AABC Commissioning Group

AIA Provider Number 50111116

Commissioning without Borders: International Commissioning in the 21st Century

AIA Course Number CXENERGY1523

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Summary

Commissioning has been around since the 1960's. Increasing numbers of international building owners are recognizing the benefits of green building, and with it, the value of commissioning; with or without an optional external certification process. Last year, Elm Engineering completed the commissioning of the US$235 Million Grand Hyatt West Tower at Incheon Airport in Korea. In April of 2015, the hotel received LEED Gold Certification from the USGBC.

Here is how we approached this large international commissioning project.

Learning Objectives

By the end of the this course, participants will:

1. Learn how commissioning goals and expectations may vary in countries outside of the United States of America.

2. Understand how sustainability objectives and environmental parameters differ among building owners and construction investors from different countries.

3. Understand how to best manage construction and commissioning among teams comprised of members who speak different languages.

4. Learn how an international team of architects, engineers and commissioning authorities successfully worked together on the construction and delivery of the Grand Hyatt West Tower for the Korean Airlines (KAL) Hotel Network in South Korea.

Agenda

- International Commissioning Overview
- Grand Hyatt West Tower Project:
  - Initial Contract Negotiations
  - Design Quality Reviews of Drawings
  - Owner's Project Requirements (OPR)
  - Commissioning Plan
  - Shop Drawings
  - Commissioning Site Visits
  - Functional Testing
  - Measurement and Verification Plan

The International Commissioning Industry

Building Commissioning originated in the United Kingdom and the US in the 1960's. International building owners use commissioning not only as quality assurance but also to:

- Minimize construction change orders and problems;
- Lower energy, maintenance, and operating costs;
- Hold their designers and contractors accountable for meeting project objectives;
- Further their sustainability goals; and
- Save money.

The International Commissioning Industry

Global revenues (including US) of $2.7 Billion*

Examples of International Green Building Certifications

- BREEAM (UK)
- LEED (US)
- BCA Green Mark (Singapore)
- International Green Construction Code
- GBL (China)

Examples of International Commissioning Accrediting Organizations:

- Association of Energy Engineers
- ASHRAE – Commissioning
- Building Commissioning Association
- AABC Commissioning Group

*Source: Navigant Research report – 1Q 2015

LEED International

In the US, LEED is based on a number of codes and standards:

- ANSI/ASHRAE/IESNA
- NEC
- NFPA
- UPC/IPC
- ICC

Many credits also reference standards specific to the US, such as EPA regulations.

LEED International

No specific standards are referenced by LEED for Fundamental or Enhanced commissioning for international work.

Good resources for guidance include:

- ASHRAE Standard 202—Commissioning Process for Buildings and Systems
- Building Commissioning Association—The Building Commissioning Handbook.

For the KAL Grand Tower West project, Elm used ASHRAE Standard 202 as the basis of the commissioning plan.

International Green Building Codes

World building codes vary widely. For example, the Asia-Pacific Economic Cooperation (APEC), is a group of 21 member nations bordering the Pacific Ocean.

Members (and their referenced codes) include:

- The United States
- Korea–Korean Standards (KS); international equivalents. such as ASHRAE and ICC are also accepted and cited in KS.
- Japan—Building Standard Law and Fire Service Law; codes are actually ratified as laws.
- China—four levels of standards: national, professional, local, and enterprise.

International Commissioning

- In lieu of the reference standards specifically cited by LEED, GBCI generally requires proof that the applicable local code meets or exceeds the LEED-referenced standard
- The CxA should be aware of and familiar with local codes for international projects and whether they meet LEED requirements.
- If not, this issue needs to be raised as early as possible into the project—preferably during LEED charrette or OPR/BOD review, and before energy and water goals are set.

International Commissioning

Initial Commissioning, including enhanced and fundamental.

Existing Building Optimization, including:

- Retro-Commissioning
- Re-Commissioning
- Monitoring-based commissioning
- Continuous commissioning

International Commissioning Goals and Expectations

Europe:

*A "survey of building sector executives commissioned by the GBPN in collaboration with BPIE finds that European real estate and construction executives are convinced that European legislation for energy efficiency and energy performance in buildings is a benefit for the building sector. While the financial crisis has set a downward trend to real estate valuations, the renovation of the existing building stock could be a means to reverse the tendency. Regulatory uncertainty seems to be the main barrier to increased energy efficiency investments."**

**The Economist Intelligence Unit Report, April 2013, commissioned by GBPN, in collaboration with BPIE*

International Commissioning Goals and Expectations

Asia:

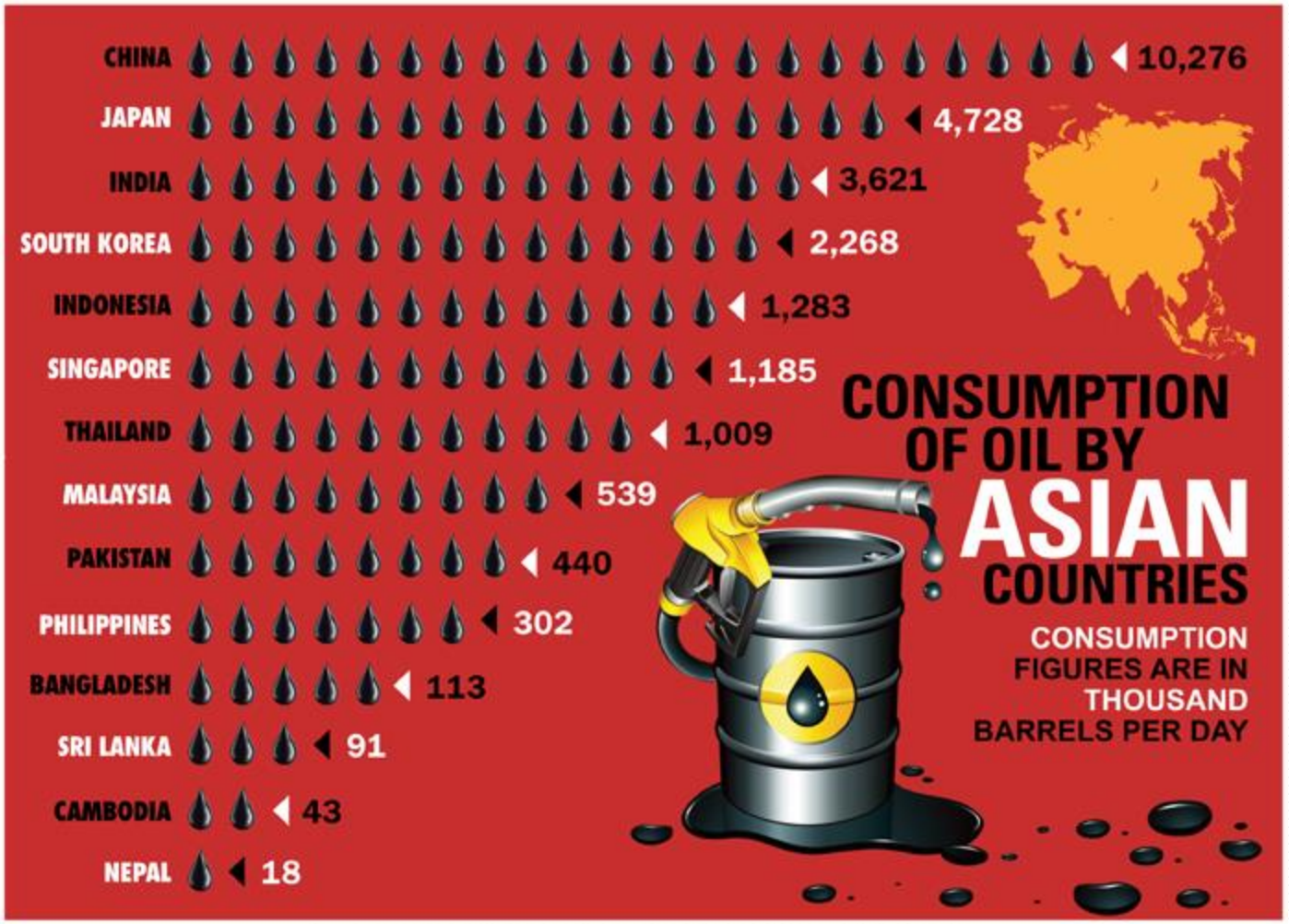
Generally slower acceptance of green building codes and commissioning than in Europe and the US. Large national and international corporations beginning to recognize the value of commissioning, especially in Singapore, Hong Kong, Japan, and Korea.

Asia has the most LEED projects outside of the US, and continues to be a strong construction market.

Overall growth in Asia is at a faster rate than elsewhere – China alone accounted for US$1.78 trillion in construction spending in 2013. Korea, US$154 billion.

The Grand Hyatt West Tower was a part of this growth.

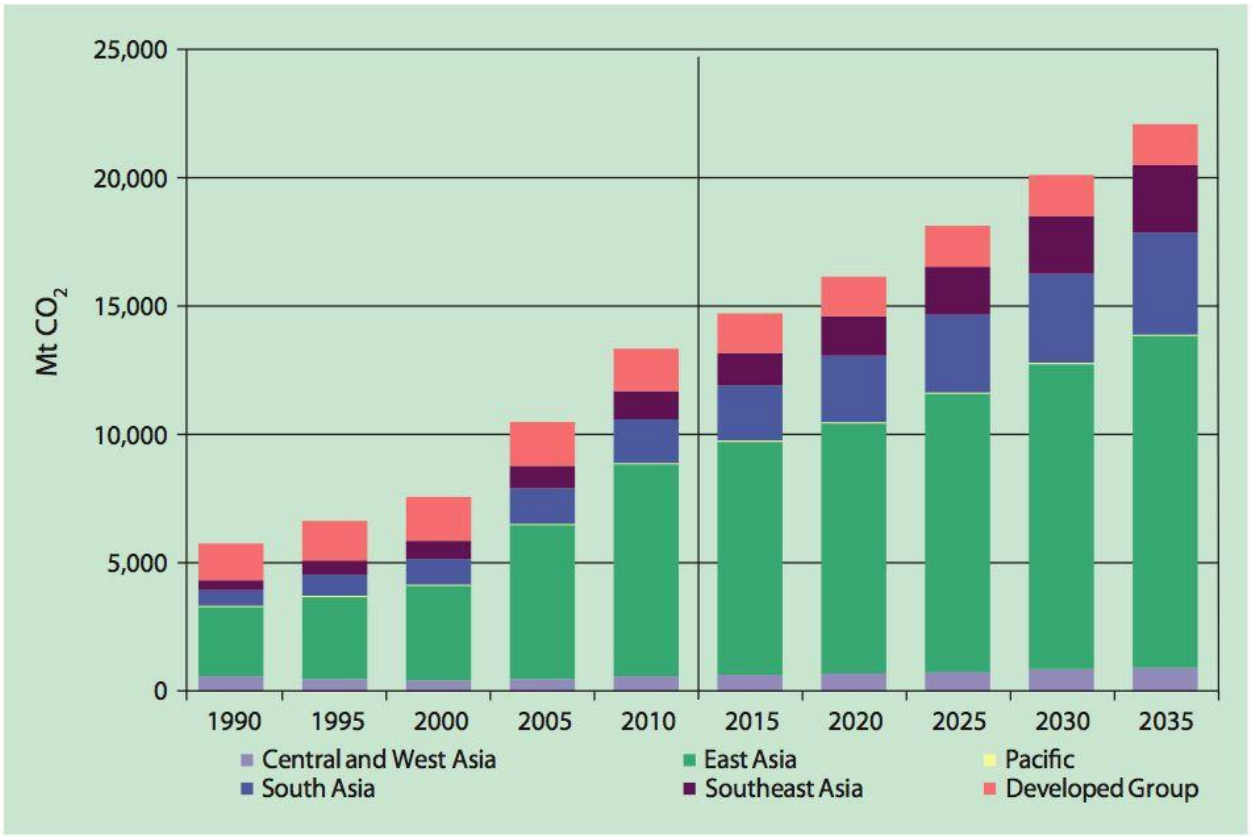
Asian Energy Consumption



(SOURCE: US ENERGY INFORMATION ADMINISTRATION, 2012)

More than half the world's GHG emissions will come from Asia by 2035*

Figure 6.1 Carbon Dioxide Emissions by Region (1990–2035)



Mt CO_2 = million tons of carbon dioxide.

Source – Asian Development Bank

Int'l Commissioning Issues

International commissioning takes more time.

- Meetings and conference calls require significantly more coordination, especially in Asia.
- Jet lag and adjustment to local time zone may result in lost productivity.
- Distance can be a bottleneck - transmission speeds and wireless reliability vary when transmitting documents from the field.
- If you need a document in the field but forgot to pack it, you might not be able to get another copy until the next day!

Language

- Not an issue in other English-speaking countries
- Typically not a problem in countries where English is a common second language (e.g. France, Germany, Israel)
- Drawings, specifications, shop drawings and project communications are usually in language of project location
- Important traits to look for in translators:
  - Familiarity with other country's culture, business practices
  - Familiarity with architectural/engineering concepts and terminology
- Hire local architect and/or engineer to assist with on-site issues and translations

More Int'l Commissioning Issues

Potential roadblocks to successful commissioning:

- Construction documents need to be translated accurately.
- Shop drawings, O&M documents, etc., need to be translated.
- Language difference complicates the CxA's training program for future facility operators.
- Lack of understanding of cultural norms may result in offending the client.

Cultural Issues in International Commissioning

- Understand the business culture of the project location's country.
- Learn the social and business customs of the host country.
- What is the hierarchy and reporting structure for the project?
- Is formality important?
- How to handle "saving face".
- How to obtain cooperation from project location contractors and other team members.
- Practical business manners culturally different from the US.
- Train your team in the host country etiquette.
- How to handle conflict resolution.

Grand Hyatt West Tower Project

- The Chairman of Korean Airlines needed a new hotel to serve the 17th Annual Asian Games, held September 19 ~ October 4, 2014.
- Opening Day September 4, 2014.
- US$235 Million Project Cost
- Required to be LEED Gold, energy and water efficient.
- 44 month design and construction schedule.

Korean Building Regulatory System

- Centralized and structured.
- Senate and House issue Building Act (BA) decree.
- Administered by Ministry of Land, Transport, and Maritime Affairs (MLTM).
- MLTM issues ordinances to supplement the Act.
- Korean Standards Agency develops the Korean Standards (KS).
- Other international standards are allowed, for example, ASTM, ASHRAE, and International Code Council (ICC).
- BA mandates standards for energy efficiency, water, construction waste recycling and reuse for buildings in Korea.
- Protection of indoor air quality is mandatory.

LEED GOLD
v. 2009

- 500 room hotel
- 72,000 square meters ~ 775,000 square feet.
- Incheon International Airport, Republic of Korea.
- Korean based contractors, construction managers, architects and engineers.
- US based schematic design architect and engineer.
- Fundamental and enhanced commissioning.
- Measurement and Verification.

Project Team

Project Responsibility	Firm
Owner	Korean Airlines Hotel Network
Architect	Gensler (US) Junglim (Korea)
MEP Engineer	Syska Hennessy (US) HiMEC (Korea)
Construction Manager	Parsons Brinckerhoff Korea
LEED Consultant	Gensler (US)
Commissioning Agent	Elm Engineering (US)

Project Information

Elm's scope of work:

- Fundamental commissioning
- Enhanced commissioning
- Measurement and verification

Systems commissioned:

- HVAC systems
- Plumbing systems
- Building Automation Systems (more about that later)
- Electrical and lighting systems and controls
- Grey water system
- Room controls
- NO building envelope

Energy Targets:

To be 12% less than ASHRAE 90.1 – 2007 plus Energy Star rating of at least 80.

Project Information

HVAC Systems:

- Energy model performed by US engineer was based on ASHRAE 90.1–2007 Appendix G.
- Two 680 ton absorption chillers (primary).
- Two 478 ton electric chillers (secondary) at 70% of hotel total cooling capacity.
- District Energy Plant provided hot water for absorption chillers, heating, and domestic hot water.
- Roof mounted cooling towers at 1400 tons.
- Dedicated cooling towers for kitchen equipment.
- Steam boilers at 200 hp each.
- Building Automation System with manual overrides and manual controls.
- 100% economizer option on air handling units.
- Guest rooms served by fan coil units.

Project Information

Plumbing Systems:

- District energy plant provided grey water for toilet flush and cooling towers.
- District energy provided hot water for domestic water via heat exchangers.
- Boiler back up for hot water demand.
- Water conservative plumbing fixtures.
- Redundant water service to facility from the District Energy Plant.
- Redundant pumping packages.
- Maximum velocity of 1.8 m/s and minimum pressure of 2.4 bar in public areas, 3.4 minimum in Guest Rooms.

Project Information

Electrical Systems:

- LED lighting used primarily with some fluorescent
- Electric service at 22.9 Kvprimary.
- Dual electric primary feeders with automatic throw over.
- Each feeder sized for 100% load.
- Two double ended substations – 22.9Kv to .38Kv interconnected with open tie breaker.
- Caterpillar diesel life safety generator set for fire pump, fire alarm, life safety lighting, BAS, security systems, and other critical systems, 10 hour tank.
- Lighting control system throughout.
- Room key controls lighting, HVAC, and receptacles.
- All copper in conduit. No aluminum alloy.
- Telecom cables to guest rooms – 3 voice, 1 data, one coax video/one coax video data.

LEED FOR NEW CONSTRUCTION & MAJOR RENOVATIONS (V2009)

ATTEMPTED: 70, DENIED: 0, PENDING: 0, AWARDED: 69 OF 110 POINTS

SUSTAINABLE SITES — 21 OF 26

SSp1	Construction Activity Pollution Prevention	Y
SSc1	Site Selection	1 / 1
SSc2	Development Density and Community Connectivity	5 / 5
SSc3	Brownfield Redevelopment	0 / 1
SSc4.1	Alternative Transportation-Public Transportation Access	6 / 6
SSc4.2	Alternative Transportation-Bicycle Storage and Changing Room	1 / 1
SSc4.3	Alternative Transportation-Low-Emitting and Fuel-Efficient V	3 / 3
SSc4.4	Alternative Transportation-Parking Capacity	2 / 2
SSc5.1	Site Development-Protect or Restore Habitat	0 / 1
SSc5.2	Site Development-Maximize Open Space	1 / 1
SSc6.1	Stormwater Design-Quantity Control	0 / 1
SSc6.2	Stormwater Design-Quality Control	0 / 1
SSc7.1	Heat Island Effect-Non-Roof	1 / 1
SSc7.2	Heat Island Effect, Roof	1 / 1
SSc8	Light Pollution Reduction	0 / 1

WATER EFFICIENCY — 10 OF 10

WEp1	Water Use Reduction, 20% Reduction	Y
WEc1	Water Efficient Landscaping	4 / 4
WEc2	Innovative Wastewater Technologies	2 / 2
WEc3	Water Use Reduction	4 / 4

ENERGY AND ATMOSPHERE — 11 OF 35

EAp1	Fundamental Commissioning of the Building Energy Systems	Y
EAp2	Minimum Energy Performance	Y
EAp3	Fundamental Refrigerant Mgmt	Y
EAc1	Optimize Energy Performance	2 / 19
EAc2	On-Site Renewable Energy	0 / 7
EAc3	Enhanced Commissioning	2 / 2
EAc4	Enhanced Refrigerant Mgmt	2 / 2
EAc5	Measurement and Verification	3 / 3
EAc6	Green Power	2 / 2

MATERIALS AND RESOURCES — 6 OF 14

MRp1	Storage and Collection of Recyclables	Y
MRc1.1	Building Reuse-Maintain Existing Walls, Floors and Roof	0 / 3
MRc1.2	Building Reuse, Maintain 50% of Interior	0 / 1
MRc2	Construction Waste Mgmt	2 / 2
MRc3	Materials Reuse	0 / 2
MRc4	Recycled Content	2 / 2

MATERIALS AND RESOURCES — CONTINUED

MRc5	Regional Materials	2 / 2
MRc6	Rapidly Renewable Materials	0 / 1
MRc7	Certified Wood	0 / 1

INDOOR ENVIRONMENTAL QUALITY — 12 OF 15

IEQp1	Minimum IAQ Performance	Y
IEQp2	Environmental Tobacco Smoke (ETS) Control	Y
IEQc1	Outdoor Air Delivery Monitoring	1 / 1
IEQc2	Increased Ventilation	1 / 1
IEQc3.1	Construction IAQ Mgmt Plan-During Construction	1 / 1
IEQc3.2	Construction IAQ Mgmt Plan-Before Occupancy	1 / 1
IEQc4.1	Low-Emitting Materials-Adhesives and Sealants	1 / 1
IEQc4.2	Low-Emitting Materials-Paints and Coatings	1 / 1
IEQc4.3	Low-Emitting Materials-Flooring Systems	0 / 1
IEQc4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	1 / 1
IEQc5	Indoor Chemical and Pollutant Source Control	1 / 1
IEQc6.1	Controllability of Systems-Lighting	1 / 1
IEQc6.2	Controllability of Systems-Thermal Comfort	1 / 1
IEQc7.1	Thermal Comfort-Design	1 / 1
IEQc7.2	Thermal Comfort-Verification	1 / 1
IEQc8.1	Daylight and Views-Daylight	0 / 1
IEQc8.2	Daylight and Views-Views	0 / 1

INNOVATION IN DESIGN — 5 OF 6

IDc1.1	SSc4.1: Exemplary Alt Transportation	1 / 1
IDc1.1	Innovation in Design	0 / 1
IDc1.2	SSc5.2 Exemplary Open Space	1 / 1
IDc1.2	Innovation in Design	0 / 1
IDc1.3	Innovation in Design	0 / 1
IDc1.3	SSc7.1: Exemplary Heat Island - Nonroof	1 / 1
IDc1.4	Innovation in Design	0 / 1
IDc1.4	Innovation in Design - Green Building Education	1 / 1
IDc1.5	Innovation in Design	0 / 1
IDc1.5	Innovation in Design	0 / 1
IDc2	LEED® Accredited Professional	1 / 1

REGIONAL PRIORITY CREDITS — 4 OF 4

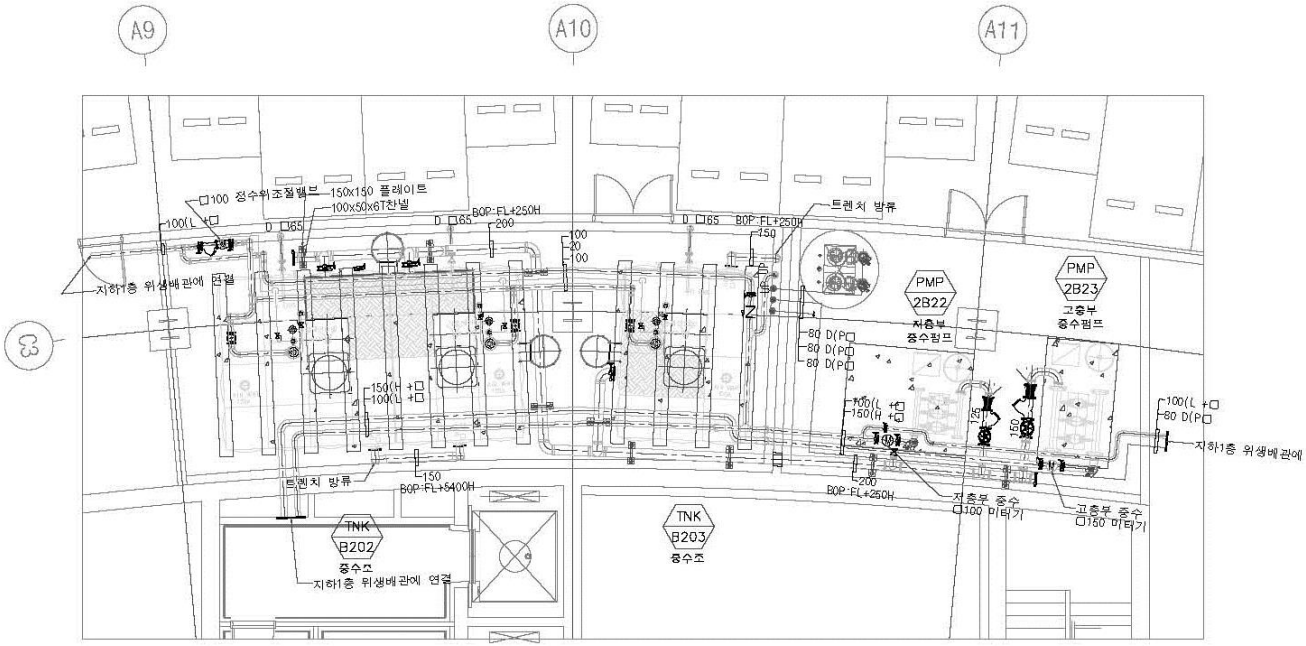
WEc1	Water Efficient Landscaping	1 / 1
WEc2	Innovative Wastewater Technologies	1 / 1
WEc3	Water Use Reduction	1 / 1
EAc1	Optimize Energy Performance	1 / 1
EAc3	Enhanced Commissioning	0 / 1
EAc5	Measurement and Verification	0 / 1

TOTAL	69 OF 110

M&V System:

- Power – Facility – Overall
- Potable Water – Facility – Overall
- Potable Water – Pool/Spa Make-up
- Re-Use Water Incoming Facility
- District Hot Water – Incoming Facility – Overall
- District Hot Water – Heating and Domestic Hot Water
- District Hot Water – Absorption Chiller
- Cooling Tower – Make-up
- Gas – Kitchen
- Gas – Facility
- BAS tracking of hvac system equipment

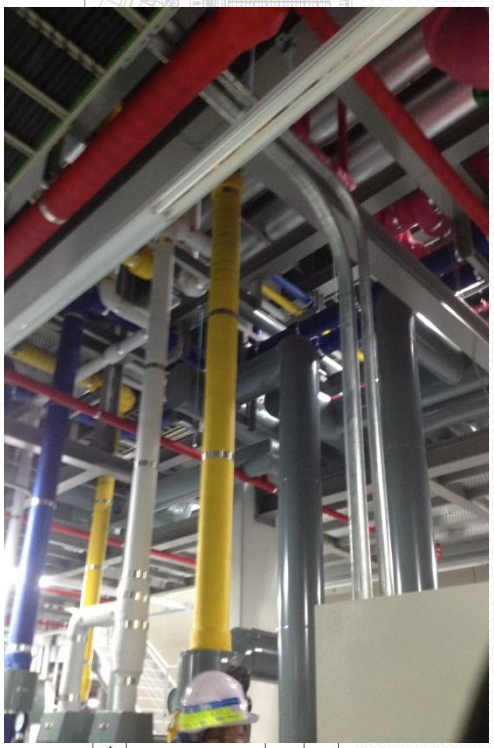
Meter Locations



장 비 LIST

기 호	장 비 명 칭	비 고
TNK B202	중수조 : 3800x6650x6150H(15STON□	
TNK B203	중수조 : 3800x2850x6150H(6STON□	
PMP 2B22	중수펌프 (저층부용□	
PMP 2B23	중수펌프 (고층부용□	

지하2층 중수조 확대배관 평면도



REV	DESCRIPTION	PREP	APPR	DATE
△				
△				
△				

KAL HOTEL NETWORK

PRIME : Gensler

SUB : JUNGLIM

DSGN CHKD APPR DATE

국제 업무 지역 호텔 2 건설사업

지하2층 중수조 확대배관 평면도

SCALE 1 : 50 DWG NO 3-403-1802-118 REV

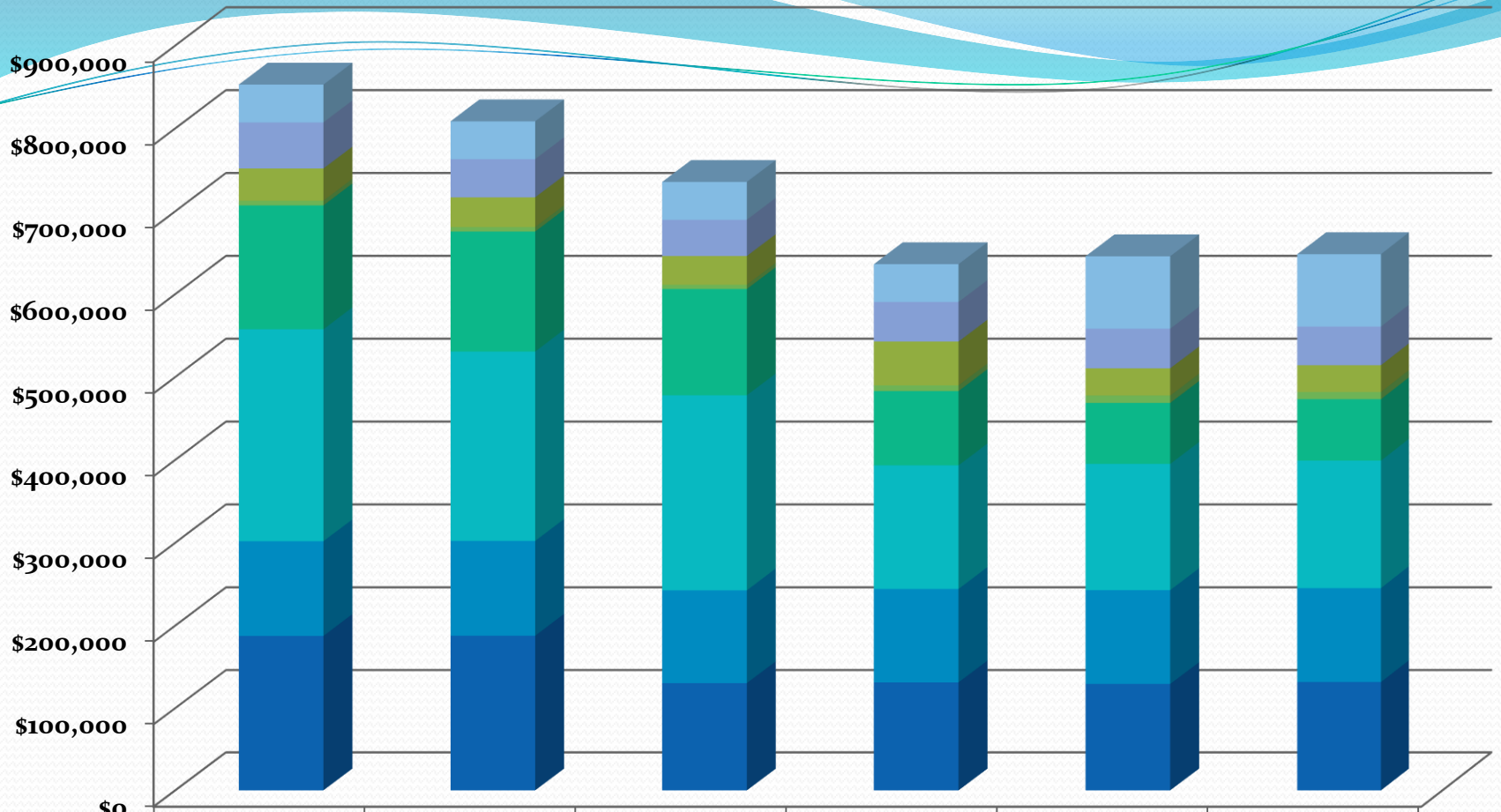
Annual Energy Cost Comparison

The following chart shows design savings achieved over the ASHRAE 90.1-2007 Baseline, in terms of both energy consumption and energy costs.

Maximum energy savings are achieved due to an improved envelope followed by efficient lighting + daylighting and mechanical systems.

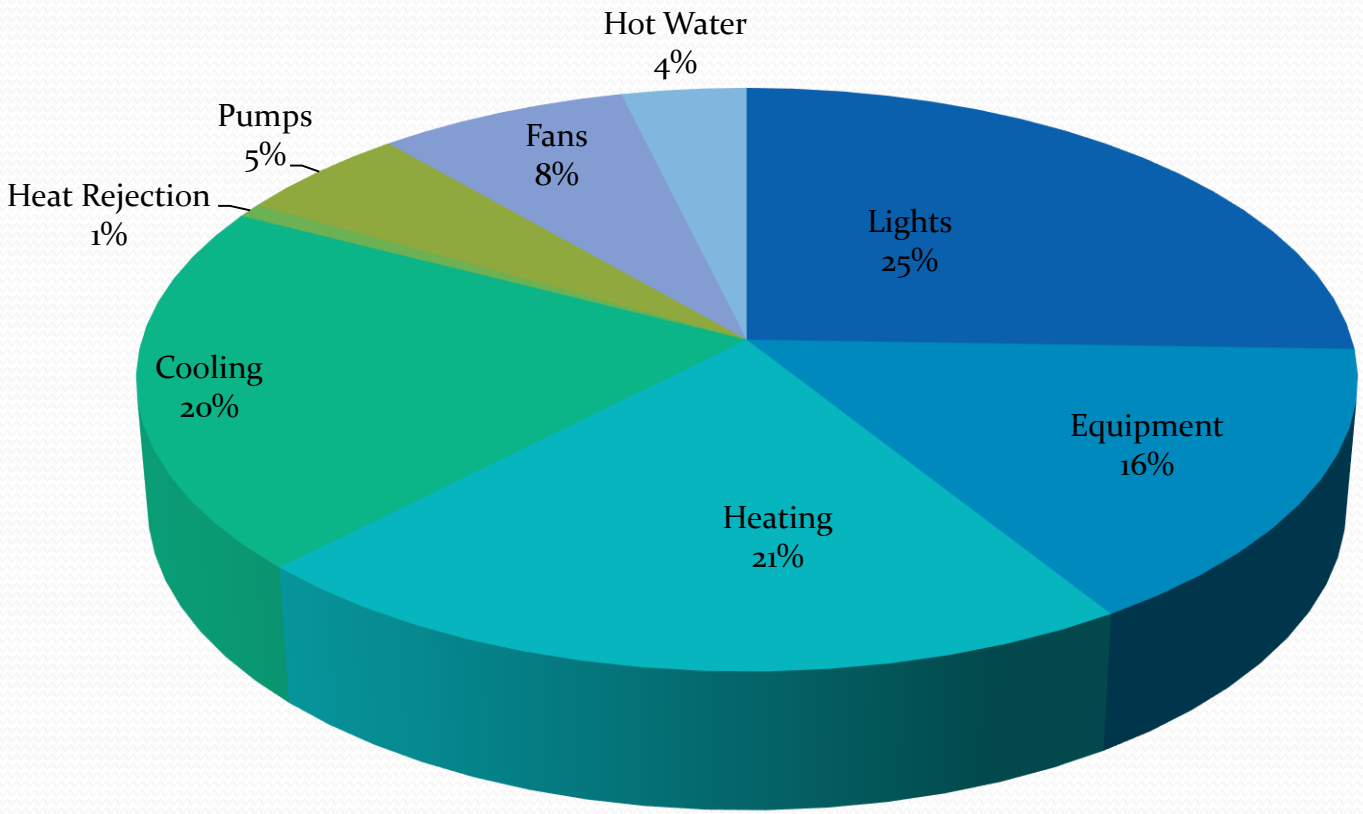
Energy plant side savings are primarily limited to heating energy owing to high efficiency boilers and energy recovery being used on the AHUs and DOAS.

Overall, the project hopes to achieve over 14% **savings over baseline** in terms of annual energy costs.



	ASHRAE 90.7-2007	Envelope Upgrades	Lighting Upgrades	Systems Upgrades	Plant Upgrades	As Designed
HOT WATER	$45,625	$45,625	$45,625	$45,625	$87,370	$87,370
FANS	$55,596	$46,036	$43,782	$47,746	$47,813	$46,641
PUMPS	$38,941	$35,949	$34,672	$52,930	$32,879	$32,278
HEAT REJECTION	$5,603	$5,327	$5,148	$6,810	$8,858	$8,715
COOLING	$149,465	$144,798	$128,216	$89,673	$73,596	$74,115
HEATING	$255,824	$228,579	$235,395	$149,149	$152,320	$153,798
EQUIPMENT	$114,303	$114,433	$112,218	$113,000	$113,521	$113,651
LIGHTS	$187,506	$187,720	$130,311	$131,219	$129,323	$131,618

Energy Consumption by System



Performance Goals:

LEED Credit		Water Savings (%/yr)	Energy Cost Savings ($/yr)	Source Energy Savings (%/yr)
WE1	Water Efficient Landscape	100%	-	100%
WE2	Innovative Wastewater Technologies	100%	-	100%
WE3	Water Use Reduction	51.66%	-	30%
EA1	Optimize Energy Performance	-	$182,276	15.29%

Performance Goals:

LEED Credit		M&V Option Used*	Summary of M&V Plan
WE1	Water Efficient Landscape	D	100% re-use water for irrigation; monitor "Re-Use Water Incoming Facility" meter
WE2	Innovative Wastewater Technologies	D	100% re-use water for toilet flushing; monitor "Re-Use Water Incoming Facility" meter
WE3	Water Use Reduction	D	Using efficient plumbing fixtures; monitor "Potable Water – Facility – Overall" meter
EA1	Optimize Energy Performance	D	Building designed to reduce lighting, HVAC loads; monitor "Power – Facility – Overall" meter

* M&V LEED option D. Guidelines include *LEED EA Credit 5: Measurement and Verification* and *International Performance Measurement & Verification Protocol (IPMVP)*, Volume 3, April 2003 (www.ipmvp.org)

Predicted Annual Savings

End Use	Energy Type	Units		Baseline Building	Proposed Building	Percent Savings
Interior lighting	Electricity	Energy Use	kWh	1,794,428	1,385,656	22.78
		Demand	kW	413	336	
Space heating	Electricity	Energy Use	kWh	343	30	91.25
		Demand	kW	0.6	1	
Space cooling	Electricity	Energy Use	kWh	1,812,986	901,470	50.52
		Demand	kW	1,121	632	
Pumps	Electricity	Energy Use	kWh	741,736	654,886	11.71
		Demand	kW	95	190	
Heat rejection	Electricity	Energy Use	kWh	68,729	58,627	14.7
		Demand	kW	126	164	
Fans - interior	Electricity	Energy Use	kWh	1,667,483	1,259,636	24.46
		Demand	kW	271	215	
Service water heating	Steam	Energy Use	kBtu	3,044,000	5,162,000	-69.58
		Demand	MBH	900	1900	

Systems Commissioned Mechanical

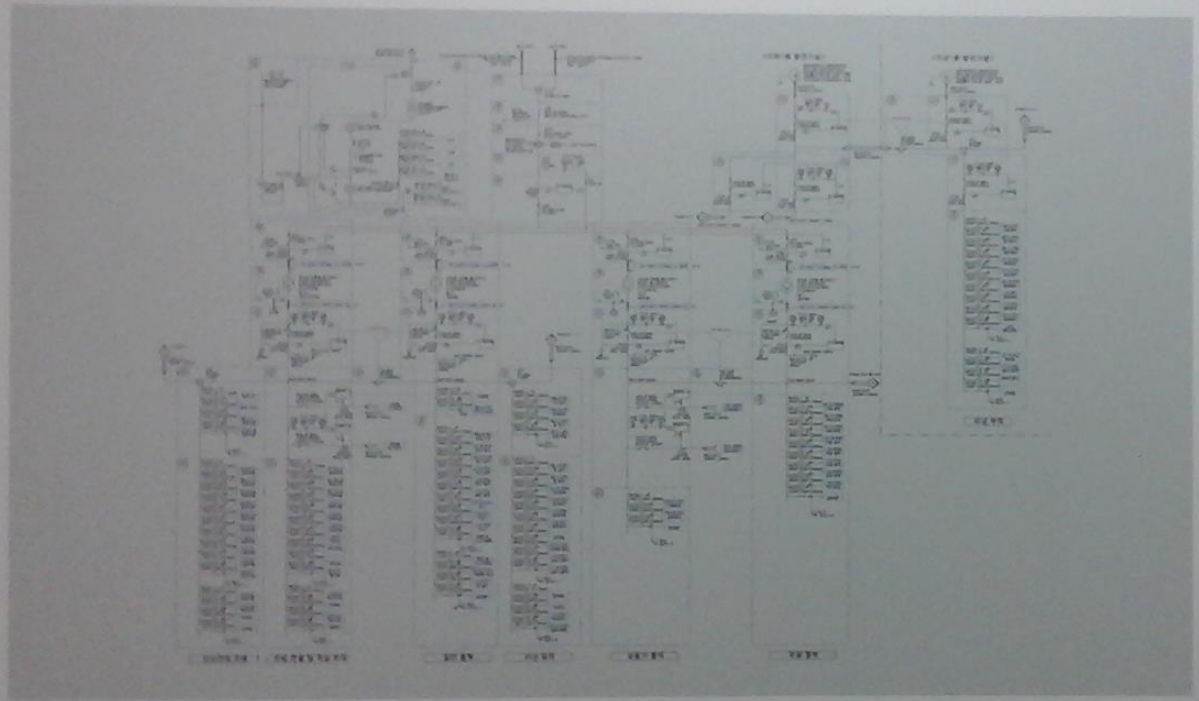
- Air handling units
- Energy recovery units
- Ventilation System
- Boilers
- Absorption and Electric Chillers
- Fan coils
- VAV boxes
- Fans
- Pumps
- VFDs
- Heat Pumps
- Monitoring System
- Building Automation System

Systems Commissioned Electrical

- Main distribution switchboards
- Phase loss protection
- Interior and exterior lighting and controls
- Power metering
- Grounding systems
- Panelboards
- Fire alarm system
- Emergency generator

GRAND HYATT INCHEON WEST TOWER

단선결선도



한전정전시 대처요령

정 전 시

1. 한전측 선로가 정전되면 HV-5 VCB반의 X-GIPAM에 내장된 UVR(27)이 동작하여 수전용 차단기(VCB)를 자동으로 차단시킵니다.
2. BUZZER가 동작하면 먼저 BUZZER STOP 버튼을 눌러 줍니다.
3. HV-5 VCB반에 설치된 27X의 RELAY 접점으로 비상 발전기에 기동신호를 보냅니다.
4. 한전선로 정전후 몇초후 발전기 운전이 시작됩니다.
5. 발전기 기동후 정격 출력전압및 주파수가 확립되면 발전기 운전반의 ACB가 자동투입되며, LV반의 ATS가 한전측에서 발전측으로 자동 절체됩니다.
6. LV반에 발전기 전원이 공급됩니다.
   (ATS는 항상 "자동" 상태로 되어 있어야 하며 ATS가 자동절체 되지 않을시에는 수동 핸들을 사용하여 수동절체 시킵니다.)

복 전 시

1. 한전측 선로가 복전되면 HV-5 VCB반의 X-GIPAM의 정상전압 확인하고 X-GIPAM의 RESET용 스위치를 누르면 RESET 상태가 됩니다.
2. HV-5 VCB반전면 DOOR에 설치된 X-GIPAM "CLOSE"를 눌러 VCB를 수동 투입 합니다.
3. X-GIPAM의 RESET용 스위치를 누르면 발전기반의 ACB는 자동으로 "OFF"가 되고 발전기는 운전정지됩니다.
4. LV반의 ATS는 "발전"상태에서 "한전"으로 자동 절체됩니다.
   (ATS가 자동절체되지 않을시에는 수동핸들 사용하여 수동절체 시킵니다.)
5. LV-3,7,11,14반의 ACB는 X-GIPAM에 "CLOSE" 버튼을 2번 눌러 ACB를 수동 투입 시킵니다.
6. 한전전원이 공급되면 LV-3,7,11,14반의 정상 전압을 확인 합니다.

조작요령

가) 특고압반 조작요령

1) ALTS 전원 이상유무 확인
2) LBS조작 스위치를 ON쪽으로 돌려 LBS를 투입한다.
3) GIPAM LCD 창의 전압을 확인한다.
4) MAIN VCB 조작 스위치인 GIPAM 의 CLOSE 버튼을 눌러 VCB를 투입한다.

나) 저압반 조작요령

1) 각 PNL의 ACB반의 DOOR에 위치한 GIPAM의 전압을 확인한다.
2) 각 PNL의 DOOR에 위치한 ACB OFF LAMP(GREEN LAMP)확인후 GIPAM 의 CLOSE 버튼을 눌러 ACB를 투입한다.
3) 각 PNL ACB ON 상태 확인후 각반의 부하용 차단기(MCCB)를 각각 ON시킨다.

비상연락망

- GRAND HYATT INCHEON WEST TOWER
  TEL : 공항공사 전력처 : 032-741-2803
  주 A 변전소 : 032-741-2811
  주 B 변전소 : 032-741-2815
- LS 산전 A/S
  TEL : 043-261-6812
- 전기안전관리자
  TEL :

Systems Commissioned Plumbing/Fire Protection

- Domestic hot and cold water
- Storage tanks
- Water re-use
- Water heaters
- Kitchen gas

- Fire sprinklers
- Fire pumps
- Storm water

Contract Negotiations

- Notice of project award June 2011.
- Contract signed November 2011.
- Lessons learned:
  - Details matter!
  - Define in utmost detail specific terms:
    - "Trip"
    - Reimbursable expenses
    - Terms of payment and currency exchange
    - Conflict resolution
- Perform credit and background checks.
- ***Never*** delete translation fees, even if there is English fluency among the host country's team.

Design Reviews

- Schematic Design performed by US based architect, engineer, and lighting designer.
- Energy model performed by US based engineer through schematic design.
- Design reviews for construction documents based on Korean based architect and engineers.
- Korean drawings only partially translated.
- Schedules were fully translated.
- Conflicts between Korean design team and US team.
- Elm presented the Design Reviews in person.

Cx Issues Log: HVAC Design Review

Item #	Sheet	Item	Date Found	Response	Action Responsibility	Response Date	Resolved
H1	HVAC BOD	Need to clarify/make final decision as to what energy saving strategies are being implemented. LEED checklist still mentions Ice Storage	11/6/2011	Ice storage is no longer in the design, and has been removed from BOD and LEED checklist.	Syska,Gensler		Yes
H2	HVAC BOD	BOD mentions 86% efficient boilers, LEED checklist states 90%. Coordinate final efficiency and correct.	11/6/2011	Will updated BOD and LEED checklist to match the equipment schedule.	Syska,Gensler		Yes
H3	HVAC BOD	It appears that ice storage has been eliminated from this project. Remove from BOD and LEED checklist	11/6/2011	Ice storage is no longer in the design, and has been removed from BOD and LEED checklist.	Syska,Gensler		Yes
H4	HVAC BOD	Qualify Seismic requirements	11/6/2011	Seismic requirements will be per local Korean codes, and will be clarified by Local Structural and Mechanical Engineers	Junglim		Pending
H5	HVAC BOD	Provide detailed information about optimization strategies such as air and water temperature resets, fan static pressure resets, etc.	11/6/2011	These details will be provided during CDs as the design progresses.	Junglim	1/31/12	Pending
H6	HVAC BOD	Explain sizing of absorption and electric chillers to include staging sequence. Not clear why there is so much chiller redundancy. No Action	11/6/2011	Absorption Chillers using District hot water are provided per Incheon Airport Energy Company (IAEC) mandatory requirements, and are sized for 100% of the load. Electric are back-up sized at 70% and approved by IEAC.			Yes, 11/28/11
H7	HVAC BOD	Quantify noise levels in the BOD	11/6/2011	Noise Level of Mechanical equipment shall be determined by the acoustical consultant's requirements. The general guidelines shall be less than 5db NC.	Junglim to quantify	1/31/12	Pending

Cx Issues Log: Plumbing and Fire Protection

Item #	Sheet	Item	Date Found	Response	Action Responsibility	Response Date	Resolved
FP1	FP BOD	Please provide a detailed Basis of Design in future submittals showing total water efficiency goals for the project.	11/6/2011	-Designed in accordance with NFSC. -Fire-pump : SP, H, IH compatible (main, reserve and jokey pump) -Fire Water : 75 ton (Secondary water is substituted with reserve pump.)		The Comments from GENSLER mean They does not know the general fire protection system. Please review the drawings from KFUBIS and comment.(Please follow the national code.)	Pending
FP2	FP System	Please provide a proposed fire protection systems narrative.	11/6/2011	KFUBIS has wholly reviewed and designed to comply with NFSC. Because it is impossible to get the permission with the drawings from GENSLER. (Please review the proposals from GENSLER.			Pending
FP3	FP Drawings	Please clarify the use of high-rise standpipes/ Class I requirements.	11/6/2011	High-rise standpipes can be run by fire engine's pump pressure itself. (70m) (doesn't need additional pumps.)			Pending
FP4	FP Drawings	It appears that standpipe locations are required in all exit stairwell in accordance NFPA-14.	11/6/2011	The locations of standpipes are reflected in accordance with NFSC502(indoor-hydrant).			Pending
FP5	FP Drawings	Dry standpipe and sprinkler systems provided in garage and areas subjected to freezing conditions, please address methods to reduce freezing.	11/6/2011	Please review fire mechanical drawings. Heating cables are reflected in sprinkler and indoor-hydrant equipments provided in areas subjected to freezing conditions.			Pending
FP6	FP Drawings	Please verify that the allocated space for the two fire pumps provides adequate clearances	11/6/2011	Please review enlarged floor plans for fire pump rooms.(Fire pump can be sufficiently installed.)			Pending
P1	Plumbing BOD	In Section 3.2.3, consider redundant grease separators to minimize disruption to facility activities.	11/6/2011				Pending

Cx Issues Log: Lighting

Item #	Sheet	Item	Date Found	Response	Action Responsibility	Response Date	Resolved
L 13	Specifications 2.2 T	Consider adding an item to this section to specify that all LED products are required to employ passive cooling techniques for heat rejection.	11/6/2011	CD+M to clarify which specs have active cooling and which do not.			PENDING
L 14	Specifications 2.2 T 5	Verify that the performance of the specified LED products can meet the color rendering specifications.	11/6/2011	CD+M to check specs against luminaire schedule.			PENDING
L 15	Specifications 2.2 T 6	Consider increasing the performance specification for the LED products to reflect the performance of the LED industry at time of product ordering and delivery.	11/6/2011	CD+M to Specify level of performance and not necessarily a product.			PENDING
L 16	Specifications 2.2 T 13	Consider specifying products with exterior ratings of IP66 for exterior applications.	11/6/2011				PENDING
L 17	Specifications 2.3 B & C	This item references Section 16500 and others, which do not exist in this specification.	11/6/2011				PENDING
L 18	Lighting Fitting Schedule ELB	Color temperature mismatch in schedule. Please verify.	11/6/2011				PENDING
L 19	Lighting Fitting Schedule FC	Verify lamping in this product. Verify dimming range with specifications.	11/6/2011				PENDING

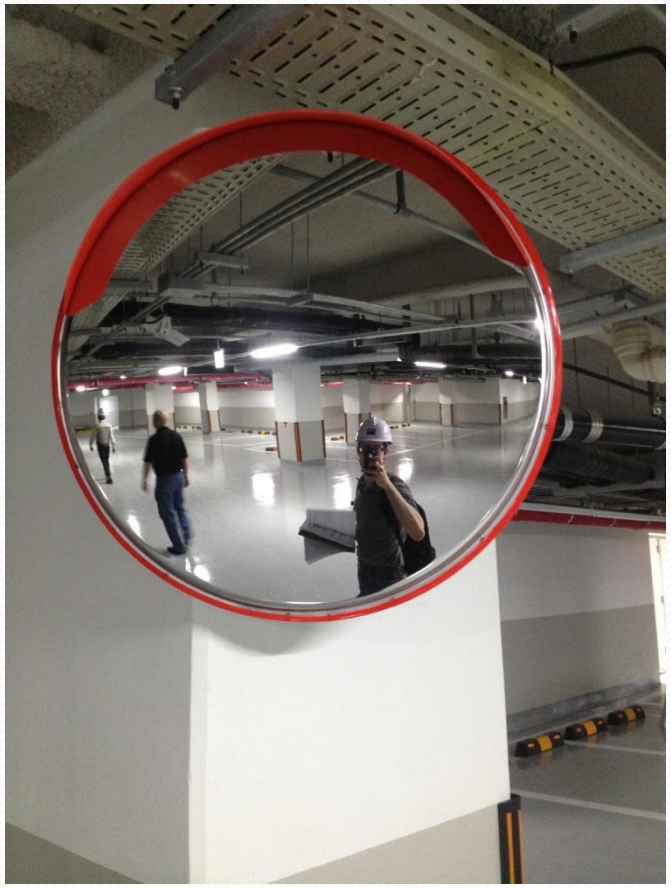
Commissioning Kick Off Meeting

- Training may be an essential part of kick off meeting.
- Emphasize collaborative nature of commissioning and the reasons for commissioning.
- Explain role of commissioning authority in explicit terms.
- Present design reviews and the commissioning plan.
- Identify key team members among all parties.
- Obtain buy in for OPR and project objectives.
- Ensure cooperation among all stakeholders.
- Communication is the key to success!

Site Construction Office

Commissioning During Construction

- Get shop drawings and construction management reports translated.
- Skype comments and hold regular progress meetings.
- Depending on stay length, may want to consider renting local apartment.
- Perform site visits to determine progress of construction.
- Report findings promptly and in person during site visit.
- Allow time for issues to be addressed during the site visit.



The Hotel site was kept extremely clean. NO other US sites were like this.

Functional Testing and Commissioning

- At March 2014 site visit, most of the equipment not operational with lots of installation still to go.
- Two weeks of functional testing were scheduled for June of 2014.
- Elm received start up test forms one week prior to departure.
- Even with assurances that all equipment was functional:

They were not ready for us. But we started anyway.

Sometimes the CxA simply acts as a motivating presence to accomplish completion.

Absorption Chiller Testing

Functional Testing and Commissioning

The heart of any building and where we spend most of our time was with the Building Automation System (BAS).

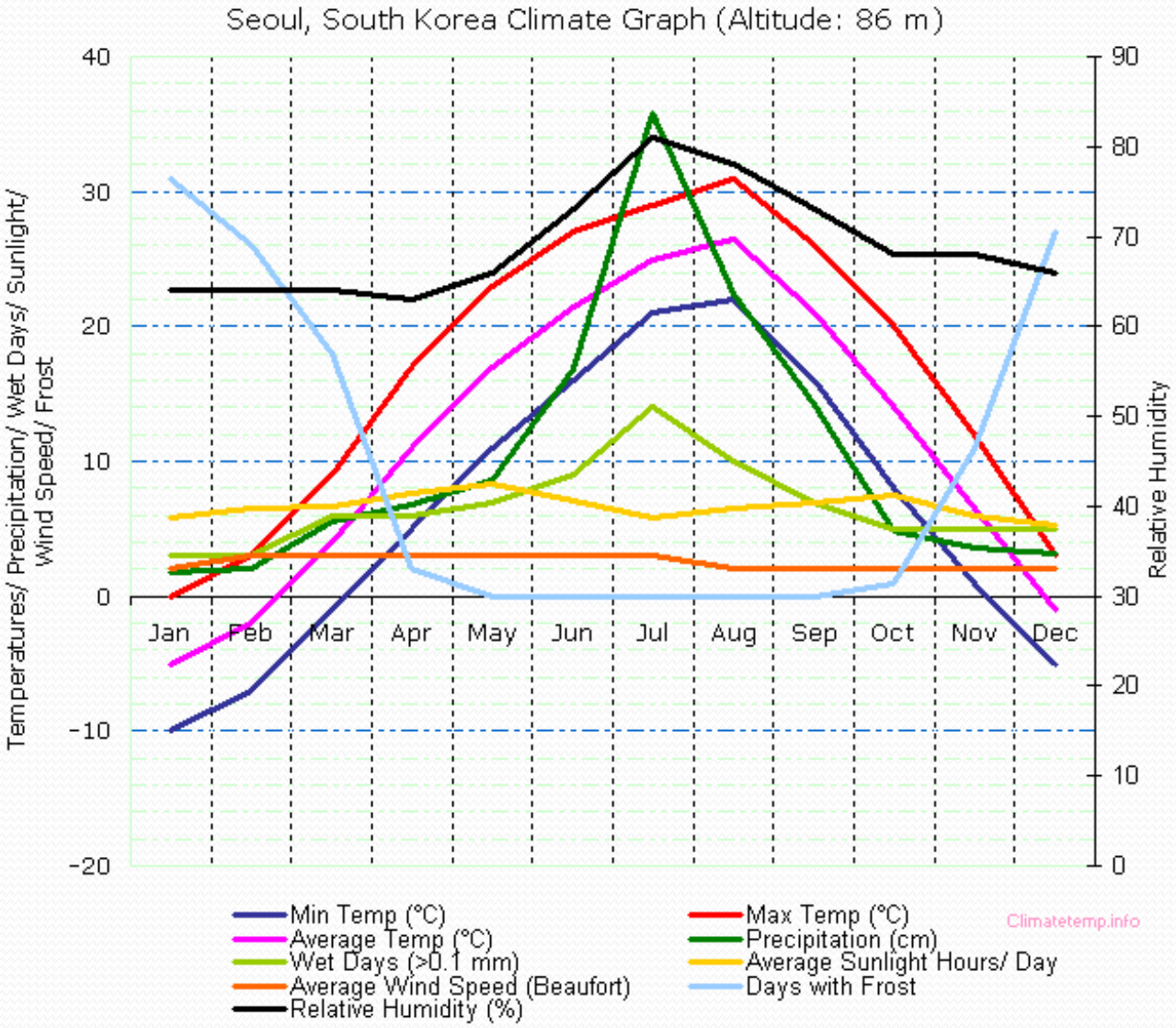
The hotel's BAS was different from similar US installations. This is typical of Korean building control systems, and is also similar for other Asian countries.

- Personnel occupy a control room 24x7, 365 days a year.
- Not fully automated.
- Switchover between cooling and heating is manual.
- No setpoint resets of heating and cooling systems.
- Manually shut down systems if no load – both chilled water and hot water systems – at every opportunity.
- Cooling is required year round.

Functional Testing and Commissioning

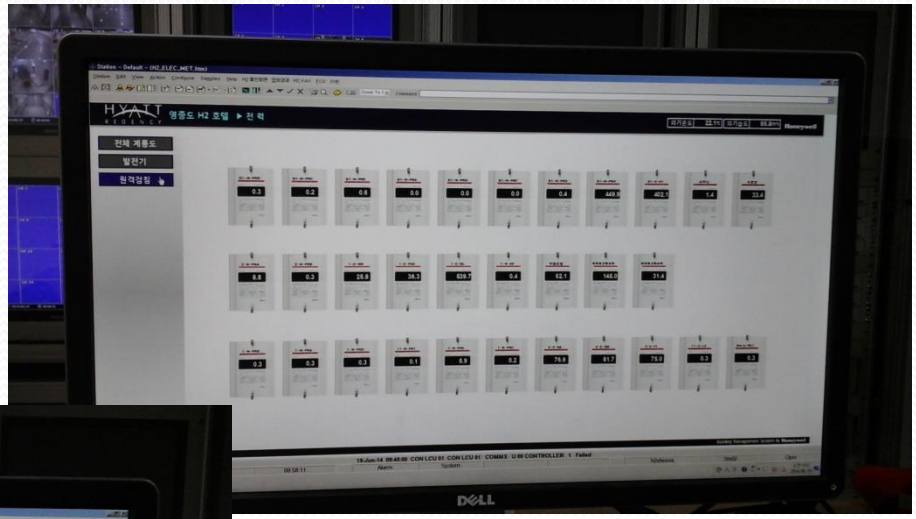
- Chiller controls are different from US – manually bring on first one then the next chiller vs. being fully automated.
- Automation sequences are fewer.
- The Hotel project needed a specific controls specialist called in during the functional testing.
- Controls more delegated in responsibility. The programmer does not necessarily understand what is meant by the control points.
  - E.g., the relief + outside air dampers default setting was 20%; many units not moving into economizer cycle when tested because not set up.

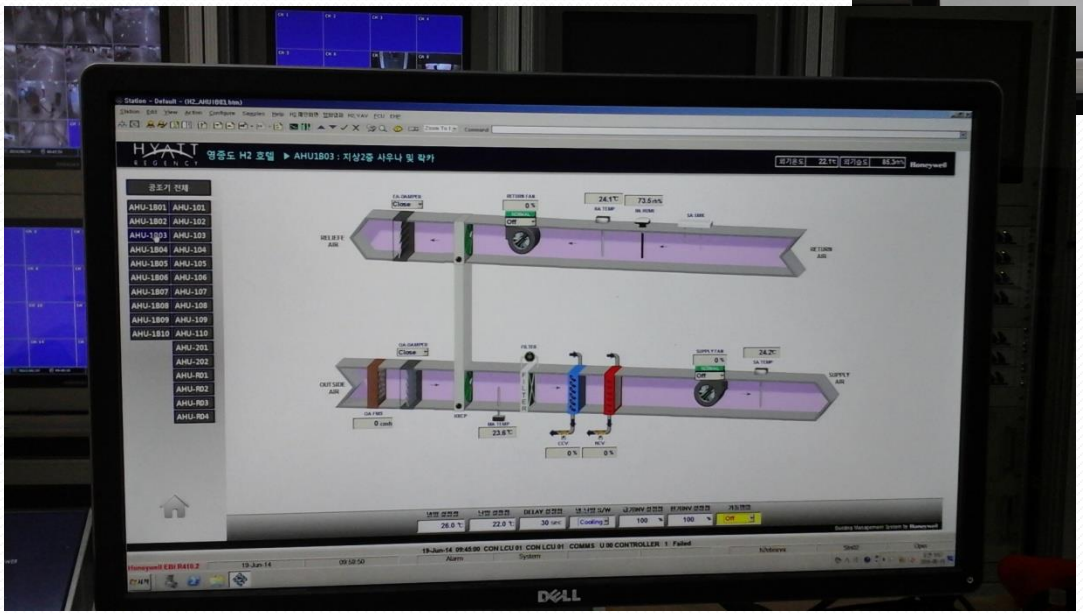
Temperature and Humidity Conditions



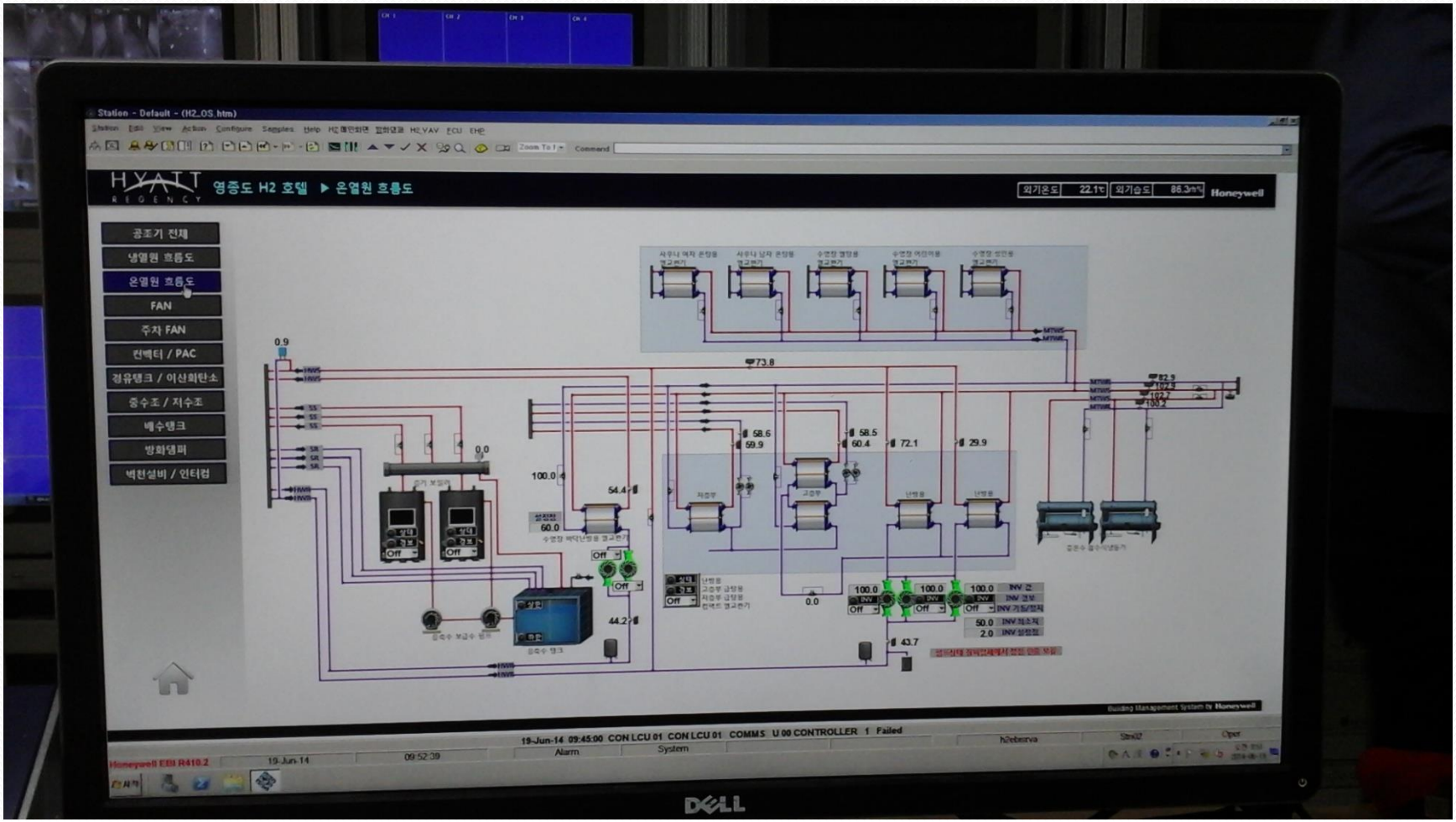
Functional Testing and Commissioning

BAS graphics





Functional Testing and Commissioning



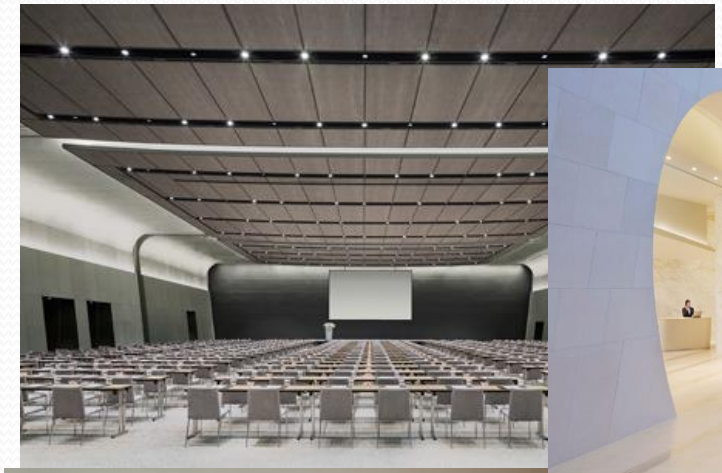
Functional Testing and Commissioning

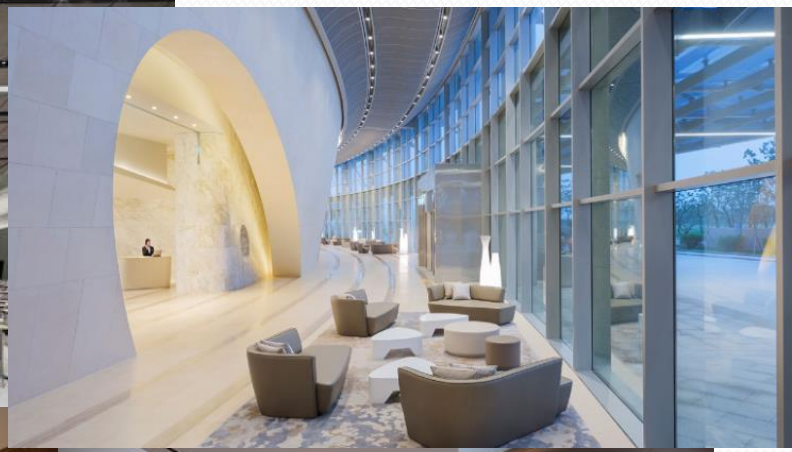
Electric
Chillers

Absorption
Chillers

Functional Testing and Commissioning

Panelboard with integrated controls



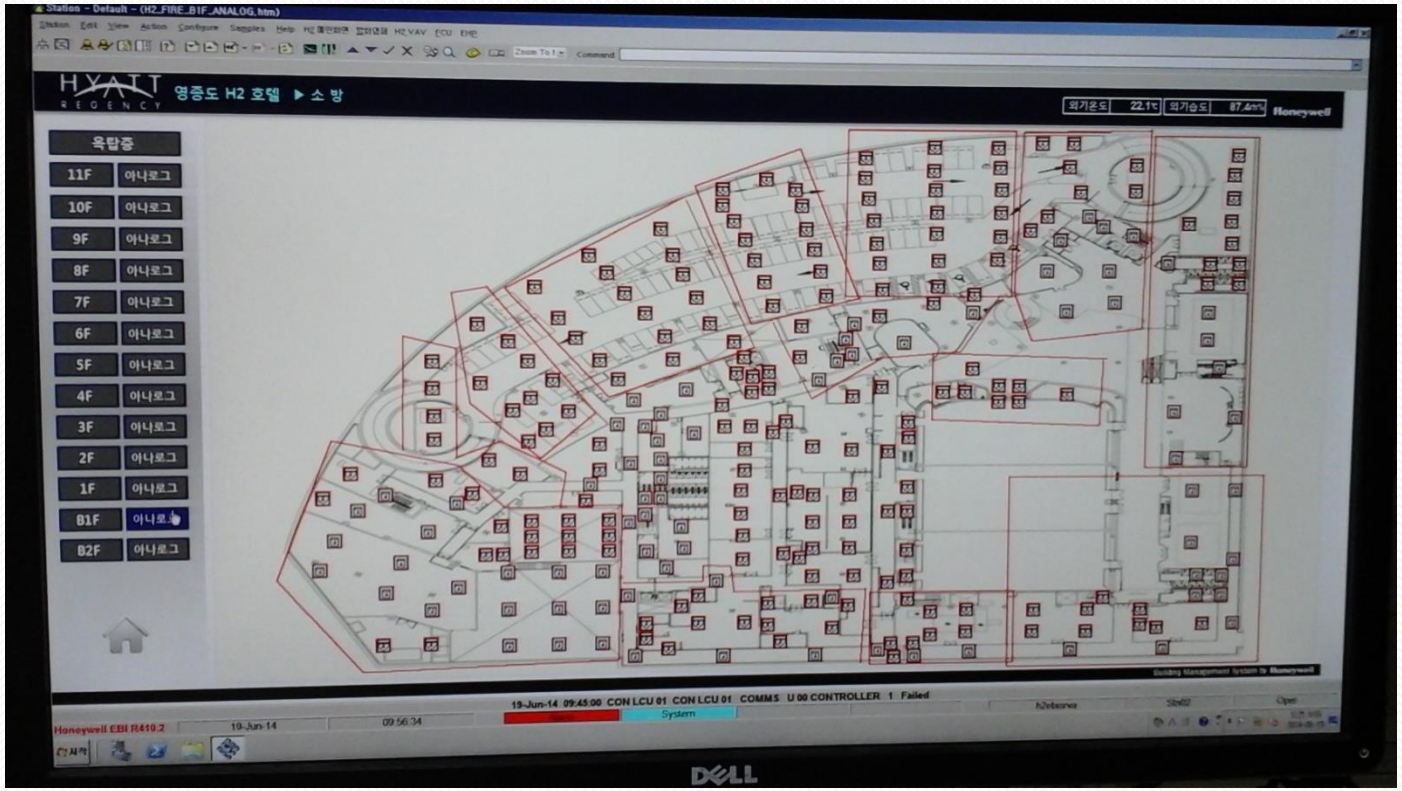


Interior Lighting

Functional Testing and Commissioning

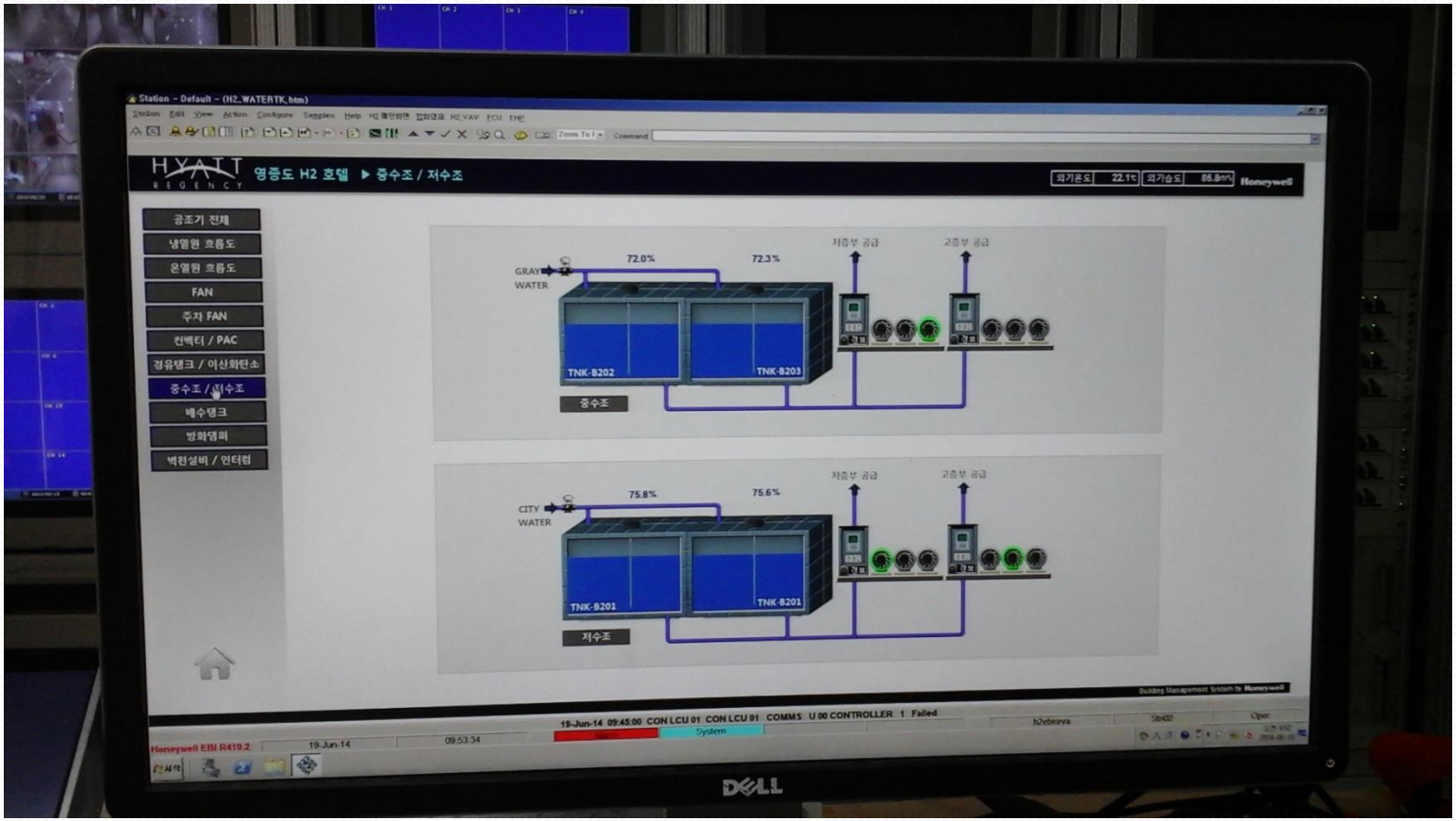
- Sensor calibration was a huge issue!
- Over 10% of sensors failed due to not being hooked up or improperly calibrated.
- Smoke control sequences had to be implemented.
- Water flow to upper flows was a big problem (like most of our projects) – there was too much air in the system which took days to correct.
- Interactive process – Cx issues were addressed on the spot or within hours or overnight.
- We were in awe of the Korean team's pride of workmanship, attention to detail, and unbelievably positive attitude.

Functional Testing and Commissioning



BAS Screenshots – sensors

Functional Testing and Commissioning



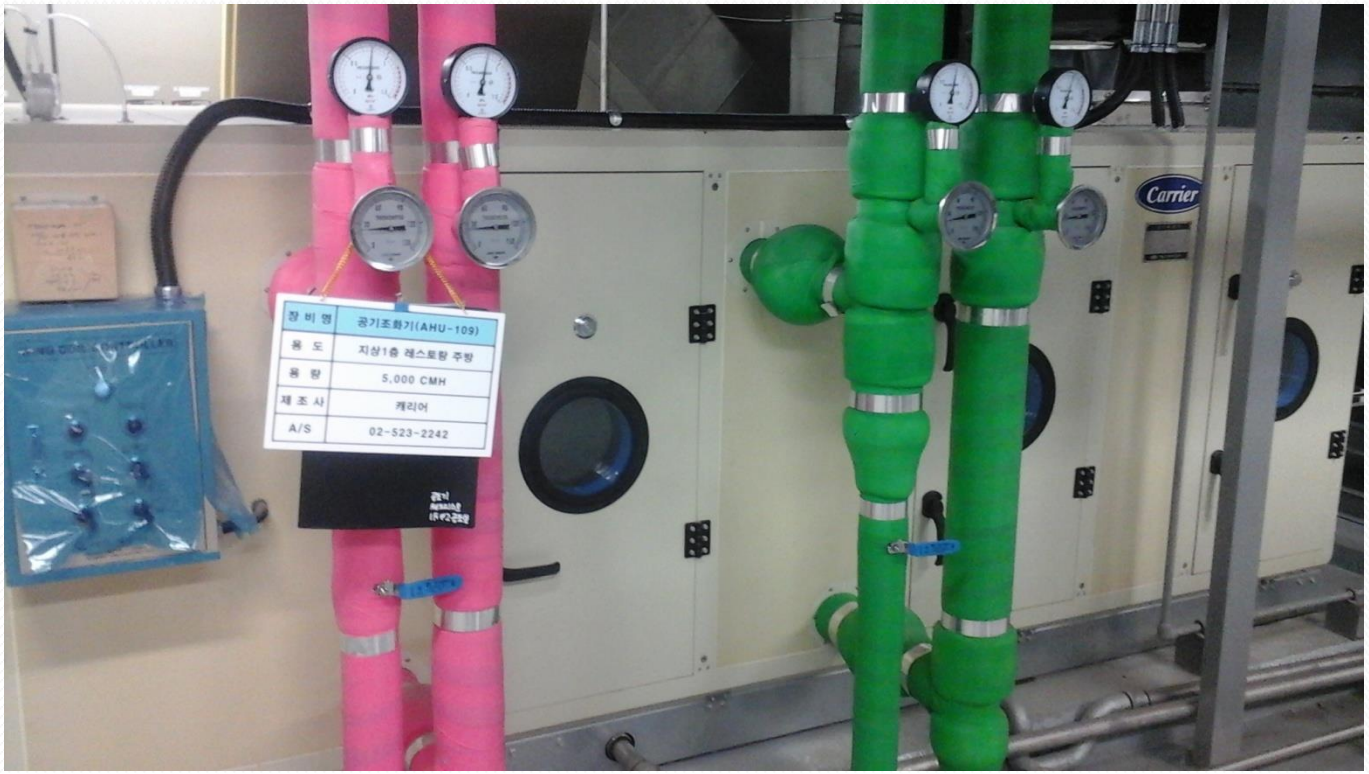
Grey water system

Functional Testing and Commissioning

- When first arrived on site for functional testing, started in the hotel rooms first.
- One member assigned to checking the automation system the entire two weeks.
- Trained staff and contractors in order to achieve completion on schedule.
  - E.g., air handling units were not set up to track static pressure – programmer worked all night to write sequences.
  - Some units (AHU's, CV, and VAV systems) were not maintaining mixed air temperatures.

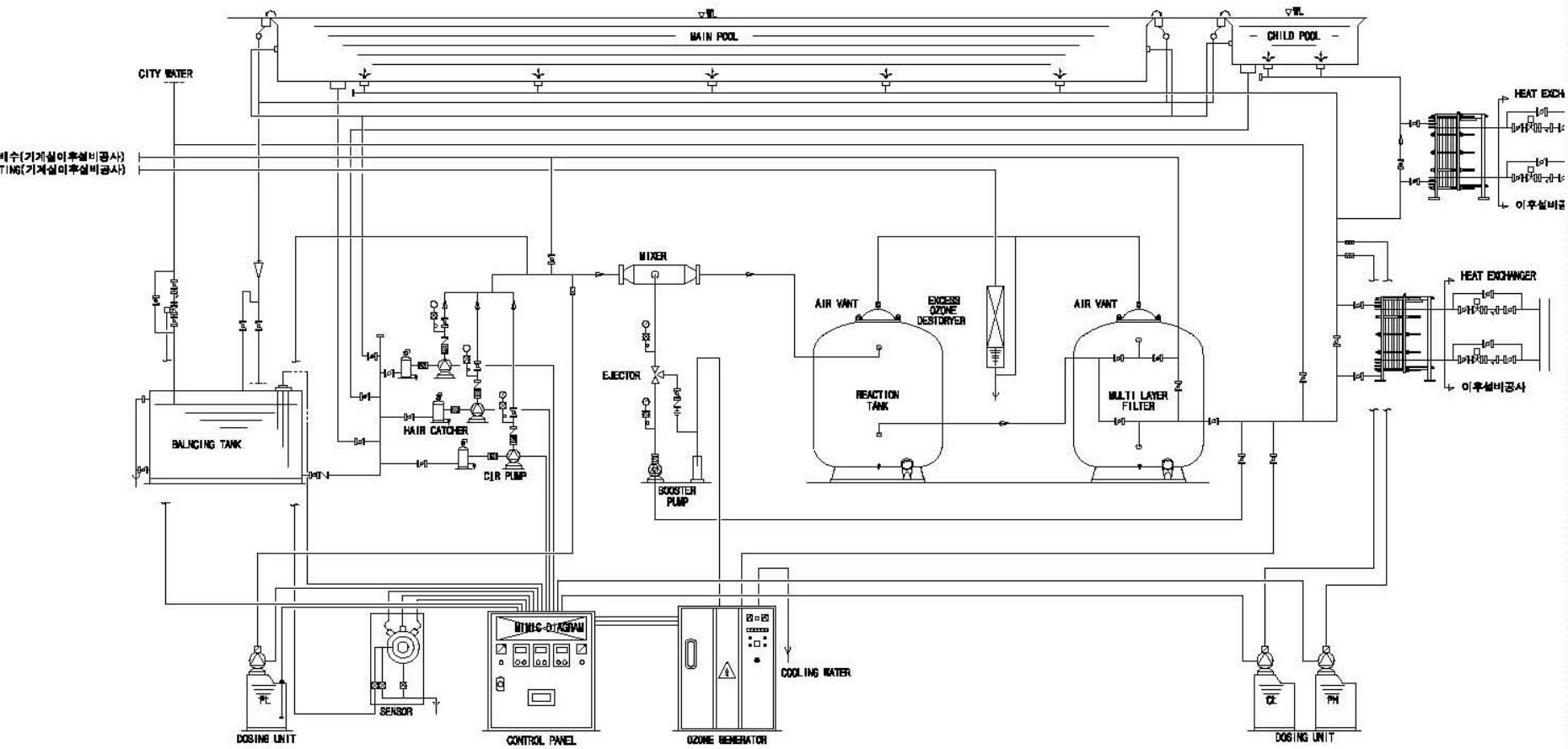
Cooperation, encouraging, coaching, and constructive suggesting are a big part of international commissioning.

Functional Testing and Commissioning



Carrier Air Handling Units

O & M Manuals



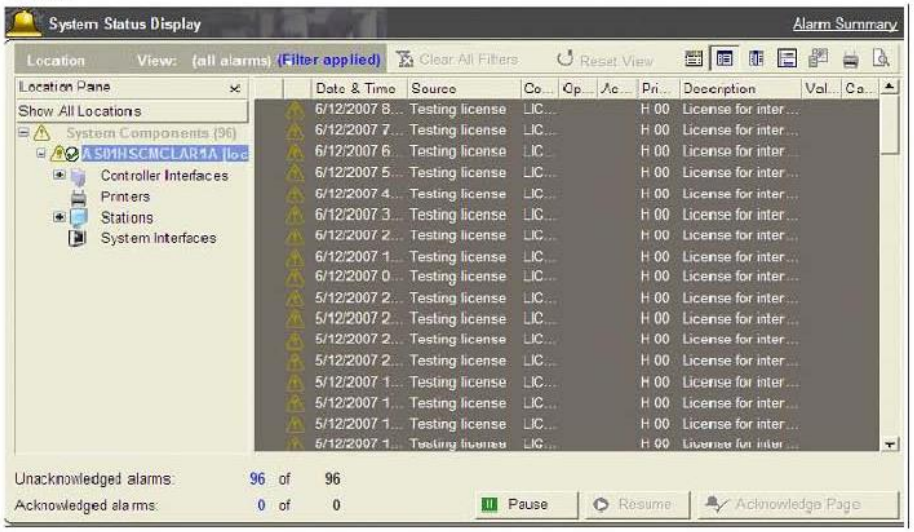
*** 수영장 정수 설비공사 제외사항 ***

1. 옥외배수라인 기계실 이후 배관공사
2. 수영장 수위조절탱크 상부까지의 시수인입 배관공사
3. 열교환기 중온수 인입,용축수 배관 및 자동제어공사

O & M Manuals

예를 들어, 보안 관련 그래픽 화면에는 특정 층의 레이아웃이 표시되고빌딩 제어 관련 그래픽 화면에는 에어컨 시스템의 공기 처리기 구성도가 포함될 수 있습니다. 그래픽 화면과 함께 스테이션은 일반적으로 조작 절차가 포함된 웹 페이지와 Microsoft Word 문서 등의 파일을 표시할 수 있습니다.

Img 1) Typical System Graphic Screen



Img 2) Typical User Definition Graphic Screen

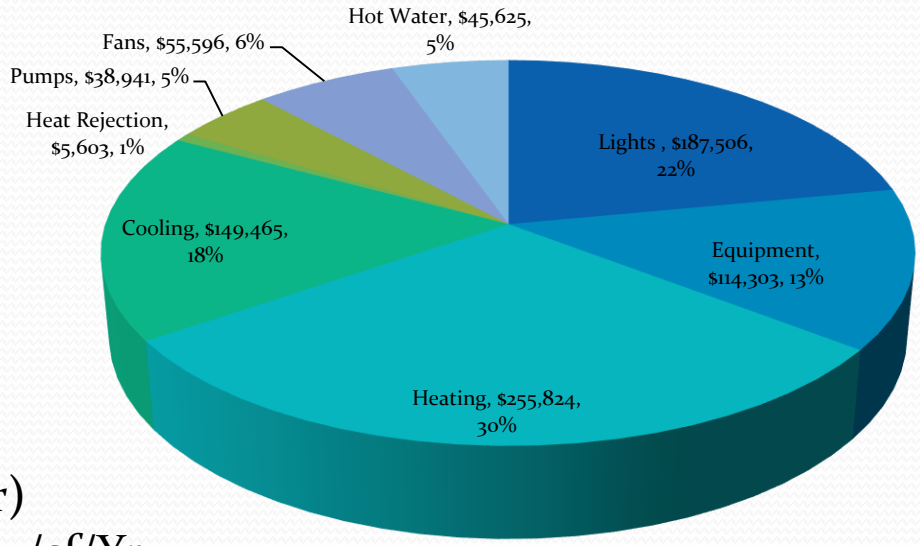
Page from Honeywell Control system manual

Promises Kept

- At the first project meeting, the construction manager for PBK made the promise that Elm would have no unresolved issues when we functionally tested the hotel.
- They kept their word.

M&V – More to Come

Elm returns to the site in September 2015 to verify the first year's energy and water performance – to see if actual usage (once factor corrected), will match the predicted.



ASHRAE 90.1 – 2007
LEED® Baseline
Site Energy Costs by End Use ($/Yr)
Annual Energy Cost Intensity: $1.50/sf/Yr

Summary

- Pay attention during contract negotiations. Don't back down on issues of expenses and translation. Once contract is signed, there is no room for additional services.
- Respect the host country's culture.
- Learn as much of the language as you can. It will be appreciated.
- Study the country's culture and social norms.
- Train your staff to be sensitive to the above.
- Stand your ground on important issues, on others, learn to be flexible. Appreciate the differences.
- Expect to be challenged.
- Have fun!

Questions?

Thank you!

This concludes The American Institute of Architects Continuing Education Systems Course

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