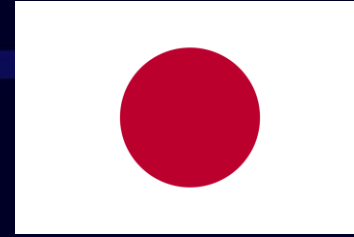


Paris Session
2022



Installation of rapeseed oil transformers for environmentally benign substation

SC A2
PS2 / Q.5

Kazuhiro.SHIBATA, Japan



Kansai Transmission and Distribution

Question and our contribution

Question PS2.5

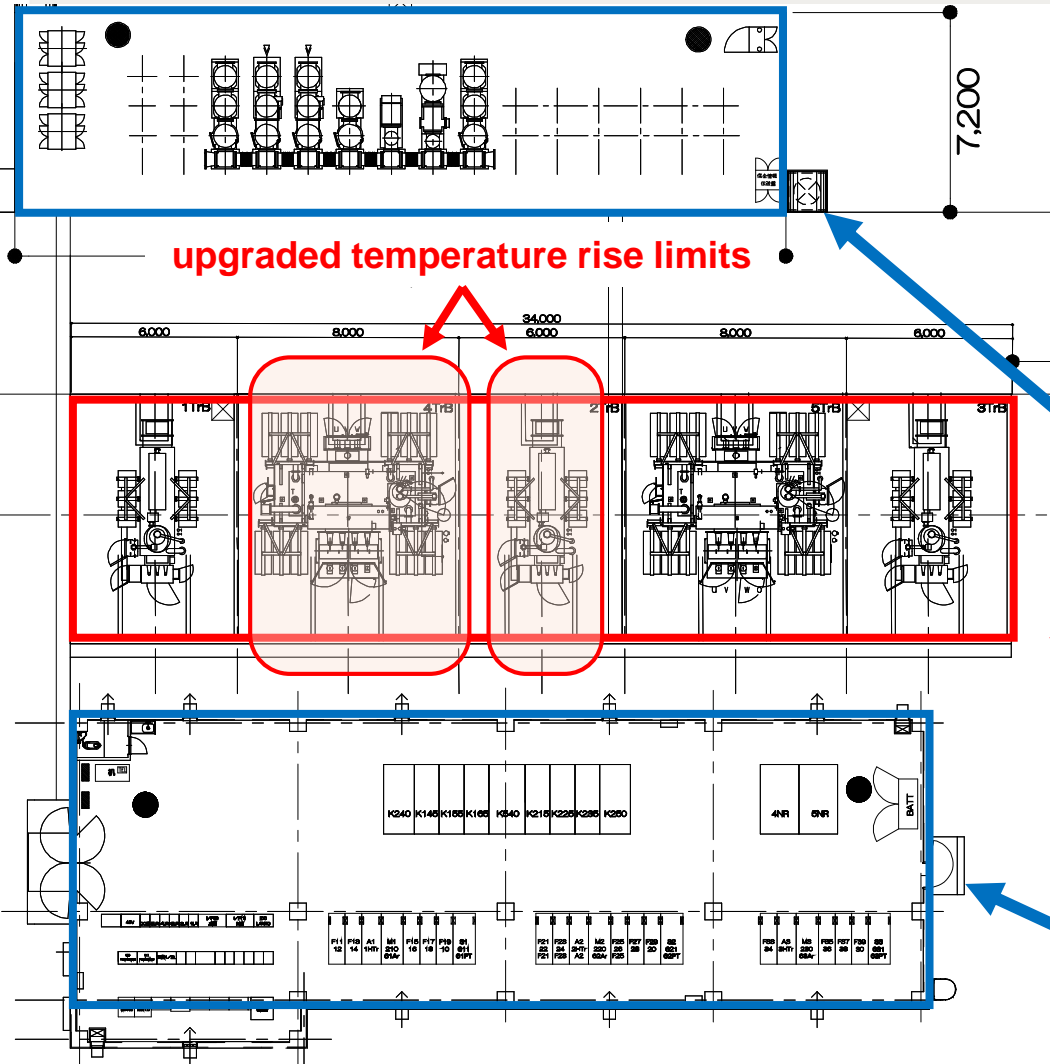
There seem to be conflicting opinions concerning the use of some alternative transformer technologies at higher temperatures, especially ester-immersed transformers. What is **the experience of using alternative transformer technologies at higher temperatures** ? What **further work** is needed on this subject ?

Answer

- ✓ ***The experience of using alternative transformer technologies at high temperatures***
 - The natural ester (rapeseed oil) immersed transformers will be installed in a new substation.
 - The expected lifetime of the transformer can be the same even if the operating temperature is higher in natural ester oil transformers than in mineral oil transformers.
 - By upgraded temperature rise limits, it is possible to reduce the number of radiators and make it more compact.
- ✓ ***Further work***
 - To further upgrade the temperature rise limits, use inexpensive insulators with high heat resistance.

Group Discussion Meeting

Installation of rapeseed oil transformers



- Of the five ester oil (rapeseed oil) transformers, three are compliant with the Japanese Electrotechnical Committee (“JEC-2200-2014”) standards and two are upgraded temperature rise limits compared to the JEC standards.
- Since this was the first time to install transformers that exceeded the temperature rise limits specified by JEC standards, one each of 77/22kV and 77/6.6kV transformer upgraded temperature rise limits was installed on a trial basis.

Gas-Insulated Switchgear (GIS)

natural ester oil (rapeseed oil) transformers

- JEC : 3 transformers
- **Upgraded temperature rise limits : 2 transformers**

switchgear, relay panels, control panels, etc.

Figure 1. Equipment layout plan of new substation (E-SSS*)

Characteristics of rapeseed oil transformer

- High flash point (322°C) and flame retardant.
- High biodegradability (89%) reduces environmental risk in case of oil leakage.
- The saturated water content is about 10 times that of mineral oil and rapeseed oil easily absorbs the water in the insulating paper, which has the effect of suppressing the deterioration of the insulating paper.
- Rapeseed oil is less expensive than soy oil and can be produced in Japan.
- Care should be taken due to high water absorption content and kinematic viscosity.

Table 1. Properties of vegetable-derived insulating oil

Classification		Natural Ester	Vegetable Oil Ester	Low Viscosity Silicone	Mineral Oil	
Name		Rapeseed Oil	Soy Oil	Palm Fatty Acid Ester		PDMS
Flash Point (COC)	°C	322	330	176	260	148
Fire Point (COC)	°C	360	360	-	-	160
Kinematic Viscosity	mm ² /s(40°C)	35	34	5	16	8
	mm ² /s(100°C)	8	8	2	7	2
Biodegradability	% (28 days)	89	100	77	-	0.13
Water Content	ppm	~ 1000	-	-	-	≤ 100

Application of transformers with upgraded temperature rise limits

- There are eased criteria (oil : 70K, winding : 75K) for the temperature rise limits of transformers than JEC standards (Figure 2).
- According to IEC 60076-14:2013, natural ester/thermally upgraded paper system can be upgraded by 20.6K in the temperature rise limits if they are expected to have the same lifetime as mineral oil.
- The temperature rise limits of transformers were determined so that the total cost of the transformer would be the lowest.
- By upgrading the temperature rise limits, the number of radiators can be reduced (Figure 3).

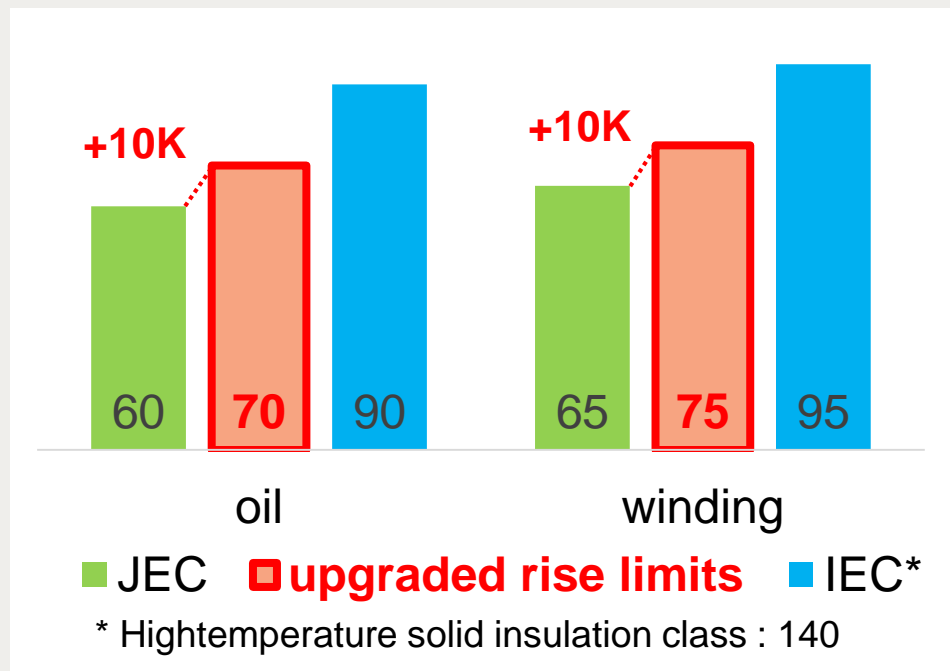


Figure 2. Temperature rise limits [K]

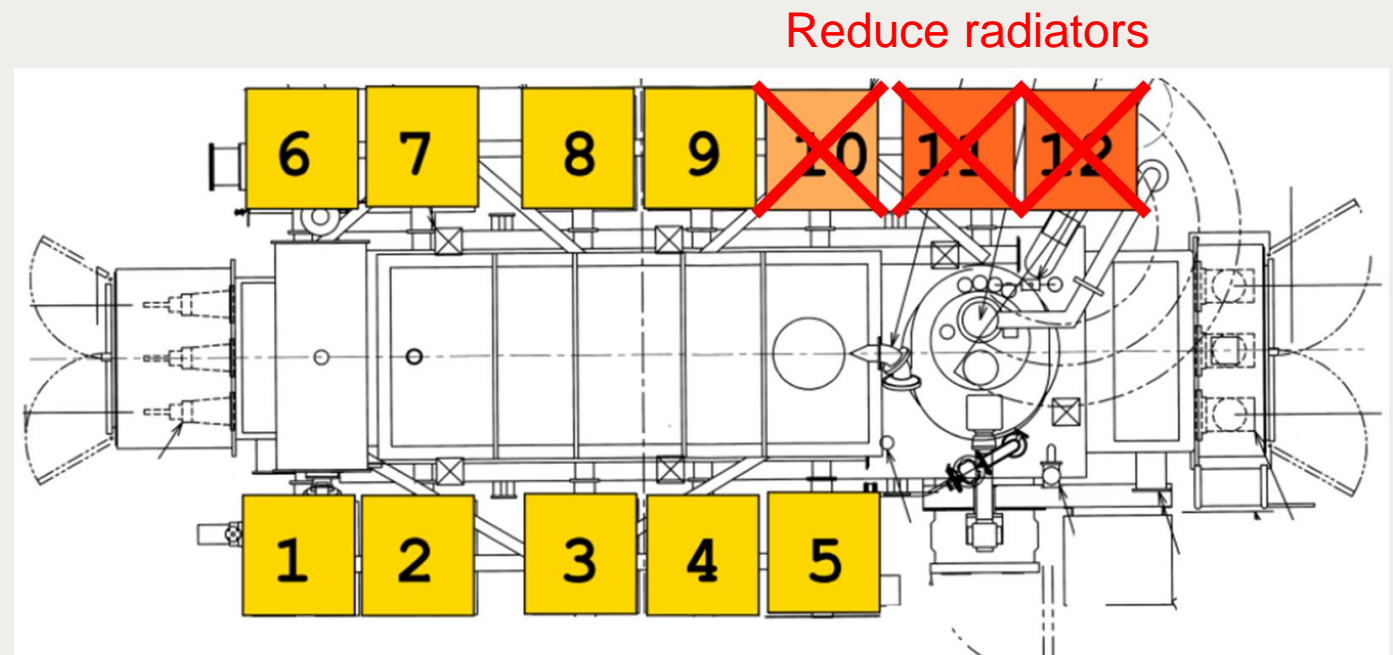


Figure 3. Transformer radiator with upgraded temperature rise limits (18.26MVA)