ASEAN BEST PRACTICE COMPETITION FOR ENERGY MANAGEMENT IN BUILDINGS

BERAKAS GARRISON OFFICERS’ ACCOMMODATION REACTIVATION:
Condensation mitigation and energy conservation

ASEAN ENERGY AWARDS 2015
Category: Small and Medium Building

MINISTRY OF DEFENCE
BRUNEI DARUSSALAM
### Category:
- [ ] Industries
- ✔ Buildings

### Size Category:
- [ ] Large
- ✔ Small and Medium

### Title of Activity / Project / Theme:
BERAKAS GARRISON OFFICERS’ ACCOMMODATION REACTIVATION: Condensation mitigation and energy conservation

### Applicant General Information

<table>
<thead>
<tr>
<th>Name of Company</th>
<th>Ministry of Defence, Brunei Darussalam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Address</td>
<td>Ministry of Defence</td>
</tr>
<tr>
<td></td>
<td>Bolkiah Garrison</td>
</tr>
<tr>
<td></td>
<td>BB3510 Brunei Darussalam</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>6 persons (Energy Management Team)</td>
</tr>
<tr>
<td>Age of Building</td>
<td>11 years</td>
</tr>
<tr>
<td>Nature of Business</td>
<td>To Implement Defence Policy</td>
</tr>
<tr>
<td></td>
<td>To Enhance Force Capability</td>
</tr>
<tr>
<td></td>
<td>To Promote Defence Diplomacy</td>
</tr>
<tr>
<td></td>
<td>To Contribute to Nation Building</td>
</tr>
</tbody>
</table>

#### Contact Person

<table>
<thead>
<tr>
<th>Name</th>
<th>DAYANGKU ROSELAWATI BINTI PENGIRAN HAJI HALUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>ACTING ASSISTANT DIRECTOR FOR ESTATE</td>
</tr>
<tr>
<td></td>
<td>MAINTENANCE &amp; MANAGEMENT,</td>
</tr>
<tr>
<td></td>
<td>DIRECTORATE OF DEVELOPMENT AND WORKS SERVICES</td>
</tr>
<tr>
<td>Telephone</td>
<td>(+673) 238 6043</td>
</tr>
<tr>
<td>Mobile Phone</td>
<td>(+673) 885 1441</td>
</tr>
<tr>
<td>Fax</td>
<td>(+673) 238 2156</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:roselawati.halus@mindef.gov.bn">roselawati.halus@mindef.gov.bn</a></td>
</tr>
</tbody>
</table>
CERTIFICATION AND ENDORSEMENT

The Single Officers’ Accommodation at Berakas Garrison hereby agreed to allow the ACE Board of Judges and the Japanese experts to visit the building and verify the authenticity of the data. However, two weeks advance notice is required to allow for necessary arrangements.

The undersigned certified that the information given is true and accurate and prepared with the consent of the party/ies involved.

HAJAH MARLIYANA BINTI HAJI ABDULLAH FUNG
Director of Development and Works Services
Ministry of Defence
Brunei Darussalam
Tel : (+673) 238 6382
Fax : (+673) 238 2156
E-mail : marliyana.abdullah@mindef.gov.bn

DAYANGKU ROSELAWATI BINTI PENGIRAN HAJI HALUS
Acting Assistant Director for Estate Maintenance and Management
Directorate of Development and Works Services
Ministry of Defence
Brunei Darussalam
Tel : (+673) 238 6043
Fax : (+673) 238 2156
E-mail : roselawati.halus@mindef.gov.bn

Energy Data collected & compiled by:

JAN TZE HONG
(SCEM #553)
Tel : (+673) 871 5968
E-mail : ori.ent@hotmail.com
The Single Officers’ Accommodation at Berakas Garrison.
(Left photo: Front view; Right photo: Rear view).

**Project/Activity Overview:**

The Officers Accommodation at Berakas Garrison have been plagued with constant condensation problems. The rooms’ wall are always observed to be wet and over a period of time, greenish algae or molds are observed to grow on this surfaces. Certain ceiling areas are observed to have the same problems as well.

The Building was built to accommodate army officers in a camp. The initial consultant designs the air-conditioning system to provide comfort cooling for the officers in our tropical climate. During the design stage and subsequent construction, each room for the officers’ quarter was equipped with a 2.5hp split type air conditioning system. The idea was to provide comfort to the young officers after their hard day works.

The group of photos below shows the original conditions of the ceiling and walls caused by condensation.
Since taken over the project and ownership of the building, the maintenance staffs are having a hard time trying to maintain the rooms in a comfortable manner. The occupants are complaining of water stains; mold growth and discomfort for the past years.

Numerous civil contractor have come in to re-design the walls etc to try to alleviate the problems but without much success. Further, different paint that claimed to prevent condensation and mold growth have been trial without any success as well.

This has come to the attention of the Top Management and decision has been made to look into ways to improve comfort for the occupants within the facility. In addition, due to the fact that Directorate of Development and Works Services (DDWS) are starting to try to implement GREEN CONCEPT for all the building stocks under their management, the energy efficiency for this building is look upon and the project becomes a Building Alteration and Repair with Energy Efficiency Project.

The Management starts off with a clear goal to provide the building occupants with a Safe, Cosy and Comfortable environment for them to reside. No compromise on these qualities is allow as the Management do not want any distraction to the Officers resting hours.

After numerous proposals, the Management has chosen one that base on a holistic and systematic approach. The proposal plan to

- Study the root cause of the condensation problem
- Verified that the root problems to be identified
- Provide a complete solution to eliminate the mold growth issues
- Look for ways to operate the building in a more Energy Efficient way.

The plan is to follow guide line as ISO50001 that call for the process of PDCA.

**Plan:**
Definition of objectives and work scopes boundaries to deliver results in line with the energy policies of the organization.

**Do:**
Implementation of defined processes.

**Check:**
Monitor and measure processes against energy benchmark, policy principles, strategic and operational objectives, statutory requirements and documentation of results.
Act:
Take improvement actions to continually improve the Energy Management System.

The work flow for the project is described as follows;

- Engage an Energy Manager to lead and advice on energy perspective.
- Perform a detail study of the problem by looking at temperature and Relative humidity.
- Identify the root cause of the condensation problem.
- Implement the retrofit works in a chosen room.
- Verify that the retrofit works eliminate the cause in the chosen room.
- Implement the same retrofit works on other rooms.
- Monitor the performance of these rooms.

A. FACILITY INFORMATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross floor area</td>
<td>350 m² (per floor)</td>
</tr>
<tr>
<td>No. of buildings</td>
<td>1</td>
</tr>
<tr>
<td>No. of floor</td>
<td>2</td>
</tr>
<tr>
<td>Year constructed</td>
<td>2004</td>
</tr>
<tr>
<td>Type of usage</td>
<td>Residential</td>
</tr>
</tbody>
</table>

Air-conditioned in room areas and no air condition in corridor and porch.

B. SITE ENERGY CONSUMPTION

It is a common practise in Negara Brunei Darussalam that the Government will pay for all electric bills within the living quarter of the uniform officers. Hence there is no past history of the electricity being utilized by the building.
DESCRIPTION OF THE SYSTEM

Work Scope
The scope of the improvement works will be the ground floor rooms consist of 12 bed rooms to accommodate 12 officers.

Building Description
The building is a 2-storey resident building that house 12 officers on each floor of the building. Each room is equipped with a minimum 2.5hp split type air-conditioners and the occupants are free to choose to adjust the temperature to suit their individual preferences.

1. IMPACT

1.1 ENERGY SAVING

RIGHT SIZING OF THE SPLIT AIR CONDITIONING

The original design call for the installation of 1 number 2.5 hp split type air condition. Due to occupants not fully aware of energy conservation policy and practice of sustainability, the air conditioning system are left to operate 24 hours per day 365 days a year. Most systems are operating at temperature setting in 18-ish range. This practice consumed a lot of energy and at the same time waste a lot of energy as vacant rooms is left with oversized air conditioning operation cooling empty rooms. Hence the rooms are over cooled with all 4 walls temperature down to 22 degree C.

After right sizing the air conditioning system, from original 2.5hp to present 1 hp, we are able to conserve at least 35% of energy as compare with previously.

As a further advantage to this replacement work, we are able to phase out the old R-22 split type air conditioners to the new more environmental type with refrigerant R-410a. This ensures our air conditioners replacement works are in tune with the overall Government Policy on refrigerant usage.
OPERATION OPTIMIZATION

The original design of the air condition do not allow for any control as all control function rest with the remote controller. If the occupants forgotten to turn off the air conditioning on his way out, the air conditioning are left on for the whole day cooling an empty room.

As there is no billing or any data to demonstrate the energy usage by each occupant, it is normal human practise to leave the lighting and air conditioners to be ON even when the occupants leave the rooms.

We have introduced the use of Occupancy Sensor with time base to provide control of the air conditioning system. The Occuancy Sensor works by monitoring the IR emitted by the occupant in the room. When the occupant stays in the room, the Sensor detected the occupant
and does nothing. But when the Sensor detected there is no one present in the room, an internal timer goes into a countdown mode. Upon reaching the countdown setting time, the Sensor sends a signal to turn off the air conditioners. The count time can be adjusted from 15 minutes to 1 hour.

For this particular project, we do not set the Sensor to turn off the air conditioners as there is still no official policy governing air conditioner usage for residential purposes. The Sensor actually sent a signal to reset the air conditioners to operate at maintaining 25º C with a medium fan speed.

<table>
<thead>
<tr>
<th>The Occupancy Sensor cum Controller senses the occupancy of the occupant and will reset the temperature to 25ºC with Med fan speed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term plan is to ensure controller will turn off the air conditioner after 30 minutes detecting occupant is not in the room.</td>
</tr>
</tbody>
</table>

With this in place, we are able to conserve another 15% of energy consumed as compare with the previous practise.

It is quite impossible to estimate accurately the energy conserved in these two conservation efforts as the energy consumed depend on the air conditioners efficiency, the operation set point, and the indoor and outdoor temperature. But in order to provide a magnitude to approximate the saving potential, power meter are used to determine the power consumption of

1. Old existing air conditioners, 7.2kW cooling capacity
2. New air conditioner, 0.825kW cooling capacity
Power meter logging of the air conditioner power consumption.

The summary of the power meter energy measurement are as follows:

<table>
<thead>
<tr>
<th>A/C COOLING CAP, kW</th>
<th>AVERAGE ENERGY, kWh per month (Logged Data)</th>
<th>% REDUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.20 kW</td>
<td>1,296 kWh</td>
<td>(Baseline)</td>
</tr>
<tr>
<td>0.825 kW</td>
<td>675 kWh</td>
<td>621 kWh savings (48%)</td>
</tr>
</tbody>
</table>

** The energy data are logged base on individual room occupant’s personal temperature set point adjustment and own operation requirement.

1.2 ENVIRONMENT EFFECTS

Although we are unable to collect the historical energy data for the building prior to this retrofitting works as there was no meter being installed. But base on the estimation of the replacement of the air conditioner by right sizing the capacity and the installation of the Occupancy Sensor Controller, the total amount of energy conserved will come to approximately 89,424 kWh per year. That is equivalent to 62 metric tons of CO2.

For 1 room, saving of 621 kWh per month.
For 12 rooms, total energy saving will be $= 12$ rooms x 621 kWh x 12 month $= 89,424$ kWh / year
1.3 ECONOMIC EFFECT

The total cost of the implementation of the energy efficiency program comes to approximately $20,000. The actual rectification works to repair the damages due to excessive cooling comes to 4 times the energy retrofitting works. This involved the removal of damaged ceiling and replace with new ceiling, clean and repaint damaged walls and other clean up works. In addition, the occupants have to bear with the moldy and un-hygienic conditions before the actual alteration and repair works are carry out. This also pose a potential health effect to the occupants if prolong exposure to this conditions.

The approximate simple payback calculated will be 1 year base on local energy tariff of B$0.15.

Investment = $20,000.00
Savings = 89,424 kWh x B$0.15 = $13,414.00

Simple Payback = $20,000 / $13,414 = 1.5 years

1.4 ENERGY EFFICIENCY INDEX (EEI)

We are unable to calculate and present the EEI as there are no provisions for power meter mounting and there is no individual electricity bill for each unit.

2. SUSTAINABILITY

2.1 LEVEL OF PARTICIPATION AND INVOLVEMENT

This pilot study of implementation of a Building Alteration and Repair project that involves the appointment of an Energy Manager has proven to be successful in improving the Energy Efficiency and Performance of the building.

The original objective of the Building Alteration and Repair is to remedial the mold and condensation issues. There are many proposals from various civil and architect proposes the internal insulation of the building walls and ceiling and first floor wall.

But due to the present of an Energy Manager in the team who took a different view and assist the team to identify the root cause of the condensation. Then by eliminating the root cause that caused the wall over cooling, this solved the condensation hence the mold issue. And with the right sizing of the air conditioners, this provides a lot of energy saving potential for the building.
The net result is a more pleasant and healthy for the officers to live. Less expenditure on routine building repair and repainting. A lot of energy savings.

With this project, the department prove that even with minor retrofit works, there is huge energy saving without capital spending to upgrade the whole air condition plant. It is common norm to throw money into buying more energy efficiency equipment like changing of split unit to VRV system but without looking at measures to improve on the fundamentals like right size air conditioners, operation efficiency and so on.

The management wish to use this as a learning lesson to high light that by taking a holistic approach to look at energy conservation, the improve operator awareness and improve scheduling can have a significant effect to reduce energy consumption in any facility.

At the same time, this has proven the concept of the ISO50001 and with an appointed Qualified Person to champion energy conservation efforts, if correctly implemented can yield good energy saving potential. This is also a show of support for the Brunei’s Energy White Paper 2014 published by the Energy Department, Prime Minister Office (EDPMO) that call for adoption of ISO50001 and the instatement of Energy Manager to assist the policy for facilities manage by the DDWS.

2.2 TOP LEVEL MANAGEMENT COMMITMENT

There is an energy policy and guidelines set up by the Ministry of Defence as part of the strategic plan to manage facilities under the Ministry. The target goals are clearly set and become part of the responsibility from the top management down to all levels within the organisation. The energy policy covers the implementation of efficient technology for energy conservation, energy awareness training and seminars for all in the organisation.

The policy and guidelines will be a key reference whenever a process involving building retrofitting and improvement works plan for building within the jurisdiction of the DDWS.

The department plan to implement the Energy Management Program systematically base on the concept of ISO50001. The appointment of Qualified Person to carry out pre and post energy measurement for the process is of great importance as this information provides a good justification and verification of the amount of energy conserved.
2.3 SHORT AND LONG-TERM PLAN

It is identified that there is still a lack of technical know-how within the organization on the energy conservation measures that can be quantified and verifiable from the implementation point of view. The Management will look into and tackle this with the following approach.

- To engage external help at this point in time by working with Energy Consultant to continuous improve on energy conservation efforts,
- To improve department’s capacity building by providing training for employee including opportunity to work with Energy Consultant while executing projects
- To document all energy conservation efforts such that similar process can be adopted within the same organization for same and similar process.

In addition, the department will look into working with the EPDMO in adoption of the ISO50001 such that all facility under the management will be implemented with the Energy Management Program.

In the meantime, the DDWS plan to document the following process such that a more transparent view of how the buildings within the DDWS management are performing comparing with similar type in different location.

The Propose Scheme for future Building Retrofit Project

```
Conduct Energy Review on each projects implemented by DDWS

Identify the Significant Energy Consumption activities within the built environment

Set-up base line and Energy Performance Indicator for these activities

Check compliance with regulatory requirements and policies

Set up Energy Objective, Target and implementation plan to reduce the energy consumption
```
2.4 ORGANISATION

2.4.1 ESTABLISHES ORGANISATION FOR ENERGY MANAGEMENT

3. REPLICABILITY

3.1 MANAGEMENT PRACTICES AND MEASURES/ TECHNOLOGY

There are numerous facilities that are under the management of the DDWS that are already equipped with similar type of air-conditioning equipment. The split type air conditioners is the predominant type of air conditioners as this system do not require extensive design, cheap and provide individual room cooling.

But, the side effect of the split air conditioners is they are **not very energy efficient**. Further, centralized control requires implementation of new technology. Hence, it will be up to the individual to control the system based on individual liking. This always results in ignorant and abuse of the air conditioning system that result in excessive energy wastage.
It is hoped that the same approach of achieving the goals of energy conservation will be implemented for all these facilities with the same type of equipment as it has been proven beyond doubt that right air conditioners sizing will provide the simplest solution to achieve air conditioners energy efficiency and conservation.

Further, with the Occupancy Sensor and Controller installed to control the usage and operational of the split air conditioners, there will not be wastage due to air conditioning cooling an empty room.

These 2 approaches by itself can provide energy conservation to the existing air conditions without replacing existing working air conditioners into a higher efficiency system. Major replacement of air conditioners should be look upon with major improvement to the air conditioning systems like the water cool centralized air conditioning plant to improve energy efficiency.

The top management totally supported this concept and there are already plan that similar effort will be implemented in other buildings that has the same type of equipment.

As to move forward on the same project on energy conservation for the resident quarter or similar project, the following are plan to

- The use of air conditioners waste heat for water heating to provide warm water for shower room.
- The collection of grey water for the watering of lawn and gardening.

4. ORIGINALITY

4.1 CREATIVITY / INNOVATION

The initial project was design as a building civil works. Hence the architect put in a normal building with wall etc suitable for tropical climate. But with the oversizing of the air conditioners, these results in condensation follow by moldy problems and occupants discomfort and wet ceiling and walls.

Similarly, during the retrofitting time, all the consultant fail to realize the over cooling of the air conditioners that are operating 24 hours daily, 365 days a year. Most consultants recommended the walls to be thickened, insulate and painted with anti-condensation paint. All these efforts fail due to incomplete assessment of the root cause.
We have employed a qualified IR thermographer to conduct an IR thermography on the surrounding walls to pinpoint the heat movement. With the deployment of this new application, we are able to get an insight as to the temperature profile of the walls being impacted by the cold air stream from the Fan Coil unit. Hence the identification of the cause of the condensation problem.

Thermograph clearly showing the room wall at 23 to 24 deg C. This causes condensation on the other side of the wall if high humid air at room temperature are allow to enter the neighbour room.

Further, with the appointment of an energy consultant, we are able to study and identified the root cause of the condensation problem. Hence right sizing the air conditioners. Then the room temperature are controlled without excessive cooling to the walls and ceiling as the occupancy sensor controller actually reset and raise the room temperature to a higher set point when no occupant is present.

The benefits after the retrofitting works not only satisfy the original goal set up for the project which is to resolve mold growth issue and resolved condensation issue. The project also provide for a better comfort for the occupants as no more over cooling for occupants within the room and a sudden rise in temperature when they step out of the room. In addition, the client achieve tremendous amount of energy savings.

DDWS has documented this and similar procedure and consideration will be given to future building retrofitting works. Further, the directorate is looking into introducing the Occupancy
Sensor Controller for other resident accommodation to control the use of air conditioners especially in time of occupants left the room.

In addition, DDWS is looking into using similar control strategy to control the split air conditioners in offices where occupant may leave the room and forgotten to turn off the air conditioners. This will allow energy saving throughout the organization from learning gain from implementation of this pilot project.