**Additional Information on the Proposed Methodology**
**"Energy Saving by Introduction of High Efficiency Centrifugal Chiller"**

## 1. Market share of chiller manufacturer in Thailand

In Thailand, the American manufacturers, such as Company A, Company B, and Company C, are dominant in the centrifugal chillers market according to a news article published by JARN[1] in 2014 and an interview with a Japanese manufacturer, KOBELCO.

## 2. Research on the COP values of chillers in Thailand

### 2.1 Catalogue COP values

Catalogue COP values of centrifugal chillers sold in Thailand are collected on the web.

In the case of new installation, it is possible to assume that centrifugal type chiller of Company A, Company B and Company D, are chosen. This is because the survey shows that company C probably has a refrigerant that is going to be phased out by Montreal Protocol. Company D is a Japanese major chiller manufacturer and also selling chillers in Thai market

As a result, 14 COP values of non-inverter type centrifugal chiller from Company A, total 49 COP values of inverter type including 26 from Company B and Company D, are ranging from 250 USRt to 1,500 USRt in Thai are obtained.

### 2.2 Standardized COP* values and determination of the reference COP values

COP values of centrifugal chillers marketed in Thailand are calculated from values of the 63 catalogue data (14 non-inverter type and 49 inverter type) by manufacturer's testing based on industrial standards[2] and standardized with the equation as indicated in the proposed methodology. These are summarized in Table 1 and Table 2 below.

*Standardized COP is calculated based on the same manner stated in Criterion 2 on the proposed methodology

It is observed that COP values of non-inverter type (Table 1) show higher efficiency than those of inverter type (Table 2). Therefore, the reference COP values are determined by the types of chillers,

[1] Japan Air Conditioning, Heating & Refrigeration News: First published in February 1969, JARN is the only English magazine published in Japan that covers worldwide information about HVAC&R industry/market, products, new technology, major trade shows and various promotional activities by the global industry leaders through its long-standing information network. (https://www.ejarn.com/about.aspx)

[2] JIS B 8621:2011 Centrifugal Water Chillers, ANSI/AHRI 550/590-2011: Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle

inverter and non-inverter.

### 2.2.1 The reference COP values of non-inverter type

For non-inverter type, however COP value varies according to cooling capacity, it is observed that those COP values with cooling capacity of less than 400 USRt show clearly smaller than those ranging more than 400 USRt. Therefore, two cooling capacity ranges are set to determine the reference COP values for each range.

The most efficient COP, which has the largest value, in each capacity range is selected as the reference COP and shown in Table 1 below in red circles.

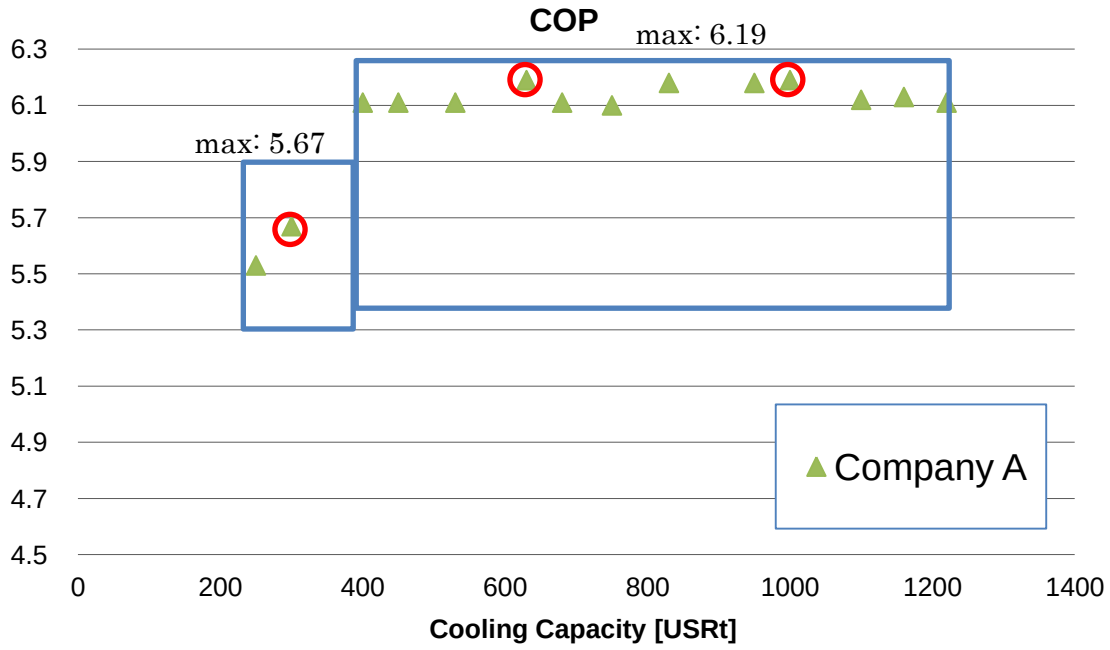


Figure 1: COP values of non-inverter type centrifugal chiller marketed in Thailand

The reference COP of non-inverter type for each cooling capacity range is determined and shown in Table 1 below. ("x" in the table represents cooling capacity per unit.)

Table 1: Established $COP_{re,i}$ of non-inverter type for the proposed methodology

| | Cooling capacity per unit (USRt) | |
|---|---|---|
| | 250≦x<400 | 400≦x≦1,220 |
| COP* | 5.67 | 6.19 |

### 2.2.2 The reference COP values of inverter type

For inverter type, it is observed that similar COP values fall into a certain cooling capacity range. Therefore, four cooling capacity ranges are set to determine the reference COP values for each range. The most efficient COP, which has the largest value, in each capacity range is selected as the reference COP and is shown in Table 2 below in red circles.

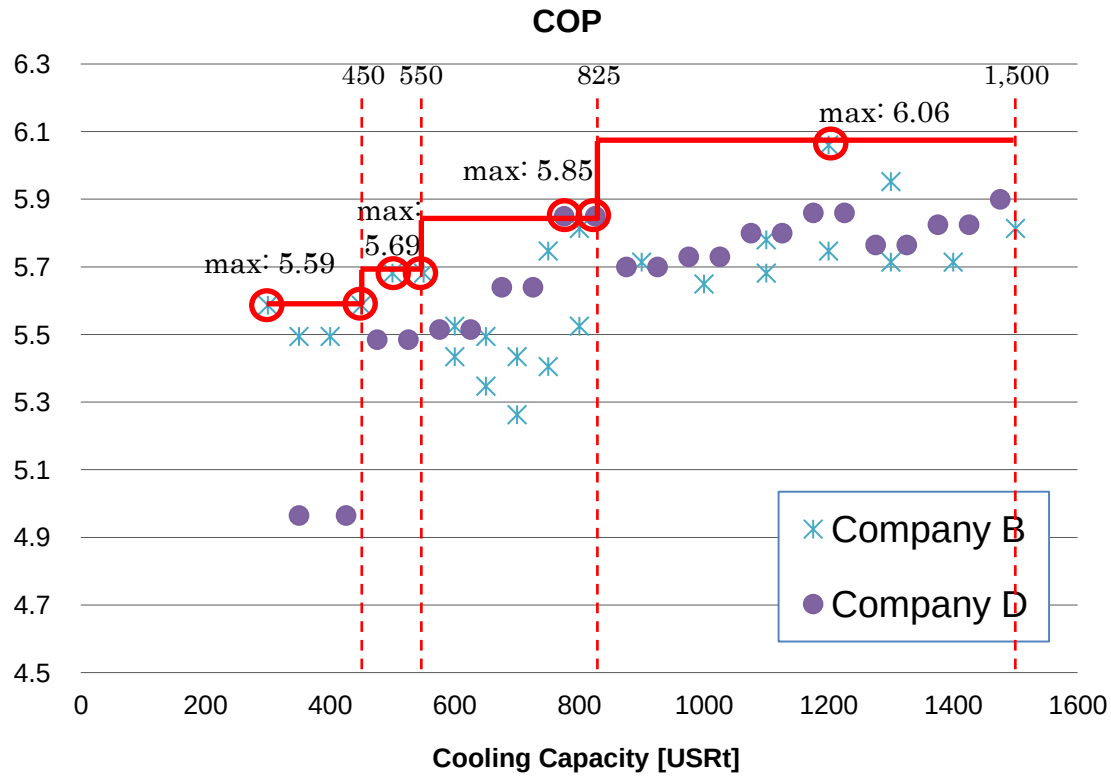


Figure 2: COP values of inverter type centrifugal chiller marketed in Thailand

The reference COP of inverter type for each cooling capacity range is determined and shown in Table 2 below. ("x" in the table represents cooling capacity per unit.)

Table 2: Established $COP_{re,i}$ of inverter type for the proposed methodology

| | Cooling capacity per unit (USRt) | | | |
|---|---|---|---|---|
| | 300≦x≦ 450 | 450<x≦ 550 | 550<x≦ 825 | 825<x≦ 1,500 |
| COP* | 5.59 | 5.69 | 5.85 | 6.06 |