DAQO Technical Differences of Isolated Phase Bus Standards

Study of Design Standard Variances, Insulator Design and Shipping Section Design
Global Reference Medium Voltage Electrical Equipment Standards

- **“GB”** = GB Standard (P.R.C. China) developed from German DIM standard in 1960s.
- **“ANSI” or “IEC”** = Most well known international standards
- 1) Technical Section: Conductor Support Insulators
2) ANSI-IEEE C37.23 2003 document
3) Insulator test report
4) Technical Section: IPB Shipping Section Length design
Difference in the standards
BIL and Electrical Clearances

Three major variances between GB standard and ANSI or IEC standard:

1) ANSI and IEC do not stipulate electrical clearances

2) B.I.L. (lightning withstand) ratings differ based on maximum operating voltage

3) ANSI and IEC do not stipulate creep distance for insulators or air gaps (phase to phase or phase to ground)
BIL and Electrical Clearances

The major variance:

“GB” standard stipulates how electrical products are to be designed and manufactured,

whereas “ANSI” and “IEC” only require that electrical products meet design (type) test criteria.
BIL and Electrical Clearances

Typical ANSI or IEC Design

Phase to Ground = 225 mm minimum @ 125kV BIL
Equals Approximately 1.8 mm per kV (non-insulated conductor)

Insulator creep distance = 2.3 mm per kV
Approximately 290 mm @ 125kV BIL

Note: Rated voltage is not considered in international markets

B.I.L. rating is the major design consideration
# BIL and Electrical Clearances

## IPB and Non-segregated Phase Bus

<table>
<thead>
<tr>
<th>Maximum Operating (kV)</th>
<th>Power Frequency Withstand (kV rms) dry 1 minute</th>
<th>Lightning Impulse Withstand (kV peak) (B.I.L.)</th>
<th>Insulator Creep Distance Required (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB</td>
<td>ANSI</td>
<td>GB</td>
<td>ANSI Specified</td>
</tr>
<tr>
<td>1.20</td>
<td>.635</td>
<td>4.2</td>
<td>2.2</td>
</tr>
<tr>
<td>7.20</td>
<td>4.76</td>
<td>32</td>
<td>19</td>
</tr>
<tr>
<td>10.50</td>
<td>8.25</td>
<td>42</td>
<td>36</td>
</tr>
<tr>
<td>15.80</td>
<td>15.00</td>
<td>51</td>
<td>36</td>
</tr>
<tr>
<td>18.00</td>
<td>15.50</td>
<td>61</td>
<td>50</td>
</tr>
<tr>
<td>27.60</td>
<td>27.00</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>40.50</td>
<td>38.00</td>
<td>100</td>
<td>80</td>
</tr>
</tbody>
</table>

**Lightning Impulse Withstand (kV peak) (B.I.L.):**

- **GB**
- **ANSI**

**Power Frequency Withstand (kV rms) dry 1 minute:**

- **GB**
- **ANSI**

**Insulator Creep Distance Required (mm):**

- **GB Specified**
- **ANSI Estimate**
Insulator Application & Design
Typical ANSI or IEC Design

- **Insulator Design Spacing is Based On:**

  1) IPB conductor weight (current rating)
  2) Momentary Current (S.C. rating)
  3) Shipping Section Length
  4) “As installed state”

  In other words, design of insulator spacing should only consider the installed state of the IPB sections.

  Design of insulator spacing should never be considered for shipping purposes.
Insulator Application & Design
Typical ANSI or IEC Design

- **Insulator Spacing**
  
  Regardless of design:
  should never be less than 6 meters on center

Only 2 Insulator locations and only 2 insulators per set!
Insulator Application & Design
DAQO Design

2 Meters
1 Meter
# Insulator Application & Design

## Insulator Design Cost Comparison
(Based on Yuhuan Design (3) insulators per set)

<table>
<thead>
<tr>
<th>Item Description</th>
<th>GB Design</th>
<th>ANSI-IEEE Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Bus Length</td>
<td>800 meters</td>
<td>800 meters</td>
</tr>
<tr>
<td>Average Spacing of Insulators (O.C.)</td>
<td>3.7 meters</td>
<td>6.1 meters</td>
</tr>
<tr>
<td>Total Number of Insulator Sets Required</td>
<td>648</td>
<td>393</td>
</tr>
</tbody>
</table>
## Insulator Application & Design

### Typical ANSI or IEC Design

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>Number of Insulators per Location</th>
<th>Average Insulator Spacing</th>
<th>*Maximum Momentary Current (asym)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 300mm</td>
<td>1 design</td>
<td>6 meters</td>
<td>Up to 140kA</td>
</tr>
<tr>
<td>Up to 450mm</td>
<td>2 design</td>
<td>6 meters</td>
<td>Up to 225kA</td>
</tr>
<tr>
<td>Over 450mm</td>
<td>3 design</td>
<td>6 meters</td>
<td>Up to 350kA</td>
</tr>
</tbody>
</table>

* Momentary current ratings shown are estimated.

Actual maximum ratings depend on insulator cantilever strength and actual IPB momentary current rating. This will be determined in Part 2.
Insulator Application & Design

Typical ANSI or IEC Design

18 meter section 3 insulator locations, single insulator design
IPB Shipping Section Design

Shipping Section Design Considerations:

- Straight sections designed as long as possible
- Elbow and T-tap should be as short as possible
- Section design should consider reducing crating and shipping cost
- Standardize Design Concept
IPB Shipping Section Design

- Section design should consider reducing crating and shipping cost
- Long, straight sections reduce crating and shipping costs
- Long, straight sections reduce installation costs...DAQO advantage
Insulator Design

Insulator Choices: Epoxy or Porcelain