Version c

The HOKKAIDO-HONSHU HVDC System

Interconnection between	Hakodate, Hokkaido, Japan (north island)	Kamikita, Honshu, Japan (main island)
AC System Frequency	50 Hz	50 Hz
AC System Voltage	187 kV	275 kV
Power Co.	Electric Power Development Co.Ltd., Tokyo, Japan.	Electric Power Development Co.Ltd., Tokyo, Japan.
Manufacturer	Hitachi, Ltd. Japan (Hakodate), and Toshiba Corporation, Japan for the valves, transformers and D.C. equipment. Nissin Electric Co., Ltd., Japan for the A.C. filters and D.C. filters.	
Commissioned	First stage : 150 MW December 1979 Second stage : 300 MW June 1980 Final stage : 600 MW April 1993	
Main Purpose	The HVDC link interconnects the power systems of Hokkaido and Honshu with the aim of improving reliability and economy through wide-area power system operation. The purpose of this link is a saving of reserve power, effective control of frequency variations, mutual emergency power assistance in fault occurrences and economical power exchange in wide-area power system operation.	
Main data	600 MW, bipole metallic return at ±125 kV DC and 1200 A. Overload capacity : None	
A.C. Networks	At both terminals four 3-phase converter transformers are used.	
	Hakodate 1st and 2nd stages 187 MVA, 187 kV + 19.5 %/- 7.5 %/110 kV. Min. short circuit capacity = 900 MVA. Hakodate Final stage 187 MVA, 187 kV+19.5%/106 kV.	Kamikita 1st and 2nd stages 187 MVA, 275 kV + 18.3%/- 8.6%/110 kV. Min. short circuit capacity = 1500 MVA. Kamikita Final stage 187 MVA, 275 kV+18.3%/-

	Min. short circuit capacity = 900 MVA. The four transformers are connected to the 50 Hz 187 kV AC network.	8.6%/106 kV. Min. short circuit capacity = 1500 MVA. The four transformers are connected to the 50 Hz 275 kV AC network
HVDC System	Route length = 167 km Overhead lines : length in Hokkaido = 27km length in Honsu = 97km Line towers : Self supporting steel structures Conductors : main circuit = 810 mm2, ACSR, 810 mm2 EACSR/EAS return circuit = 240 mm2, EACSR, 240 mm2 AS (double) Insulator leakage : 3.8 / 6.9 cm/kV	
HVDC Cable	Submarine cables : Length = 43 km The cables used for the Tsugaru Strait crossing are : <u>Main circuits</u> : An oilfilled cable (OF) with a Cu-conductor = 600 mm^2 and designed with an oil channel, d = 25 mm in the center - Normal oil pressure = 2.31 MPa - Transient max. = 3.61 MPa - Total diameter of the cable = 125 mm <u>Return circuit</u> : A polyethylene cable (XLPE) - with a Cu-conductor = 500 mm^2 - total diameter of the cable = 75 mm Both cables have a single layer of galvanized steel armouring (8 mm for main circuit cable, 6 mm for return circuit cable).	
Electrodes		

A.C. Filters

1st and 2nd stages

Harm.	Mvar	R=Ω	L=mH	C=μF
5	32.0	4.55	144.9	2.79
7	16.0	6.37	144.9	1.43
11	9.81	6.54	94.6	0.884
13	7.0	7.73	94.6	0.634
HP	30.2	166	8.38	2.75

Final stage

Harm.	Mvar	R=Ω	L=mH	C=μF
11	17.1	3.74	54.1	1.55
13	12.3	4.42	54.1	1.11
HP	30.2	151	6.97	2.75

1st and 2nd stages

Harm.	Mvar	R=Ω	L=mH	C=μF
5	32.0	9.85	313.7	1.29
7	16.0	13.8	313.7	0.661
11	13.8	10	144.9	0.578
13	9.89	11.8	144.9	0.414
HP	25.3	428	21.7	1.06

Final stage

Harm.	Mvar	R=Ω	L=mH	C=μF
11	21.7	6.38	92.4	0.907
13	15.6	7.54	92.4	0.653
HP	25.3	390	18.0	1.06

DC Filters

Hakodate : 6th and HP filters

Kamikita : 6th and surge capacitor

HVDC Valves

1st and 2nd stages

Thyristor valves are used. Each terminal has two 6 pulse converter units in series connection, and 6 or 12 pulse operation is possible.

Hakodate : 19 modules in series connection and each module has 6 thyristors in series and none in parallel. This makes a total of 114 thyristors per valve section or 684 thyristors per 6 pulse converter unit.

Kamikita : 28 modules in series connection and each module has 4 thyristors in series and none in parallel. This makes a total of 112 thyristors per valve section or 672 thyristors per 6 pulse converter unit.

The double valves are air insulated and air cooled. Each 6 pulse unit is for 125 kV DC and 1200 A

Final stage

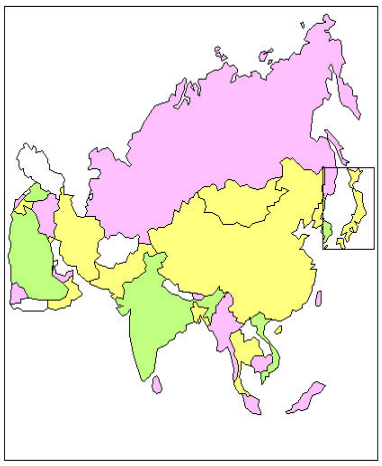
Direct light triggered and water cooled thyristor valves are used. Each terminal has two 6 pulse converter units in series connection and 12 pulse operation only is possible.

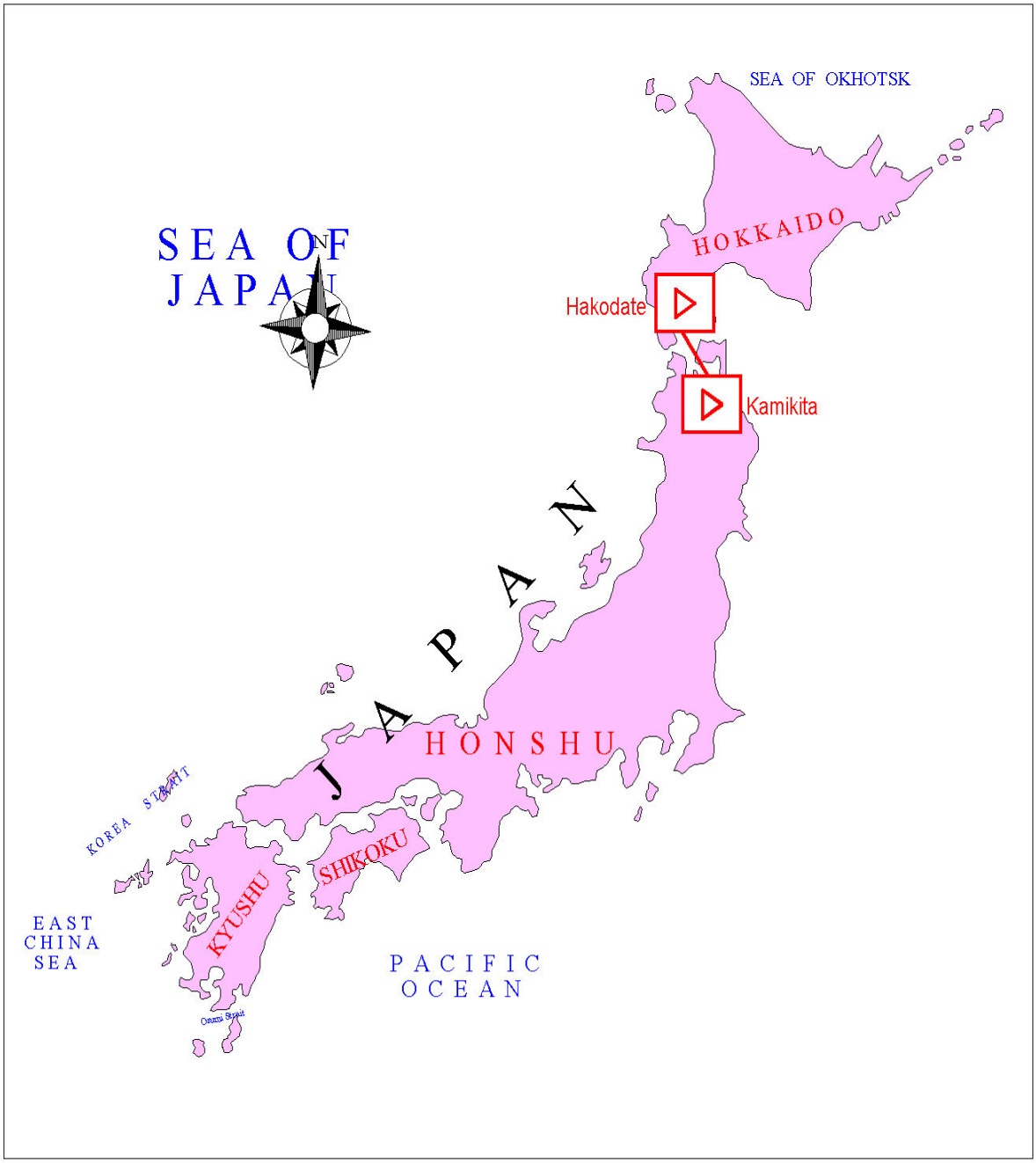
Hakodate : 8 modules in series connection and each module has 7 thyristors in

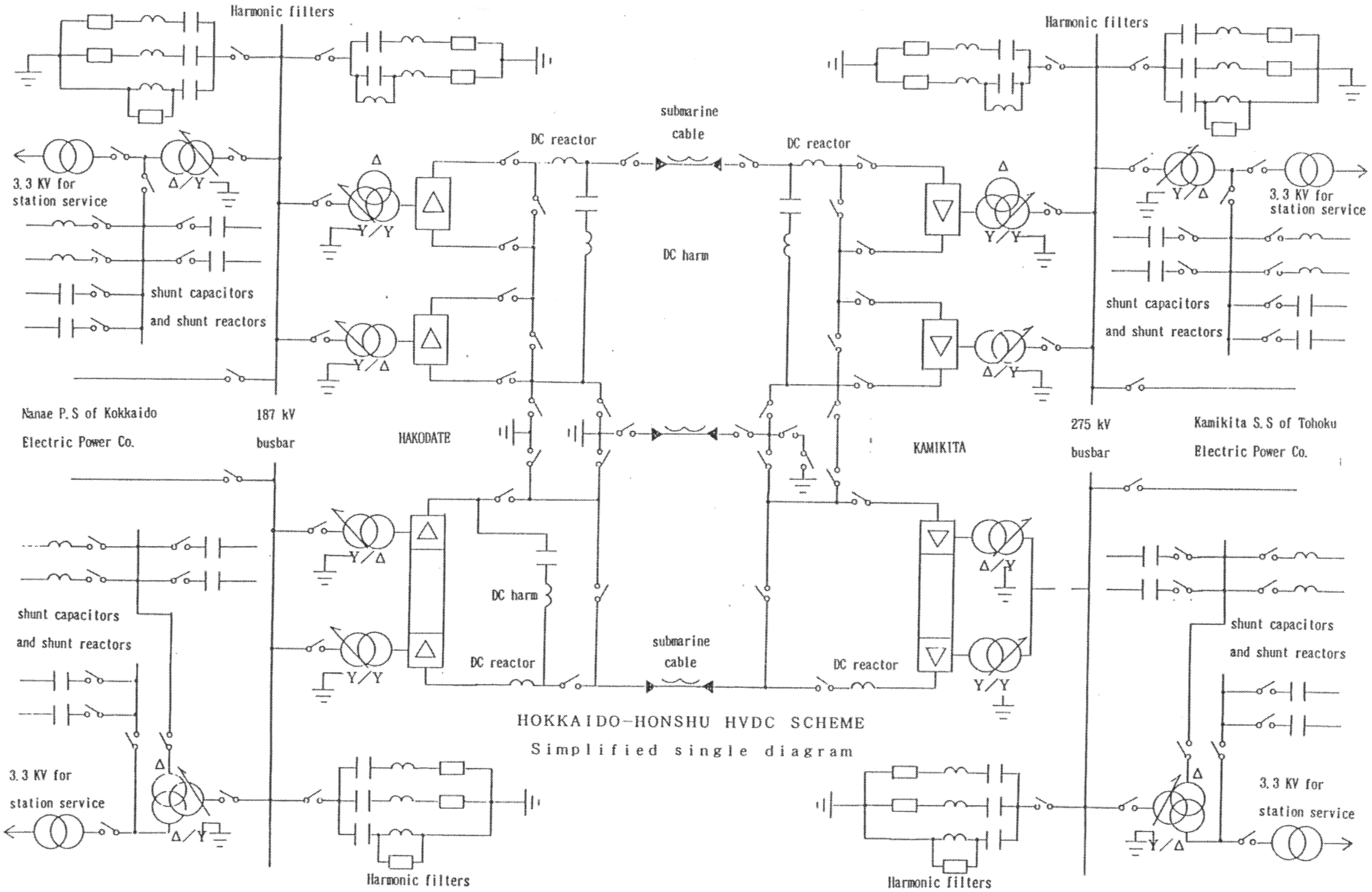
	series and none in parallel. This makes a total of 56 thyristors per valve section or 336 thyristors per 6 pulse converter unit. Kamikita : 8 modules in series connection and each module has 7 thyristors in series and none in parallel. This makes a total of 56 thyristors per valve section or 336 thyristors per 6 pulse converter unit. The quadrivalves are air insulated. Each 6 pulse unit is for 125 kV DC and 1200 A.
Valve Cooling	
D.C. Reactor	The smoothing reactors are placed on the high voltage side and are designed for 250 kV DC and 1.0 H at 1200 A.
References	CIGRE 1980 - paper 14-03 - "Hokkaido - Honshu HVDC Link" by T. Takenouchi, et al. CIGRE 1992 - paper 14-102 "New Technologies Applied to the Recent HVDC Converter Stations in Japan" by T. Senda, et al.
System correspondent	Mr Masatoshi Sampei Electrical Engineering Dept. Electric Power Development Co., Ltd 15-1 Ginza 6-chome Tokyo 104 JAPAN Telex : EPDCTOK J26716 Telephone : +81 3 3546 9399 Fax : +81 3 3546 8485

HOKAIDO-HONSHU HVDC SYSTEM

Geographic map






Harmonic filters
3.3 KV for
station service
shunt capacitors
and shunt reactors
Nanae P.S of Kokkaido
Electric Power Co.
187 kV
busbar
HAKODATE
DC reactor
submarine
cable
DC harm
KAMIKITA
275 kV
busbar
Kamikita S.S of Tohoku
Electric Power Co.
HOKKAIDO-HONSHU HVDC SCHEME
Simplified single diagram