INFRARED THERMOGRAPHY INSPECTION SERVICES
REPORT OF SQUARE D BUSWAY SYSTEM

At

ABC PLAZA

For

ABC PROPERTY MANAGEMENT
(Client)

SCHNEIDER ELECTRIC (Hong Kong) LIMITED
PRJXXXXX
Report Print Date
INFRARED THERMOGRAPHY INSPECTION SERVICES
REPORT OF SQUARE D BUSWAY SYSTEM

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Infrared ThermoGRAPHY inspection services
Report of square D busway system

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INFRARED THERMOGRAPHY INSPECTION SERVICES
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EXECUTIVE SUMMARY

In general results of inspected locations where incorporated at this report were commented at Normal Condition.

In addition to above classification, there are only TWO anomalies location finding which are described as Indicate Deficiency and stated below in briefly, and have detail analysis within the report.

<table>
<thead>
<tr>
<th>Delta-T Classification</th>
<th>Action Required (Recommendation)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C to 3°C</td>
<td>Warrant Investigation</td>
<td>Indicate Possible Deficiency.</td>
</tr>
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<td>4°C to 15°C</td>
<td>Repairs should be made as time permits</td>
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</tr>
<tr>
<td>16°C and above</td>
<td>Repairs should be made immediately</td>
<td>Indicate Major Deficiency</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Busway Code</th>
<th>Ampere Rating (A)</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>B4</td>
<td>3000</td>
<td>Tenant</td>
<td>G/F to 18/F</td>
</tr>
</tbody>
</table>

Location 1 (anomaly):
G/F, Main Switch Room No. 2

THE BUSWAY JOINT CONNECTION (J1),
TEMPERATURE RISE Delta-T 4.7°C
As against with its reference temperature at 32.2°C

Location 2 (anomaly):
G/F, Main Switch Room - MCB Board

OVERHEATING at 37.2°C and 37.3°C respectively.
As against Satisfactory Spot (Sp03) at 31.1°C
Temperature Rise 6.1°C & 6.2 °C
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Section 1
SCOPE OF WORK

To perform quantitative thermography inspections to below location of existed installed Square D Busway System.

<table>
<thead>
<tr>
<th>Site Address:</th>
</tr>
</thead>
<tbody>
<tr>
<td>--</td>
</tr>
</tbody>
</table>

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<tr>
<td>B4</td>
<td>3000</td>
<td>Tenant</td>
<td>G/F to 18/F</td>
</tr>
</tbody>
</table>
REferenced Standards

ASTM E1934-99a
Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.

NEMA Standards Publications BU 1.1-2000
General Instructions for Handling, Installation, Operation, and Maintenance of BUSWAY Rated 600 Volts or Less.
Section 3

GENERAL CONCEPT AND PRINCIPLES

Conventional techniques such as impedance testing and torque checking have a relatively low effectiveness in detecting and preventing failure due to these causes. Thermal imaging is the technique for making invisible infrared radiation visible (can be described below by the Stefan-Boltzmann law) and is the non-contact on-line mapping and analysis of thermal patterns from the surface of an object that can be employed to detect these temperature rises as "hot spots". Identification of hot spots can be used to trigger remedial works, reducing the number of defects and improving reliability.

Principles of Thermal Imaging, the radiation emitted from the surface of an object is a function of the object temperature as described by the Stefan-Boltzmann relationship. The infrared element of the radiation is measured and constructed from a multitude of point measurement taken in sequence whilst scanning the field of view by representing the point temperature values.

\[
W = \sigma \varepsilon T^4
\]

Where

- \( W \) is the radiant power emitted \((W/m^2)\)
- \( \sigma \) is the Stefan-Boltzmann constant \((5.69 \text{ W/m}^2\text{K}^4)\)
- \( \varepsilon \) is the object emissivity
- \( T \) is the absolute temperature of the object \((\text{K})\)

Note:

The Stefan-Boltzmann law states every object at any specific temperature, \( T \), will radiate energy is proportional to the fourth power of the absolute temperature: \( T^4 \)

The number one application for infrared thermography globally is electrical applications. The temperature of electrical components and connections are indicative of their health. Excessive heat due to increased electrical resistance (can be described below by Joule's law) will be generated by faulty components and by loose or deteriorated connections, short-circuit, overload, mismatched or improperly installed components. Equipment running hot can also be related to load imbalance, failure of cooling etc. Missed or deteriorated materials, improper installation or insufficient amounts of material usually cause anomalies in insulation system.

\[
P = I^2R
\]

Where

- \( P \) is the Effect (Watts)
- \( R \) is the Resistance (OHMS)
- \( I \) is the Current (Amperes)

Note:

The Joule's law states that if the resistance \( R \) does not change and the current doubles, the power consumption will increase four \((4)\) times thereby increasing the temperature of component. This means the higher the current flow, the higher the temperature of the entire circuit.

Further increase of resistance by badly made joint connect will therefore be reflected by the abnormal temperature rises.
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Section 4

INSPECTION METHODOLOGY

In addition to the referenced standards, the following method statements are being carried out in order to make quantitative thermal imaging and accuracy of inspection data results.

(A) Equipment used:
- FLIR ThermaCAM E30 Camera, C/W 19 degree lens
- PC notebook (for extra storage of images)
- Digital Camera
- Psychrometer
- HILTI PD20 (object distance measuring device)

(B) Method Statements:
- Discuss with qualified site technical assistance about the inspection services detail planning prior to conduct thermal scanning.
- Obtain authorization and by safety access route leading of qualified technical assistance to inspection area in terms of efficiency.
- Inspect the busway with the Equipment relocated from vantage point to vantage point.
- Provision of actual load (phase by phase) of busway circuit by qualified site technical assistance as required by Infrared Thermographer.
- Record date, time and the Busway Location / Sections to be inspected.
- Record the Ambient Temperature.
- Record the distance of Busway to IR camera.
- Take quantitative IR images associate with its digital image to the area / location / anomaly of Busways being inspected.
- Take digital images for those busway where installed at unexposed area, if any.

ThermaCAM Report Professional is used with ThermaCAM E30 Camera for processing of inspection results analysis.
**INFRARED THERMOGRAPHY INSPECTION SERVICES**
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**Section 5**

**INSPECTION CONDITIONS**

<table>
<thead>
<tr>
<th>Date of Inspection Services:</th>
<th>15th April 2005 (Friday)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time:</td>
<td>10:30am ~ 11:30am</td>
</tr>
<tr>
<td>Location:</td>
<td>As Specified</td>
</tr>
<tr>
<td>Thermographer Profile:</td>
<td>Mr. Chris Lam / Mr. Raymond Yu</td>
</tr>
<tr>
<td>Qualified Site Technical Assistance:</td>
<td>Mr. Technician</td>
</tr>
</tbody>
</table>

**Busway Inspected Conditions:**
All inspected busways are adequate for conducting Infrared Thermography Scanning. Date, time, ambient temperature, distance of Busways to IR camera, Busway Rating and its relevant phase-to-phase loading are specified on Inspection Results individually.
Section 6

INSPECTION RESULTS ANALYSIS

Site: ABC PLAZA
Job Reference: PRJXXXXX

Location: G/F, Main Switch Room No.2

Equipment / Environmental Data:

<table>
<thead>
<tr>
<th>Sketch #</th>
<th>Index</th>
<th>Circuit No.</th>
<th>Rated Load (A)</th>
<th>Phase A (Amp.)</th>
<th>Phase B (Amp.)</th>
<th>Phase C (Amp.)</th>
<th>Phase N (Amp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>B4</td>
<td>3000A</td>
<td>1500A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Fault Spot (SP02) HOT at 37.6°C
As against Satisfactory Spot (Sp01) at 32.9°C
Temperature Rise 4.7°C

ANALYSIS:

RECOMMENDATION

Power OFF the Busway, Check and Clean Each Copper Phases Surfaces.
Re-tigten With Correct Level of Torque Loading at 60-80 lbs-ft.
INFRARED THERMOGRAPHY INSPECTION SERVICES
REPORT OF SQUARE D BUSWAY SYSTEM

Section 6

INSPECTION RESULTS ANALYSIS

Site: ABC PLAZA
Location: Tower 2, 13/F Meter Room

Equipment / Environmental Data:

<table>
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<tr>
<th>Sketch #</th>
<th>Index</th>
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<td>--</td>
<td>--</td>
<td>--</td>
</tr>
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</table>

ANALYSIS:
Average Temperature Range from 33.2°C to 33.3°C

RECOMMENDATION
Continue to monitor the Temperature Trending to seek if any of abnormal.
Section 6

INSPECTION RESULTS ANALYSIS

Site: ABC PLAZA  |  Job Reference: PRJXXXXX
Location: G/F, Main Switch Room

Equipment / Environmental Data:

- MCB Board

![IR Thermography Image]

**IR information**

<table>
<thead>
<tr>
<th>Date of creation</th>
<th>Time of creation</th>
<th>File name</th>
<th>Camera type</th>
<th>Camera serial number</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 05 2005</td>
<td>3:41:57 PM</td>
<td>Ir_0042b.jpg</td>
<td>ThermaCAM E30</td>
<td>24301907</td>
</tr>
</tbody>
</table>

**Object parameter**

<table>
<thead>
<tr>
<th>Emissivity</th>
<th>Object distance</th>
<th>Ambient temperature</th>
<th>Relative humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.79</td>
<td>1.0 m</td>
<td>28.5°C</td>
<td>0.53</td>
</tr>
</tbody>
</table>

**IR Text Comment**

- DC File Name: DC02413V.JPG
- Joint Indication: -

**ANALYSIS:**

Fault Spot (Sp01) & (Sp02) **OVERHEATING at 37.2°C and 37.3°C** respectively.

As against Satisfactory Spot (Sp03) at 31.1°C

Temperature Rise **6.1°C & 6.2°C**

**RECOMMENDATION**

- Power OFF the Equipment.
- Break Each Joint in Turn.
- Check and Clean Both Connecting Surfaces.
- Remake and tighten with the correct level of Torque Loading.
In general results of inspected locations where incorporated at this report were commented at Normal Condition.

In addition to above classification, there are only TWO anomalies location finding which are described as **Indicate Deficiency** and stated with comment as to the required recommendation action.

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**Location 1 (anomaly):**
G/F, Main Switch Room No. 2

**THE BUSWAY JOINT CONNECTION (J1),**
**TEMPERATURE RISE Delta-T 4.7°C**
As against with its reference temperature at 32.2°C

**RECOMMENDATION**

Power OFF the Busway, Check and Clean Each Copper Phases Surfaces.
Re-tigten With Correct Level of Torque Loading at 60-80 lbs-ft.
Location 2 (anomaly):
G/F, Main Switch Room - MCB Board

OVERHEATING at 37.2°C and 37.3°C respectively.  
As against Satisfactory Spot (Sp03) at 31.1°C  
**Temperature Rise 6.1°C & 6.2 °C**

**RECOMMENDATION**

Power OFF the Equipment. Break Each Joint in Turn. Check and Clean Both Connecting Surfaces.  
Remake and tighten with the correct level of Torque Loading.