

## Coal fired Castle Peak Power Station in Hong Kong modifies 250 m reinforced concrete chimney with four steel flues



### Albert de Kreij

Albert de Kreij joined Hadek Protective Systems in 1989. He has been closely involved in a number of projects with the use of Borosilicate Glass Block Linings especially in wet stack operation conditions.

CLP Power, a subsidiary of China Light & Power, is the leading supplier of electricity in Hong Kong. CLP Power’s Castle Peak Power Station (figure 1), one of the largest coal firing power stations in the world, has four 677 MW units that were commissioned between 1985 and 1989. Running at over 38% efficiency at full load, the Castle Peak B units are a key generating asset for the Hong Kong economy.

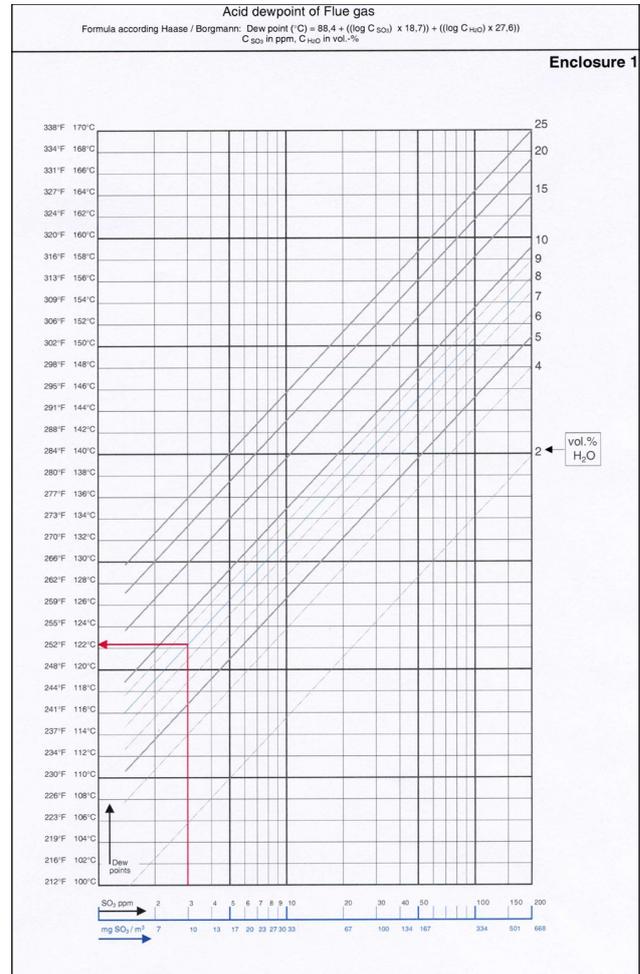


**Figure 1 : Castle Peak B Power Station**

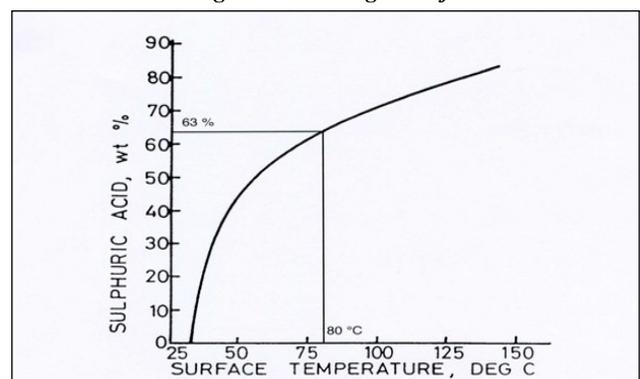
To help improve air quality, it was decided in 2006 that all four units of Castle Peak B Power Station should be equipped with highly efficient wet limestone flue gas desulphurization plants.

The four units of Castle Peak B use a common 250 m high reinforced concrete chimney, which contains four corten steel flues each with a diameter of 6.6 m. The steel flues were originally constructed without an internal lining. CLP Power recognized however that following the FGD retrofit, the flue gas temperature would drop well below its acid dewpoint, resulting in the need for a chimney flue lining system.

With the FGD working, the treated flue gas will be reheated by Gas-to-Gas heaters to 80°C. Graph 1 shows the determination of the sulphuric acid dewpoint according to the Haase-



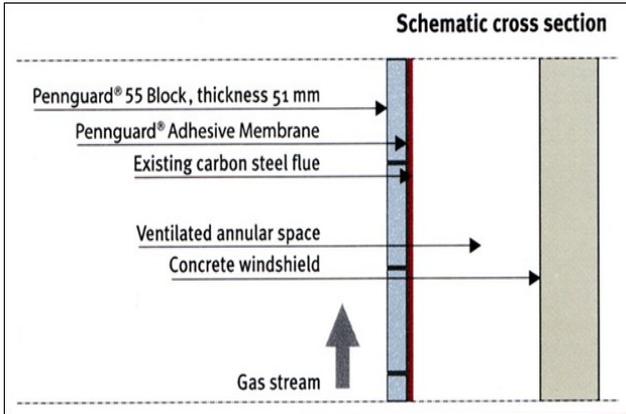
**Graph 1: Determination of sulphuric acid dewpoint according to Haase-Borgmann formula**



**Graph 2: Variation of condensed sulphuric acid concentration with temperature**

Borgmann formula. For a flue gas with 10 mg/Nm<sup>3</sup> SO<sub>2</sub> and 8 % water, the expected acid dewpoint will be 122°C. The flue gas temperature in the steel flues will therefore be 40°C under sulphuric acid dewpoint.

Graph 2 shows the relation between the temperature and the concentration of condensed sulphuric acid.



**Graph 3: Schematic cross section of the Pennguard lined steel flues**

With a flue gas temperature of 80°C, the estimated concentration of sulphuric acid will be 63 %. The sulphuric acid concentration will be highly corrosive. The flues must be lined to resist the corrosive conditions.

Following an evaluation of different chimney flue lining technologies, CLP Power selected the Pennguard Block Lining System, using 51 mm thick Pennguard Block 55 (Graph 3). The Pennguard linings were installed in all four flues during planned boiler outages, each about 70 days long, in 2008, 2009 and 2010.

CLP Power awarded the lining installation contract to Balanced Engineering & Construction Pte Ltd (BEC) from Singapore. To ensure a safe, timely, high quality completion of the works, BEC paid close attention to several key aspects.

**1. Access and weather protection**

A strong platform, with a full floor and a fast, separate hoist for materials supply was built, to ensure optimum access to all steel surfaces, as well as an uninterrupted supply of Pennguard materials to the installation crews (figure 2). The top of the chimney was sealed off with a temporary roof (figure 3).



**Figure 2: Work platform, separate hoist for lining materials**



**Figure 3: Temporary roof**

**2. Surface preparation**

Gritblasting up to 250 m high was made possible by a single 336 m<sup>3</sup>/hour compressor (figure 4) placed on ground level, with 3 blast pots placed on the support floors within the chimney windshield.



**Figure 3: 336 m<sup>3</sup>/hour compressor**

**3. Condition of steel plate and welds**

Pennguard linings offer a great advantage for lining used steel flues that were not originally fabricated as “fit-for-lining” (figure 4) : small imperfections in welds, such as rip-



**Figure 4: Protruding welds and slight roughness in used steel flues are acceptable for the Pennguard Block Lining System**

ples, protrusions and pinholes can be left uncorrected and even slight pitting in the steel plate is not a problem.

#### 4. Short time available for lining installation

The Pennguard lining installation work was performed by two teams, each with 8 trained brick layers, working in two shifts per 24 hours (figure 5). The typical productivity per day was 250 m<sup>2</sup>.



Figure 5: Pennguard lining installation

#### 5. Quality Assurance during lining installation

All works were supervised by Hadek QA Inspectors (figure 6). One QA Inspector attended during surface preparation. During installation of the Pennguard lining, one Inspector was present during the day shift and a second Inspector worked during the night shift. As on most Pennguard lining projects, Hadek performed intensive, systematic QA Supervision, allowing any defects to be identified and corrected immediately.

**Cold spots: a fundamental problem for steel chimneys and chimney flues that is eliminated by the use of Pennguard linings**

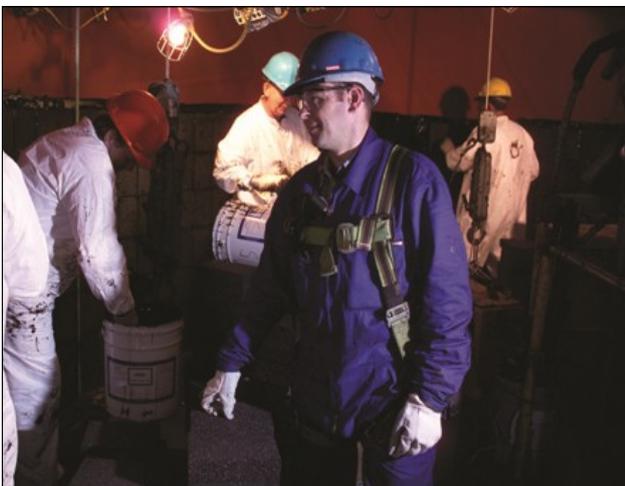
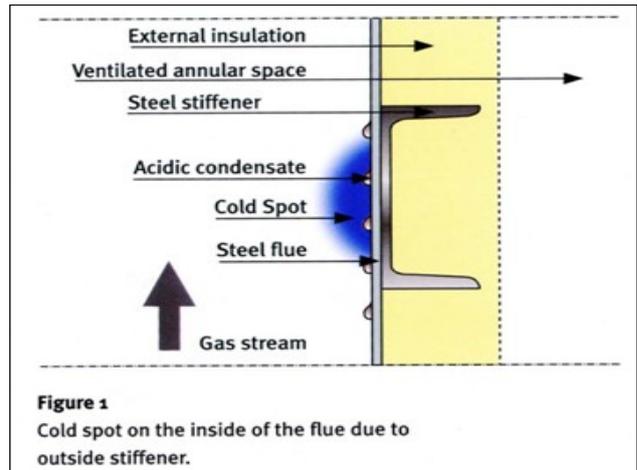


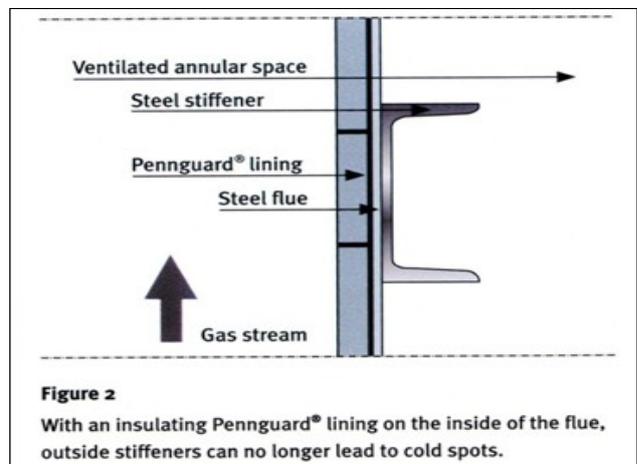
Figure 6: All works were supervised by Hadek QA Inspectors

For structural stability as well as for construction purposes, every steel chimney / steel chimney flue has stiffeners on its outside. In these areas, the steel is much thicker than the standard plate thickness and it is often difficult to apply an effective thermal insulation.

These stiffeners generate “cold spots” on the inside of the chimney flue, where excessive condensate formation can take place especially during start-ups and low load operation (graph 4).



Graph 4: Situation prior to Pennguard lining installation and removal of external insulation



Graph 5: Situation following Pennguard installation and removal of external insulation

The use of thermally insulating Pennguard linings on the inside of steel flues eliminates this problem. The Pennguard lining system will provide effective thermal insulation in all areas of the flue, even where the outside flue surface is covered with external stiffeners (graph 5).

#### Summary and Conclusion

- Operating conditions are corrosive regardless of reheat;
- Pennguard linings successfully installed in 70 day outages;
- Lining system tolerance of steel plate and weld imperfections prevented time consuming repair works.