Report

ENERGY MANAGEMENT PLAN - ROCHE DISTRIBUTION FACILITY

Greystanes Southern Employment Lands - Roche Distribution Facility - Precinct C
Hansen Yuncken Pty Ltd

CONFIDENTIAL

Revision: 2.0 – FOR INFORMATION
Issued: 13 December 2012

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Table of Contents

1. EXECUTIVE SUMMARY

1.1. Purpose

The purpose of this report is to provide an Energy Management Plan for Roche Distribution facility located in Precinct C of the DEXUS Estate Industrial Park – Greystanes Southern Employment Lands (SEL). As part of the consent conditions from the Minister for Planning for the DEXUS Estate Industrial Park – Greystanes SEL, a specific Energy Management Plan must be submitted to the Director-General for approval, prior to commencement of construction of the building.

The Energy Management Plan is in accordance with the energy efficiency initiatives detailed in the Urban Design Plan (UDP) prepared by Turner Hughes Architects for the Greystanes SEL concept plan, dated July 2008. Reference is also made to the Energy & Greenhouse Gas Assessment – Update prepared by Norman Disney & Young, which outlines the site wide utility consumption and the energy savings and GHG emissions reduction resulting from adoption of energy efficiency initiatives.

1.2. Energy Management Plan

The Energy Management Plan **(EMP)** is required to describe the measures that need to be implemented to minimise energy on site and it should address:

1. Energy consumption levels;
2. Predicted energy saving;
3. Options for alternative energy sources :

The Plan is also required to include:

1. A program for monitoring the effectiveness of these measures;
2. Protocol for the review of the plan.

1.3. Information Sources

The following documents form the basis of this report:

1 Design Brief – Roche Diagnostic Australia Pty Ltd – dated 6th August 2012

2 Warehouse C3 - Precinct C Master Plan – 4024_SK024 dated September 2012

3 Site Plan – Roche facility – 4047_SK007 dated October 2012

4 The Australian Institute of Refrigeration, Air-Conditioning and Heating (AIRAH) Technical Handbook (3rd and 4th Edition).

5 NABERS Office Rating Tool (Whole Building).

6 Green Star - Industrial version1 – Greenhouse Gas Emissions Calculator Guide (2010).

7 Australian/NZ Standard AS/NZS 3000:2007 and AS 2676.1 – 1992

1.4. Authority

Authority to undertake this report was provided by Chris Lykoudis of Hansen Yuncken on 12 November 2012.

1.5. Revision History

	Date Issued	Comment
1.0	20/11/2011	Draft – For Review
2.0	13/12/2012	For Information

2. DEVELOPMENT OVERVIEW

The proposed distribution facility is located in Precinct C of the Greystanes Southern Employment Lands (SEL). The facility will comprise a warehouse facility with an area of 9,939m^2 and an office area of approximately 169m^2. The facility will be purposely built for Roche Diagnostic Australia Pty Ltd. The Energy Management Plan is based on the Roche Design Brief.

The industrial facility will require air conditioning for the office area, refrigeration for the cool room and freezer area, mechanical ventilation for storage of ambient temperature products and ventilation to amenities in accordance with the National Construction Code (NCC). To ensure energy efficient operation of the facility, tenant fit out works will be carried out with due consideration to the impact on energy consumption.

Several energy efficiency measures will be incorporated in the building works. These measures cover energy consumption in the office area, general warehouse lighting and power, cool room and freezer area, car park and external lighting.

3. ENERGY CONSUMPTION LEVEL

A number of targets have been set for energy consumption associated with each area of the facility, described in detail below.

3.1. Office

The energy consumption limit associated with the office components of the development will be on the basis of 4 Star NABERS Energy for Office - whole building rating. The design of each office will target a 5% improvement on the greenhouse gas emissions over the 4 Star NABERS requirement to allow for a margin of safety and tolerance in the construction.

Table 1 – Target annual office energy consumption and CO_2 emissions – Roche

Benchmarking	Maximum Operational Threshold	Design target
NABERS benchmarking factor for 4 stars (kg CO_2-e/m^2.yr)	193	183
Electricity Consumption (kWh/yr)	29,620	28,139
Emissions scope 1,2 (kg CO2-e/yr)	26,362	25,044
Emissions scope 1,2,3 (kg CO2-e/yr)	31,397	29,827
Electricity Consumption (kWh/m^2.yr) GFA	**175.3**	**166.5**

Note: From the total office GFA is of 189m^2, with assumed 75% layout efficiency, NLA is estimated at 126.75m^2

These figures are based on occupancy of 8 people using standard NABERS occupancy density of 15m^2 of NLA per person. Hours of office operation is also based on 50 hours per week, which is the NABERS default figure. Please also note that reduced occupancy and reduced number of work hours per week will result in reduced energy allowance to achieve 4 Star NABERS Energy for Office.

The above energy consumption figure will be used as the target in designing the energy efficient building fabric and services, in addition to complying with the mandatory requirements of the NCC Section J.

This energy consumption will be used as the minimum energy performance benchmark to monitor the office energy performance during operation. This is an annual figure. Monthly energy estimate needs to be developed, as required in Section 6.3.

3.2. Warehouse

The building has secured a tenant hence the building work will be integrated with tenancy fit out. The warehouse will be used as a distribution facility for Roche.

The following are the major energy uses predicted in the warehouse area:

- Warehouse general lighting
- Warehouse general power
- Freezer and cool room
- Mechanical ventilation and exhaust

Each major energy use is addressed on detail, below.

3.2.1. Warehouse – General Lighting

The warehouse area will be provided with high bay fluorescent lighting fitted with PIR/ occupancy sensors and time clock. The ESD criteria of the brief stipulate that the fluorescent lamp to be used in the facility should only be either T5 or compact fluorescent. The energy consumption has been estimated based on the facility using an equivalent to a Philips T5 High Output Energy Advantage lamp that is ideal for medium-bay and high-bay retail and industrial applications.

The warehouse is required as per the brief to maintain 160 lux lighting level at 1m horizontally from floor level. The following table estimates the annual warehouse energy consumption.

Table 2 – Target annual warehouse lighting energy consumption – Roche Distribution Facility

Lamp power T5	49	Watt
Luminaire power (Nominated Lamp Power (NLP) + ballast)	55.9	Watt
Initial lumens	4950	Lumens
Efficacy	88.55	Lumens/watt
Lumens required to achieve 160 Lux (assumed maintenance factor of 0.75, ceiling mounted luminaires, reflectances for ceiling is 0.5, wall 0.5, surface is 0.3), assumed the typical lighting is applied to all warehouse area of 9,939m^2	2,097,665	Lumens
Power required based on lamp efficacy with 50% losses allowed	23,689	Lumens
Illumination Power Density to achieve 160 Lux	4.77	Watt/m2
Energy Consumption	24.1	kWh/m^2.yr

The above energy consumption has been based on lighting schedule from Green Star Industrial version 1 Greenhouse Gas Emissions Calculator Guide (2010) for spaces with long working day, that are typically operated for more than one shift.

Occupancy sensor controls will further reduce the energy use associated with lighting during unoccupied hours. It has been estimated that during unoccupied hours, only 5% of lighting is on, compared to 15% in a standard practice building.

Table 3 – Target annual general warehouse lighting energy consumption with occupancy sensor – Roche Distribution Facility

Energy Consumption target with occupancy sensor	22.2	kWh/m^2.yr

3.2.2. Warehouse – General Power

The brief requires the installation of power factor correction unit, to provide power correction from 0.8 to 0.95. This allows the utilisation of additional 0.15 watt of real power per each 1 VA of electricity supply.

The Roche design brief has allowed nominal lighting and power load of 35VA/m^2 for the warehouse, excluding cool room load. This figure does not include a diversity factor to take account

the normal operating conditions during which not all equipment will operate simultaneously at full load or for long periods. In order to provide a conservative estimate of the saving associated with the installation of the power factor correction unit, the equipment load has been based on Australian/NZ Standard AS/NZS 3000:2007 maximum demand for warehouses (table C3).

- Light & Power Range: 5 - 15 VA/m^2 Average: 10 VA/m^2

Table 4 – Target annual warehouse power energy consumption – Roche Distribution Facility

Equipment power based on AS/NZS 3000 maximum demand - excluding lighting	10.0	VA/m^2
Equipment power based on AS/NZS 3000 for general warehouse area (ambient storage area) - 6,789m^2	67.9	kVA
Real power without power factor correction unit (0.8 power factor)	54.3	kW
Annual energy target	**277,350**	**kWh/yr**
Annual energy target per m^2	**40.85**	**kWh/ m^2.yr**
Apparent power (VA) required to get the same amount of power (54.3kW) and the same annual energy use, when supply is corrected to 0.95	57.2	kVA
Saved apparent power	10.7	kVA
Saved real power	10.2	kW
Annual energy saving	**52,003**	**kWh/yr**
Annual emission saving	**55.1**	**Tonnes CO_2/yr**

3.2.3. Warehouse Ventilation

The general warehouse area that will be used to store ambient temperature products will be provided with mechanical ventilation as required by the National Construction Code (NCC). Due to the type of products stored (health care products) mechanical assisted ventilation is preferred to avoid dust and enable filtration if required.

The Australian/NZ Standard AS/NZS 3000:2007 (Electrical Installations) provides guidance on the energy demand for warehouse ventilation system, i.e. 5 VA/m^2.

Table 5 – Predicted energy saving for ambient warehouse mechanical ventilation

Energy target 5 VA/m^2 (with standard 0.8 power factor)	4	Watt/m^2
Power required to all ambient warehouse 6,789m^2	27.156	kW
Annual energy consumption for ambient warehouse area	**123,180**	**kWh/yr**
Annual energy target per m^2	**18.14**	**kWh/ m^2.yr**
Apparent power used to get the same amount of real power with power factor correction to 0.95)	4.2	VA/m2
Saved apparent power	0.79	VA/m2
Saved real power	0.75	W/m2
Annual saving	**23,096**	**kWh/yr**
Annual emission saving	**24.48**	**Tonnes CO_2/yr**

3.2.4. Cool Room and Freezer area

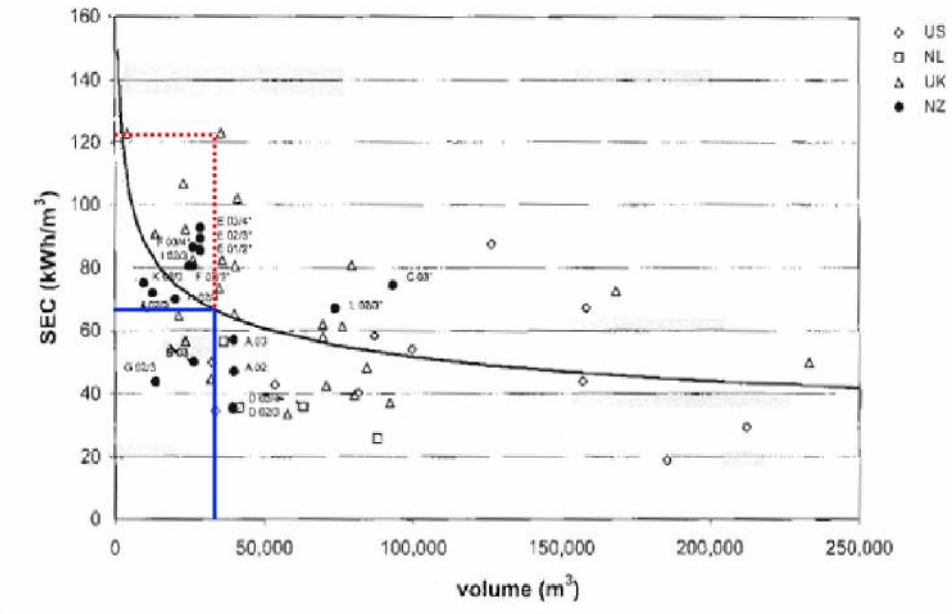
Cool rooms and freezer area will be provided to accommodate refrigerated temperature controlled products (2 to 8 degrees, with an average of 5 degree Celsius) and frozen temperature products (-15 to -25 degrees, with an average of -20 degree Celsius), as outlined in Roche design brief. The following table summarises the area and estimated volume of the refrigerated warehouse, based on 10.5 m wall height to accommodate the storage of 7 pallets high, as described in Roche design brief.

Table 6 – Target annual freezer and cool room energy consumption – Roche Distribution Facility

Area	Area (m^2)	Estimated Volume (m^3)
Freezer area	150	1,575
Cool room	1,500	15,750
Future cool room	1,500	15,750
Total refrigerated storage	3,150	33,075

The energy target will be based on the energy consumption benchmark derived from surveyed data of Specific Electricity Consumption (SEC) of refrigerated warehouses in Europe, New Zealand and US, derived from the Energy Benchmarking of Warehouses for Frozen food (July 2008), prepared by Department of Biological and Agricultural Engineering University of California for California Energy Commission. The graph below summarises the surveys.

Figure 1 – Benchmarking of refrigerated warehouses using SEC



Specific Electricity Consumption (SEC) of refrigerated warehouses operating in New Zealand, UK, Netherlands and US

Reading from the graph, cold storage with a refrigerated volume of approximately 33,000m^3 has a SEC ranging from 35kWh/m^3 (UK data) to 122kWh/m^3 (UK data). The median performance of the refrigerated warehouses is on the SEC of 68kWh/m^3. Data from New Zealand shows warehouses of similar size have a SEC ranging from 50kWh/m^3 to 94 kWh/m^3.

In consideration to the above study, the targeted energy performance for Roche's refrigerated storage area can be expected to be approximately 68kWh/m^3. This equates to 2,249,100kWh of annual energy consumption or 714kWh/m^2.

3.2.5. Mechanical Exhaust in Battery room

Australian standard AS 3011.1 requires that the average hydrogen concentration by volume in a battery room or enclosure must be maintained below 2%. The minimum exhaust ventilation rate depends on the number of battery cells from all batteries in the enclosure and the charging rate.

No energy consumption target has been determined for this energy use.

Energy saving measures will be adopted to ensure the selection of fans that balances the need for energy conservation against the need to satisfy the required exhaust ventilation rate (e.g. Variable Speed Drives).

3.3. Car parking

The Australian/NZ Standard AS/NZS 3000:2007 (Electrical Installations) provides the following guidance on estimating maximum demand for car park lighting.

- Open Air Range: 0 - 10 VA/m^2 Average: 5 VA/m^2

As per the Greystanes SEL whole site Energy and Greenhouse Gas Assessment report, the car parking is proposed to have an average maximum demand of 5 VA/m^2.

Table 7 – Target annual car parking energy consumption and CO_2 emissions – Roche Distribution Facility

Car park & hardstand Area (m^2)*	Energy Consumption (kWh/yr)	CO_2 Emissions (tonnes CO_2/yr)
7,603	72,806	77.2

Note : Car park and hardstand area has been calculated based on lot area minus building foot print.

3.4. Transport

3.4.1. Staff Vehicles

As shown on Site Plan drawing – Roche facility – 4047_SK007 dated October 2012, there will be 47 car parking spaces provided for Roche Distribution.

The following assumptions have been made:

- 90% of the parking spaces are used by staff (10% spare for visitors).
- Each occupied space represents a car doing a round trip of 40km of assumed average commuting distance from high density suburbs (e.g. eastern suburbs).
- The average private vehicle emission rate is 180 g CO_2/km.

Based on these assumptions the following emissions have been calculated.

Table 8 – Annual CO_2 emissions associated with staff vehicles

No. Parking Spaces	CO_2 Emissions (tonnes CO_2)
47	76.7

3.4.2. Delivery Vehicles

The following assumptions have been made:

- 1 delivery/pickup per day per 500m^2 of warehouse area.
- Average distance travelled by each delivery vehicle is 100km, assumed travel distance within Sydney metropolitan area and Wollongong.
- The average delivery vehicle emission rate is 300 gCO_2/km.

Based on these assumptions the following emissions have been calculated.

Table 9 – Annual CO_2 emissions associated with delivery vehicles

Warehouse Area (m^2)	No. deliveries/ pick-ups per day	CO_2 Emissions (tonnes CO_2/yr)
9,939	20	150.3

4. ENERGY SAVING MEASURES

A number of strategies will be adopted to reduce energy consumption at the facility. These include measures within the warehouse and office areas.

4.1. Office

A target of a 4 Star NABERS whole building energy rating has been set for the office building. The target energy rating can be achieved through a number of means, including:

- Thermal insulation
- Solar shading
- Glazing performance
- Efficient air conditioning
- Low energy lighting
- Systems controls
- Renewable technology, where feasible

Insulation will be used in the walls, internal walls adjacent to non-conditioned spaces, roof and floor to (as a minimum) comply with Section J of the National Construction Code (NCC) formerly known as the BCA. Increased insulation might be required to improve the energy performance of the building fabric, with the aim of achieving the targeted 4 star NABERS.

High performance low-e glazing for windows and glazed doors, as per minimum Section J NCC (NCC) compliant requirements, will reduce the load on the air conditioning system, and reduce associated energy consumption.

Air conditioning equipment will be selected to have energy efficiency ratios in excess of the minimum Deemed to Satisfy (DTS) requirements stated in NCC Section J. Zoning for air conditioning system will be set per each thermal zones (each perimeter and central).

All office lighting will be provided using T5 energy efficient fluorescent lamps to achieve, as a minimum, illumination power density in accordance with NCC Section J DTS requirements.

Group switches will be provided in the office areas to create zoned lighting and allow lighting to be turned off in unoccupied areas. Individual switches to all enclosed space such as private offices, toilet, tea room, plant room etc.

4.2. Warehouse

High output T5 high bay open style fluorescent lighting fitted with occupancy sensor and time clock will be provided in the warehouse area. The high efficacy of the luminaires will result in lower illumination power density than the maximum illumination power density allowed in the BCA (table J2.6a) for storage shelving higher than 75% of the height of the aisle lighting. Occupancy sensors will further reduce the energy consumption during unoccupied hours.

- Lighting zone: One lighting zone per 1,000 m2 to be provided
- Roof light to ambient temperature warehouse – 10% of roof area

Consideration will be given to a "cool roof" (i.e. a light coloured or white roof coating) to reduce solar gains to the warehouse space.

Exterior - perimeter lighting and loading dock will be provided with high efficient flood lights controlled by photocells/ day light sensor.

The cool room and freezer areas are special tenant fit-out requirements. While these refrigerated storage facilities are known to have high energy consumption, measures have been adopted to minimise their impact on the overall energy consumption, including the following:

- Fast acting doors will be installed in both the freezer and cool room. These doors help reduce air infiltration and heat gain to refrigerated spaces. They save significant amount of energy compared to manual doors, or strip or air curtains [Note 3)].
- Higher insulation values than the minimum BCA (NCC) Section J requirement of R-value 2.8. Insulated sandwich panels (R-value 7.15) will be used on external walls to improve the thermal performance of the building envelope.
- The air tightness of the construction will be over and above the requirement of Part J3 Building Sealing. Ensure good detailing in design and construction. All service penetrations to be properly sealed. BSRIA Specification 10/98 Air Tightness Specifications specify that for cold stores, an air tightness specification of 1.0 m^3/hr.sqm at 50 Pascal is the maximum allowable air leakage. Aim to achieve best practice performance of 0.5m^3/hr.sqm at 50 Pascal where possible.
- Other energy saving opportunities will be considered in the operation of the facility, such as:
    - Variable Frequency Drives (VFDs) to adjust the speed of electric motors and thus reduce overall energy use by allowing equipment to operate at the necessary speeds.
    - Duty cycling that involves cycling equipment on and off to match the equipment capacity to the load.
    - Demand Refrigeration
    - Improving part load performance
    - Automated Defrost control

[Note3] Derived from *Opportunities for Energy Efficiency and Automated Demand Response in Industrial Refrigerated Warehouses in California* (May 2009), prepared by Environmental Energy Technologies Division, Ernest Orlando Lawrence, Berkeley National Laboratory

4.3. Estimated Energy Savings

The predicted energy savings associated with the proposed initiatives are as follows:

Table 10 – Estimated Energy Savings

Building Component	Standard Practice	Proposed Building - Roche	Standard Practice	Proposed Building - Roche	Estimated saving	Notes
	kWh/ m^2.yr	kWh/ m^2.yr	Tonnes CO_2/yr	Tonnes CO_2/yr	Tonnes CO_2/yr	
Office	249.5	175.3	44.7	31.4	13.3	Standard practice building is based on average NABERS rating of 2.5 NABERS Office-Whole Building Rating
Warehouse – General Lighting	40.4	22.2	426.1	234.0	192.2	Standard practice building is based on 8 W/m2 of BCA Section J table J6.2a Maximum Illumination power density for storage with shelving no higher than 75% of the height of the aisle lighting
Warehouse – General Power - Ambient storage	40.9	40.9	294.0	294.0	55.1	No target for work/ process equipment. Savings derived from utilising Power Factor Correction (PFC) unit
Warehouse ventilation			130.6	130.6	24.5	Based on 5VA/m2 energy demand. There is no increased target compared to standard building. Savings derived from utilising Power Factor Correction (PFC) unit
Cool room and freezer area	987	714.0	3,295.6	2,384.0	911.5	Energy saving compared to the least performing refrigerated warehouse of similar size in NZ 94kWh/m3)
Lighting at car park and hardstand area			154.3	77.2	77.2	Standard practice building is based on 10VA/m2 of maximum demand AS3000
Staff vehicles			76.7	76.7	0.0	No saving estimated
Delivery vehicles			150.3	150.3	0.0	No saving estimated
Estimated Energy Savings					**1,273.8**	Tonnes CO_2/yr saving

5. ALTERNATIVE ENERGY SOURCES

Alternative sources of energy will be considered to further reduce the greenhouse gas emissions associated with the use of the energy on the site. Given the large roof area associated with the facility it is recognized that there is significant potential for solar technology.

5.1. Solar Power Generation

Consideration will be given to the use of solar power based on the available amount of energy, lifecycle cost and available government funding for such provision.

5.2. Potential for third party access to roofs for solar generation

Dexus is supportive of future opportunities to allow third parties to be granted leases over roof space for the purpose of installing photovoltaic solar panels to generate renewable electricity. This will include an investigation into the potential impacts on site security, the operation of the facility, and OH&S measures in place to allow access to the roof panels by a third party for cleaning, repairs and maintenance.

5.3. Utilisation of solar air conditioning

Consideration will be given to the use of solar thermal energy to drive absorption chillers in the future.

6. EMP MONITORING & REVIEW PROGRAM

In order to achieve the objectives of the Energy Management Plan, the measures outlined below will be adopted.

6.1. Provision of Adequate Metering

Sub metering will be provided so that the energy consumption of the facility can be monitored. Separate metering of lighting and power will allow close monitoring of energy consumption, and appropriate building tuning actions to be taken.

Power metering will be provided so that each component of the facility can be separately metered. This will include:

1. Office component
    a. Air conditioning
    b. Server room air conditioning
    c. Lighting
    d. Power
2. Warehouse
    a. Warehouse general lighting
    b. Warehouse general power
    c. Freezer room
    d. Cool room
    e. Mechanical exhaust
    f. Other miscellaneous plant
3. External lighting;
4. Miscellaneous.

6.2. Verification of Metering Readings

Monthly verification of metering readings will be carried out by comparing the total utility consumption via the site meters and the utility providers' billing information.

Corrections/calibration of the site metering system will be carried out in the event of any discrepancy.

6.3. Energy Consumption Benchmark

The maximum annual energy consumption for office in order to achieve the target of a 4 star NABERS Energy rating has been discussed in the previous Section 3.1.

Energy modelling will be carried out during the detailed design phase to confirm that the proposed office design will not result in higher energy consumption than the stated maximum energy allowance. The energy model will confirm the level of performance required from building fabrics and services to achieve the targeted energy performance. The model's construction requirements in conjunction with requirement of NCC (NCC) Section J, must govern the building fabrics and services energy performance.

The result of energy modelling will also provide predicted energy consumption on a monthly basis. This will be used as the energy benchmark in monthly energy monitoring to track the building performance to achieve the 4 star NABERS Energy target for the office area.

6.4. Energy Analysis and Energy Management Review

By comparing the actual energy consumption with benchmark values, root cause analysis will be carried out on month by month basis using qualified technical experts. This will be followed by the required rectification and tuning in the areas which contribute to any identified excessive use of energy.

When necessary, the Energy Management Plan will be revised to include measures to ensure any identified areas of energy wastage will not be repeated in the future.

7. TENANT GUIDELINES

To ensure continued energy efficient operation of the facility, tenant fit out works must be carried out with due consideration to their impact on the building's energy consumption.

As a minimum all work must comply with the requirements of the latest version of the NCC Section J requirements. Additional consideration should be given to measures that can further reduce the tenant's impact on energy consumption where appropriate.

7.1. Office Building

A number of steps can be taken to assist with the energy performance of the office building.

Temperature set points should be chosen to give the best energy performance. Increasing temperature ranges based on adaptive comfort criteria can create good energy savings by reducing load and operating criteria for air conditioning plant.

The use of external doors should be interlocked with associated air conditioning plant. If doors are to be held open, air conditioning plant should be switched off to avoid loss of conditioned air to the outside.

Doors from conditioned space leading to the non-conditioned internal space should be provided with self closing damper to reduce the leakage of conditioned air and avoid additional cooling load to the conditioned space.

7.2. Warehouse

Insulation – Boundaries between refrigerated /frozen storage to ambient temperature areas should be provided with insulation to minimise the heat transfer and energy consumption of the refrigeration plant.

Leakage rates – Construction quality should be of a high standard to minimise air leakage to/from the refrigerated/frozen space.

Environmental condition requirements – Space temperature (and humidity if applicable) set points must be selected to provide the required space temperature for the process/activity. Over heating/cooling of a space will lead to energy wastage. Control sensors should be intelligently located to optimise system control.

Efficiency – Refrigeration plant Coefficient of Performance (COP)/efficiencies should meet and exceed the minimum requirements of NCC Section J and MEPS (Minimum Energy Performance Standards).

Mechanical Ventilation – Selection of highly efficient fans with variable speed drives for the mechanical ventilation is crucial to reduce the energy consumption from mechanical ventilation. Time clock control is required to limit fan operation during unoccupied hours.

Equipment Energy Use – Equipment must be selected with due consideration of the energy efficiency performance (i.e. select high efficiency equipment).

Metering – Metering for equipment can provide valuable information for the ongoing monitoring and improvement of energy consumption for the facility.

Maintenance – Access for maintenance must be considered. Poorly maintained equipment will suffer from reduced efficiency if maintenance items are not performed.