

Krassimir Kutlev
Martin Magnusson
Ulf Andersson



Reliable and Cost Effective Solutions for HVDC Switchyards

CIGRE – IEC - 2016

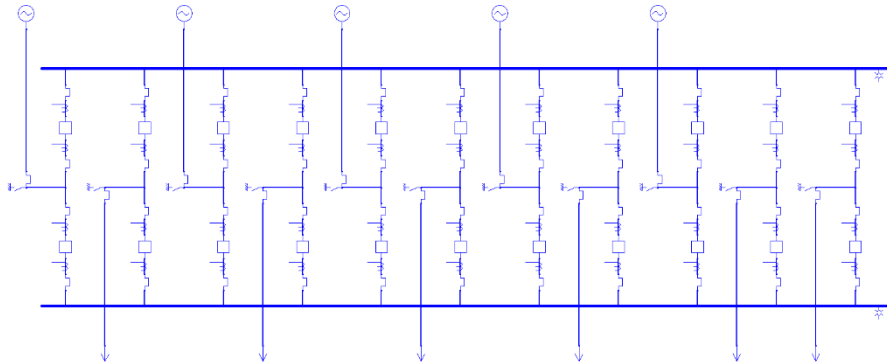


ABB

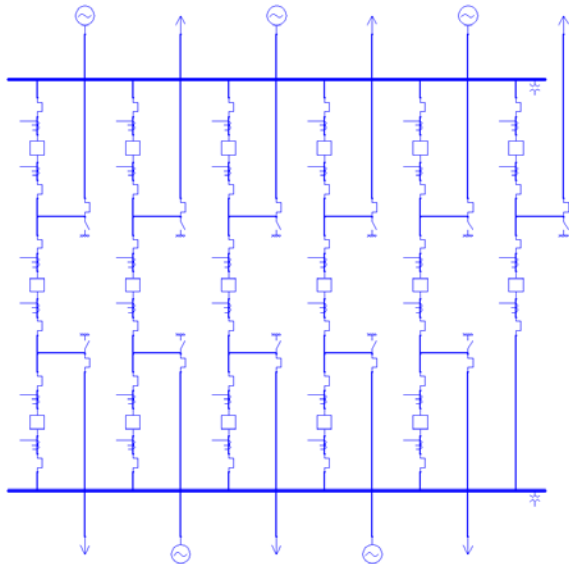


Switchyards Alternatives –reliability models

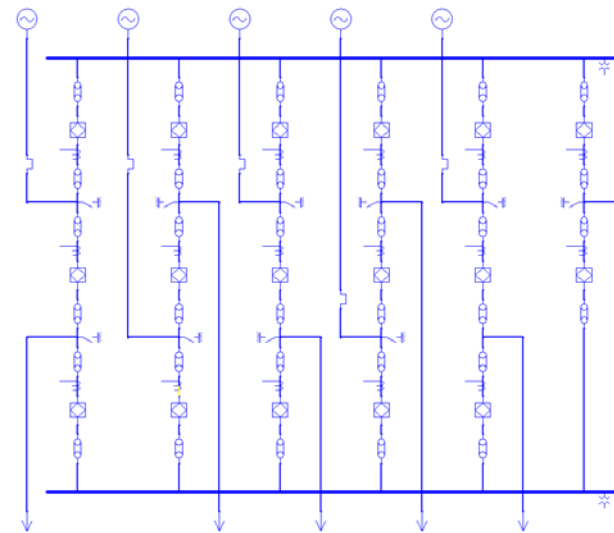
- **Double-Bus-Double-Breaker (DBDB)**



- **Breaker-And-A-Half (BAAH) – Traditional AIS**



- **Breaker-And-A-Half (BAAH) – DCB**



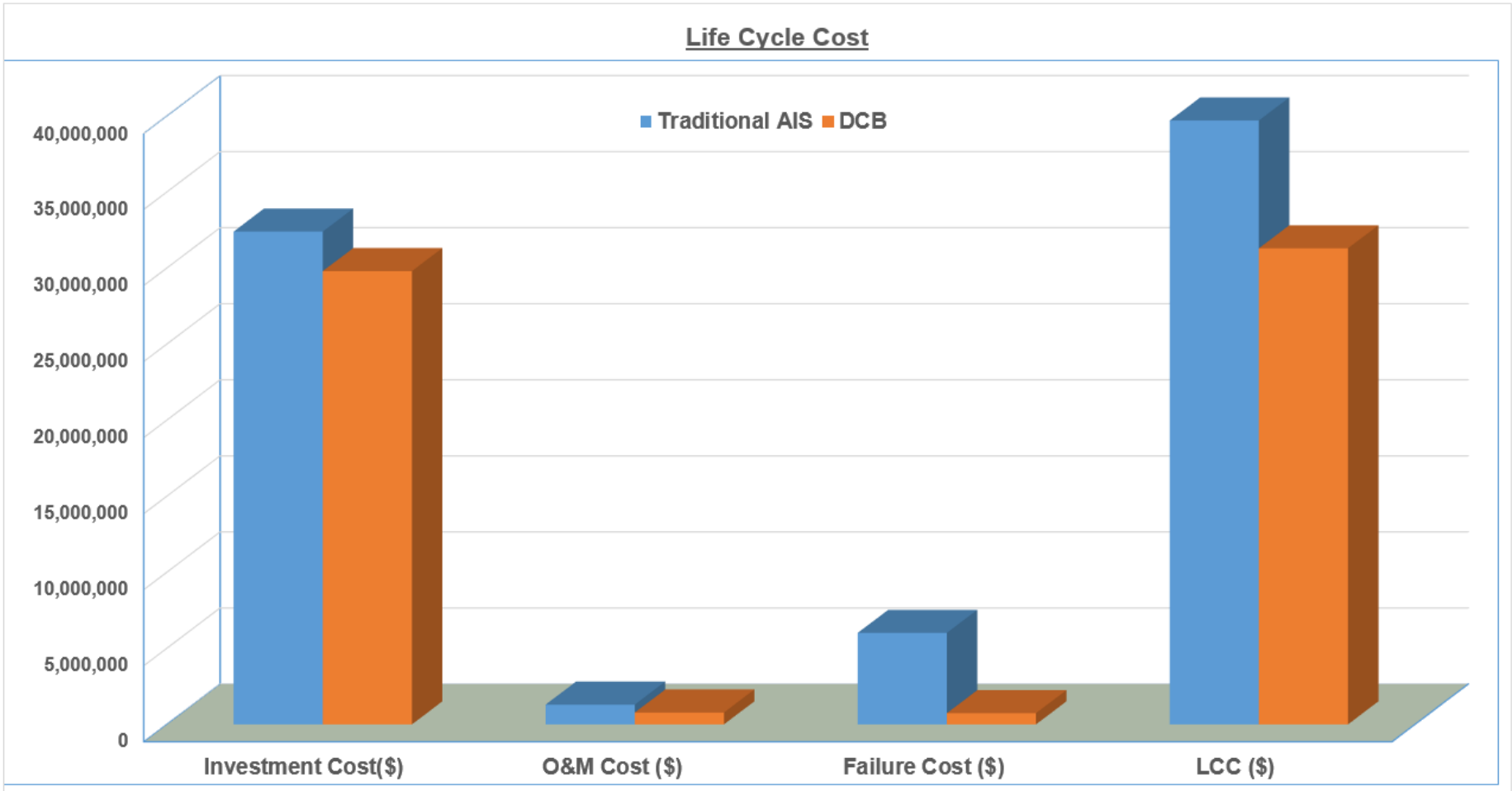
Reliability Results

Configuration	Feeder	Failure OF	Maint. OF	Total OF	Failure OD	Maint. OD	Total OD	Forced MTBF
	Name	/yr	/yr	/yr	hr/yr	hr/yr	hr/yr	yr
Option 1 DBDB with traditional AIS	Load T1	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
	Load T2	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
	Load T3	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
	Load T4	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
	Load T5	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
	Load T6	0.2455678	0.600	0.8455679	0.25272	4.800	5.05272	4.07
Option 2 BAAH with traditional AIS	Load T1	0.2459218	0.600	0.8459218	0.25324	4.800	5.05324	4.07
	Load T2	0.2459218	0.600	0.8459218	0.25324	4.800	5.05324	4.07
	Load T3	0.2459386	0.600	0.8459386	0.25325	4.800	5.05325	4.07
	Load T4	0.2459846	0.600	0.8459846	0.25328	4.800	5.05328	4.07
	Load T5	0.2459386	0.600	0.8459386	0.25325	4.800	5.05325	4.07
	Load T6	0.2459218	0.600	0.8459218	0.25324	4.800	5.05324	4.07
Option 3 BAAH with DCB technology	Load T1	0.0249000	0.133	0.1583444	0.05950	0.267	0.32631	40.16
	Load T2	0.0257709	0.133	0.1591709	0.06110	0.267	0.32790	38.80
	Load T3	0.0249000	0.133	0.1583402	0.05940	0.267	0.32624	40.16
	Load T4	0.0258000	0.133	0.1591692	0.06110	0.267	0.32790	38.76
	Load T5	0.0258000	0.133	0.1591695	0.06110	0.267	0.32790	38.76
	Load T6	0.0233000	0.133	0.1567467	0.04670	0.267	0.31349	42.92

- **OF – Outage Frequency**
- **OD – Outage Duration**
- **MTBF – Mean Time Between Failure**



Life Cycle Cost Comparison – BAAH Switchyard



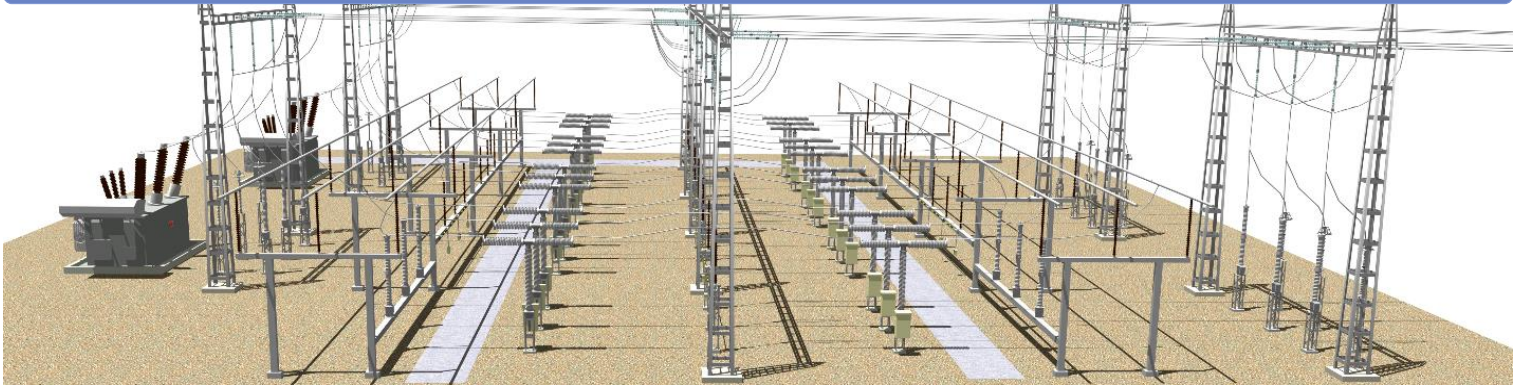
DCB with integrated Fiber Optic Current Sensors

DCB 420kV
with CT and
analog
communication



Taking the extreme availability double breaker transmission substation 420 kV one step further

DCB 420kV
with integrated
FOCS and
process bus
IEC 61850-9-2



Conclusions & Recommendations

Suggested steps for selecting a cost-effective switchyard solutions for HVDC

- **Identify potential switchyard configuration alternatives**
- **Choose between different technologies – AIS, GIS, Hybrid, etc.**
- **Model, calculate and analyze reliability for each alternative**
- **Perform Life Cycle Cost analysis for each alternative**
- **Select reliable and cost-effective solution**

The image shows the ABB logo in a large, bold, red font. The letters are stylized with a grid-like pattern of white lines, giving them a modern, industrial appearance. The 'A' is composed of three vertical and two horizontal lines. The 'B's are composed of three vertical and two horizontal lines.

Power and productivity
for a better world™

The image shows the ABB logo in a smaller, bold, red font. The letters are stylized with a grid-like pattern of white lines, giving them a modern, industrial appearance. The 'A' is composed of three vertical and two horizontal lines. The 'B's are composed of three vertical and two horizontal lines.