

IEA ExCO Meeting  
January 30, 2017 @RSE, Milan, Italy

# HTS Cables and Regulations in Japan

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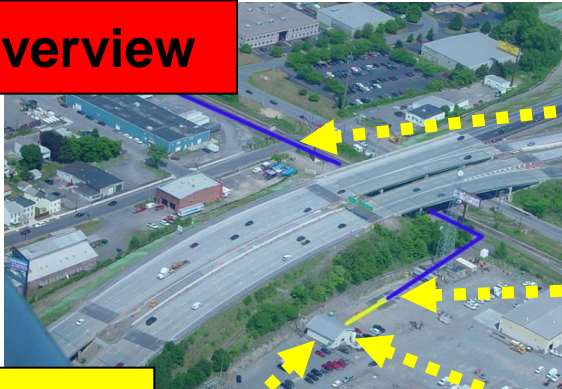
Sumitomo Electric Industries, LTD.

# Albany Cable PJ, NY, USA

(SuperPower, SEI, Linde, National Grid)

DI-BSCCO <sup>2</sup>

Overview



Cable



Joint



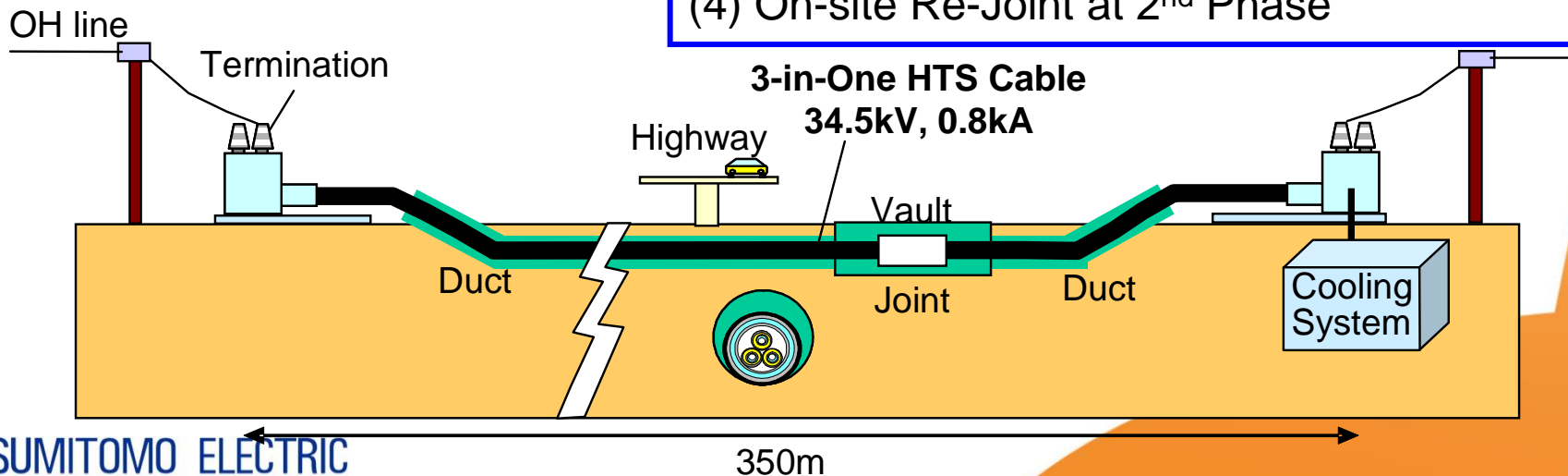
Coolers



Terminal



- (1) 7,000 Hrs Operation to supply Electricity to 70,000 Homes (1<sup>st</sup> phase: July 2006-May 2007)
- (2) 2<sup>nd</sup> Phase Grid Connection started on January 9<sup>th</sup>, 2008
- (3) On-site Joint at 1<sup>st</sup> Phase
- (4) On-site Re-Joint at 2<sup>nd</sup> Phase



## First 'in real-grid' HTS Cable demonstration in Japan

### Location & spec

- Asahi S/S, Yokohama, TEPCO's network
- $66 \text{ kV}_{\text{rms}} - 1.75 \text{ kA}_{\text{rms}}$  / 200 MVA, 240 m

### Check items for the system

- Reliable and stable operation over 1 year
- Cooling controllability at heat load fluctuation
- Maintenance without system shutdown

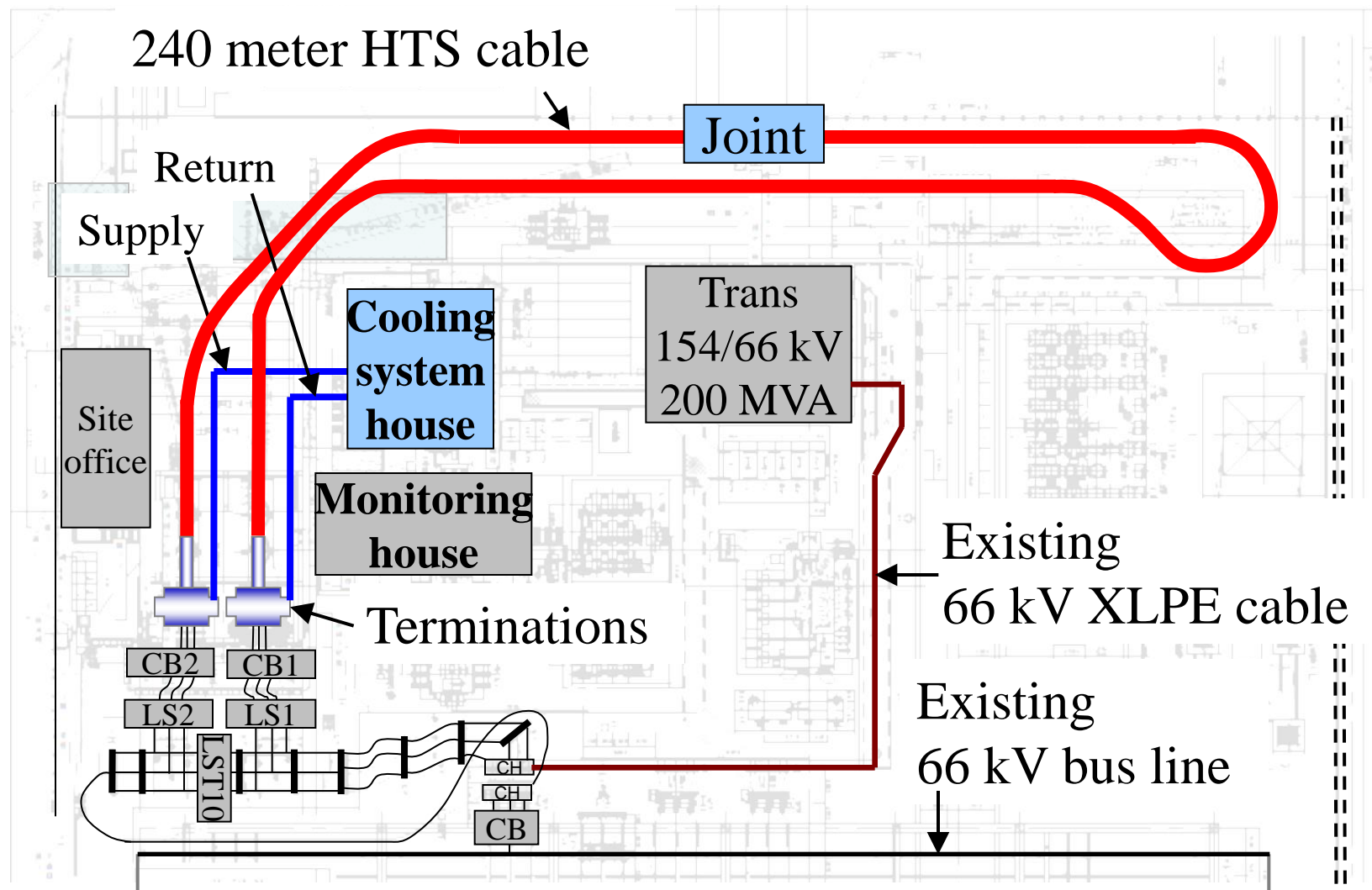


TOKYO ELECTRIC POWER COMPANY

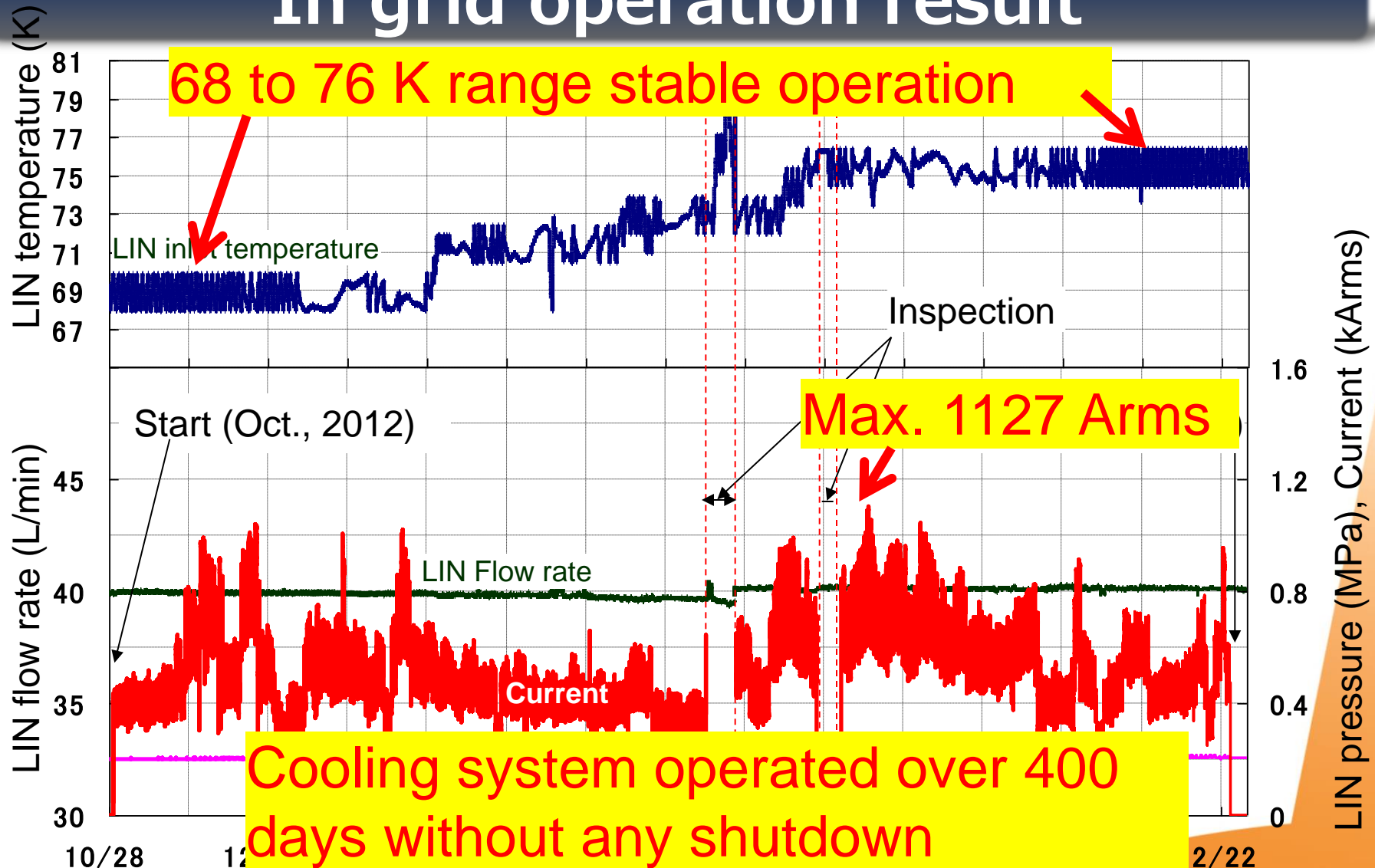
**Host Power Company**

SUMITOMO ELECTRIC

**HTS cable system design,  
manufacture and installation****Cooling system design,  
manufacture and installation**  
**Refrigerator development**経済産業省  
Ministry of Economy,  
Trade and Industry**Project funding and  
management**



# In grid operation result



# Outline of New national project

6

## **Project :**

**Verification tests and study on safety and reliability of HTS cable**

## **Purpose:**

- To verify the safety and reliability of HTS cables at accidents by conducting model tests with actual dimension cable for 22 kV, 66kV and 275 kV class.
- To develop 5 kW class Brayton refrigerator system with higher performance and to confirm its stable operation in the grid at Asahi SS.

**Period :** From July 2014 to March 2019

## **Members :**

NEDO (Project management)

Tokyo Electric Power Company (Utility , Project leader)

Sumitomo Electric, Furukawa Electric (Cable manufacturer)

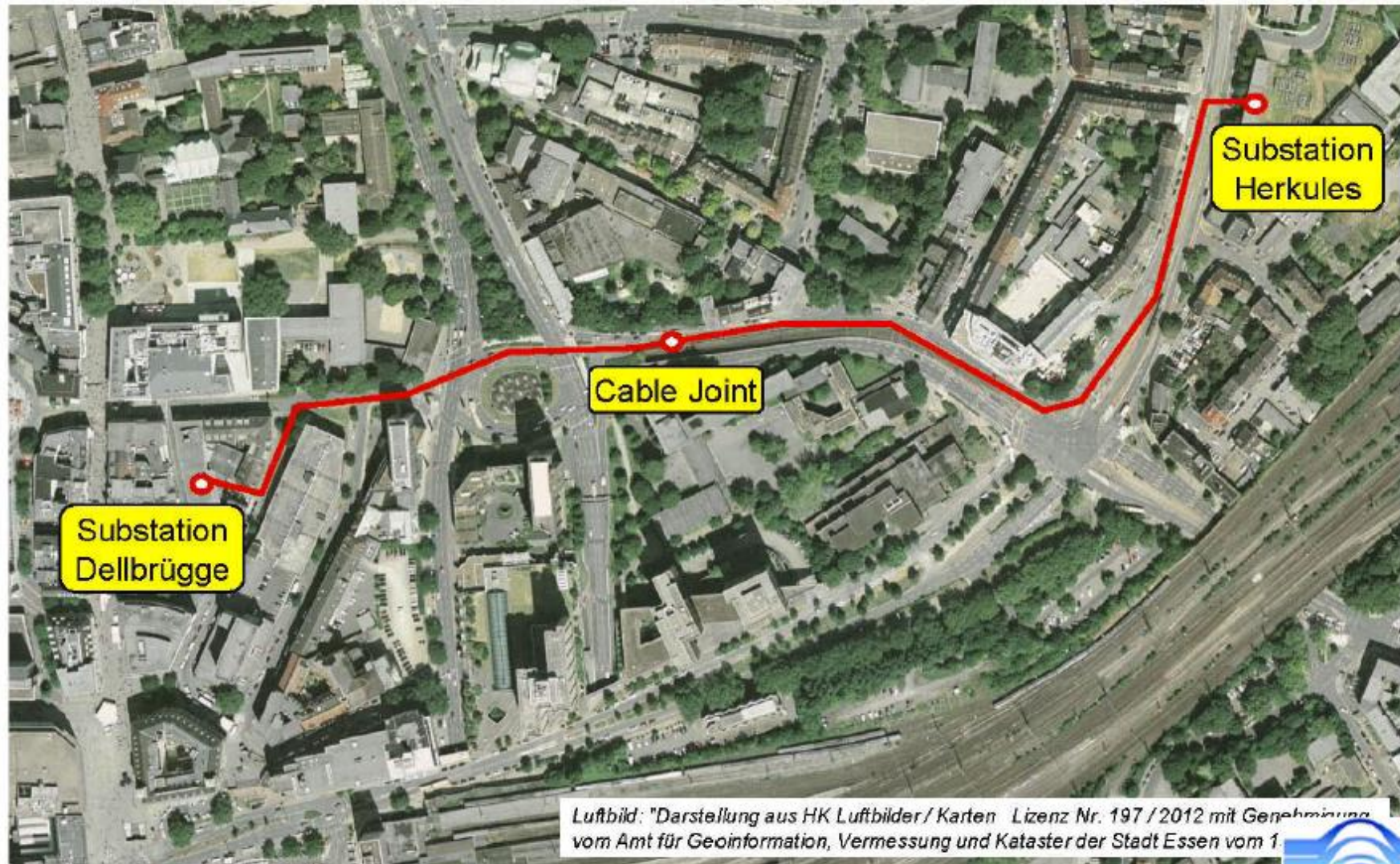
Mayekawa Co. (Refrigerator manufacturer)



# Testing items on safety evaluations

7

	Assuming accidents	Evaluating items
a) Fault current passing test	Passing amount of fault current caused by accidents at the outside of HTS cable	<ul style="list-style-type: none"><li>• LN2 T and P rising level</li><li>• Damage for HTS cable</li><li>• Possibility of rapid restart operation</li></ul>
b) Ground fault test	Ground fault of HTS cable itself caused by dielectric breakdown	<ul style="list-style-type: none"><li>• LN2 T and P rising level</li><li>• Damage for HTS cable</li></ul>
c) Penetrating damage test	c-1) Damage on outer cryostat pipe followed by degradation of Vacuum rate	<ul style="list-style-type: none"><li>• Vacuum rate degradation</li><li>• T and P rising level caused by increasing heat invasion</li></ul>
	c-2) Penetration damage on inner cryostat pipe followed by leakage and blow out of LN2	<ul style="list-style-type: none"><li>• Influence on its circumference such as soil, surrounding apparatus, other cables.</li><li>• Lack of oxygen in case of tunnel or joint vault</li></ul>







Opening ceremony was 18<sup>th</sup> Mar.  
2016 in Jeju Island  
AC 154kV/600MVA, 1km



Groundbreaking ceremony was 7<sup>th</sup> Oct.  
2016 in Seoul Area  
AC 22.9kV/50MVA, 1km  
The 1<sup>st</sup> Commercial Project

# HTS cable testing method

## - IEC standard 1 -



20/1656/RVN

### RESULT OF VOTING ON NEW WORK ITEM PROPOSAL

IEC/TC or SC <u>20</u>		Date of circulation 2016-08-12	
Allocated project number <b>IEC 63075 Ed.1.0</b>			
Reference number of the proposal 20/1637/NP		Title of the TC or SC concerned Electric cables	
Title of proposal: <u>High temperature superconducting power cables and their accessories for rated voltages from 6 kV (Um = 7.2 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements</u>			
Voting results  see printout attached			
Number of P-members <u>approving</u> the new work. item proposal	Number of P-members <u>not</u> <u>approving</u> the new work item proposal	Number of P-members having nominated or confirmed an expert and approving the new work item proposal	Number of P-members in the committee
26	0	8	39

# HTS cable testing method

## - IEC standard 2 -

- ☒ The proposal is supported by a simple majority of the P-members voting
- ☒ At least 4 P-members in the case of a committee with 16 or fewer P-members, or at least 5 P-members in the case of committees with more than 16 P-members, have nominated or confirmed the name of an expert **and** approved the new work item proposal

Under the voting criteria for the acceptance of new work items (see ISO/IEC Directives, Part 1, 2.3.5

☐ the proposal is not approved

☒ the proposal is approved and the new work item has been introduced in the programme of work under the following title:

High temperature superconducting power cables and their accessories for rated voltages from 6 kV (Um = 7.2 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements

(Titre F):

The project is assigned to	project team/working group no. PT 63075	name of project leader Dr. Mark Stemmler
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Draft attached to Form NP will be

☐ distributed as a CD

☒ discussed (with comments annexed)  
on 19/20 Sept 2016

☐ distributed as a CDV

Proposed target date for submission of a CD: 2017-07

CDV: 2018-07

FDIS: 2019-04

IS: 2019-07

The date and place of the first PT or WG meeting are: 19/20 Sept 2016, Paris or arrangements for electronic operations are annexed ☐.

The list of experts nominated is annexed ☒.

Proposals for further modifications are annexed ☐.

- Technical report (recommendation) of HTS cable testing method has already issued by CIGRE WG B1.31

## RECOMMENDATIONS FOR TESTING OF SUPERCONDUCTING CABLES

WG B1.31

### Members

D. Lindsay, **Convenor** (US), T. Masuda, **Secretary** (JP),  
R. Awad (CA) M. Bechis (IT) J. Diaz (ES) A. Geschiere (NL) D. Knoll (US) N. Lallouet (FR)  
S. Lee (KR) S. Mukoyama (JP) F. Schmidt (DE)



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In many cases in Japan, superconducting system should be comply with high pressure gas safety law.

## What is high pressure gas?

### 1) Compressive gas

**>1MPaG at regular use**

-> He gas in the compressor for cyo-cooler

### 2) Liquid gas

**>0.2MPaG at regular use & 0.2GpaG at <35°C**

-> Liquid nitrogen for cable cooling

# High pressure gas regulation

	Japan	US	Note
Rule	LAW	CODE	US Law: Compliance with ASME Code
Technical base	High pressure gas safety law	ASME code	Same design rule
Inspection	Check by safety law by public administration (local government or certification organization (KHK))	Acquisition of stamp by private certified factory	Japan: cumbersome procedure  US: flexible and easy procedure
Penalty	Yes	No	No penalty in US <b>But, not covered by insurance</b>
Daily check	Once a day	No rule	US: <b>Independent operation rule</b> can be determined.
Periodic check	Once a year	No rule	
Unattended operation	Impossible	Possible	
Remote control	Impossible	Possible	



## 【High pressure gas safety law】

(Exemption)

**3** This law is not applied for below high pressure gas

3-6 High pressure gas in the electric equipment determined by Electricity Enterprises Law

## Yokohama PJ : Asahi substation of TEPCO

2013年11月13日 実証運転開始から **380** 日経過

高温超電導ケーブル実証プロジェクト



First in grid operation in Japan  
(2012/10/29~2013/12/25)

HTS System as a part of substation

Electricity Enterprises Law

## Ishikari DC Cable PJ

METI, Chiyoda Corporation, Sakura Internet,  
Chubu University, Sumitomo Electric



500m DC cable between PV and  
data center

1km isolated cable on the ground



石狩湾新港地域

- Licensed chief engineer of electric technology

**OK**

- Safety regulation of each equipment (or place where electric equipment is used : ex. Substation) should be determined by the operator and report to the authority.

**OK**

- Compliance of the technical standard

**There are no technical standard of HTS cable.**

**Especially, safety against the high pressure gas**

In Japan, discussion about safety regulation has started and technical report will be issued soon.