

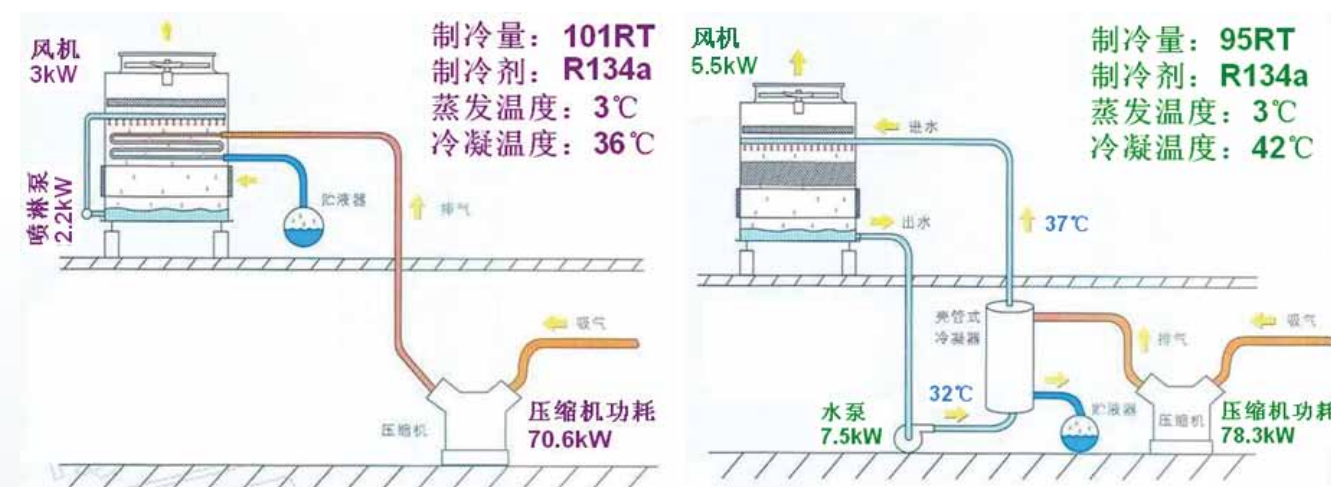
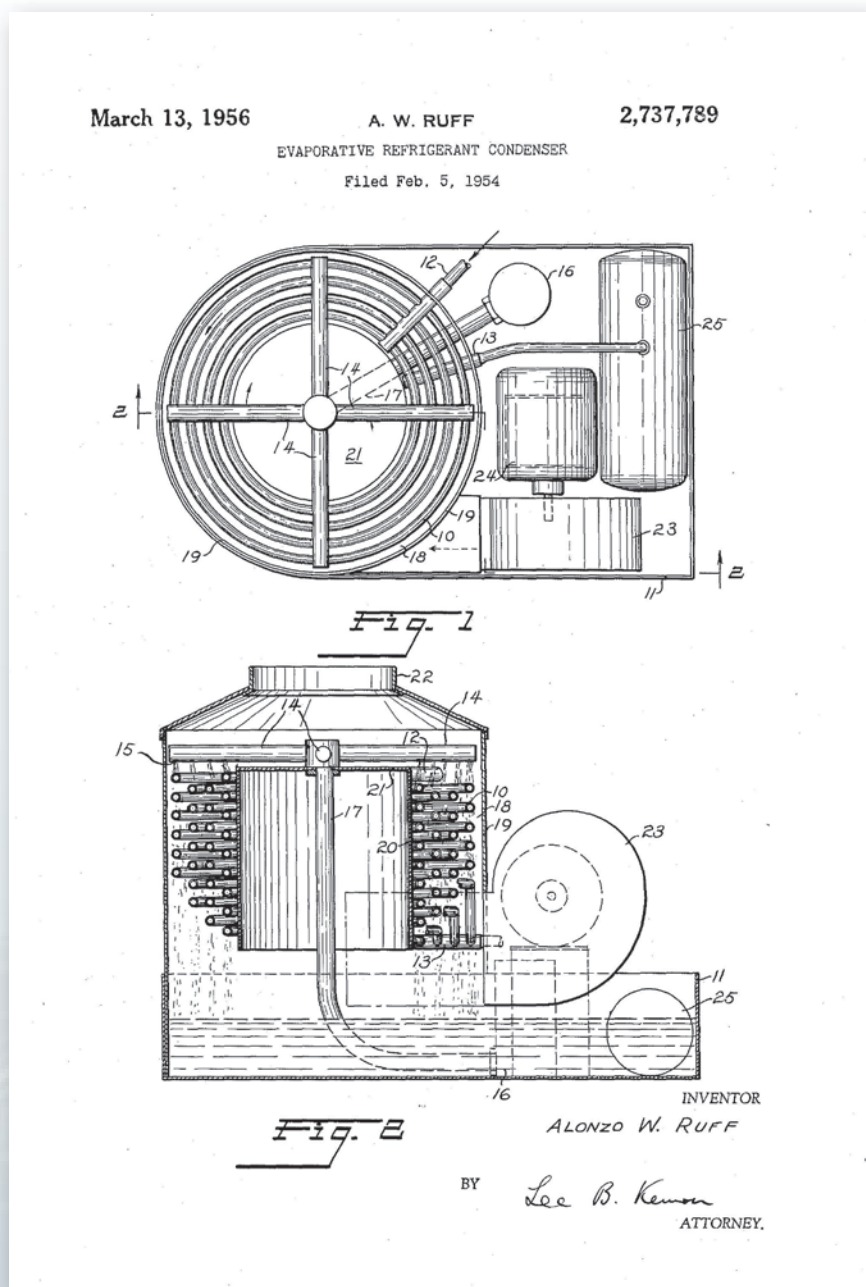
# 蒸發式冷凝器冷水機組

蕭家祥博士

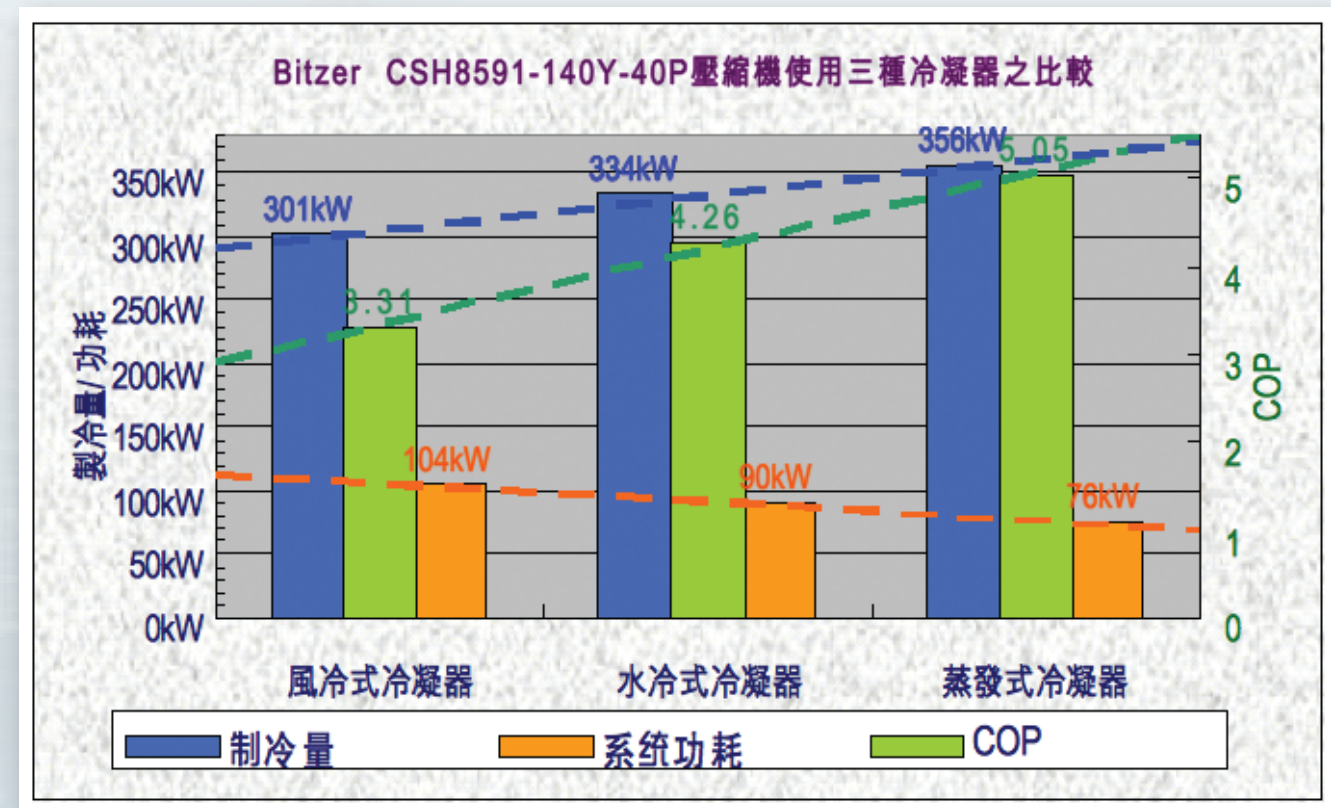
在今天香港的空調行業中，有一種較新的產品出現——“蒸發式冷凝器冷水機組”，但這產品卻不是一種新的科技。蒸發式冷凝器這項技術早在1956年已在美國申請了專利，而在冷凍行業中更使用了好幾十年，但在空調行業中，卻很少使用。原因是在70-80年代，香港淡水供應有限，所以對於空調系統使用淡水冷卻塔有限制。隨著中國內地為香港提供充足的淡水，香港機電工程署在2000年5月30日開始，準許在指定地區的非住宅性建築使用淡水作為水冷式空調系統排熱用，所以水冷式和蒸發式冷水機組開始廣泛應用。

一般冷凝器可分為風冷及水冷兩大類，而蒸發式冷凝器卻是結合了風冷及水冷兩項形式在一起。蒸發式冷凝器是一種高效的換熱設備，一般情況下，水冷式冷凝器入水溫差為4-6°C。理論上在水冷式冷凝器中，1kg的冷卻水能帶走8.37~25.12 kJ的熱量，而1kg的水在35°C的常壓下氣化潛熱為2418kJ/kg。同時它省去了冷卻水在冷凝器中顯熱傳遞階段，使冷凝溫度有可能更接近空氣的濕球溫度，其冷凝溫度可比冷卻塔水冷式冷凝器系統低3~5°C，比風冷式冷凝器更低8~11°C，這大大降低了壓縮機功耗，同時由於循環水量的減少，因整體式蒸發式冷水機組是把蒸發式冷凝器，冷卻水水泵，壓縮機等，都已一體化整合在一起，使冷卻水行程大為減低，水泵的動力消耗同時明顯降低。

- 此外，蒸發式冷凝器是穩定運行的核心部分，因此蒸發式冷凝器應具有以下要求：
1. 高導熱性及有耐腐蝕性塗層的金屬，防止在沿海地方使用時腐蝕；
  2. 銅管與銅管之間有足夠的間距，容易清洗和保養，確保在任何時候的高熱傳導。



- ★ 製冷劑可以透過銅管直接與空氣和水進行熱交換，換熱效率高、冷凝溫度低。
  - ★ 低冷凝溫度，壓縮機功耗更小。
  - ★ 水泵阻力很小，功耗低。
  - ★ 水系統管路簡單，設備安裝工程量小。
  - ★ 散熱風量比冷卻塔小，風機功率低。
- ★ 製冷劑需要先與水進行熱交換，再用熱水與空氣進行熱交換，換熱效率低，冷凝溫度較高。
  - ★ 高冷凝溫度帶來更高的壓縮機功耗。
  - ★ 水泵需要克服管道揚程阻力，
  - ★ 水系統管路複雜，設備安裝工程量大。





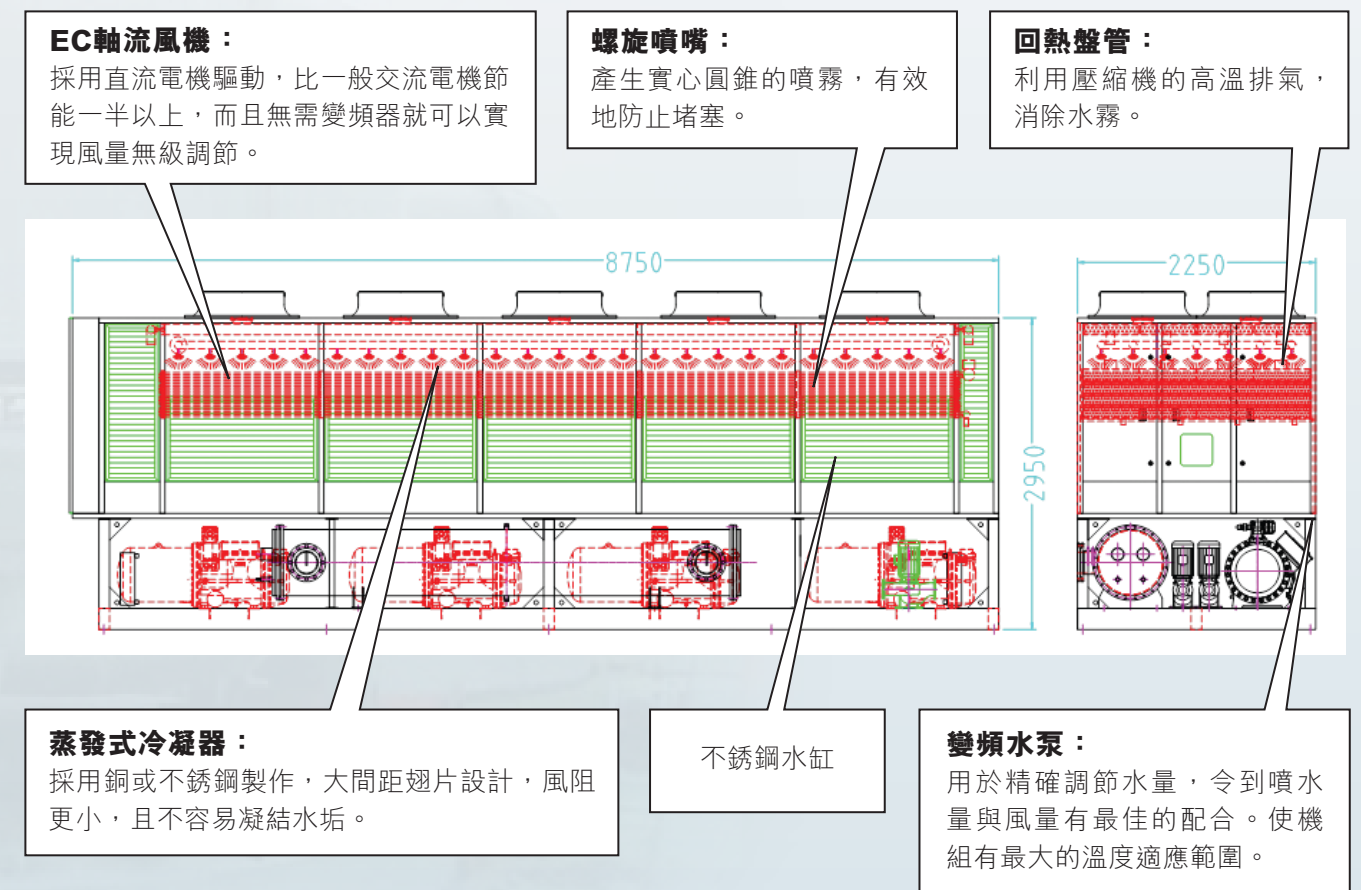
	風冷式冷凝器	水冷式冷凝器	蒸發式冷凝器
佔用空間情況	使用顯熱交換，冷凝溫度與空氣之乾球溫度相關，冷凝溫度高，需要很大的散熱面積，設備空間佔用很多。	使用顯熱/潛熱交換相結合，冷凝溫度介於風冷式冷凝器和蒸發式冷凝器之間，雖然設備空間佔用比風冷式冷凝器有優勢，但因需要額外配置冷卻塔，設備佔用空間仍然較大。	完全使用潛熱交換，冷凝溫度與空氣濕球溫度相關，在高溫下仍可發揮良好效果，散熱面積遠比風冷式冷凝器小，一體化的機組設計，使得設備佔用空間比水冷式冷凝器機組節約15%，比風冷式冷凝器機組節約30%。
安裝成本	系統能一體化設計，安裝簡單，但因空間佔用多同一冷量外形尺寸大，搬運成本會較高。	需要配套冷卻塔使用，工程人員需要安裝散熱水路，還要增加冷卻塔和冷卻水泵的控制箱，工程複雜，安裝成本高。	一體化設計的機組，無需令外配置冷卻塔和冷卻水泵，工程無需做冷卻水路，無需額外的冷卻系統的控制箱，空間佔用少，設備輕巧，安裝成本低。
使用成本	高冷凝溫度帶來高的耗電量，使用成本很高。	冷凝溫度較低，使得耗電量有一定優勢，但因需配套冷卻塔和冷卻水泵使用，而且風機功率和水泵功率還比較大，使用成本較高。	更低的冷凝溫度非常有利於節能，耗電量最低，使用成本低。
生產技術	生產技術已非常成熟，生產商現集中於冷凝器設計翅片設計而提升耐用程度。	生產技術已非常成熟，生產商現集中於提升機組效能。	生產技術較成熟，生產商現集中於改善冷凝器抗腐蝕效能。如全不銹鋼設計或無焊點在熱交換表面告結垢問題。
維修成本	維修成本較低。	要定期清洗水塔、落藥和抽取水板化驗，以防止退伍軍人症，維修成本高。	除基本風冷及水冷的維修程序外，零件比較多，還要定期檢查噴嘴，防止堵塞，維修成本較高。
供應量	很多	很多	只有兩至三個
製冷量	10~400冷噸	50~2000冷噸	20~600冷噸
機組參數價錢	1	0.83	1.65
停水後時間	無影響	一般兩小時，受制於水缸的容量。	維持約一半的製冷量。

(\*) 註：機組價錢參考數，只是對冷水機組本身價錢作比較，並沒有包括所需配套設備的整體計算。

### 耗電量比較

	風冷機組	水冷機組	蒸發式機組
冷負荷	300 kW		
每天工作時長	8 h/day		
全年工作天	125 day/year		
年度冷負荷	300000 kW/year		
SEER	3.41 kW/kW*h	4.18 kW/kW*h	5.37 kW/kW*h
年度耗電量	87977 kW*h/Year	71770 kW*h/Year	55866 kW*h/Year
平均功耗	87.9765 kW	71.7703 kW	55.8659 kW
電價	1.00 HKD/kW*h		
每小時平均費用	87.98 HKD	71.77 HKD	55.87 HKD
年度費用	87977.00 HKD	71770.00 HKD	55866.00 HKD

### 蒸發式冷凝器冷水機組結構圖



在現今全球都以節省能源及減少碳排放為大前題下，由風冷冷水機改為水冷式及蒸發式冷水機組可節省運行成本並同時大大減少碳排放量。



# Centennial Campus



## Overview

The project of Centennial Campus includes the construction of two 9-storey and one 10-storey academic buildings with three level basement and three level podiums. The project team was faced a challenge to provide energy efficient air conditioning and mechanical ventilation systems for the academic buildings, which are used to relieve the existing campus space shortfall and provide additional space required for implementation of "3+3+4" as well as catering for the increased number of non-local students.

## HVAC System

With total cooling capacity 4,500 RT, the chiller plant is configured with four 900 Tons and two 450 Tons R123 water-cooled VSD chillers. The small chiller is used as night mode chiller to optimize the efficiency of the equipment. Since the chiller plant is located next to the theatre, noise and vibration performance are important criteria for selection of chillers.

The Variable Speed Drive (VSD) technology has been widely used in the HVAC industry for a long time, especially in air handling unit fans, cooling tower fans and water pumps, due to its capability to save power. It continuously monitors several operating conditions such as chilled water temperature, chilled water set point, refrigerant pressures, pre-rotation vane position and the actual motor speed. This information is then fed to a microprocessor that determines the most efficient way to operate. It optimizes both motor speed and the pre-rotation vane position and changes the frequency of the power input to the motor, in order to consume the least amount of energy.

Moreover, five fresh water cooling towers (each with 1,125 RT heat rejection) are used in this system, and the fresh air rate is 10 L/s/person. This design is based on outdoor and indoor design conditions. For outdoor, it is 33.5°C / 29°C (WB) in summer and 7°C / 2°C (WB) in winter design condition. On the other hand, it is 25.5°C / 55 % RH for indoor design condition.

On the air side, the project used 93 numbers of PAU/AHU. Some of AHU are incorporated with both cooling and heating coils which provides better humidity control. Additional 2,700 numbers of VAV box are used for air ventilation.

## Summary

The systems in Centennial Campus were designed and installed using an integrated approach to achieve best energy efficiency. Stringent measures were implemented to minimize any disturbance to the University and the surrounding neighborhood during the construction period. Last but not least, sustainability is the major consideration of the project team. This concept applied to every aspect of this project, including using intelligent building materials and natural energy, recycling grey water, green roof and natural ventilation. As a result, this project has achieved an Indoor Air Quality (IAQ) excellent level, and buildings are rewarded with HKBEAM at Platinum grade and under assessment of LEED Certificate aiming at Platinum grade too. Providing evidence of lower energy consumption and reduced environmental footprint.

### PROJECT SUMMARY

Project Site : Pokfulam, Hong Kong  
 Client : The University of Hong Kong  
 Architect : Wong & Ouyang (HK) Ltd.  
 M&E Consultant : Wong & Ouyang (Building Services) Ltd.  
 ACMV Contractor : Gammon E&M Ltd.  
 Completion Date : Phase I - July 2012



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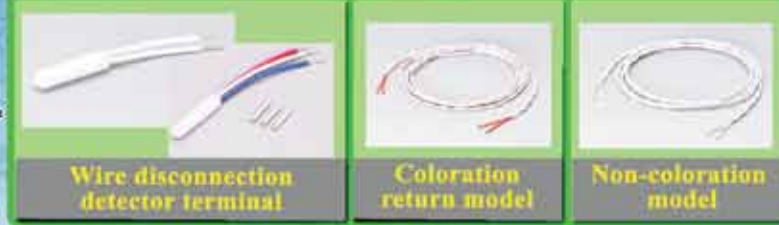
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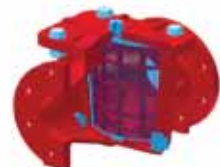
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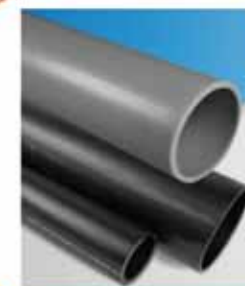


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Design Stage 設計階段	Implementation Stage 實施階段	Testing & Commissioning Stage 檢驗和調試階段	Operation Stage 操作階段
<ul style="list-style-type: none"> <li>Optimization of System Design</li> <li>Selection of High Efficiency Equipment</li> <li>Adaptation of System</li> <li>優化系統設計</li> <li>選擇高效率設備</li> <li>採用合適設備</li> </ul>	<ul style="list-style-type: none"> <li>EOS &amp; BMS Implementation</li> <li>EOS Control Algorithms Development</li> <li>總機設備安裝</li> <li>建立系統控制方案</li> </ul>	<ul style="list-style-type: none"> <li>Verification of System Configuration, Commissioning and Fine Tuning</li> <li>校核系統配置及調試</li> </ul>	<ul style="list-style-type: none"> <li>Continuous monitoring of system performance and energy consumption</li> <li>持續監察系統能源消耗</li> </ul>

**Job Reference 成功案例**

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# Basketball Competition 2012

The final of Basketball Competition was held on 29<sup>th</sup> September 2012 and there were lots of fireworks. The spirit of all players showed the team unwilling to let any chance slip away.

- Champion** : The Jardine Engineering Corporation Limited  
**1<sup>st</sup> runner-up** : ATAL Engineering Limited  
**2<sup>nd</sup> runner-up** : Analogue Technical Agencies Limited



Mr Dave Chan (middle), Chairman of ACRA, presented the award to 1<sup>st</sup> runner-up team.



Mr Ringo Shea (middle), President of ACRA, presented the award to Champion team.

Mr Dave Chan (middle), Chairman of ACRA, presented the award to 2<sup>nd</sup> runner-up team.

# Table Tennis Tournament 2012

This year the ACRA Table Tennis Tournament rounded off on 12<sup>th</sup> September 2012. Overwhelming response was received and there were 9 teams to compete for the champion.

- Champion** : Young's Engineering Company Limited (Team B)  
**1<sup>st</sup> runner-up** : Young's Engineering Company Limited (Team A)  
**2<sup>nd</sup> runner-up** : Gotop Engineering (HK) Limited



Mr Ringo Shea (middle), President of ACRA, presented the award to Champion team.



Mr Ringo Shea (2<sup>nd</sup> from the left), President of ACRA, presented the award to 2<sup>nd</sup> runner-up team.





# Training of HVAC Control Systems & Practical Application

This 4-day comprehensive training is co-organized with ASHRAE Hong Kong Chapter in September 2012 targeting those who are familiar with the mechanical systems of HVAC components but would like to know more about the fundamentals of controls in the industry. It includes introduction to HVAC control fundamentals, control system components, common control theories in HVAC applications, contemporary and future trends in control industry, IT influence to control industry and subsystems interface protocols, monitoring and control of various subsystems, and case study. Supportive responses were received from members and there were more than 70 attendants.



A photo of ACRA / ASHRAE HKC representatives and attendants.



Mr. Ringo Shea, President of ACRA, made an opening speech for the training course.

# Joint Comprehensive Certificate Course on HVAC&R System

Co-organized with ASHRAE Hong Kong Chapter, the 'Joint Comprehensive Certificate Course on HVAC&R System' was conducted in February-April 2012 to broaden junior engineers' knowledge on major issues encountered in the Air Conditioning and Mechanical Ventilation Systems. It was also useful for those who want to refresh their knowledge of practical areas. Speakers came from experienced professors, government officers, and professional engineers of reputable consultants / contractors / manufacturers / facility management companies.



# Caring Committee

With the full support of members, ACRA formed the 'Caring Committee' in October 2012.

The aims of this committee are to enhance ACRA's charity work, provide platform for members to participate and enable them to become the Caring Company in the coming future. Links will be set up with community to provide services and charity functions on a long term basis.

We are also very delighted to have our Past President, Mr Raymond Synn, to be the Chairman of this committee. We strongly believe that under the leadership of Raymond, ACRA's charity work would be well organized and developed in the coming future, not just limited in promoting the image of the association but really deliver our care, concerns and substantial helps to the community.

More information would be issued regarding the details of the operation of the committee and look forward to your support.



To celebrate forming 'Caring Committee', the kick-off meeting was held on 11<sup>th</sup> October 2012.

<b>Chairman</b>	
<b>Mr. Raymond Synn</b> Krueger Engineering (Asia) Limited	
<b>Mr. Dave Chan</b> ATAL Engineering Limited	<b>Mr. Simon Siu</b> Raising Engineering Limited
<b>Mr. Kenneth Tsang</b> Bun Kee (International) Limited	<b>Mr. Ringo Shea</b> Southa Company Limited
<b>Mr. Dominic Yiu</b> Chivas Corporation Limited	<b>Mr. Pachu Leung</b> Welcome Oncho Denki Limited
<b>Mr. John Lo</b> Cold Magic Efatar (HK) Company Limited	<b>Mr. KY Ip</b> Young's Engineering Company Limited
<b>Mr. Derek Leung</b> Fook Loong (Hong Kong) Limited	<b>Ms. Polly Mui</b> ACRA

**Vision 願景/宗旨**

To foster the concept of 'Caring Industry' in Hong Kong by leveraging and uniting practitioners of the HVAC industry to take up social responsibilities.

透過團結暖通空調從業員的力量，共同承擔更多社會責任，促進實現「關懷業界」的理念。

**Mission 使命**

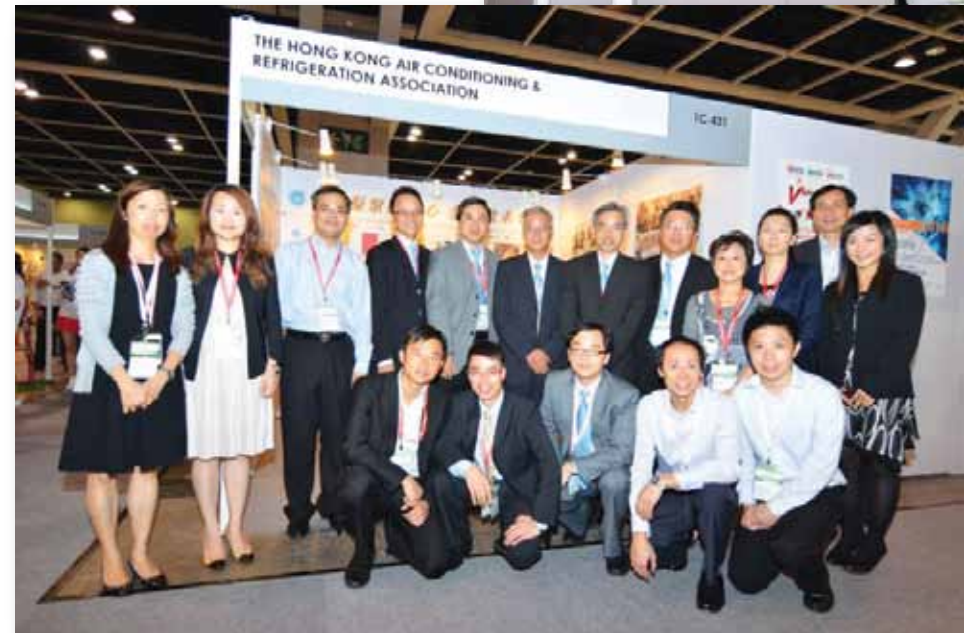
- Encourage and support our members to become 'Caring Company' 鼓勵和支持會員獲得「商界展關懷」的標誌
- Provide a platform to embrace united efforts in charitable activities 成為集合業界關懷力量的平台
- Promote partnership with social services sectors 促進業界與社會伙伴合作
- To be recognized as first 'Caring Industry' 成為首個被認同的「關懷業界」





# Build4Asia

On 4th – 6th June 2012, ACRA participated at Build4Asia Exhibition in Hong Kong Convention and Exhibition Centre. The show gathered more than 500 international and local exhibitors from sustainable architecture, design, building services and electrical engineering industries. ACRA also had a booth at the show to demonstrate all important milestones since it was established in 1961, including recent seminars, technical visits, social activities and charity program. Through the presence in different occasions, we hope more organizations in the industry will know ACRA better and enroll as our member.



ACRA's booth at the exhibition hall.



Many members visited ACRA's booth to show their support.

# Heads-up on Next Charity Activity



ACRA and Open Door Ministries (開心社區服務) will co-organize 千歲宴 again on 8<sup>th</sup> December 2012 to celebrate Winter Solstice Festival with elderlies living in Lam Tin. We look forward to your support and participation, see you there!

Company Name	Contact Number	Website / Email	Trade	
<b>ACRA Fellow Members</b>				
ATAL Engineering Limited	安樂工程有限公司	2565 3399	www.atal.com.hk	Contracting & Maintenance
Carrier Hong Kong Limited	開利(香港)有限公司	2694 5618	www.carrier.com.hk	Supplier
Krueger Engineering (Asia) Limited	高雅機電工程有限公司	2860 7333	www.krueger.com.hk	Contracting
Newland Engineering Limited	新陸工程有限公司	2967 8620	moshiu@newland.com.hk	Contracting
REC Engineering Company Limited	盈電工程有限公司	2619 8888	www.yaulee.com	Contracting
Shinryo (Hong Kong) Limited	新菱工程香港有限公司	2237 8624	victorcheung@shinryo.com.hk	Contracting
Shun Hing Engineering Contracting Company Limited	信興機電工程有限公司	2419 8282	www.shecon.com	Contracting
The Jardine Engineering Corporation Limited	怡和機器有限公司	2807 4511	www.jec.com	Supplier, Contracting & Maintenance
<b>ACRA Fellow Members</b>				
Trane Hong Kong	特靈香港	3128 4711	www.tranehk.com	Supplier
Winston Air Conditioning & Engineering (Hong Kong) Company Limited	永通冷氣工程(香港)有限公司	2764 1200	winhk@winston-hk.com	Contracting
York International (Northern Asia) Limited	約克國際(北亞)有限公司	2590 0012	www.johnsoncontrols.com	Supplier & Maintenance
Young's Engineering Company Limited	景福工程有限公司	2235 0900	www.youngs.com.hk	Contracting
<b>ACRA Fellow Members</b>				
Trane Hong Kong	特靈香港	3128 4711	www.tranehk.com	Supplier
Winston Air Conditioning & Engineering (Hong Kong) Company Limited	永通冷氣工程(香港)有限公司	2764 1200	winhk@winston-hk.com	Contracting
York International (Northern Asia) Limited	約克國際(北亞)有限公司	2590 0012	www.johnsoncontrols.com	Supplier & Maintenance
Young's Engineering Company Limited	景福工程有限公司	2235 0900	www.youngs.com.hk	Contracting
<b>ACRA Corporate Members</b>				
Alliance Contracting Company Limited	聯和承造有限公司	2891 9083	enquiry@alcc.com.hk	Contracting
Analogue Technical Agencies Limited	安樂科技有限公司	2565 3399	www.analogue.com.hk	Supplier
Bun Kee (International) Limited	彬記(國際)有限公司	2748 9370	hvac@bunkeintl.com.hk	Supplier
Chevalier (Hong Kong) Limited - A/C Division	其士(香港)有限公司 - 冷氣部	2111 4811	aircondi@chevalier.com	Contracting
China State Mechanical & Electrical Engineering Limited	中國建築機電工程有限公司	2823 7888	applelau@cseh.com	Contracting
Chun Wo E & M Engineering Limited	俊和機電工程有限公司	3758 8007	bs@chunwo.com	Contracting
Cold Magic Efatar (HK) Company Limited	高美怡輝(香港)有限公司	2606 6922	www.cold-magic.com	Supplier & Manufacturing
Daikin Airconditioning (Hong Kong) Limited	大金冷氣(香港)有限公司	2570 2786	miky@daikin.com.hk	Supplier
Efatar Engineering Co. Ltd.	怡輝冷凍工程有限公司	2606 6922	www.efatar.com.hk	Supplier
Fook Loong (Hong Kong) Limited	福隆(香港)有限公司	2393 7773	www.flhk.com.hk	Supplier
Gammon E&M Limited	金門機電工程有限公司	2516 8823	www.gammonconstruction.com	Contracting
Honeywell Limited	霍尼韋爾(香港)有限公司	2331 9133	Candy.Lam@honeywell.com	Supplier
Hsin Chong Aster Building Services Limited	新昌亞仕達屋宇設備有限公司	2579 8238	josephfung@hcg.com.hk	Contracting
Johnson Controls Hong Kong Limited	江森自控香港有限公司	2590 0012	www.johnsoncontrols.com	Supplier & Maintenance
K-Thorn Engineering Company Limited	旗鋒工程有限公司	2481 2918	main@k-thorn.com.hk	Contracting
Lucky Engineering Company Limited	運通冷氣電業有限公司	2780 5285	general@luckyeng.com.hk	Contracting & Supplier
McQuay Air-Conditioning Limited	麥克維爾空調有限公司	2893 6261	custdept@mcquay.com.hk	Supplier
Meco Engineering Limited	德實工程有限公司	2891 8722	wg_chu@meco-group.com	Contracting
Quad-Tech Engineering (Hong Kong) Company Limited	高得工程有限公司	2573 1832	quadtech@hkstar.com	Contracting
Raising Engineering Limited	威信工程有限公司	2395 6081	raising@netvigator.com	Contracting
Ryowo (Holding) Limited	菱和(集團)有限公司	2391 8381	ryinfo@ryowo.com	Manufacturing
Siemens Limited	西門子有限公司	2107 6506	andy.wong@siemens.com	Supplier
Skyforce Engineering Limited	天科工程有限公司	2885 1620	info@skyforce.com.hk	Contracting
Southa Company Limited	南龍有限公司	2963 7175	www.southa.com	Supplier & Contracting
Standard Refrigeration & Engineering Company Limited	立德工程有限公司	2781 0871	SRE@hkpg.com.hk	Contracting
Takasago Thermal Engineering (Hong Kong) Company Limited	高砂熱學工業(香港)有限公司	2520 2403	sales@takasago.com.hk	Contracting
Technicon Engineering Limited	得力確工程有限公司	3193 1300	technic@technicon.com.hk	Contracting
Welcome Oncho Denki Limited	偉基溫調電機有限公司	2806 8316	www.saiver-welaire.com.hk	Supplier
Westco Air Conditioning Limited	威高冷氣工程有限公司	2426 3123	mandylo@scee.com.hk	Contracting
<b>ACRA Associate Members</b>				
A&R Engineering Company Limited	奇樂工程有限公司	2408 2960	arengo@netvigator.com	Contracting
Air Master International Limited	雅士(國際)空調有限公司	2764 0307	winston@airmaster.com.hk	Manufacturing
Air Trade Centre Limited	裕風先達有限公司	2887 7000	anthony@atc.hk	Supplier
Alison M & E Engineering Limited	雅訊機電工程有限公司	2595 1199	contacts@alison.com.hk	Contracting
Alpha Appliances Limited	第一電業有限公司	2529 7555	hkwa@alpha-general.com	Supplier
Alstern Technologies (Hong Kong) Limited	奧思(香港)有限公司	2647 8163	www.alstern-technologies.com	Contracting
Anway Engineering Company Limited	正佳工程有限公司	2598 4228	www.anway.com.hk	Supplier
Armaccell Asia Limited	阿樂斯亞洲有限公司	2574 8376	sam.s.yeung@armaccell.com	Supplier
Arnhold & Co., Ltd.	安利有限公司	2807 9400	patricklai@arnhold.com.hk	Supplier
A Shing Engineering Company Limited	亞成冷氣工程有限公司	2537 1818	wilkiengan@ashing.com.hk	Contracting & Supplier
Boca International Limited	寶加國際有限公司	3176 6028	dr.richardchan@gmail.com	Supplier
Brightwell Air-Conditioning Limited	冠昇空調有限公司	2331 8559	brightwell@biznetvigator.com	Supplier
Brisky Limited	穿梭科技有限公司	2511 3161	tkwan@briskyltd.com	Supplier
CDBM Engineering Consultant Company Limited	新雄力工程顧問有限公司	2598 1088	mail@cdbm.asia	Contracting
Chi Yip Engineering Company	志業工程公司	3078 9984	canny@acmv-cy.com	Contracting
Chivas Corporation Limited	瑞峰洋行有限公司	2521 9768	info@chivascorp.com.hk	Supplier
Chong Kin Air-Condition Trading Engineering Company Limited	創建冷氣貿易工程有限公司	2307 5159	www.chongkinaircon.biz.com.hk	Supplier
<b>ACRA Associate Members</b>				
C.J. Wishing International Limited	惠生電業有限公司	2799 9797	cjwish@cjwish.com.hk	Supplier
Clydeman Engineering Limited	佳電工程有限公司	2332 3591	daniel@clydeman.com	Contracting
Crownint Limited	冠殿有限公司	8202 0830	clchoy@crowntingrp.com.hk	Contracting
Dah Chong Hong (Engineering) Limited	大昌貿易工程有限公司	2768 3595	www.dch.com.hk	Contracting
Delta Pyramax Company Limited	佳澤科技有限公司	2511 2118	alanyip@dpx.hk	Supplier
Dextra Pacific Limited	德士達太平洋有限公司	2511 8236	www.dextragroup.com	Supplier
Dynamic Success Company Limited	勁技有限公司	2116 9021	amok@dsuccess.com.hk	Supplier
Eaxon International Company Limited	恩索有限公司	3590 4656	gamescheung@eaxon-group.com	Supplier
ebm-papst Hong Kong Limited	依必安派特香港有限公司	2145 8678	www.ebmpapst.com.cn	Supplier / Manufacturing