Accreditation of ISO 55001 / PAS 55 for AGL System in Hong Kong International Airport

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Airport Authority Hong Kong

8 Jul 2015
Contents

- Hong Kong International Airport (HKIA)
- Airfield Ground Lighting (AGL) System
- Asset Management System
- Certification of ISO 55001 and PAS 55
- HKIA future development
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## Hong Kong International Airport (HKIA)

<table>
<thead>
<tr>
<th><strong>Open since</strong></th>
<th>6 July 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total site area</strong></td>
<td>1,255 hectares</td>
</tr>
<tr>
<td><strong>No. of runways</strong></td>
<td>Two 3,800m (L) x 60m (W) each</td>
</tr>
<tr>
<td><strong>Total terminal area</strong></td>
<td>750,000 sq m (including T1, T2, North Satellite Concourse and SkyPier)</td>
</tr>
</tbody>
</table>
| **Total no. of aircraft stands** | 173  
Passenger stands: 86  
Cargo stands: 43  
Long term & maintenance stands: 44 |
Reaching Half of the World’s Population

... within five hours of flying time

World Population: 7.1 billion
No. 1 -- China (1.39 billion*)
No. 2 -- India (1.25 billion*)
No. 4 -- Indonesia (0.25 billion*)

*Source: United Nations 2013 data
No. 3 -- USA (0.32 billion)
Connecting Hong Kong with the World

- More than 100 airlines serving approximately 180 destinations worldwide (including 47 mainland cities); about 1,100 flight movements daily
Solid & Robust Traffic Growth

- In 2014, HKIA handled 63.3 million passengers, 4.38 million tonnes of cargo and 391,000 flight movements.
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South & North Runway in HKIA
Airfield Ground Lighting (AGL) System
AGL System Major Assets

- Electrical Power Supply Equipment including 11kV and 380V Switchboards, HV/LV transformers, LV Generators and UPS
- Airfield lighting including AGL light fittings, lighting power cables and Constant Current Regulators (CCRs)
- Control and Monitoring System comprises PLCs, workstations and Dedicated Networks (DN)
Airfield Ground Lighting (AGL)

North Runway
- 184 circuits, supply from 110 nos. of CCRs
- Operation Mode: CATI, II, IIIA

South Runway
- 143 circuits, supply from 80 nos. of CCRs
- Operation Mode: CATI, II
### Power Supply System at LV side

<table>
<thead>
<tr>
<th>Operation Mode</th>
<th>Primary Power</th>
<th>Secondary Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>City Power</td>
<td>Generators</td>
</tr>
<tr>
<td>CAT I</td>
<td>City Power</td>
<td>Generators</td>
</tr>
<tr>
<td>CAT II / III</td>
<td>Generators</td>
<td>City Power</td>
</tr>
</tbody>
</table>

**CAT I Power Supply Mode**
- City Power
- Generators
- AGL Equipment (CCRs, DN, workstations)
- Dedicated Network
- AGL WS

**CAT II Power Supply Mode**
- City Power
- Generators
- AGL Equipment (CCRs, DN, workstations)
- Dedicated Network
- AGL WS
# Secondary Power Supply’s Switch Over Time
As per ICAO Requirement

<table>
<thead>
<tr>
<th>Precision Approach (Cat. No.)</th>
<th>AGL type</th>
<th>Max. Switch-over Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Approach lighting system, Runway edge, Runway threshold, Runway end, Essential taxiway, Obstacle</td>
<td>15</td>
</tr>
<tr>
<td>II</td>
<td>Approach lighting system, Runway edge, Runway threshold, Runway end, Runway centre line, Runway touchdown zone, Stop bars at taxi-holding position, Essential taxiway including stop bars, Obstacle</td>
<td>1   15     1 1 1 15 15</td>
</tr>
<tr>
<td>III</td>
<td>(same as category II except all stop bars : 1 second)</td>
<td></td>
</tr>
</tbody>
</table>
Interleave Series Circuits

50% Lights Remains
AGL Control and Monitoring System (CMS)
AGL Maintenance Works

**AGL workshop**
- Checking & Refurbishment
  - Checking for physical condition
  - Cleaning the surface of prisms

**Light Measurement Tunnel**
- Monitoring the Performance
- According to ICAO specification
- After refurbishment or maintenance
- Before reinstalling the light on site

**Runway**
- Preventive Maintenance
  - Replacement of bulbs
  - General Checking

- Photometric measurement
  - At intervals of two months
  - Providing statistical data for analysis

**Availability**

**Maintainability**

**Reliability**

- Reliable AGL System in HKIA
Report for Photometric Measurement

Light Measurement Tunnel

ISO candela diagram
• High resolution
• Analyzing and comparing the performance of the light beam

Status
Pass / Fail

ICAO (%)
The compliance percentage according to the ICAO specification

Position of the light beam
Vertical and Horizontal angel

HONG KONG INT AIRPORT
Measurement date: 15/01/2015
Time: 10:25:09
Measurement run by: AGL

LIGHT
Light Reference: tbd 2
Color: W

Status: PASS

Average (Cd): 4385
ICAO (%): 88
Ratio (max/min): 4.26

Max (Cd): 6590
Min (Cd): 1547
H(°): -3
H°: 4
V(°): 4.75
V°: 7.57
Geographic Information System (GIS)

Providing statistical data for analysis
- Facilitate planning of Bulk Replacement
- Paying attention to frequent cases

AGL Fault Statistics Report – Bi-Weekly

Legend
- Green dot: 1 fault case
- Blue square: 2 fault cases

Follow-up actions
- Replacement of bulbs
- Drawing attention to the situation

Extraction of Maintenance history of each AGL
## Risk Management

### Risk Matrix

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Frequent</td>
<td>5A</td>
</tr>
<tr>
<td>Occasional</td>
<td>4A</td>
</tr>
<tr>
<td>Remote</td>
<td>3A</td>
</tr>
<tr>
<td>Improbable</td>
<td>2A</td>
</tr>
<tr>
<td>Extremely Improbable</td>
<td>1A</td>
</tr>
</tbody>
</table>

### Risk Register

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Operational Risk</th>
<th>Possible Effect (Impact)</th>
<th>Existing Controls</th>
<th>Likelihood (LOE)</th>
<th>Consequence (LOE)</th>
<th>Risk Treatment</th>
<th>Risk Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low carbon emission requirement that creates a stress to use LED lights</td>
<td>New failure mode</td>
<td>Throttle</td>
<td>3</td>
<td>B</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>Improper action caused damage of equipment &amp; power consumption</td>
<td>Suspension of services</td>
<td>C</td>
<td>4</td>
<td>C</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>Unavailable access to PP, etc.</td>
<td>Transportation</td>
<td>3</td>
<td>3</td>
<td>B</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>Technical staff competence development and evaluation</td>
<td>Lower system recovery time</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>5</td>
<td>Retention of professional and experienced staff</td>
<td>Lower efficiency in performing maintenance work</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>6</td>
<td>Frequent change maintenance window</td>
<td>Undermine the maintainability level</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>7</td>
<td>Short maintenance duration</td>
<td>Undermine the maintainability level</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>8</td>
<td>Some taxways and taxi lanes are difficult to close for maintenance</td>
<td>Undermine the maintainability level</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>9</td>
<td>Communication about the asset risk between different stakeholders</td>
<td>Undermine the maintainability level</td>
<td>M</td>
<td>4</td>
<td>D</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

- **Risk Treatment**
  - Treatment Plan (A)
  - Treatment Plan (B)
High-speed imaging for AGL inspection (Trial Assessment)
AGL Inspection System – Assessment

Assessment Objectives

1. Using high-speed imaging for AGL inspection at day & night as trial

2. Identification of system design variables

3. Characterization of image quality for automatic optical inspection (AOI)

4. Consolidation of proposed system design for onward development and deployment
Major Results

1. Tested high speed imaging of AGL on moving platform at 30 to 80 kmph

2. Confirmed that image quality under this condition can be processed for automatic AGL inspection

3. Inspection was confirmed to cover:
   i. AGL integrity (i.e. any missing of light)
   ii. Bolt presence (on ring and light)
   iii. Bolt looseness (i.e. orientation of stroke marking)
   iv. Crack presence (i.e. epoxy on outer ring)

4. Tested in both day & night conditions
Data Collection Setup
Data Collection Setup
AGL Inspection System – High Speed Camera

High Speed Imaging Products
ZEUS and ZEUS lite
- 8,000 fps @ VGA resolution
- 2,000 fps @ 1.3 MP resolution
Application:
- High throughput inspection
- Material science study
- Collision and impact study
- Ballistic experiment
- Structural analysis

Thermographic Imaging Products
HELISO 384 and HELIOS 80
- 60 fps @ 384 x 288 resolution, 50mK
- 8.6 fps @ 80 x 60 resolution, 50mK
Applications:
- Tunnel monitor
- Long range wildfire detection
- Border control
- Public hygiene control
- Pedestrian detection
- Radiator design and analysis
- Material science
AGL Inspection System – High Speed Camera

**Imaging Combo for Aerial Survey**
Cameras and processing & sensing unit for wide spectral imaging (LWIR, NIR, VIS)
Application:
- Wide area yield control & monitoring
- Water stress study
- Soil status monitoring
- Photosynthesis analysis
- Multi-purpose geodetic surveying

**8K Ultra HD Imaging Product**
- 10,000 x 7,000 resolution @ 3fps
- 8/10/12-bit pixel depth
- Living streaming capable
Application:
- PCB Inspection
- Bank note quality check
- Commercial photography
- Ultra wide FOV microscopic imaging
- Biometric security
AGL Inspection System – Assessment

High-speed Imaging (At night time)

Observer
AGL Inspection System – Assessment

High-speed Imaging (At night time)
AGL Inspection System – Assessment

High-speed Imaging (At day time)
AGL Inspection System – Assessment

High-speed Imaging (At day time)
Overview of Processing Pipeline

- GNSS Annotation
- Geometric Component Extraction
- Homography Transformation
- SVM Classification
- Model Feature Characterization

An Excerpt of the Processing Results – AGL 1

Transform: OK
Ring: OK
Light: OK
Bolts on ring: OK
Bolts on light: OK
Mark found.
Bolt heading(1/2): OK
Mark found.
Bolt heading(2/2): OK
An Excerpt of the Processing Results – AGL 2

Overview of Processing Pipeline

- GNSS Annotation
- Geometric Component Extraction
- Homography Transformation
- SVM Classification
- Model Feature Characterization

Transform: OK
Ring: OK
Light: OK
Bolts on ring: OK
Bolts on light: OK
Mark not found.
Possible crack(1)
Possible crack(2)
Possible crack(3)
AGL Inspection System – Assessment
Proposed AGL Inspection System

System Architecture

- Active Stabilizer
- Illumination
- Data Storage & Backup
- Control Panel & Monitor
- High-speed Imaging Unit
- Processing Unit
- Result Propagation System

Control Panel & Display

Conventional Hatchback Vehicle

Proposed AGL Inspection System

All units in mm.
Proposed AGL Inspection System

System Architecture

- Active Stabilizer
- Illumination
- Data Storage & Backup
- Control Panel & Monitor
- High-speed Imaging Unit
- Processing Unit
- Result Propagation System

Processing Pipeline

- GNSS Annotation
- Geometric Component Extraction
- Homography Transformation
- SVM Classification
- Model Feature Characterization

All units in mm.
Proposed AGL Inspection System

**User Level**
- Drive-thru the AGLs for inspection
- Receive notification & provide feedback
- Responses

**System Level**
- GNSS Annotation
- Geometric Component Extraction
- Homography Transformation
- SVM Classification
- Model Feature Characterization
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Asset Management System (AMS)

- The AMS was established to provide a systematic, holistic and cost-effective framework for management of AGL in HKIA since December 2013

Asset Management System (AMS)

- In 2014, the AMS was revised to align to the international standard of ISO 55001:2014, Asset Management – Management Systems: Requirements.
Structure of Asset Management System

- Asset management policy
- Asset management strategy, objectives and plans
- Contingency planning

- Asset management enablers and controls
  - Structure, authority and responsibilities
  - Outsourcing of asset management activities
  - Training, awareness and competence
  - Communication, participation and consultation
  - Asset management system documentation
  - Information management
  - Risk management
  - Legal and other requirements
  - Management of change

- Plan
  - Implementation of asset management plan(s)
  - Life cycle activities
  - Tools, facilities and equipment

- Do
  - Asset Management System Structure

- Check
  - Performance assessment and improvement
  - Performance and condition monitoring
  - Investigation of asset-related failures, incidents and nonconformities
  - Evaluation of compliance
  - Audit
  - Improvement actions
  - Records

- Act
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Asset Management Objectives

1. Aim to achieve the below Key Performance Indicators (KPI):

<table>
<thead>
<tr>
<th>Description</th>
<th>Key Performance Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Availability *</td>
<td>&gt;99.5%</td>
</tr>
<tr>
<td>Emergency Response in 10 minutes</td>
<td>&gt;94%</td>
</tr>
</tbody>
</table>

* System availability = (Total Required Operating Time – Total Downtime)
Asset Management Objectives

2. Ensure a reliable, robust and safe AGL system

3. Maintain Availability for each component of critical AGL spare part to 100%

4. Achieve average AGL staff training not less than 4.5 days/staff/year
Asset Management Strategy

The asset management strategy was established to achieve the defined objectives. The strategy is to:

a. implement Reliability Centered Maintenance (RCM) and Condition Based Maintenance processes on assets

b. Maintain relevant and reliable maintenance data and records of all assets

c. Conduct periodic risk-based system review to identify single point failure and area of improvement to maintain system reliability
d. Identify critical spare parts to determine the minimum ordering and re-ordering levels

e. Utilize information system (e.g. AAMS or GIS) on records of maintenance works planning

f. Maintain timely and effective fault response

g. Communicate with relevant stakeholders including Civil Aviation Department (CAD), International Civil Aviation Organization (ICAO), International Federation of Airline Pilot’s Association, etc.
g. Integration of Safety Management Plan

h. Upgrade the core infrastructure of AGL System to extend the system life so as to cope with the air traffic movements

i. Provide appropriate training to staffs

j. Review technology trend in the market to improve system performance
Main Stakeholders

Airport Authority H.K.
- Owner of AGL System
- Responsible for maintaining the system operation

Civil Aviation Department
- Regulator and Controller of AGL System

Electrical and Mechanical Services Department
- Maintenance Contractor of AGL System
- Support Airport Authority to perform maintenance works
Established in 1989 as a non-profit-distribution organization by the Hong Kong Government. Hong Kong Quality Assurance Agency (HKQAA) helps industry and commerce in the development of quality, environmental, safety, hygiene and social management systems.
Roadmap for Accreditation of PAS 55 and ISO 55001

Before 2013
Condition Based Maintenance
Reliability Centred Maintenance (RCM) System

Jan 2013
Formulation of Asset Management Strategy

Mar 2013
Asset Management Plan established

May 2013
Completion of Asset Management Manual

Jun 2013
Implementation of Asset Management System

Jun 2014
Certification of PAS 55

Dec 2014
Certification of ISO 55001
Asset Management Plan

Operation & Maintenance
ICAQ Standards Annex 14 Vol. 1 – Aerodrome Design and Operations, FAA, IEC, CAD, EMSD, FSD etc.
Aerodrome Manual

Management
Asset Management Policy and Strategy

Safety
ICAQ Standards Annex 19 – Safety Management
Safety Management Plan

Asset Management Plan for AGL
Asset Management System Manual

- Asset Management Plan
- Performance monitoring, training
- Investigation of accident, Root Cause Analysis
- Contingency Planning and Operation Control
- Allocation of Manpower and Resource
- Management of Change, System Change Request (SCR)
- Performance Monitoring, Analysis and Evaluation
- Investigation of accident, Root Cause Analysis
The ICAO Annex 19 – Safety Management stipulates the requirements for States / Administrations to establish a State Safety Programmes (SSP) in order to achieve an acceptable level of safety performance in civil aviation.
Hong Kong Safety Management

In line with the basic principles of safety management, the ultimate objectives of SSP is the continues improvement of aviation safety. The 4 components and 11 elements in the Hong Kong Safety Programme are based on ICAO’s framework as the below table.
## Hong Kong Safety Programme Framework

### 1. State Safety Policy and Objectives

1.1 Hong Kong safety legislative framework
1.2 Hong Kong safety responsibilities and accountabilities
1.3 Accident and incident investigation
1.4 Enforcement policy

### 2. State Safety Risk Management

2.1 Safety requirements for the service provider’s SMS
2.2 Agreement of the service provider’s safety performance

### 3. State Safety Assurance

3.1 Safety oversight
3.2 Safety data collection, analysis and exchange
3.3 Safety-data-driven targeting of oversight on areas of greater concern or need

### 4. State Safety Promotion

4.1 Internal and external training, communication and dissemination of safety information
Performance Evaluation

• Proactive Monitoring
• Reactive Monitoring
• Evaluation of Compliance
• Internal Audit
• Improvement Action
• Preventive Action
• Management Review
• Management of Change
ISO 55001 / PAS 55 Certification

HKIA is the first international airport to achieve the certification of ISO 55001 and PAS 55 for maintenance services on AGL system within Asia and Pacific region in 2014.
Accreditation of ISO 55001 and PAS 55-1
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Medium-Term Plan: Midfield Development and West Apron Expansion

**West Apron Expansion**

HK$2.5 bn project
- 28 new parking stands
- A cross-runway tunnel linking the west apron and the cargo area
- Fully operational in early 2015

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**Midfield Development**

HK$10 bn project
- A concourse with 105,000 m² of floor area
- 20 aircraft parking stands
- Extension of APM from T1
- A cross-field taxiway
- To be completed by end 2015
3RS Project of HKIA

- New Passenger Concourse with 57 parking positions
- Extended APM system
- New Baggage Handling System
- Expansion of T2
Target to Commission 3RS in 2023

**Planning**
- Environmental Impact Assessment studies
- Associated designs/details

**Approval**
- Environmental permit - was issued on 7 Nov 2014
- Project cost updates and funding options
- Other statutory requirements

**Implementation**
- Detailed designs/contract documentation
- Land formation
- Construction of related facilities

*Indicative timeline that is subject to change*
3RS Project of HKIA

• Environmental friendly feature
  – courtyard situated at the centre of the concourse
  – advanced air-conditioning & lighting systems
  – power generated by solar energy
END