conductor	No switches or heating elements are used.	N/A
22.3	Appliance provided with pins: no undue strain on socket-outlets	Not cord-connected.	N/A
	Applied torque not exceeding 0.25 Nm	Not cord-connected.	N/A
	Pull force of 50N to each pin after the appliance has being placed in the heating cabinet; when cooled to room temperature the pins are not displaced by more than 1mm	Not cord-connected.	N/A
	Each pin subjected to a torque of 0.4Nm; the pins are not rotating unless rotating does not impair compliance with the standard	Not cord-connected.	N/A
22.4	Appliance for heating liquids and appliance causing undue vibration not provided with pins for insertion into socket-outlets	Not cord-connected.	N/A
22.5	The appliance is supplied at rated voltage. Any switch is then placed in the off position and the appliance is disconnected from the supply mains at the instant of voltage peak. One second after disconnection, the voltage between the pins of the plug is measured with an instrument that does not appreciably affect the value to be measured.	Not cord-connected.	N/A
	The voltage shall not exceed 34 V	Not cord-connected.	N/A
22.6	Electrical insulation not affected by condensing water or leaking liquid or snow which might enter the appliance enclosure.	The unit is constructed so that their electrical insulation cannot be affected by water that could condense on cold surfaces or by liquid that could leak from containers, hoses, couplings and similar parts of the appliance.	P
	Electrical insulation of Class II appliances not affected in case of a hose rupture or seal leak	Not a Class II appliance	N/A
22.7	Adequate safeguards against the risk of excessive pressure in appliances provided with steam-producing devices	This unit does not utilize any steam-producing devices.	N/A

Clause	Requirement – Test	Result	Verdict
22.8	Electrical connections not subject to pulling during cleaning of compartments to which access can be gained without the aid of a tool, and that are likely to be cleaned in normal use	All electrical connections can not be accessed without the use of tools to remove doors.	P
22.9	Insulation, internal wiring, windings, commutators and slip rings not exposed to oil, grease or similar substances	All internal wiring is not exposed to oils or grease.	P
22.10	Not possible to reset voltage-maintained non-self-resetting thermal cut-outs by the operation of an automatic switching device incorporated within the appliance (IEC 60335-1:2010)	It is not possible to reset voltage-maintained non-self-resetting thermal cut-outs by the operation of an automatic switching device incorporated within the appliance.	P
	Non-self resetting thermal motor protectors have a trip-free action, unless they are voltage maintained (IEC 60335-1:2010)	Not Applicable	N/A
	Location or protection of reset buttons of non-self-resetting controls is so that accidental resetting is unlikely (IEC 60335-1:2010)	Accidental resetting is unlikely.	P
22.11	Reliable fixing of non-detachable parts that provide the necessary degree of protection against electric shock, moisture or contact with moving parts	Reliable fixing of non-detachable parts that provide the necessary degree of protection against electric shock, moisture or contact with moving parts was acceptable.	P
	Obvious locked position of snap-in devices used for fixing such parts	Obvious locked position of snap-in devices are used.	P
	No deterioration of the fixing properties of snap-in devices used in parts that are likely to be removed during installation or servicing	No deterioration of the fixing properties of snap-in devices will occur if removed during installation or servicing	P
	Tests as described	No testing required.	N/A
22.12	Handles, knobs etc. fixed in a reliable manner	No handles or knobs are on this unit.	N/A
	Fixing in wrong position of handles, knobs etc. indicating position of switches or similar components not possible	No handles or knobs are on this unit.	N/A
	Axial force 15 N applied to parts, the shape being so that an axial pull is unlikely to be applied	Not required.	N/A
	Axial force 30 N applied to parts, the shape being so that an axial pull is likely to be applied	Not required.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
22.13	Unlikely that handles, when gripped as in normal use, make the operators hand touch parts having a temperature rise exceeding the value specified for handles which are held for short periods only	No handles or knobs are on this unit.	N/A
22.14	No ragged or sharp edges creating a hazard for the user in normal use, or during user maintenance	No ragged or sharp edges are present that may create a hazard for the user in normal use, or during user maintenance	P
	No exposed pointed ends of self tapping screws etc., liable to be touched by the user in normal use or during user maintenance	No exposed pointed ends of self tapping screws etc., are exposed that may be touched by the user in normal use or during user maintenance	P
22.15	Storage hooks and the like for flexible cords smooth and well rounded	No storage hooks are used.	N/A
22.16	Automatic cord reels cause no undue abrasion or damage to the sheath of the flexible cord, no breakage of conductors strands, no undue wear of contacts	No automatic cord reels on this unit.	N/A
	Cord reel tested with 6000 operations, as specified	No automatic cord reels on this unit.	N/A
	Electric strength test of 16.3, voltage of 1000 V applied	No automatic cord reels on this unit.	N/A
22.17	Spacers not removable from the outside by hand or by means of a screwdriver or a spanner	No spacers are used.	N/A
22.18	Current-carrying parts and other metal parts resistant to corrosion under normal conditions of use	Current-carrying parts and other metal parts resistant to corrosion under normal conditions of use are resistant to corrosion.	P
22.19	Driving belts not used as electrical insulation	No driving belts are used.	N/A
22.20	Direct contact between live parts and thermal insulation effectively prevented, unless material used is non-corrosive, non-hygroscopic and non-combustible	Any direct contact between live parts and thermal insulation has been effectively prevented.	P
	Compliance is checked by inspection and, if necessary, by appropriate test	No testing required.	N/A
22.21	Wood, cotton, silk, ordinary paper and fibrous or hygroscopic material not used as insulation, unless impregnated	No wood, cotton, silk, ordinary paper and fibrous or hygroscopic material were used as insulation.	P
22.22	Appliances not containing asbestos	Appliance did not contain asbestos.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
22.23	Oils containing polychlorinated biphenyl (PCB) not used	No oils containing polychlorinated biphenyl were used.	P
22.24	Bare heating elements adequately supported to prevent contact with accessible metal parts in case of rupture or sagging (IEC 60335-2-40:2005)	No heating elements are used.	N/A
	Bare heating elements only used with metal enclosures (wood or composite enclosures not allowed) (IEC 60335-2-40:2005)	No heating elements are used.	N/A
22.25	Sagging heating conductors cannot come into contact with accessible metal parts	No heating elements are used.	N/A
22.26	The insulation between parts operating at safety extra-low voltage and other live parts complies with the requirements for double or reinforced insulation	No double or reinforced insulations required.	N/A
22.27	Parts connected by protective impedance separated by double or reinforced insulation	No double or reinforced insulations required.	N/A
22.28	Metal parts of Class II appliances conductively connected to gas pipes or in contact with water: separated from live parts by double or reinforced insulation	Not a class II appliance.	N/A
22.29	Class II appliances permanently connected to fixed wiring so constructed that the required degree of access to live parts is maintained after installation	Not a class II appliance.	N/A
22.30	Parts serving as supplementary or reinforced insulation fixed so that they cannot be removed without being seriously damaged, or	Not a class II appliance.	N/A
	so constructed that they cannot be replaced in an incorrect position, and so that if they are omitted, the appliance is rendered inoperable or manifestly incomplete	Not a class II appliance.	N/A
22.31	Clearances and creepage distances over supplementary and reinforced insulation not reduced below values specified in clause 29 as a result of wear	All clearance spacings were acceptable.	P
	Clearances and creepage distances between live parts and accessible parts not reduced below values for supplementary insulation, if wires, screws etc. become loose	All spacings between live parts are acceptable are properly secured.	P
22.32	Supplementary and reinforced insulation designed or protected against deposition of dirt or dust	All insulation will protect against deposition of dirt and dust.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Supplementary insulation of natural or synthetic rubber resistant to ageing, or arranged and dimensioned so that creepage distances are not reduced below values specified in 29.2	No natural or synthetic rubber used for insulation of unit.	N/A
	Ceramic material not tightly sintered, similar material or beads alone not used as supplementary or reinforced insulation	No ceramic materials used.	N/A
	Oxygen bomb test at 70°C for 96 h and 16 h at room temperature	No test required.	N/A
22.33	Conductive liquids that are or may become accessible in normal use are not in direct contact with live parts	No conductive liquids to be used.	P
	Electrodes not used for heating liquids	Electrodes are not used for heating liquids	P
	For class II constructions, conductive liquids that are or may become accessible in normal use, not in direct contact with basic or reinforced insulation	Not class II appliance	N/A
	For class II constructions, conductive liquids which are in contact with live parts, not in direct contact with reinforced insulation	Not class II appliance	N/A
22.34	Shafts of operating knobs, handles, levers etc. not live, unless the shaft is not accessible when the part is removed	No knobs or handles are used.	N/A
22.35	Handles, levers and knobs, held or actuated in normal use, not becoming live in the event of an insulation fault	No knobs or handles are used.	N/A
	Such parts being of metal, and their shafts or fixings are likely to become live in the event of an insulation fault, they are either adequately covered by insulation material, or their accessible parts are separated from their shafts or fixings by supplementary insulation	Not Applicable	N/A
	This requirement does not apply to handles, levers and knobs on stationary appliances other than those of electrical components, provided they are either reliably connected to an earthing terminal or earthing contact, or separated from live parts by earthed metal	All live electrical components are properly grounded.	P
22.36	Handles continuously held in the hand in normal use are so constructed that when gripped as in normal use, the operators hand is not likely to touch metal parts, unless they are separated from live parts by double or reinforced insulation	No handles are continuously held during normal use of unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
22.37	Capacitors in Class II appliances not connected to accessible metal parts, unless complying with 22.42	Not a class II appliance.	N/A
	Metal casings of capacitors in Class II appliances separated from accessible metal parts by supplementary insulation, unless complying with 22.42	Not a class II appliance.	N/A
22.38	Capacitors not connected between the contacts of a thermal cut-out	Capacitors are not connected between the contacts of a thermal cut-out	P
22.39	Lamp holders used only for the connection of lamps	No lampholders are used.	N/A
22.40	Motor-operated appliances and combined appliances intended to be moved while in operation, or having accessible moving parts, fitted with a switch to control the motor. The actuating member of the switch being easily visible and accessible	Unit is not intended to be moved during operation.	N/A
22.41	No components, other than lamps, containing mercury	No components contain Mercury.	P
22.42	Protective impedance consisting of at least two separate components	Protective impedance consists of at least two separate components.	P
	Values specified in 8.1.4 not exceeded if any one of the components are short-circuited or open-circuited	Not Applicable	N/A
22.43	Appliances adjustable for different voltages, accidental changing of the setting of the voltage unlikely to occur	This unit is not designed to have an adjustable voltage.	N/A
22.44	Appliances are not allowed to have an enclosure that is shaped and decorated so that the appliance is likely to be treated as a toy by children	Appliance is not shaped and decorated so that it may be treated as a toy by children	P
22.45	When air is used as reinforced insulation, clearances not reduced below the values specified in 29.1.4 due to deformation as a result of an external force applied to the enclosure	Air is not used a reinforced insulation.	N/A
22.46	Software used in protective electronic circuits is software class B or C (IEC 60335-1:2010):	The only software provided with the unit is included in Controller, which is CE compliant.	P
22.47	Appliances connected to the water mains withstand the water pressure expected in normal use (IEC 60335-1:2010)	This unit is not intended to be connected to water mains.	N/A

Clause	Requirement – Test	Result	Verdict
	No leakage from any part, including any inlet water hose (IEC 60335-1:2010)	This unit is not intended to be connected to water mains.	N/A
22.48	Appliances connected to the water mains constructed to prevent backsiphonage of non-potable water (IEC 60335-1:2010)	This unit is not intended to be connected to water mains.	N/A
22.49	For remote operation, the duration of operation shall be set before the appliance can be started unless the appliance switches off automatically at the end of a cycle or it can operate continuously without giving rise to a hazard.	No switches are used on this unit.	N/A
22.50	Controls incorporated in the appliance, if any, shall take priority over controls actuated by remote operation.	Controls incorporated in the unit were set before testing and then rendered inoperable during testing.	P
22.51	A control on the appliance shall be manually adjusted to the setting for remote operation before the appliance can be operated in this mode. There shall be a visual indication on the appliance showing that the appliance is adjusted for remote operation. The manual setting and the visual indication of the remote mode are not necessary on appliances that can - operate continuously, or - operate automatically, or - be operated remotely, without giving rise to a hazard.	Controls incorporated in the unit were set before testing and then rendered inoperable during testing.	P
22.52	Socket-outlets on appliances accessible to the user shall be in accordance with the socket-outlet system used in the country in which the appliance is sold.	Unit is intended to be permanently connected.	N/A
22.101	Appliances intended to be fixed, securely fixed (IEC 60335-2-40:2005)	Appliance is stationary and fixed to the floor.	P
22.102	Double thermal cut-out in appliances with supplementary heating elements (the first one shall be a self-resetting and the other a non-self-resetting thermal cut-out) (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
	Thermal cut-outs of the capillary type open in the event of leakage of the capillary tube (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
	Thermal cut-outs comply with 24.3 (switches) (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
	Thermal cut-outs operating in Cl. 19 shall be of the non-self-resetting type (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
22.102.1	Appliances provided with supplementary heaters for air shall be provided with at least two thermal cut-outs. The thermal cut-out intended to operate first shall be a self-resetting thermal cut-out, the other thermal cut-out shall be a non-resetting thermal cut-out. (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
22.102.2	Appliances provided with supplementary heaters for water shall incorporate a non-self-resetting thermal cut-outs, providing all-pole disconnection that operates separately from water thermostats. (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
22.102.3	Thermal cut-outs of the capillary type shall be so designed that the contacts open in the event of leakage from the capillary tube. (IEC 60335-2-40:2005)	No supplementary heaters are used.	N/A
22.103	Non-self-resetting cut-outs independent of other control devices (IEC 60335-2-40:2005)	Non-self-resetting cut-outs were independent of other control devices	P
22.104	Containers of sanitary hot water heat pumps shall withstand the water pressure occurring in normal use. (IEC 60335-2-40:2005)	This unit is not considered a sanitary hot water heat pump.	N/A
22.105	Air or vapour cushion in closed containers not exceeding the 10% (IEC 60335-2-40:2005)	Not Applicable to this condensing unit air conditioner.	N/A
22.106	Pressure relief devices operating at 0.1MPa over the permissible pressure (IEC 60335-2-40:2005)	All pressure relief devices are acceptable for its intended use.	P
22.107	Water outlet systems of open containers free from obstruction causing over-pressure (IEC 60335-2-40:2005)	Unit is not an open container.	N/A
	Vented containers of sanitary hot water heat pumps always open to the atmosphere through appropriate aperture (IEC 60335-2-40:2005)	This unit is not considered a sanitary hot water heat pump.	N/A
22.108	No vented open containers are subjected to a test in accordance with 22.104 to a vacuum of 33kPa for 15 min (IEC 60335-2-40:2005)	This unit is not considered a sanitary hot water heat pump.	N/A
22.109	Replacement of non-self-resetting thermal cut-outs does not damage other connections (IEC 60335-2-40:2005)	Only one thermal fuse was used.	N/A
22.110	Non-self-resetting thermal cut-outs operate without short-circuiting live parts of different potential and without causing contact between live parts and the enclosure (IEC 60335-2-40:2005)	No fuses are used.	N/A
	Test repeated five times without blowing a 3 A fuse which connects the appliance to earth (IEC 60335-2-40:2005)	No fuses are used.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Electric strength test as specified in 16.3 for supplementary heating elements (IEC 60335-2-40:2005)	No electric heat is on this unit.	N/A
22.111	Manual resetting of thermostats not necessary after power supply interruption (IEC 60335-2-40:2005)	Thermostat reset is not necessary after power supply interruption.	P
22.112	The construction of the refrigerating system shall comply with the requirements of Section 3 of ISO 5149. (IEC 60335-2-40:2005)	Not Applicable	N/A
22.113	When a flammable refrigerant is used, refrigerant tubing shall be protected or enclosed to avoid mechanical damage. (IEC 60335-2-40:2005)	All refrigerant tubing is protected within the enclosure.	P
22.114	When a flammable refrigerant is used, low temperature solder alloys, such as lead/tin alloys, are not acceptable for pipe connections. (IEC 60335-2-40:2005)	Low temperature solder alloys are not used for pipe connections.	P
22.115	The total refrigerant mass (*M*) of all refrigerating systems within the appliance employing flammable refrigerants shall not exceed m_3 as defined in Annex GG. (IEC 60335-2-40:2005)	Not Applicable	N/A
22.116	Appliances using flammable refrigerants shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the appliance where electrical components, which could be a source of ignition and which could function under normal conditions or in the event of a leak, are fitted. (IEC 60335-2-40:2005)	No flammable refrigerant is used.	N/A
22.117	Temperatures on surfaces that may be exposed to leakage of flammable refrigerants shall not exceed the auto-ignition temperature of the refrigerant reduced by 100 K; some typical values are given in Annex BB. (IEC 60335-2-40:2005)	Not Applicable	N/A
22.118	When a flammable refrigerant is used, all appliances shall be charged with refrigerant at the manufacturing location or charged on site as recommended by the manufacturer. (IEC 60335-2-40:2005)	Not applicable for evaluation.	N/A
22.201	Appliances having integral pins for insertion into socket outlets shall comply with the appropriate requirements of AS/NZS 3112. (IEC 60335.1:2011)	This unit is not cord-connected.	N/A

23	INTERNAL WIRING		——
23.1	Wireways smooth and free from sharp edges	Wireways are smooth and free from sharp edges.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Wires protected against contact with burrs, cooling fins etc.	Wireways are smooth and free from contact with burrs.	P
	Wire holes in metal well rounded or provided with bushings	All wire holes through metal walls are provided with bushings.	P
	Wiring effectively prevented from coming into contact with moving parts	All wiring is prevented from coming in contact with moving parts.	P
23.2	Beads etc. on live wires cannot change their position, and are not resting on sharp edges or corners	No ceramic insulators are used.	N/A
	Beads inside flexible metal conduits contained within an insulating sleeve	No beads are used on this unit.	N/A
23.3	Electrical connections and internal conductors movable relatively to each other not exposed to undue stress	Electrical connections and internal conductors are movable to each other not exposed to undue stress.	P
	Flexible metallic tubes not causing damage to insulation of conductors	No flexible metallic tubing is used.	N/A
	Open-coil springs not used	Open-coil springs were not used.	P
	Adequate insulating lining provided inside a coiled spring, the turns of which touch one another	No insulated coil springs were used.	N/A
	No damage after 10,000 flexings for conductors flexed during normal use or 100 flexings for conductors flexed during user maintenance	Not Applicable	N/A
	Electric strength test, 1000 V between live parts and accessible metal parts	Not Applicable	N/A
23.4	Bare internal wiring sufficiently rigid and fixed	No bare internal wiring was used within the enclosure.	P
23.5	The insulation of internal wiring withstanding the electrical stress likely to occur in normal use	Insulation is sufficient for its intended use.	P
	No breakdown when a voltage of 2000 V is applied for 15 min between the conductor and metal foil wrapped around the insulation	Not test required.	N/A
23.6	Sleeving used as supplementary insulation on internal wiring retained in position by positive means	No supplementary heating is used.	P
23.7	The colour combination green/yellow used only for earthing conductors	Green conductor used only for grounding conductors.	P
23.8	Aluminum wires not used for internal wiring	Aluminum wires are not used for internal wiring.	P

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
23.9	No lead-tin soldering of stranded conductors where they are subject to contact pressure, unless clamping means so constructed that there is no risk of bad contact due to cold flow of the solder	No tin-lead soldering of stranded conductors.	P
23.10	The insulation and sheath of internal wiring, incorporated in external hoses for the connection of an appliance to the water mains, at least equivalent to that of light polyvinyl chloride sheathed flexible cord (60227 IEC 52) (IEC 60335-1:2010)	No internal wiring to be incorporated in external hoses.	N/A

24	COMPONENTS		——
24.1	Components comply with safety requirements in relevant IEC standards	All components are CE compliant or CE declared.	P
	List of components	Information was provided that shows components are CE compliant or are declared CE compliant for their intended use within the end product.	P
	Components not tested and found to comply with relevant IEC standard for the number of cycles specified are tested in accordance with 24.1.1 to 24.1.6	Not Applicable	N/A
	Components not tested and found to comply with relevant IEC standard, components not marked or not used in accordance with its marking, tested under the conditions occurring in the appliance	Not Applicable	N/A
	Motor-compressors not required to be tested according to IEC 60335-2-34 (not necessary to meet all requirements of IEC 60335-2-34) (IEC 60335-2-40:2005)	Not Applicable	N/A
24.1.1	Capacitors likely to be permanently subjected to the supply voltage and used for radio interference suppression or for voltage dividing, complying with IEC 60384-14, or	Not Applicable	N/A
	tested according to annex F	Not Applicable	N/A
24.1.2	Safety isolating transformers complying with IEC 61558-2-6, or	Not Applicable	N/A
	tested according to annex G	Not Applicable	N/A
24.1.3	Switches complying with IEC 61058-1, the number of cycles of operation being at least 10,000, or	Not Applicable	N/A

Clause	Requirement – Test	Result	Verdict
	tested according to annex H	Not Applicable	N/A
	If the switch operates a relay or contactor, the complete switching system is subjected to the test	Not Applicable	N/A
24.1.4	Automatic controls complying with IEC 60730-1 with relevant part 2. The number of cycles of operation being:		——
	- thermostats: 10,000	Not Applicable	N/A
	- temperature limiters: 1,000	Not Applicable	N/A
	- self-resetting thermal cut-outs (IEC 60335-2-40:2005): 3,000	Not Applicable	N/A
	- voltage maintained non-self-resetting thermal cut-outs: 1,000	Not Applicable	N/A
	- other non-self-resetting thermal cut-outs: (IEC 60335-2-40:2005): 300	Not Applicable	N/A
	- timers: 3,000	Not Applicable	N/A
	- energy regulators :10,000	Not Applicable	N/A
	- thermostats which control motor-compressor (IEC 60335-2-40:2005): 100,000	Not Applicable	N/A
	- motor-compressor starting relays (IEC 60335-2-40:2005): 100,000	Not Applicable	N/A
	- automatic thermal motor-protectors for hermetic and semi-hermetic type motor-compressors (IEC 60335-2-40:2005): Min 2,000	Not Applicable	N/A
	- manual reset thermal motor-protectors for hermetic and semi-hermetic type motor-compressors (IEC 60335-2-40:2005): 50	Not Applicable	N/A
	- other automatic thermal motor protectors (IEC 60335-2-40:2005): 2,000	Not Applicable	N/A
	- other manual reset thermal motor protectors (IEC 60335-2-40:2005): 30	Not Applicable	N/A
	Thermal motor protectors are tested in combination with their motor under the conditions specified in Annex D (IEC 60335-1:2010)	Not Applicable	N/A
	For water valves containing live parts and that are incorporated in external hoses for connection of an appliance to the water mains, the degree of protection declared for subclause 6.5.2 of IEC 60730-2-8 is IPX7 (IEC 60335-1:2010)	Not Applicable	N/A

Clause	Requirement – Test	Result	Verdict
24.1.5	Appliance couplers complying with IEC 60320-1	Not Applicable	N/A
	However, appliances classified higher than IPX0, the appliance couplers complying with IEC 60320-2-3	Not Applicable	N/A
	Interconnection couplers complying with IEC 60320-2-2	Not Applicable	N/A
24.1.6	Small lamp holders similar to E10 lampholders complying with IEC 60238, the requirements for E10 lampholders being applicable	Not Applicable	N/A
24.1.7	If the remote operation of the appliance is via a telecommunication network, the relevant standard for the telecommunication interface circuitry in the appliance is IEC 62151.	Informative	Info
24.1.8	The relevant standard for thermal links is IEC 60691. Thermal links that do not comply with IEC 60691 are considered to be an intentionally weak part for the purposes of Clause 19.	Informative	Info
24.1.9	Contactors and relays, other than motor starting relays, are tested as part of the appliance. However, they are also tested in accordance with Clause 17 of IEC 60730-1 under the maximum load conditions occurring in the appliance for at least the number of cycles of operation in 24.1.4 selected according to the contactor or relay function in the appliance.	Informative	Info
24.2	No switches or automatic controls in flexible cords	Not Applicable	N/A
	No devices causing the protective device in the fixed wiring to operate in the event of a fault in the appliance	Not Applicable	N/A
	No thermal cut-outs that can be reset by soldering	Not Applicable	N/A
24.3	Switches intended for all-pole disconnection of stationary appliances are directly connected to the supply terminals and having a contact separation in all poles, providing full disconnection under overvoltage category III conditions	No switches are used.	N/A
24.4	Plugs and socket-outlets for extra-low voltage circuits and heating elements, not interchangeable with plugs and socket-outlets listed in IEC 60083 or IEC 60906-1 or with connectors and appliance inlets complying with the standard sheets of IEC 60320-1	Not cord-connected.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
24.5	Capacitors in auxiliary windings of motors marked with their rated voltage and capacitance and used accordingly	Not Applicable	N/A
	Voltage across capacitors in series with a motor winding does not exceed 1.1 times rated voltage, when the appliance is supplied at 1.1 times rated voltage under minimum load	Not Applicable	N/A
24.6	Working voltage of motors connected to the supply mains and having basic insulation that is inadequate for the rated voltage of the appliance, not exceeding 42V.	Unit complies.	P
	In addition, the motors are complying with the requirements of Annex I	Not required	N/A
24.7	Detachable hose-sets for connection of appliances to the water mains, complying with IEC 61770 and supplied with the appliance (IEC 60335-1:2010)	The hose-sets that are used on this unit are not considered detachable type.	N/A
24.8	Motor running capacitors in appliances for which 30.2.3 is applicable and that are permanently connected in series with a motor winding shall not cause a hazard in the event of a capacitor failure.	The capacitors used will be contained within a metallic enclosure that will prevent the emission of flame or molten material resulting from failure of the Capacitor.	P
	The requirement is considered to be met by one or more of the following conditions:	----	----
	– the capacitors are of class of safety protection P2 according to IEC 60252-1;	Not Applicable	N/A
	– the capacitors are housed within a metallic or ceramic enclosure that will prevent the emission of flame or molten material resulting from failure of the capacitor;	The capacitors used will be contained within a metallic enclosure that will prevent the emission of flame or molten material resulting from failure of the Capacitor.	P
	– the distance of separation of the outer surface of the capacitor to adjacent non-metallic parts exceeds 50 mm;	Not Applicable	N/A
	– adjacent non-metallic parts within 50 mm of the outer surface of the capacitor withstand the needle-flame test of Annex E;	Not Applicable	N/A
	– adjacent non-metallic parts within 50 mm of the outer surface of the capacitor are classified as at least V-1 according to IEC 60695-11-10, provided that the test sample used for the classification was no thicker than the relevant part of the appliance.	Not Applicable	N/A
24.101	Replaceable parts of thermal control devices identified by marking (IEC 60335-2-40:2005)	Not Applicable.	N/A

Clause	Requirement – Test	Result	Verdict
25	SUPPLY CONNECTION AND EXTERNAL FLEXIBLE CORDS		——
25.1	Appliance not intended for permanent connection to fixed wiring, means for connection to the supply:		——
	- pins for insertion into socket-outlets	Not cord-connected.	N/A
	- supply cord fitted with a plug may be provided, if (IEC 60335-2-40:2005):	Not cord-connected.	N/A
	• the appliance is only for indoor use	Appliance is intended for outdoor use only.	N/A
	• it is marked with a rating of 25 A or less	Not cord-connected.	N/A
	• it complies with the code requirements of the country where it will be used	Unit will be permanently connected.	N/A
	Appliance inlet not allowed (IEC 60335-2-40:2005)	Not Applicable	N/A
25.2	Appliance shall not be provided with more than one means of connection to the supply mains	Unit is not to be provided with more than one means of connection to the supply mains	P
	Stationary appliance for multiple supply may be provided with more than one means of connection, provided electric strength test of 1250 V for 1 min between each means of connection causes no breakdown	Unit is not provided with more than one means of connection to the supply mains	N/A
25.3	Connection of supply conductors for appliance intended to be permanently connected to fixed wiring possible after the appliance has been fixed to its support	Complies	P
	Appliance provided with a set of terminals for the connection of cables or fixed wiring, cross-sectional areas specified in 26.6	Cross-sectional area complies.	P
	Appliance provided with a set of terminals allowing the connection of a flexible cord	Provided with terminals allowing connection to flexible cord.	P
	Appliance provided with a set of supply leads accommodated in a suitable compartment	Supply leads not provided.	N/A
	Appliance provided with a set of terminals and cable entries, conduit entries, knock-outs or glands, allowing connection of appropriate type of cable or conduit	Unit provides for cable and conduit entries for appropriate type of cable and conduit.	P
25.4	Cable and conduit entries, rated current of appliance not exceeding 16 A, dimensions according to table 10	Dimensions are acceptable for the use it is intended.	P

Clause	Requirement – Test	Result	Verdict
	Introduction of conduit or cable does not reduce clearances or creepage distances below values specified in 29	Conduit or cable introduction does not reduce clearance distances within the enclosure.	P
25.5	Method for assemble supply cord with the appliance:		——
	- type X attachment	Not Applicable	N/A
	- type Y attachment	Not Applicable	N/A
	- type Z attachment, if allowed in part 2	Not Applicable	N/A
	Type X attachment, other than those with a specially prepared cord, not used for flat twin tinsel cords	Not Applicable	N/A
25.6	Plugs fitted with only one flexible cord	Not Applicable	N/A
25.7	Supply cord not lighter than:		——
	- braided cord (60245 IEC 51)	Not Applicable	N/A
	- ordinary tough rubber sheathed cord (60245 IEC 53)	Not Applicable	N/A
	- ordinary polychloroprene sheathed flexible cord (60245 IEC 57) (IEC 60335-1/A1)	Not Applicable	N/A
	- flat twin tinsel cord (60227 IEC 41)	Not Applicable	N/A
	- light polyvinyl chloride sheathed cord (60227 IEC 52), appliance not exceeding 3 kg	Not Applicable	N/A
	- ordinary polyvinyl chloride sheathed cord (60227 IEC 53), appliance exceeding 3 kg	Not Applicable	N/A
	Temperature rise of external metal parts exceeding 75 K, PVC cord not used, unless	Not Applicable	N/A
	appliance so constructed that the supply cord is not likely to touch external metal parts in normal use, or	Not Applicable	N/A
	the supply cord is appropriate for higher temperatures, type Y or type Z attachment used	Not Applicable	N/A
	Supply cords for outdoor use not lighter than polychloroprene sheathed flexible cord (60245 IEC 57) (IEC 60335-2-40:2005)	Not Applicable	N/A
25.8	Nominal cross-sectional area of supply cords according to table 11; rated current (A); cross-sectional area (mm²):	Not cord-connected.	N/A
25.9	Supply cord not in contact with sharp points or edges	Not cord-connected.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
25.10	Green/yellow core for earthing purposes in Class I appliance	Not cord-connected.	N/A
25.11	Conductors of supply cords not consolidated by lead-tin soldering where they are subject to contact pressure, unless clamping means so constructed that there is no risk of bad contacts due to cold flow of the solder	Not cord-connected.	N/A
25.12	Moulding the cord to part of the enclosure does not damage the insulation of the supply cord	Not Applicable	N/A
25.13	Inlet opening so shaped as to prevent damage to the supply cord	Inlet opening is shaped to prevent damage to the supply cord	P
	Unless the enclosure at the inlet opening is of insulation material, a non-detachable lining or bushing complying with 29.3 for supplementary insulation provided	Bushings and strain reliefs are to be used at the inlet opening.	P
	If unsheathed supply cord, a similar additional bushing or lining is required, unless	Not cord-connected.	N/A
	the appliance is class 0	Not Class 0 appliance	N/A
25.14	Supply cords adequately protected against excessive flexing	Not cord-connected.	N/A
	Flexing test:		——
	- applied force (N)	Test not required.	N/A
	- number of flexings	Test not required.	N/A
	The test does not result in:		——
	- short circuit between the conductors	Test not required.	N/A
	- breakage of more than 10% of the strands of any conductor	Test not required.	N/A
	- separation of the conductor from its terminal	Test not required.	N/A
	- loosening of any cord guard	Test not required.	N/A
	- damage, within the meaning of the standard, to the cord or the cord guard	Test not required.	N/A
	- broken strands piercing the insulation and becoming accessible	Test not required.	N/A
25.15	Conductors of the supply cord relieved from strain, twisting and abrasion by use of cord anchorage	Not cord-connected.	N/A
	The cord cannot be pushed into the appliance to such an extent that the cord or internal parts of the appliance can be damaged	Not cord-connected.	N/A

Clause	Requirement – Test	Result	Verdict
	Pull and torque test of supply cord, values shown in table 10: pull (N); torque (not on automatic cord reel) (Nm)	Not cord-connected.	N/A
	Max. 2 mm displacement of the cord, and conductors not moved more than 1 mm in the terminals	Not cord-connected.	N/A
	Creepage distances and clearances not reduced below values specified in 29.1	Not cord-connected.	N/A
25.16	Cord anchorages for type X attachments constructed and located so that:		——
	- replacement of the cord is easily possible	Not a cord-connected unit.	N/A
	- it is clear how the relief from strain and the prevention of twisting are obtained	Not a cord-connected unit.	N/A
	- they are suitable for different types of cord	Not a cord-connected unit.	N/A
	- cord cannot touch the clamping screws of cord anchorage if these screws are accessible, unless separated from accessible metal parts by supplementary insulation	Not a cord-connected unit.	N/A
	- the cord is not clamped by a metal screw which bears directly on the cord	Not a cord-connected unit.	N/A
	- at least one part of the cord anchorage securely fixed to the appliance, unless part of a specially prepared cord	Not a cord-connected unit.	N/A
	- screws which have to be operated when replacing the cord do not fix any other component, if applicable	Not a cord-connected unit.	N/A
	- if labyrinths can be bypassed the test of 25.15 is nevertheless withstood	Not a cord-connected unit.	N/A
	- for Class 0, 0I and I appliances: they are of insulating material or are provided with an insulating lining, unless a failure of the insulation of the cord does not make accessible metal parts live	Not a cord-connected unit.	N/A
	- for Class II appliances: they are of insulating material, or if of metal, they are insulated from accessible metal parts by supplementary insulation	Not a cord-connected unit.	N/A
25.17	Adequate cord anchorages for type Y and Z attachment	Not a cord-connected unit.	N/A
25.18	Cord anchorages only accessible with the aid of a tool, or	Not a cord-connected unit.	N/A
	so constructed that the cord can only be fitted with the aid of a tool	Not a cord-connected unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
25.19	Type X attachment, glands not used as cord anchorage in portable appliances	Not a cord-connected unit.	N/A
	Tying the cord into a knot or tying the cord with string not used	Not a cord-connected unit.	N/A
25.20	Conductors of the supply cord for type Y and Z attachment adequately additionally insulated	Not a cord-connected unit.	N/A
25.21	Space for supply cord for type X attachment or for connection of fixed wiring constructed to permit checking of conductors with respect to correct positioning and connection before fitting any cover, no risk of damage to the conductors when fitting the cover, no contact with accessible metal parts if a conductor becomes loose, etc.	Not a cord-connected unit.	N/A
	For portable appliances, the uninsulated end of a conductor prevented from any contact with accessible metal parts, unless the end of the cord is such that the conductors are unlikely to slip free	Not a portable appliance.	N/A
25.22	Appliance inlet:		——
	- live parts not accessible during insertion or removal	Not a cord-connected unit.	N/A
	- connector can be inserted without difficulty	Not a cord-connected unit.	N/A
	- the appliance is not supported by the connector	Not a cord-connected unit.	N/A
	- is not for cold conditions if temp. rise of external metal parts exceeds 75 K, unless the supply cord is not likely to touch such metal parts	Not a cord-connected unit.	N/A
25.23	Interconnection cords comply with the requirements for the supply cord, except as specified	Not a cord-connected unit.	N/A
	If necessary, electric strength test of 16.3	Not a cord-connected unit.	N/A
25.24	Interconnection cords not detachable without the aid of a tool if compliance with the standard is impaired when they are disconnected	Not a cord-connected unit.	N/A
25.25	Dimensions of pins compatible with the dimensions of the relevant socket-outlet. Dimensions of pins and engagement face in accordance with the relevant plug in IEC 60083	Not a cord-connected unit.	N/A

Clause	Requirement – Test	Result	Verdict
26	TERMINALS FOR EXTERNAL CONDUCTORS		——
26.1	Appliances provided with terminals or equally effective devices for connection of external conductors	Appliance is provided with terminals for connection of external conductors	P
	Terminals only accessible after removal of a non-detachable cover	All terminals are accessible after removal of a non-detachable cover	P
	However, earthing terminals may be accessible if a tool is required to make the connections and means are provided to clamp the wire independently from its connection (IEC 60335-1/A1)	Grounding terminals are accessible as a tool is required to make the connections and means are provided to clamp the wire independently from its connection	P
26.2	Appliances with type X attachment and appliances for connection to fixed wiring provided with terminals in which connections are made by means of screws, nuts or similar devices, unless the connections are soldered	Not a type X attachment.	N/A
	Screws and nuts serve only to clamp supply conductors, except internal conductors, if so arranged that they are unlikely to be displaced when fitting the supply conductors	Screws and nuts serve only to clamp supply conductors.	P
	If soldered connections used, the conductor so positioned or fixed that reliance is not placed on soldering alone	No soldered connections are used.	N/A
	Soldering alone used, barriers provided, clearances and creepage distances satisfactory if the conductor becomes free at the soldered joint	No soldered connections are used.	N/A
26.3	Terminals for type X attachment and for connection to fixed wiring so constructed that the conductor is clamped between metal surfaces with sufficient contact pressure and without damaging the conductor	Not a type X attachment.	N/A
	Terminals for type X attachment and those for connection to fixed wiring so fixed that when tightening or loosening the clamping means:		——
	- the terminal does not loosen	Not a type X attachment.	N/A
	- internal wiring is not subjected to stress	Not a type X attachment.	N/A
	- clearances and creepage distances are not reduced below the values in 29	Not a type X attachment.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	Compliance checked by inspection and by the test of subclause 8.6 of IEC 60999-1, the torque applied being equal to two-thirds of the torque specified. Nominal diameter of thread (mm); screw category; torque (Nm)	Not a type X attachment.	N/A
26.4	Terminals for type X attachment, except those with a specially prepared cord, and those for connection to fixed wiring, no special preparation of conductors required, and so constructed or placed that conductors prevented from slipping out	Not a type X attachment.	N/A
26.5	Terminals for type X attachment so located or shielded that if a wire of a stranded conductor escapes, no risk of accidental connection to other parts that result in a hazard	Not a type X attachment.	N/A
	Stranded conductor test, 8 mm insulation removed	Not a type X attachment.	N/A
	No contact between live parts and accessible metal parts and, for class II constructions, between live parts and metal parts separated from accessible metal parts by supplementary insulation only	Not a type X attachment.	N/A
26.6	Terminals for type X attachment and for connection to fixed wiring suitable for connection of conductors with required cross-sectional area according to table 13; rated current (A); nominal cross-sectional area (mm^2) .	Not a type X attachment.	N/A
	Terminals only suitable for a specially prepared cord	Not a type X attachment.	N/A
26.7	Terminals for type X attachment accessible after removal of a cover or part of the enclosure	Not a type X attachment.	N/A
26.8	Terminals for the connection to fixed wiring, including the earthing terminal, located close to each other	Terminals for the connection to fixed wiring, including the earthing terminal, are located close to each other	P
26.9	Terminals of the pillar type constructed and located as specified	No terminals of the pillar type used.	N/A
26.10	Terminals with screw clamping and screwless terminals not used for flat twin tinsel cords, unless conductors ends fitted with a device suitable for screw terminals	Not Applicable	N/A
	Pull test of 5 N to the connection	No test required.	N/A
26.11	For type Y and Z attachment: soldered, welded, crimped and similar connections may be used	Not a type Y and Z attachment unit.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	For Class II appliances: the conductor so positioned or fixed that reliance is not placed on soldering, welding or crimping alone	Not a class II appliance.	N/A
	For Class II appliances: soldering, welding or crimping alone used, barriers provided, clearances and creepage distances satisfactory if the conductor becomes free	Not a class II appliance.	N/A

27	PROVISION FOR EARTHING		——
27.1	Accessible metal parts of Class 0I and I appliances, permanently and reliably connected to an earthing terminal or contact of the appliance inlet	Unit is reliably connected to a grounded terminal.	P
	Earthing terminals not connected to neutral terminal	Earthing terminals are not connected to neutral terminal	P
	Class 0, II and III appliance have no provision for earthing	Not Applicable	N/A
	Safety extra-low voltage circuits not earthed, unless protective extra-low voltage circuits	Safety extra-low voltage circuits were not grounded.	P
27.2	Clamping means adequately secured against accidental loosening	Clamping means is adequately secured against accidental loosening	P
	Terminals used for the connection of external equipotential bonding conductors allow connection of conductors of 2.5 to 6 mm², and	Terminals used in the control boxes comply.	P
	do not provide earthing continuity between different parts of the appliance	Terminals do not provide grounding continuity between different parts.	P
	Conductors cannot be loosened without the aid of a tool	Conductors cannot be loosened without the aid of a tool.	P
27.3	For detachable parts that are plugged into another part of the appliance, and having an earth connection, the earth connection made before and separated after current-carrying connections when removing the part (IEC 60335-1/A1)	No detachable parts are used.	N/A
	For appliances with supply cord, current-carrying conductors become taut before earthing conductor, if the cord slips out of the cord anchorage	Not cord-connected.	N/A

Clause	Requirement – Test	Result	Verdict
27.4	No risk of corrosion resulting from contact between metal of earthing terminal and other metal	No risk of corrosion resulting from contact between grounding terminal metal and other metal.	P
	Adequate resistance to corrosion of coated or uncoated parts providing earthing continuity, other than parts of a metal frame or enclosure	There is adequate resistance to corrosion of uncoated parts providing grounding continuity.	P
	Parts of steel providing earthing continuity provided at the essential areas with an electroplated coating, thickness at least 5 µm	Legs are made of copper.	P
	Adequate protection against rusting of parts of coated or uncoated steel, only intended to provide or transmit contact pressure	There is adequate resistance to corrosion of uncoated parts providing grounding continuity.	P
	In case of aluminium alloys precautions taken to avoid risk of corrosion	Unit does not use aluminium alloys, terminals are made of steel.	N/A
27.5	Low resistance of connection between earthing terminal and earthed metal parts	There is low resistance between grounding terminal and grounded metal parts.	P
	This requirement does not apply to connections providing earthing continuity in the protective extra-low voltage circuit, provided that clearances of basic insulation are based on the rated voltage of the appliance	Not Applicable	N/A
	Resistance not exceeding 0.1 Ω at the specified low-resistance test	Test not required.	N/A
27.6	The printed conductors of printed circuit boards not used to provide earthing continuity in hand held appliances	This unit that utilizes printed circuit boards are not considered a hand held appliance.	N/A
	They may be used in other appliances if:		——
	- at least two tracks are used with independent soldering points and the appliance complies with requirements of 27.5 for each circuit	Not Applicable	N/A
	- the material of the printed circuit board complies with IEC 60249-2-4 or IEC 60249-2-5	Not Applicable	N/A

28	SCREWS AND CONNECTIONS		——
28.1	Fixings, electrical connections and connections providing earthing continuity withstand mechanical stresses	Fixings, electrical connections and connections providing earthing continuity will withstand mechanical stresses	P

Clause	Requirement – Test	Result	Verdict
	Screws not of soft metal liable to creep, such as zinc or aluminium	Screws are not made of soft metal liable to creep, such as zinc or aluminium	P
	Diameter of screws of insulating material min. 3 mm	Diameter of screws of insulating material are a minimum of 3 mm	P
	Screws of insulating material not used for any electrical connection or connections providing earthing continuity	No screws of insulating materials are used for any electrical connections or connections providing earthing continuity.	P
	Screws used for electrical connections or connections providing earthing continuity screw into metal	Complies	P
	Screws not of insulating material if their replacement by a metal screw can impair supplementary or reinforced insulation	Complies	P
	Type X attachment, screws to be removed for replacement of supply cord or for user maintenance, not of insulating material if their replacement by a metal screw can impair basic insulation	Not a type X attachment.	N/A
	For screws and nuts; test as specified	No test required.	N/A
28.2	Electrical connections and connections providing earthing continuity constructed so that contact pressure not transmitted through insulating material liable to shrink or distort, unless shrinkage or distortion compensated	Complies	P
	This requirement does not apply to electrical connections in circuits carrying a current not exceeding 0.5A	Complies	P
28.3	Space-threaded (sheet metal) screws only used for electrical connections if they clamp the parts together	Complies	P
	Thread-cutting (self-tapping) screws only used for electrical connections if they generate a full form standard machine screw thread	Not Applicable	N/A
	Such screws not used if they are likely to be operated by the user or installer unless the thread is formed by a swaging action	Not Applicable	N/A
	Thread-cutting and space-threaded screws may be used in connections providing earthing continuity, provided unnecessary to disturb the connection and at least two screws are used for each connection	Not Applicable	N/A

Clause	Requirement – Test	Result	Verdict
28.4	Screws and nuts that make mechanical connection secured against loosening if they also make electrical connections or connections providing earthing continuity	No screws or nuts that make mechanical connection against loosening are used that make electrical connections or connections providing earthing continuity.	N/A
	Rivets for electrical connections or connections providing earthing continuity secured against loosening if subjected to torsion	No rivets used.	N/A

29	CLEARANCES, CREEPAGE DISTANCES AND SOLID INSULATION		——
	Clearances, creepage distances and solid insulation withstand electrical stress	Complies	P
	For coatings used on printed circuits boards to protect the microenvironment (Type A) or to provide basic insulation (Type B), annex J applies (IEC 60335-1:2010)	Not Applicable	N/A
	The microenvironment is pollution degree 1 under Type A coating (IEC 60335-1:2010)	Not Applicable	N/A
	No creepage distance or clearance requirements under Type B coating (IEC 60335-1:2010)	Not Applicable	N/A
	For motor-compressor complies with IEC 60335-2-34, parts related not checked (IEC 60335-2-40:2005)	Motor-compressor is CE marked.	P
	For motor-compressor not complying with IEC 60335-2-34, additions and modifications as specified (IEC 60335-2-40:2005)	Motor-compressor is CE marked.	P
29.1	Clearances not less than the values specified in Table 16, taking into account the rated impulse voltage for the overvoltage categories of Table 15, unless for basic insulation and functional insulation, they comply with the impulse voltage test of clause 14 (IEC 60335-1:2010)	Testing not required.	N/A
	However, if construction is affected by wear, distortion, movement of the parts or during assembly, the clearances for rated impulse voltages of 1500V and above are increased by 0.5mm and the impulse voltage test is not applicable (IEC 60335-1:2010)	Testing not required.	N/A
	Impulse voltage test not applicable:	(IEC 60335-1:2010)	——
	- when the microenvironment is pollution degree 3 (IEC 60335-1:2010)	Not Applicable	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	- for basic insulation of class 0 and class 0I appliances (IEC 60335-1:2010)	Not a class 0 or class 01 appliance.	N/A
	Appliances are in overvoltage category II	Not Applicable	N/A
	Compliance is checked by inspection and measurements as specified	Not Applicable	N/A
29.1.1	Clearances of basic insulation withstand the overvoltages, taking into account the rated impulse voltage	No insulations are used within the unit.	N/A
	Clearance at the terminals of tubular sheathed heating elements may be reduced to 1mm if the microenvironment is pollution degree 1	No electric heat is used.	N/A
	Lacquered conductors of windings considered to be bare conductors (IEC 60335-1:2010)	Informative	N/A
29.1.2	Clearances of supplementary insulation not less than those specified for basic insulation in table 16	No insulations are used within the unit.	N/A
29.1.3	Clearances of reinforced insulation not less than those specified for basic insulation in table 16, but using the next higher step for rated impulse voltage	No reinforced insulations were used on this unit.	N/A
29.1.4	For functional insulation, the values of table 16 are applicable, unless the appliance complies with clause 19 with the functional insulation short-circuited	No insulations are used on this unit.	N/A
	Lacquered conductors of windings considered to be bare conductors (IEC 60335-1:2010)	Informative	N/A
	However, clearances at crossover points are not measured	No crossover points detected.	N/A
	Clearance between surfaces of PTC heating elements may be reduced to 1mm	Not Applicable	N/A
	Lacquered conductors of windings assumed to be bare conductors, but the clearances specified in table 16 are reduced by 0.5mm for rated impulse voltages of at least 1500V	Not Applicable	N/A
29.1.5	Appliances having higher working voltage than rated voltage, the voltage used for determining clearances from table 16 is the sum of the rated impulse voltage and the difference between the peak value of the working voltage and the peak value of the rated voltage	Not Applicable	N/A

Clause	Requirement – Test	Result	Verdict
	If the secondary winding of a step-down transformer is earthed, or if there is an earthed screen between the primary and secondary windings, clearances of basic insulation on the secondary side not less than those specified in table 16, but using the next lower step for rated impulse voltage	Not Applicable	N/A
	Circuits supplied with a voltage lower than rated voltage, clearances of functional insulation based on the working voltage used as the rated voltage in table 15	Not Applicable	N/A
29.2	Creepage distances not less than those appropriate for the working voltage, taking into account the material group and the pollution degree	Not Applicable	N/A
	Pollution degree 2 applies, unless	Not Applicable	N/A
	precautions taken to protect the insulation; pollution degree 1	Not Applicable	N/A
	insulation subjected to conductive pollution; pollution degree 3	Not Applicable	N/A
	Compliance is checked by inspection and measurements as specified	Not Applicable	N/A
	Insulation located in airflow, pollution degree 3 unless (IEC 60335-2-40:2005)	Not Applicable	N/A
	Insulation enclosed or located so that unlikely to be exposed to pollution due to normal use (IEC 60335-2-40:2005)	Not Applicable	N/A
29.2.1	Creepage distances of basic insulation not less than specified in table 17	Not Applicable	N/A
	For pollution degree 1, creepage distance not less than the minimum specified for the clearance in table 16, if the clearance has been checked according to the test of clause 14	Not Applicable	N/A
29.2.2	Creepage distances of supplementary insulation at least as specified for basic insulation in table 17	Not Applicable	N/A
29.2.3	Creepage distances of reinforced insulation at least double as specified for basic insulation in table 17	Not Applicable	N/A
29.2.4	Creepage distances of functional insulation not less than specified in table 18	Not Applicable	N/A
	Creepage distances may be reduced if the appliance complies with clause 19 with the functional insulation short-circuited	Not Applicable	N/A

Clause	Requirement – Test	Result	Verdict
29.3	Supplementary and reinforced insulation having adequate thickness, or a sufficient number of layers, to withstand the electrical stresses (IEC 60335-1:2010)	Not Applicable	N/A
	Compliance checked by:		——
	- measurement, in accordance with 29.3.1, or	Not Applicable	N/A
	- an electric strength test in accordance with 29.3.2, or	No testing required.	N/A
	- an assessment of the thermal quality of the material combined with an electric strength test, in accordance with 29.3.3	No testing required.	N/A
29.3.1	Supplementary insulation having a thickness of at least 1mm (IEC 60335-1:2010)	Not Applicable	N/A
	Reinforced insulation having a thickness of at least 2mm (IEC 60335-1:2010)	Not Applicable	N/A
29.3.2	Each layer of material withstand the electric strength test of 16.3 for supplementary insulation (IEC 60335-1:2010)	Not Applicable	N/A
	Supplementary insulation consisting of at least 2 layers (IEC 60335-1:2010)	Not Applicable	N/A
	Reinforced insulation consisting of at least 3 layers	Not Applicable	N/A
29.3.3	The insulation is subjected to the dry heat test Bb of IEC 60068-2-2, followed by (IEC 60335-1:2010)	Test not required.	N/A
	the electric strength of 16.3 (IEC 60335-1:2010)	Test not required.	N/A
	If the temperature rise during the tests of Clause 19 does not exceed the value specified in Table 3, the test of IEC 60068-2-2 is not carried out (IEC 60335-1:2010)	Test not required.	N/A

30	RESISTANCE TO HEAT AND FIRE		——
30.1	External parts of non-metallic material,	No external parts are made of non-metallic material.	N/A
	parts supporting live parts, and	Complies	P
	thermoplastic material providing supplementary or reinforced insulation,	No thermoplastic material used.	N/A
	sufficiently resistant to heat	Complies	P
	Ball-pressure test according to IEC 60695-10-2	No test required.	N/A

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	External parts: at 40 °C plus the maximum temperature rise determined during the test of clause 11, or at 75 °C, whichever is the higher; temperature (°C)...	Not Applicable	N/A
	Parts supporting live parts: at 40°C plus the maximum temperature rise determined during the test of clause 11, or at 125°C, whichever is the higher; temperature (°C)	Not Applicable	N/A
	Parts of thermoplastic material providing supplementary or reinforced insulation, 25°C plus the maximum temperature rise determined during clause 19, if higher; temperature (°C)	Not Applicable	N/A
30.2	Relevant parts of non-metallic material adequately resistant to ignition and spread of fire	All parts of non-metallic material are resistant to ignition and spread of fire.	P
30.2.1	Glow-wire test of IEC 60695-2-11 at 550 °C, unless	No test required.	N/A
	the material is classified at least HB40 according to IEC 60695-11-10	No test required.	N/A
	Parts for which the glow-wire test cannot be carried out meet the requirements in ISO9772 for category HBF material (IEC 60335-1:2010)	No test required.	N/A
30.2.2	Not applicable (IEC 60335-2-40:2005)	Not Applicable	N/A
30.2.3	Appliances operated while unattended, tested as specified in 30.2.3.1 and 30.2.3.2	No testing required.	N/A
	Test not applicable to conditions as specified	No testing required.	N/A
30.2.3.1	Parts of insulating material supporting connections carrying a current exceeding 0.2A during normal operation, and	No testing required.	N/A
	parts of insulating material within a distance of 3mm,	No testing required.	N/A
	having a glow-wire flammability index of at least 850°C according to IEC 60695-2-12	No testing required.	N/A
30.2.3.2	Parts of insulating material supporting current-carrying connections, and parts of insulating material within a distance of 3mm, subjected to glow-wire test of IEC 60695-2-11	Test not required	N/A
	Test not carried out on material having a glow-wire ignition temperature according to IEC 60695-2-13 as specified	Test not required	N/A
	Glow-wire test of IEC 60695-2-11, the temperature being:		——

IEC / EN 60335-1 & 60335-2-40			
Clause	Requirement – Test	Result	Verdict
	-750°C, for connections carrying a current exceeding 0,2A during normal operation	Test not required	N/A
	-650°C, for other connections	Test not required	N/A
	Parts that during the test produce a flame persisting longer than 2 s, tested as specified	Test not required	N/A
	If a flame persists longer than 2 s during the test, parts above the connection, as specified, subjected to the needle-flame test of annex E, unless	Test not required	N/A
	the material is classified as V-0 or V-1 according to IEC 60695-11-10	Test not required	N/A
30.2.4	Base material of printed circuit boards subjected to needle-flame test of annex E	Test not required.	N/A
	Test not applicable to conditions as specified	Not Applicable	N/A

31	RESISTANCE TO RUSTING		——
	Relevant ferrous parts adequately protected against rusting	Relevant parts are adequately protected against rusting.	P
	Salt mist test of IEC 60068-2-52, severity 2 (IEC 60335-2-40:2005)	Testing not required.	N/A
	Before test, coatings are scratched by means of a harden steel pin as specified (IEC 60335-2-40:2005)	Testing not required.	N/A
	Five scratches made at least 5mm apart and at least 5mm from the edges (IEC 60335-2-40:2005)	Testing not required.	N/A
	Appliance not deteriorated to such an extent that compliance with cl. 8 and cl. 27 is impaired (IEC 60335-2-40:2005)	Testing not required.	N/A
	Coating not be broken and not loosened from the metal surface (IEC 60335-2-40:2005)	Testing not required.	N/A

32	RADIATION, TOXICITY AND SIMILAR HAZARDS		——
	Appliance does not emit harmful radiation	Appliance does not emit harmful radiation	P
	Appliance does not present a toxic or similar hazard	Appliance did not present a toxic or similar hazard	P

Input Test – Clause 10 **Pass:** ☒ **Fail:** ☐

Test Purpose:

To determine that the power input to the device as measured under the conditions of normal use does not exceed the marked rating by more than the values in table 1 and table 2

Test Parameters:

Motor protective devices or limit cutouts shall not trip during the test. The unit is to be operated continuously until temperatures are constant. Temperatures, pressures, and electrical loads are to be measured when unit temperatures become stable. The unit is to be loaded with the conditions listed in the tables below.

Load Conditions:

Unit Ran in COOLING Mode

Normal operating conditions: 104°F/40°C(±2°F) DB, 80°F/26.7°C(±1°F) WB

Water Flow – As specified by manufacturer. (12 GPM)

Water Inlet Temp. – At maximum as possible for the application. (27.35°C)

Unit Rated Voltage	Test Voltage[a]
200-220 V	200V
[a]Tolerance shall be ±2%	

Test Results: Unit ran at 230V, 50hz

Electrical Circuit being measured.	Measured Ratings				Marking Plate Ratings	
	Voltage	Amps			Voltage	Amps
		Leg 1	Leg 2	Leg 3		
Fan Motor	200	1.4	1.4	N/A	200-220	1.9
Compressor	200	16.6	16.9	16.6	200-220	23.9
Total	200	20.3	20.5	20.2	200-220	28.8

To Comply:

1) The marked unit ratings shall not deviate more than specified in table 1 or 2 of the standard which is 15% for this type of appliance.

Intertek Comments:

☒ The product complies with all applicable requirements of this test.

☐ The product does not comply with the requirements of this test.

Test Date: 5/13/2014

Tested By: TH

Heading Test – (clause 11) **Pass:** ☐ **Fail:** ☐

Test Purpose:

To determine that the maximum temperatures and pressures of the unit do not exceed the values specified in table 3 of the above standard

Test Parameters:

Motor protective devices shall not trip during the test. Limit cutouts shall not trip during the test. The unit is to be operated continuously until temperatures are constant. Temperatures, pressures, and electrical loads are to be measured when unit temperatures become stable. The unit is to be loaded with the conditions listed in the tables below. For units without a storage tank, the water flow rate through the unit shall be reduced with the regulating thermostat bypassed. The unit is then operated continuously until temperatures and pressures are stabilized.

Load Conditions:

Unit Ran in COOLING Mode

Normal operating conditions: 104°F/40°C(±2°F) DB, 80°F/26.7°C(±1°F) WB

Water Flow – As specified by manufacturer. (12 GPM)

Water Inlet Temp. – At maximum as possible for the application. (27.35°C)

Unit Rated Voltage	Test Voltage[a]
200 – 220V	.94 times the lowest rated voltage – 188V 1.06 times the highest rated voltage - 233V
[a]Tolerance shall be ±2%	

Test Results: Unit ran at 188 Volts						
Electrical Circuit being measured.	Measured Ratings				Marking Plate Ratings	
	Voltage	Amps			Voltage	Amps
		Leg 1	Leg 2	Leg 3		
Fan Motor	**188**	**1.6**	**1.7**	**N/A**	**200-220**	**1.9**
Compressor	**189**	**23.5**	**23.5**	**23.4**	**200-220**	**23.9**
Total	**189**	**27.9**	**27.7**	**27.7**	**200-220**	**28.8**

Ch#	Thermocouple Location	Measured Maximum Temp (°C)	Maximum Allowable Temp (°C)
1	Compressor Top	81.6	N/A
2	Compressor Middle	47.4	N/A
3	Compressor Bottom	58.2	N/A
4	Compressor Line One	47.1	90
5	Main Line one	48.3	90
6	Water Pump Motor Line One	44.1	90
7	Contactor	50.1	N/A
8	Fan Relay	62.5	N/A
9	Transformer	70.8	N/A
10	Fuse	45.8	N/A
11	Fan Motor Capacitor	41.6	45
12	Water Pump Motor	45.4	N/A
13	Fan Line One	52.6	90
14	Fan Motor	99.6	125
15	Suction Temp.	3.0	N/A
16	Discharge Temp.	31.1	N/A

Pressure:	
High Pressure (psi)	**Low Pressure (psi)**
240 PSI	90 PSI

233V, 50Hz.

Test Results:						
Electrical Circuit being measured.	**Measured Ratings**				**Marking Plate Ratings**	
	Voltage	**Amps**			**Voltage**	**Amps**
		Leg 1	**Leg 2**	**Leg 3**		
Fan Motor	**233**	**1.2**	**1.2**	**N/A**	**200-220**	**1.9**
Compressor	**233**	**12.7**	**12.5**	**11.5**	**200-220**	**23.9**
Total	**233**	**15.4**	**14.4**	**12.0**	**200-220**	**28.8**

Ch#	Thermocouple Location	Measured Maximum Temp (°C)	Maximum Allowable Temp (°C)
1	Compressor Top	86.6	N/A
2	Compressor Middle	51.5	N/A
3	Compressor Bottom	61.0	N/A
4	Compressor Line One	49.1	90
5	Main Line one	51.3	90
6	Water Pump Motor Line One	48.5	90
7	Contactor	56.3	N/A
8	Fan Relay	66.5	N/A
9	Transformer	79.6	N/A
10	Fuse	46.4	N/A
11	Fan Motor Capacitor	44.6	45
12	Water Pump Motor	45.9	90
13	Fan Line One	54.4	90
14	Fan Motor	104.9	125
15	Suction Temp.	6.2	N/A
16	Discharge Temp.	37.7	N/A

Pressure:	
High Pressure (psi)	**Low Pressure (psi)**
250 PSI	95 PSI

To Comply:

1) The unit shall not attain temperatures at any point sufficiently high enough to constitute a risk of fire or to damage any materials employed in the equipment.

2) The unit shall not attain temperatures that exceed temperatures specified above .

3) The measure test pressures shall be within the unit's ratings.

Intertek Comments:

☒ The product complies with all applicable requirements of this test.

☐ The product does not comply with the requirements of this test.

Test Date: 5/13/2014

Tested By: TH

Electric Strength at operating temperature: CE (13.3) **Pass:** ☒ **Fail:** ☐

Test Purpose:

The dielectric strength shall be sufficient to withstand the test voltages.

Test Parameters:

Apply the test voltages as indicated below for 1 minute.

Circuit under test:	Working Voltage	Applied Voltage	Pass/Fail
Line One to Ground	200-220VAC	1414VDC	Pass
Line Two to Ground	200-220VAC	1414VDC	Pass
Line Three to Ground	200-220VAC	1414VDC	Pass

To Comply:

During the test no breakdown shall occur. Leakage shall not exceed 0.75mA.

Intertek Comments:

☒ The product complies with all applicable requirements of this test.

☐ The product does not comply with the requirements of this test.

Test Date: 5/14/2014

Tested By: TH

Abnormal operation CE (19.5) – Water Failure Test **Pass:** ☒ **Fail:** ☐

Test Purpose:
To determine that the refrigerant pressure shall not exceed 1/5 of the pressure that the system is capable of withstanding without failure and that any part of the compressor shell shall not exceed 302°F.

Test Parameters:
The heat pump water heater shall operate in accordance with applicable CE clauses until all conditions have stabilized. The water flow shall then be restricted or stopped.

Load Conditions:
Voltage- as specified in table below Ambient Conditions-104°F/40°C(±2°F) DB, 80°F/26.7°C(±1°F) WB Water flow Rate- rated as specified by manufacturer (12 GPM) Water inlet Temperature- Maximum possible for application (80.4°F)

Unit Rated Voltage	**Test Voltage**[a]
208/230V	230V
[a]Tolerance shall be ±2%	

Measured Outlet Temperature	**Pass/Fail**
32.27℃	Pass

Results:			
			Pass/Fail
	Manufacture Specified Pressure	Test Pressure	
High Side Pressure	450	280PSI	Pass
Low Side Pressure	240	110PSI	Pass
Compressor maximum shell Temperature (°C)	98.0		Pass

To Comply:

1) The unit shall not attain temperatures at any point sufficiently high enough to constitute a risk of fire or to damage any materials employed in the equipment.

2) The unit shall not attain temperatures that exceed temperatures specified above .

3) The measure test pressures shall be within the units ratings.

Intertek Comments:

☒ The product complies with all applicable requirements of this test.

☐ The product does not comply with the requirements of this test.

Test Date: 5/14/2014

Tested By: TA

24.1	TABLE: Components			
Object / part No.	Manufacturer/ trademark	Type / model	Technical data	Mark(s) of conformity
Contactor	Square D / Schneider Electric	8910DPA33V14	600VAC, 30A, 3-Pole, 50/60Hz., 3-Phase	cULus, CE
Circuit Breaker	Moeller	FAZ-D30/3-NA	480Y/277VAC, 30A, 3-Pole, 50/60Hz.	UL, CSA, CE
Fan Relay	Hartland Controls	HCR Series	24VAC, 12A	cURus
Transformer	Veris Industries	X75CBA	120/240/277/480VAC Primary, 24V Secondary, 50/60Hz., Class 2, 75VA	cULus, CE
3 Phase Monitor	Veris Industries	H922xxxA	600VAC, 50/60Hz., 0-30/60/120A	CE
	Motorsaver	460L	Input 190-480 vac, 50/60 hz, 3phase contact rating general purpose 10A at 240 vac	cULus, CE
Fan Capacitor	Mars	Series 32 / #12005	370VAC, 5Mfd, 50/60Hz.	CE declared
Compressor	Copeland	ZP51K5E-TF5-130	200-220V, 50/60Hz., 3Ph., 13.6A	cURus, CE
Controller	Ice Energy	1395	240VAC, 1.25A	CE declared
Defrost Solenoid Valve Coil	Parker	K1U3	208-240V, 60Hz., 10-15W	UR, CSA, CE
Water Temp. Limit	Sensata	3NT	240VAC, 10A	cULus, CE
Fan Motor	Genteq	5K39HGWWD42S	230V, 1 Phase, 50Hz., 1.9A, Class B Insulation, 1/4 HP, 1100 RPM	UR, CSA, CE
High Pressure Switch	Supco	SMR410	240V, 2.9A, Opens at 410PSI, Manual reset	UR, CE
Low Pressure Switch	Supco	SMR410	240V, 2.9A, Opens at 410PSI, Manual reset	UR, CE
Fuse	Bussmann	FNQ-2 1/2	600VAC, 2.5A, 50/60Hz.	UL, CSA, CE
Fuseblock	Bussmann	HPS	600VAC, 30A, 50/60Hz.	UL, CSA, CE
Water Pump Assembly	Fluid-O-Tech	TMFR Series	220VAC, 250W, min. burst pressure: 1200 psi min.	CE
	Taizhou Yiju Mechanical and Electric Products Co., Ltd.	GRS-SS32/8	220VAC, 50Hz., 1.1A, Class F insulation	CE
Crankcase Heater	Tutco	CH196-3	460VAC, 40W	CSA, CE
Inverter Assembly	Fluid-O-Tech	FEE2DWR1E	200 - 250V, 2.7A, 50/60Hz.	CE
[1] An asterisk indicates a mark which assures the agreed level of surveillance				

SEE ATTACHED COMPONENT LIST PROVIDED.

MULTIMODAL DANGEROUS GOODS FORM

This form maybe used as a dangerous good declaration as it meets the requirements of SOLAS 74, chapter regulation 4; MAROL 73/78, Annex III, regulation 4.

1. Shipper/ Consignor/ Sender	2. Transport document number: 6066662080	
DGM New York on behalf of Ice Energy Inc Bldg T 28 8231 County Route 88 Hammondsport, NY 14840 USA	3. Page 1 of 1 pages	Shipper's Reference no.: 1505044
		5. Freight Forwarder's Reference:
6. Consignee	7. Carrier (to be completed by carrier):	

SCOTTISH & SOUTHERN ENERGY
INVERALMOND HOUSE
200 DUNKELD ROAD PERTH PH1 3AQ UK

SHIPPERS DECLARATION

I hereby declare that the contents of this consignment are fully and accurately described below by the Proper Shipping Name, and are classified, packaged, marked and labeled/ placarded and are in all respects in proper condition for transport according to the applicable international and national governments.

8. This shipment is within limitations prescribed for (Delete non-applicable)

~~PASSGENGER & CARGO AIRCRAFT~~	~~CARGO AIRCRAFT ONLY~~
10. Vessel/flight no and date NYK Meteor/V.040E/5/30/15	11. Port/ Place of Loading Hammondsport, NY
11. Port/ Place of discharge Southhampton UK	12. Destination Perth UK

9. Additional Handling Information

24-hour emergency response company PERS
Contract account DGM New York
Domestic USA: 1-800-728-2482; International: 001-801-629-0667

14. Shipping marks	*Number and kind of packages, description of goods	Gross mass (kg)	Net mass (kg)	Cube (m²)
	UN2857, Refrigerating machines, 2.2, EmS F-C, S-V, 3 Wooden boxes each containing (1) refrigerating machine x 22.7 kg	2680.73 kg G	68.1 kg	

Container identification No. / Vehicle registration No.	16. Seal Number (s)	17. Container vehicle size and type	18. Tare mass (kg)	19. Total gross including tare (kg)
: TCLU4208984	: 0871357//087158	: 40 ft dry container	: 3,600 kg	: 6280.73 kg G

CONTAINER VEHICLE PACKING CERTIFICATE

I hereby declare that the goods described above have been packaged/ loaded into the container/ vehicle identified above in accordance with the applicable provisions

MUST BE COMPLETED AND SIGNED FOR ALL CONTAINER/VEHICLE LOADS BY PERSON RESPONSIBLE FOR PACKING/ LOADING

21. RECEIIVING ORGANIZATION RECEIPT

Received the above number of packages/ container/ trailers in apparent good order and Condition, unless state hereon: RECEIVING ORGANIZATION REMARKS

20. Name of company DGM New York	Hauler's Name:	22. Name of company (shipper preparing this note) DGM New York
Name/Status of Declarant: Eric E. Muller/ DG Specialist	Vehicle registration No.:	Name/Status of Declarant: Eric E. Muller/ dangerous goods specialist
Place and date: Linden, NJ 5/22/2015	Signature and date	Place and date: Linden, NJ May 22, 2015
Signature of Declarant	Signature of Driver	Signature of Declarant ERIC E MULLER

- You must specify: Proper Shipping Name, hazard class, UN No. packing group, (where assigned) marine pollutant and observe the mandatory requirements under applicable national and international governmental regulations. For the purpose of the IMDG Code, see 5.4.1.4
- For the purpose of the IMDG see 5.4.2

Customer A Survey

The space to be cooled is a gym and studio on the first level on the East side of the building. The space is currently served by (2) Mitsubishi split system AC units. The Ice Bear will be located on the North side of the building and set on an existing concrete pad and will be connected to (2) fan coil units to create a parallel cooling system to cool the rooms during the peak hours of the day.

Survey

Gather enough information to provide a bid for a full installation.

- Confirm existing concrete pad is adequate for the Ice Bear
- Confirm power source for Ice Bear
- Determine best fan coil solution for the application. Match size of existing fan coil units in each room.

Plan for a complete installation per the attached scope

Include taking delivery of the Ice Bear units, transporting the site if necessary and setting in place

Ice Energy will provide the following to the contractor

- Site Selection assistance
- Ice Bear 30 units.
- Installation training and support
- Quick connects to interface line-sets to the IB30
- Commissioning of units

Contractor – SCOPE OF WORK:

The Contractor will provide the following materials and services required to complete the installation of the Ice Bear units.

- Engineering service, prints and permitting of the units to include.
    - Electrical
    - Mechanical
    - Structural

- Have Ice Energy's Project manager pre-approve engineering prior to permitting.
- Install new Air Conditioning unit if applicable.
- Install "Ice Coil" either inside of package unit or in series with existing DX coil.
- Install Ice Bear units (roof or ground mount)
- Provide and Install Insulated copper line-sets (1/2" supply, 7/8" return) for refrigerant service to and from the Ice Bear. Leak testing, evacuation and charging of line sets.
- All refrigerant required to complete the project.
- Sheet metal enclosure to protect line sets and wiring.
- Electrical service, conduit and wire, required by the Ice Bear and AC units per mfr. installation manuals.
- Low voltage wiring.
    1. Between Ice Bear and the DX unit it is coupled with, (1) 8 conductor 18 gauge control wire and (1) CAT5 communication wire.
    2. If multiple units are placed at one building, an additional CAT5 is required from Ice Bear to Ice Bear.

- Contractor will be responsible for all activities to install units in compliance with all applicable codes.

Customer D Survey

The space to be cooled is just inside from a well location where the Ice Bear can be installed. The room has a high heat load and at the time of our visit there were plans to install (2) split system cooling units. Ice Bear may be connected to (1) or (2) fan coil units to create a parallel cooling system to cool the room during the peak hours of the day.

Survey

Gather enough information to provide a bid for a full installation.

- Confirm the well has enough space for the Ice Bear and all necessary clearance
- Confirm power source for Ice Bear
- Determine best fan coil solution for the application. Match size of fan coils for the new ac units. May be a single fan coil or dual, wall mounted, ceiling cassette or ducted.

Plan for a complete installation per the attached scope

Include taking delivery of the Ice Bear units, transporting the site if necessary and setting in place

Customer G Survey

The space to be cooled is a computer classroom and adjacent office. The space does not currently have a cooling system. The Ice Bear will be located on the North/East side of the building, a new concrete pad will need to be provided to set it on. The Ice Bear will be connected to (2) fan coil units (1) in each room.

Survey

Gather enough information to provide a bid for a full installation

- Confirm power source for Ice Bear
- Determine best fan coil solution for the application.

Plan for a complete installation

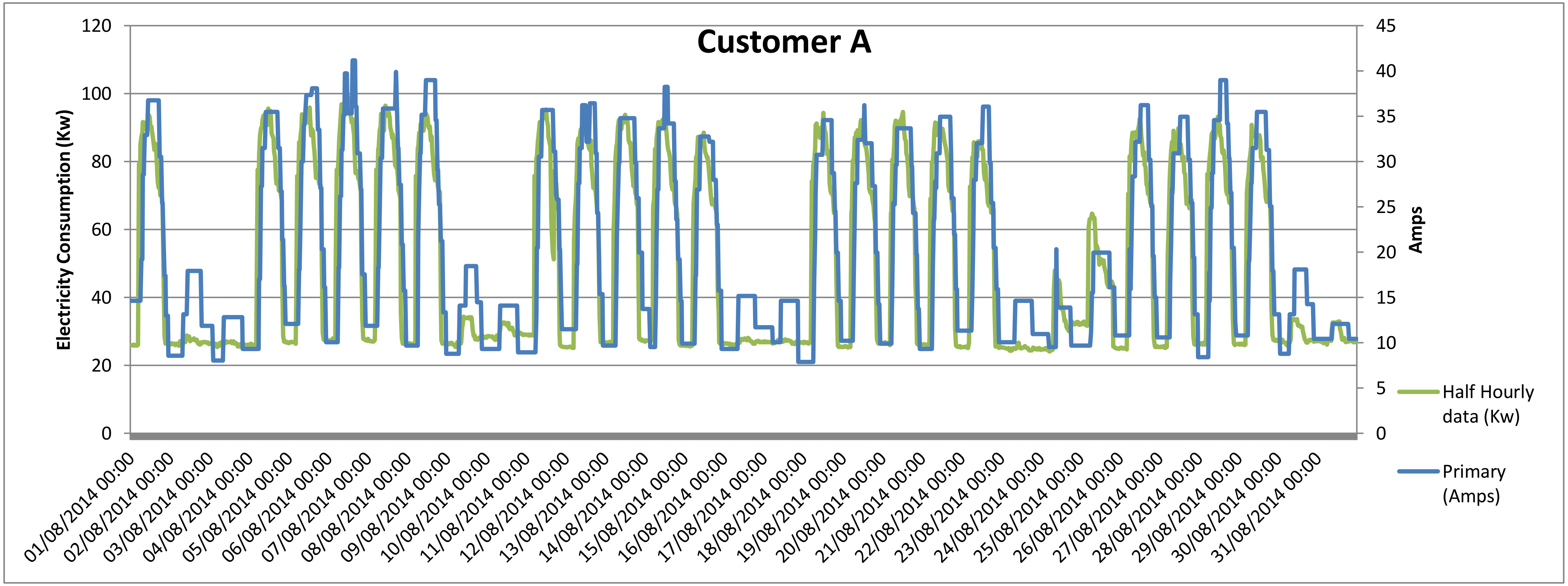
Include taking delivery of the Ice Bear units, transporting to the site if necessary and setting in place

Customer Consumption Profiles

The graphs below show consumption profiles on customers and their relevant substation over 'typical summer months' when Ice Bears were not connected to each customers premises. These graphs were used for preliminarily determination of the operation times for the Ice Bears across summer months.

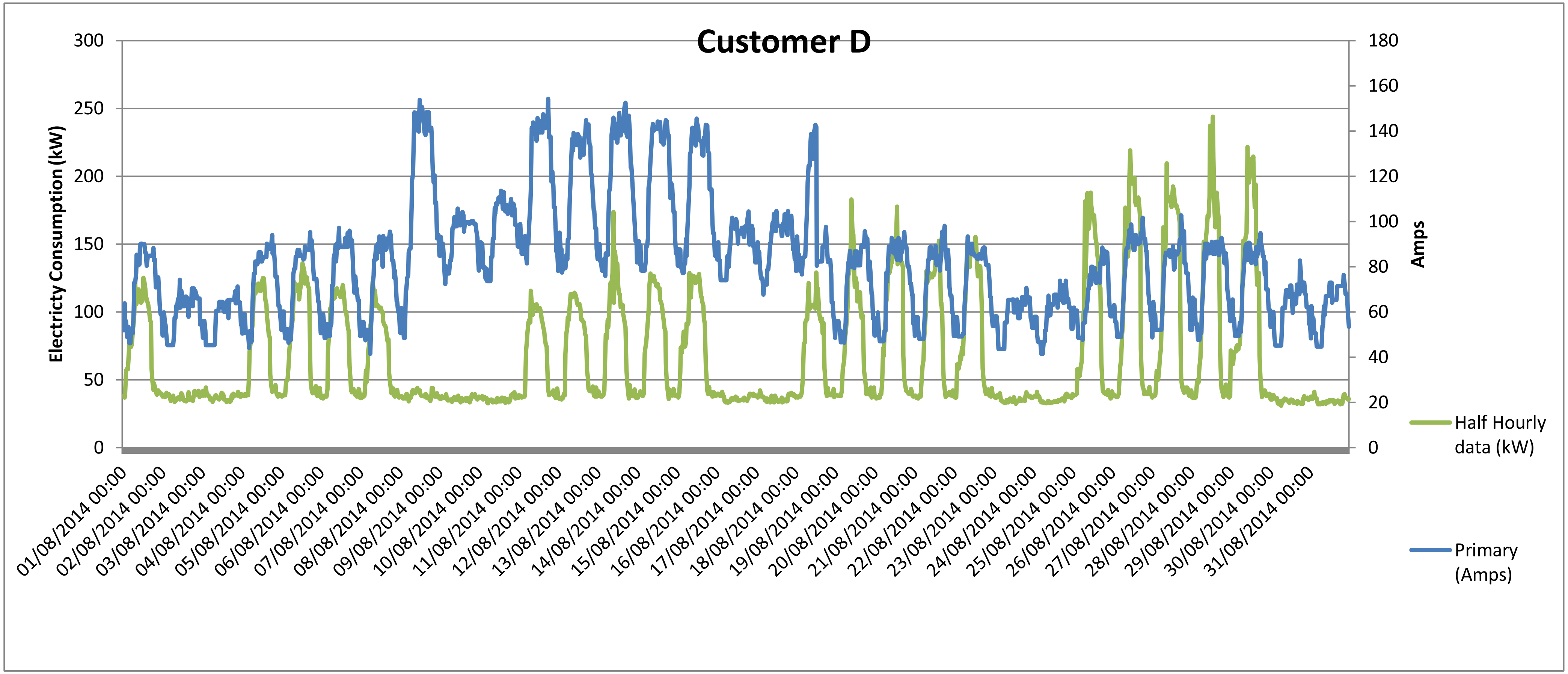
Customer A- consumption profile across the month of August 2014:

- Customer half hourly data displayed in kW in green.
- Secondary substation is single site so would display the same trend as half-hourly
- Primary Substation in amps in blue- no kW readings available on 11kV
- Customers off-peak tariffs from 12:30am-07:30am



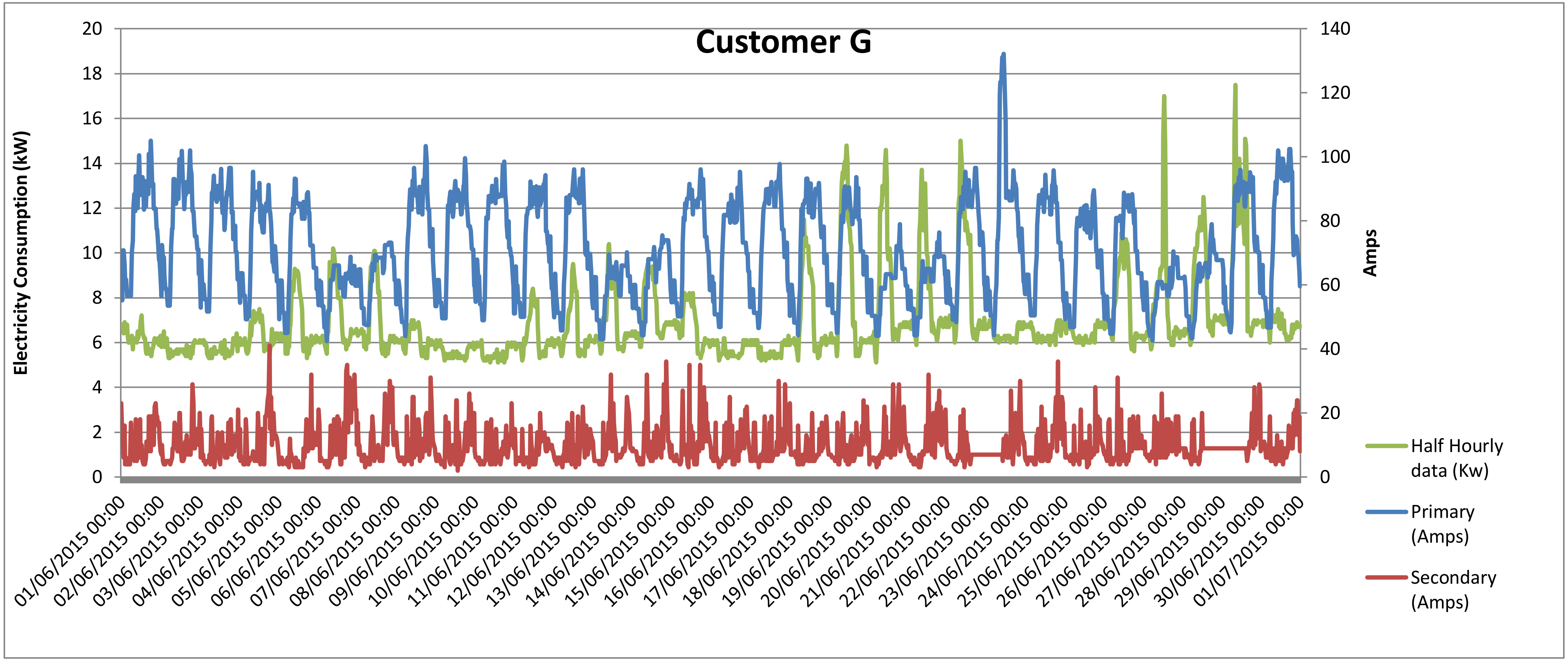
Customer D- consumption profile across the month of August 2014:

- Customer half hourly data displayed in kW in green.
- Secondary substation is single site so would display the same trend as half-hourly
- Primary Substation in amps in blue- no kW readings available on 11kV



Customer G- consumption profile across the month of June 2015 (August not used to avoid school holidays)

- Half hourly data displayed in kW in green.
- Secondary substation is three feeder and highlighted in red
- Primary Substation in amps in blue- no kW readings available on 11kV



LICENSE AGREEMENT

Identification of Parties

1. THIS LICENSE AGREEMENT is entered into by and between _______________________________________ (hereinafter referred to as the "Licensor"), Southern Electric Power Distribution plc, a public limited company, and Ice Energy Holdings Inc., a Delaware corporation (hereinafter referred to as “Ice Energy”). Southern Electric Power Distribution plc and Ice Energy Holdings Inc. shall be referred to herein collectively as the “Licensees.”

Recitals

2. Southern Electric Power Distribution plc (the “Company”) is testing a locally controlled energy storage program to enhance electric system energy efficiency and achieve a permanent peak load shift, hereinafter referred to as the “Ice Bear Program”. Under this Program, Company customers (“Customers”) permit Ice Energy to investigate the feasibility of installing Ice Bear peak load shifting and/or load management equipment (referred to herein as “PLS Equipment,” as further defined below) upon the Customer’s property, and if feasible, installing and maintaining such equipment as deemed appropriate by Licensees.

3. Licensees have offered Licensor the opportunity to participate in the Ice Bear Program, subject to the contingency that Ice Energy will evaluate and confirm that Licensor’s Property is a suitable location for the Equipment. Such determination shall be made at the sole discretion of Licensees. Licensor has agreed to participate in the Ice Bear Program subject to this contingency. Licensor may also have been offered and accepted the opportunity to participate in a related program (the “Demand Response Program”), in which case and only then, this Agreement will include an Exhibit "B", executed by the parties, attached to this Agreement and hereby incorporated by this reference, which will govern the rights and obligations of the parties under the Demand Response Program.

4. Company will retain ownership of the PLS Equipment, but the Customer may utilize such

Equipment during the term of this License to shift the Customer's electrical demand and reduce electrical bills.

5. Licensor has agreed to grant Licensees a License on the terms and conditions set for herein.

Incorporation of Recitals

6. The above recitals are hereby incorporated into and form a part of this Agreement.

Description of Property

7. Licensor is the owner of certain real property situated in the City of _________________, County of ____________________________, State of ______________ commonly known as ____ (hereinafter referred to as the "Property") and more particularly described in Exhibit "A", which is attached to this Agreement and hereby incorporated by this reference.

Grant of License

8. Licensor hereby grants to Licensees and their respective contractors, subcontractors and agents, a license (hereinafter referred to as the "License") to perform the following acts on the Property: the construction, installing, operating, maintaining, replacing, upgrading and/or removing the PLS Equipment and necessary appurtenances attached thereto, or as from time to time may be reconstructed, enlarged or otherwise changed, over, on and/or across Licensor's Property. This License includes, as necessary and reasonable, access to install the PLS Equipment and connect it to existing or new Heating, Ventilation and Air Conditioning Equipment ("HVAC Equipment"), access and the right to operate, service and/or replace said Equipment, as may be required from time to time, including access to the exterior of the building or through the building.

Ingress and Egress

9. The Licensees shall have the right of ingress and egress over and along said right of way for its representatives, vehicles and equipment, including cranes as necessary and reasonable for the

construction, installation, operation, maintenance, repair, upgrading and/or removing related Equipment; as well as the right to keep the right of way free from brush, wood growth or obstructions which might be deemed a hazard. Licensor hereby agrees that it shall procure written confirmation by any tenant or possessor of the Property that it agrees to provide access to the property consistent with this License.

Use of Property

10. Except as otherwise permitted or required by law or regulation, Licensees shall not use the Property for any other purpose or business without obtaining Licensor's prior written consent. Further, Licensees shall only use this License to service equipment or facilities which are located on the Property and being used for the benefit of Licensor and the Property.

Ownership of the Equipment

11. Licensor shall have no ownership of the PLS Equipment and shall keep such PLS Equipment free and clear of any liens that may be created upon the Property. Subject to Exhibit B, the HVAC Equipment is exclusively the property of the Licensor.

Maintenance and Operating Responsibilities

12. Maintenance of the HVAC Equipment shall be Licensor’s responsibility. Maintenance of the PLS Equipment shall be performed by Ice Energy for a term of one (1) year. Licensor may request inspection of or repairs to the PLS Equipment. Such inspection and repairs shall be at no cost to the Licensor provided that such inspection and repair work is within the scope of the Ice Bear Program. If any inspection or repair work falls outside the scope of the Ice Bear Program, Ice Energy will so advise the Company and Licensor. The Company and Licensor may elect to proceed with such inspection or repairs. The expense of any such inspections or repairs will be the responsibility of the Company and/or Licensor, as agreed upon by these parties.

Warranties

13. The PLS Equipment will be made available to Licensor at no cost and on an as-is basis. Ice Energy provides a limited warranty for the benefit of the PLS Equipment owner. Except as set

forth in the Ice Energy limited warranty, for the benefit of the PLS Equipment owner, Licensees do not warrant the PLS Equipment or their performance in any way. ANY AND ALL EXPRESS OR IMPLIED WARRANTIES, INCLUDING THE WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY DISCLAIMED.

Assignment

14. This License shall not be assigned by any of the parties without having first obtained the prior written consent of the other parties. Notwithstanding the foregoing, any of the Licensees may, upon Licensees' mutual agreement, transfer their rights and obligations under this Agreement to one another without the Licensor's consent, provided that Licensees notify Licensor of such assignment. Additionally, if the ownership of Licensor's Property is transferred or conveyed to another party, the Licensor shall endeavor to assign all of its rights and obligations under this Agreement to the new Property Owner upon notice to the Licensees. If the new Property owner does not accept such assignment, the License shall automatically terminate.

Term

15. This License shall commence on the date this Agreement is executed by all parties and shall continue until terminated by either Licensor or Company as hereinafter described.

Termination of License

16. This License shall terminate immediately upon the occurrence of any of the following events:

    A. The Licensees determine the Property is not, or is no longer, compatible for installation of the PLS Equipment;

    B. After its initial installation, the PLS Equipment is removed from the Property;

    C. The expiration of thirty (30) days after written notice of termination is given by either party to the other; provided however, that if Licensor terminates this Agreement sooner than twelve (12) months following the installation of the PLS Equipment, then Licensor shall reimburse

Company for the cost of removing the PLS Equipment and any and all applicable opt-out fee(s) associated with the Demand Response Programs, if and only if Demand Response Equipment and/or System(s) has or have been installed on the Property under this Program; or

D. Licensor no longer owns the Property, and the new owner of the Property does not accept the assignment of all of the Licensor's rights and responsibilities under this Agreement.

Removal of Equipment

17. Upon termination of the License, Licensees shall remove all of its personal property and the PLS Equipment, repair any damage caused to any improvements on the Property by the installation and/or removal of the PLS Equipment and surrender possession of the Property to Licensor in good order and repair satisfactory to the Licensor, normal wear and tear excepted.

Indemnity

18. Licensees, as a material part of the consideration to be rendered to Licensor pursuant to this Agreement, waives all claims against Licensor for damages to all personal property in, on, or about the Property and for injuries to persons in or about the Property, to the extent such claims arise out of the Licensees' use of the Property hereunder. Further, Licensees agree to hold Licensor exempt and harmless for and on account of any damage or injury to any person or personal property of any persons, including injury or death of persons and any third party property loss and damage, (a) to the extent resulting from or caused by any negligent act or omission or willful misconduct of Licensees or any of their contractors, subcontractors or agents in the use of the Property hereunder, or (b) Licensees' failure to keep the PLS Equipment clean and in good condition. Licensor shall not be liable to Licensees for any damage by or from any act or negligence of any other occupant of the Property or any occupant of adjoining or contiguous property caused in whole or in part, by the PLS Equipment. Ice Energy agrees to pay for all damages to the Property, as well as all damage to persons and to the property of such persons caused by Licensees' misuse or neglect of the Property in connection with this Agreement.

Insurance

19. Licensees further agree that Ice Energy shall maintain in full force during the term of this License, at Ice Energy's own expense, a policy of comprehensive liability insurance, including property damage, which will insure Licensees and Licensor against liability for injury to persons, damage to property, and death of any person occurring in or about the Property. The policy shall not be less than Two Million Dollars ($2,000,000.00) combined single limit. Ice Energy shall provide the Licensor with Ice Energy's certificate of insurance for such policies.

Entire Agreement

20. This instrument contains the entire agreement between the parties relating to the rights herein granted and the obligations herein assumed and supersedes any and all previous or contemporaneous agreements between them, whether oral or written. The parties hereto acknowledge, understand and agree that there are no promises, representations or statements of any kind, character or notice whatsoever concerning the subject matter hereof that have been made by either party to the other, except as set forth herein. Any prior agreements, promises, negotiations, or representations not expressly set forth in this Agreement shall be of no force or effect.

Amendment and Modification

21. The parties hereto agree that this Agreement may not be altered, amended or modified in any way whatsoever, except by a writing executed by the parties hereto which specifically refers to this Agreement.

Legal Fees

22. In the event of any controversy, claim, or dispute relating to this Agreement or the breach thereof, the prevailing party shall be entitled to recover from the losing party reasonable expenses, attorneys' fees and costs.

Binding Effect

23. This instrument shall be binding on and shall inure to the benefit of the successors, and assigns of

Licensor and Licensees.

Survival of Provisions

24. All representations and warranties contained in this Agreement shall survive the execution and delivery of this Agreement and the consummation of the transaction contemplated herein.

Jurisdiction

25. This agreement and any disputes or claims arising out of or in connection with it or its subject matter or formation (including non-contractual disputes or claims) are governed by and construed in accordance with the law of England and Wales.

26. The parties irrevocably agree that the courts of England and Wales have exclusive jurisdiction to settle any dispute or claim that arises out of or in connection with this agreement or its subject matter or formation (including non-contractual disputes or claims).

IN WITNESS WHEREOF, Licensor and Licensees have executed this Contract on the days and year set forth below and said Contract will become effective on the data signed by the last entity:

Southern Electric Power Distribution plc

Dated: ________________ ___________________________________

By:

ICE ENERGY CALIFORNIA (OPERATIONS), LLC

A Delaware Limited Liability Company

Dated: _________________ ___________________________________

By:

LICENSOR

Dated: _________________ ___________________________________

By:

(type or print name of signatory)

____

____

____

(Mailing address - required)

Attachments:

Exhibit A – Description of Property

Exhibit A

Description of Property

Description of Property

Description of Existing HVAC Equipment to be replaced

Description of Replacement HVAC Equipment

Estimated Reinforcement Costs

Assumptions/ Notes

- The network reinforcement would be the samllest incremental step availbale within SEPD standards
- To be consistent with language use in the SEPD Charging Statement, min and max costs are calculated
- Assumes all additional cable requirments are greater than 10m

Name of Customer	**Customer a**
Primary S/S	**Bracknell**
Primary Feeder	**E5L2**
Seconday S/S	[redacted]
Seconday Sub Station Capicity kVA	**800**
Capacity After reinforcement	**1000**
MIN Upgrade S/S Transformer to (Refer to refence tab 1)	**£33,000.00**
MAX Upgrade S/S Transformer to (Refer to refence tab 1)	**£63,000.00**
MIN Cost of Additional Cable (Initial 10m)	**£1,700.00**
MAX Cost of Additional Cable (Initial 10m)	**£3,500.00**
MIN Cost of Additional Cable /m	**£98.00**
Max Cost of Additional Cable /m	**£242.00**
Length of Cabling to Secondary S/S	**20**
Assumed Length of Cable to be reinfor	**20**
Additional Capacity Achieved	**200**

	Min **£**	**Max** **£**
Smallest Increment Cost S/S	**33000**	**63000**
Cable Costs (Initial + 10m) (From refernce tab 2)	**£1,700.00**	**£3,500.00**
Cable Costs (Per Metre) (From reference tab 2)	**£980.00**	**£2,420.00**
Total Cost of Reinforcement	**£35,680.00**	**£68,920.00**
£/kVA	**£178.40**	**£344.60**

Name of Customer	**Customer g**
Primary S/S	**Bracknell**
Primary Feeder	**E5L14**
Seconday S/S	[redacted]
Seconday Sub Station Capicity kVA	**300**
Capacity After reinforcement	**500**
MIN Upgrade S/S Transformer to (Refer to refence tab 1)	**£25,000.00**
MAX Upgrade S/S Transformer to (Refer to refence tab 1)	**£55,000.00**
MIN Cost of Additional Cable (Initial 10m)	**£1,700.00**
MAX Cost of Additional Cable (Initial 10m)	**£3,500.00**
MIN Cost of Additional Cable /m	**£98.00**
Max Cost of Additional Cable /m	**£242.00**
Length of Cabling to Secondary S/S	**60**
Assumed Length of Cable to be reinfor	**60**
Additional Capacity Achieved	**200**

	Min **£**	**Max** **£**
Smallest Increment Cost S/S	**25000**	**55000**
Cable Costs (Initial + 10m) (From refernce tab 2)	**£1,700.00**	**£3,500.00**
Cable Costs (Per Metre) (From reference tab 2)	**£4,900.00**	**£12,100.00**
Total Cost of Reinforcement	**£31,600.00**	**£70,600.00**
£/kVA	**£158.00**	**£353.00**

These figures are taken from SEPD's Statement of Methodology and Charges for Connection- April 2015 (https://www.ssepd.co.uk/Library/ChargingStatements/SEPD/)

Data for Customer d hasn't been included here as a result of data limitations.

HV/EHV network reinforcement costs within the Thames Valley

The below figures give estimated total costs of previous reinforcement carried out across the Thames Valley area.

The Bracknell- Camberley project is currently in progress, with the additional capacity of 114MVA not yet available.

Scheme	**MVA**	**MW**[1]	**£ (Million)**	**£/kW**
132 kV				
Bracknell - Camberley	114	114	38	£333
Wokingham	114	114	2	£18
33 kV				
Bracknell	21	21	2	£95

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[1] Assumes unitary power factor, hence MVA=MW. Power factor on Bracknell Primary between 1/5/15 and 19/8/15 calculated at 99.9 % (3 sig. fig.). SSEPD Power Factory usually above 0.98