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## The SAKUMA HVDC System

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<b>Interconnection between</b>	The 50 Hz 275 kv AC system at Sakuma Japan.	The 60 Hz 275 kv AC system at Sakuma Japan.
<b>AC System Frequency</b>	50 Hz	60 Hz
<b>AC System Voltage</b>	275 kV	275 Hz
<b>Power Co.</b>	Electric Development Co,Ltd. Tokyo, Japan	
<b>Manufacturer</b>	<p>Toshiba Corporation, Japan for the valve equipment (50 Hz) and the smoothing reactor.</p> <p>Hitachi Ltd. Japan for the valve equipment (60 Hz)</p> <p>Mitsubishi Electric Corporation, Japan for the converter transformers.</p> <p>Nisshin Electric Co., Japan for the AC filters.</p>	
<b>Commissioned</b>	<p>10 th October 1965 with mercury arc valves manufactured by ASEA, Sweden and decommissioned 4th May 1993.</p> <p>12th June 1993 refurbishment by thyristor valves with the same capacity.</p>	
<b>Main Purpose</b>	Supply of energy between the two AC systems in case of AC network disturbances, lack of energy or economical exchange in either of the systems.	
<b>Main data</b>	300 MW at $\pm 125$ k DC and 2400 A. Overload capacity : None	
<b>A.C. Networks</b>	<p>The converter station is situated about 1 km from the Sakuma Power Station. This station is connected to the 60 Hz, 275 kV AC network via Nagoya with interconnections to Osaka and the Western area.</p> <p>The station is also connected to the 50 Hz Network with interconnections to the Northeastern area.</p> <p>In the vicinity of the Sakuma power systems some hydro power plants are connected to the 50 Hz and 60 Hz systems with a total capacity of approximately 700 MW and 900 MW respectively.</p>	

	<p><u>Converter transformer nos. 1 and 2 :</u>  60 Hz, 2 x 187 MVA, 275 ± 10% / 55 kV (one 4.5 MVA, 275/3.3 kV for auxiliary supply.  The three transformers are housed in one tank and they are ordinary 2 winding transformers with separate transformer cores.  Min. short circuit capacity = 1750 MVA.</p> <p><u>Converter transformer nose 3 and 4 :</u>  50 Hz, 2 x 183 MVA, 275 ± 10%/54 kV  The two transformers are housed in separate tanks.  Min. short circuit capacity = 1220 MVA.</p> <p>The 50 Hz and 60 Hz transformers have a sound absorbing metal cover respectively.</p>																																																												
<b>HVDC System</b>	<p>Due to the station design (back to back) there are no transmission lines.</p> <p>The LIWL across the valves is 350 kV.</p>																																																												
<b>Submarine Cable</b>																																																													
<b>Electrodes</b>																																																													
<b>A.C. Filters</b>	<p>Harmonic filters are provided on the 50 Hz and 60 Hz side:</p> <table border="1"> <thead> <tr> <th>Har m</th> <th>MVA r</th> <th>C=μ F</th> <th>L=m H</th> <th>R=Ω</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>20.8</td> <td>0.842</td> <td>480</td> <td>15.1</td> </tr> <tr> <td>7</td> <td>10.4</td> <td>0.429</td> <td>480</td> <td>21.2</td> </tr> <tr> <td>11</td> <td>11.7</td> <td>0.488</td> <td>171</td> <td>11.9</td> </tr> <tr> <td>13</td> <td>13.0</td> <td>0.541</td> <td>111</td> <td>9.1</td> </tr> <tr> <td>HP</td> <td>35.4</td> <td>1.49</td> <td>14</td> <td>100</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Har m</th> <th>MVA r</th> <th>C=μ F</th> <th>L=m H</th> <th>R=Ω</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>17.4</td> <td>0.585</td> <td>480</td> <td>18.1</td> </tr> <tr> <td>7</td> <td>8.7</td> <td>0.3</td> <td>480</td> <td>25.3</td> </tr> <tr> <td>11</td> <td>9.8</td> <td>0.34</td> <td>171</td> <td>14.2</td> </tr> <tr> <td>13</td> <td>10.8</td> <td>0.375</td> <td>111</td> <td>10.9</td> </tr> <tr> <td>HP</td> <td>44.3</td> <td>1.55</td> <td>14</td> <td>100</td> </tr> </tbody> </table>	Har m	MVA r	C=μ F	L=m H	R=Ω	5	20.8	0.842	480	15.1	7	10.4	0.429	480	21.2	11	11.7	0.488	171	11.9	13	13.0	0.541	111	9.1	HP	35.4	1.49	14	100	Har m	MVA r	C=μ F	L=m H	R=Ω	5	17.4	0.585	480	18.1	7	8.7	0.3	480	25.3	11	9.8	0.34	171	14.2	13	10.8	0.375	111	10.9	HP	44.3	1.55	14	100
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<b>DC Filters</b>	<p>No DC filters are installed.</p>																																																												
<b>HVDC Valves</b>	<p>Direct light triggered and water cooled thyristor valves are used.  The valves are self supported, air insulated and they are installed in the existing valve hall.</p> <p>The valve group consists of two 6 pulse converter units and configured in 12 pulse as quadrivalves.</p> <p>Each valve section has 7 thyristors rated at 6000 V and 2500 A in series and none in parallel.</p>																																																												

	This makes a total of 28 thyristors per valve section or 168 thyristors per 6 pulse converter unit.
<b>Valve Cooling</b>	
<b>D.C. Reactor</b>	The smoothing reactor is designed for 125 kV and 0.12 H at 2400 A.
<b>References</b>	<p>"Electra" no. 63 1979, "AC Harmonic Filter and Reactive Compensation for HVDC"</p> <p>A General Survey by SC14 - WG 03. "Upgrading of HVDC Systems" by D.A. Woodford et al., CIGRE International Colloquium on HVDC and FACTS, Wellington, New Zealand, September 1993.</p>
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# THE SAKUMA HVDC SYSTEM

Geographic map

