

**SUSITARIMAS NR. 3
DĖL 2021 M. GRUODŽIO 29 D. „NAUJŲ SINCHRONINIŲ KOMPENSATORIŲ
ĮRENGIMAS LIETUVOS EES“ PROJEKTAVIMO, GAMYBOS IR ĮRENGIMO
DARBŲ RANGOS SUTARTIES
NR. 21VP-SUT-244 PAKEITIMO**

Vilnius, 2022 m. gruodžio d. Nr.

LITGRID AB (toliau - **Užsakovas**), pagal Lietuvos Respublikos įstatymus įsteigta ir veikianti įmonė, juridinio asmens kodas 302564383, kurios registruota buveinė yra Karlo Gustavo Emilio Manerheimo g. 8, LT-05131 Vilnius, duomenys apie bendrovę kaupiami ir saugomi Lietuvos Respublikos juridinių asmenų registre, atstovaujama

[redacted] iš vienos pusės ir

tekėjų grupė, veikianti jungtinės veiklos sutarties pagrindu, susidedanti iš: **SIEMENS ENERGY OY LIETUVOS FILIALO**, juridinio asmens kodas 305427888, kurio registruota buveinė: J. Jasinskio g. 16C, LT-03163 Vilnius, duomenys apie bendrovę kaupiami ir saugomi Lietuvos Respublikos juridinių asmenų registre, ir **SIEMENS ENERGY GLOBAL GMBH & CO KG**, juridinio asmens kodas: HRA111200, registruota buveinė: Freyestebenstr. 1, 91058 Erlangen, Vokietija, duomenys apie bendrovę kaupiami ir saugomi Hanselsregister registre, atstovaujama direktoriaus Mindaugo Žilinsko, veikia

[redacted] (toliau

kartu - **Rangovas**), iš kitos pusės,

toliau Užsakovas ir Rangovas kartu vadinami Šalimis, o kiekvienas atskirai – Šalimi,

**AGREEMENT NO 3
FOR THE AMENDMENT TO THE CONTRACT 'DESIGN, MANUFACTURE AND
INSTALLATION WORKS OF THE INSTALLATION OF NEW SYNCHRONOUS
COMPENSATORS IN THE LITHUANIAN POWER SYSTEM' NO 21VP-SUT-244
OF 29 DECEMBER 2021**

_____ December 2022, Vilnius, No

LITGRID AB (hereinafter - **the Employer**), the company incorporated and operating in accordance with the laws of the Republic of Lithuania, legal entity code 302564383, registered office address Karlo Gustavo Emilio Manerheimo Str. 8, LT-05131 Vilnius, data about the company are collected and stored in the Register of Legal Entities of the Republic of Lithuania, represented

[redacted] on the one part, and

the group of suppliers, acting on the basis of the joint venture agreement, consisting of: **SIEMENS ENERGY OY LITHUANIAN BRANCH**, legal entity code 305427888, registered office address: J. Jasinskio Str. 16C, LT-03163 Vilnius, data about the company are collected and stored in the Register of Legal Entities of the Republic of Lithuania, and **SIEMENS ENERGY GLOBAL GMBH & CO KG**, legal entity code: HRA111200, registered office address: Freyesteben Str. 1, 91058 Erlangen, Germany, data about the company are collected and stored in the Hanselsregister, represented by

[redacted] the Contractor), on the other part,

hereinafter the Employer and the Contractor both together are referred to as the Parties, and each separately - as the Party,

ATSIŽVELGDAMOS Į TAI, KAD:

- a) Šalys 2021 m. gruodžio 29 d. sudarė „Naujų sinchroninių kompensatorių įrengimas Lietuvos EES“ projektavimo, gamybos ir įrengimo darbų rangos sutartį Nr. 21VP-SUT-244 (toliau – **Sutartis**);
- b) Vadovaujantis Bendrųjų ir Konkrečiųjų sutarties sąlygų 13.1 punktu, kuriame numatyta Pakeitimų tvarką ir sąlygos, kurios gali būti inicijuotos Užsakovo, Inžinieriaus ar Rangovo, bei 2022 m. lapkričio 24 d. Inžinieriaus išleistu nurodymu (toliau - **Nurodymas**);
- c) 2022 m. spalio 25 d. Rangovas, vadovaujantis Bendrųjų Sutarties sąlygų 13.2 punktu, atsiuntė pasiūlymą „Change request 01 SynCon and Flywheel Bearing shell temperature“ (toliau - **Pasiūlymas**), kuriame aprašė esamą situaciją, pasiūlė pakeisti techninį sprendinį, aprašė siūlomo sprendinio specifikaciją, nurodė įtaką projektui ir pateikė išvadas;
- d) Pasiūlymo išvadose Rangovas nurodė, kad kadangi Rangovas guoliams naudoja aukštesnės kokybės medžiagas, nei reikalaujama specifikacijoje, o šiuolaikinių alyvų ribos yra didesnės nei reikalaujama, Rangovas prašo pasiūlytą technologiją laikyti lygiaverte arba aukštesne nei nurodyta Užsakovo reikalavimuose;
- e) Inžinierius įvertino ir patvirtino Rangovo Pasiūlymą kaip technologiškai galimą ir priimtina, bei išleido 2022 m. lapkričio 24 d. nurodymą.
- f) Vadovaujantis Sutarties 10 punktu, *Sutarties sąlygos sutarties galiojimo laikotarpiu gali būti keičiamos tik laikantis Lietuvos Respublikos pirkimų, atliekamų vandentvarkos, energetikos, transporto ar pašto paslaugų srities perkančiųjų subjektų, įstatymo 97 punkto reikalavimų (toliau - Pirkimų įstatymas)*;
- g) Vadovaujantis Pirkimų įstatymo 97 straipsnio 1 dalies 5 punktu, Sutartis jos

WHEREAS:

On 29 December 2021, the Parties have entered into the ‘Design, manufacture and installation works of the installation of new synchronous compensators in the Lithuanian power system’ Works Contract No 21VP-SUT-244 for design, manufacture and installation works (hereinafter - **the Contract**);

In accordance with Clause 13.1 of the General and Particular Conditions of the Contract, which stipulates the procedure and conditions of Variations, Variations may be initiated by the Employer, the Engineer or the Contractor. and 24 November 2022 by the order issued by the Engineer (hereinafter - **the Instruction**).

On 25 October 2022 the Contractor sent pursuant to Clause 13.2 of the General Conditions of the Contract a proposal "Change request 01 SynCon and Flywheel Bearing shell temperature" (hereinafter - **the Proposal**), which described the current situation, suggested changing the technical solution, described the specification of the proposed solution, indicated the impact on the project and presented conclusions;

In the conclusions of the Proposal , the Contractor stated that since the Contractor uses higher quality material for bearings than have been requested by specification and as limits of the modern oils are higher than requested, the Contractor requested to consider offered technology as equivalent or higher than specified by the Employer’s Requirements.

The Engineer evaluated and approved the Contractor’s Proposal that the proposed change is technologically suitable and acceptable and issued an instruction on 24 November 2022.

In accordance with Clause 10 of the Contract, *during the term of the Contract, the terms of the Contract can be changed only in accordance with the requirements set out in the Point No. 97 of the Republic of Lithuania Law on Procurement, performed by the entities, operating in the field of Wastewater Management, Energy, Transport or Postal Services (hereinafter - **the Procurement Law**)*;

In accordance with Article 97 Paragraph 1 section 5 of the Procurement

galiojimo laikotarpiu gali būti keičiama neatliekant naujos pirkimo procedūros, kai pakeitimas, neatsižvelgiant į jo vertę, nėra esminis;

Šalys sudarė šį susitarimą dėl Sutarties pakeitimo (toliau – Susitarimas), kuriuo susitarė:

1. Rangovo Pasiūlyme pasiūlytą technologiją laikyti lygiaverte arba aukštesne nei nurodyta Užsakovo reikalavimuose ir siūlomą pakeitimą laikyti technologiškai tinkamu ir priimtiniu.
2. Pakeisti Sutarties priedo „Užsakovo reikalavimai“ 1 priedo „Sinchroninių kompensatorių techninės specifikacijos C0012677“ punkto 11.3.5 „Guoliai“ tekstą iš „Darbinio paviršiaus temperatūra, matuojant įmontuotais varžos termometrais, neturi viršyti 90 ° C.“ į „Darbinio paviršiaus temperatūra, matuojant įmontuotais varžos termometrais, neturi viršyti 111 ° C.“.
3. Kitos Sutarties sąlygos nekeičiamos ir lieka galioti visa apimtimi.
4. Visus Šalių tarpusavio santykius, atsirandančius iš Susitarimo ir neaptartus jo sąlygose, reglamentuoja Sutartis ir Lietuvos Respublikos teisės aktai.
5. Susitarimas įsigalioja ir tampa neatskiriama Sutarties dalimi nuo dienos, kai abi Šalys jį pasirašo.
6. Susitarimas pasirašytas Šalių kvalifikuotais elektroniniais parašais.
7. Susitarimo priedas yra neatskiriama šio Susitarimo dalis. Prie Susitarimo pridedama:
 - 7.1. 2022 m. spalio 25 d. Rangovo Pasiūlymas „Change request 01 SynCon and Flywheel Bearing shell temperature“.
 - 7.2. 2022 m. lapkričio 24 d. Inžinieriaus išleistas nurodymas.
Pirkėjo vardu / On behalf of the Employer:

Law, the Contract may be changed during its validity period without conducting a new procurement procedure, when the change, regardless of its value, is not essential;

The Parties have entered into this Agreement on the amendment to the Contract (hereinafter - the Agreement), whereby they have agreed:

To consider the technology, proposed in the Contractor's Proposal as equivalent or superior to that specified in the Employer's Requirements and to consider the proposed change as technologically suitable and acceptable.

To change Employer's Requirements Annex 1 "Technical specifications of synchronous compensators C0012677" Article Nr.11.3.5 "Bearings" Paragraph "The operating surface temperatures shall not exceed 90°C, measured by embedded RTDs" and change as follows: "The operating surface temperatures shall not exceed 111°C, measured by embedded RTDs".

Other terms of the Contract are not changed and they shall remain valid in their entirety.

All and any relationships between the Parties arising out of the Agreement and not covered by its terms are regulated by the Contract and by the legal acts of the Republic of Lithuania.

The Agreement shall enter into force from the date in which it is signed by both Parties and shall become an integral part of the Contract.

The Agreement has been signed with the qualified electronic signatures of the Parties.

Annex to the Agreement is an integral part of this Agreement. The following documents are enclosed to the Agreement:

The Contractor's Proposal "Change request 01 SynCon and Flywheel Bearing shell temperature" dated 25 October 2022.

The instruction issued by the Engineer dated 24 November 2022.

Pardavėjo vardu / On behalf of the Contractor:



(parašas / signature)



(parašas / signature)

Change request 01

SynCon and Flywheel Bearing shell temperature

Contract No. 21VP-SUT-244

Substations Alytus, Telšiai, Neris
Synchronous Condenser project

by

Siemens Energy Oy Lithuanian Branch

and

Siemens Energy Global GmbH & CO KG

Index of Revisions

Rev.	Date	Revisions	Originator	Reviewer	Approver
00	Jul 15, 2022	First Issue			
01	Oct 25, 2022	Average Bearing Shell Temp added (table 1 and Section 2). Editorial changes.			

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1. Current situation

Siemens Energy (SE) offered standard bearing solution for generators in this class. It is result of many years of experience and product development to offer their customers a cost efficient and a state-of-the-art product.

Requirement:

According to “C0012677 Synchronous Condenser Technical Specification” chapter 11.3.5 “Bearings”: “The operating surface temperatures shall not exceed 90°C, measured by embedded RTDs”.

Offered solution:

The advanced method of bearing calculation demonstrates with regards of temperatures the following results (the 4 individual bearings have individual values but with very small spreading of app. 1 K and maximum values are shown here).

Table 1: Calculated bearing and oil temperatures

Item	value (max. of 4 individual bearings)	unit	Rev
Oil inlet temperature (input value)	50	°C	
Max. oil film temperature	112	°C	
Max. bearing shell temperature (hot spot)	111	°C	01
PT-100 (thermometer) temperature	102	°C	
Average oil film temperature	74	°C	
Average bearing shell temperature	74	°C	01
Oil outlet temperature	72	°C	

For illustration of the above calculated temperature values see figure 1 and figure 2.

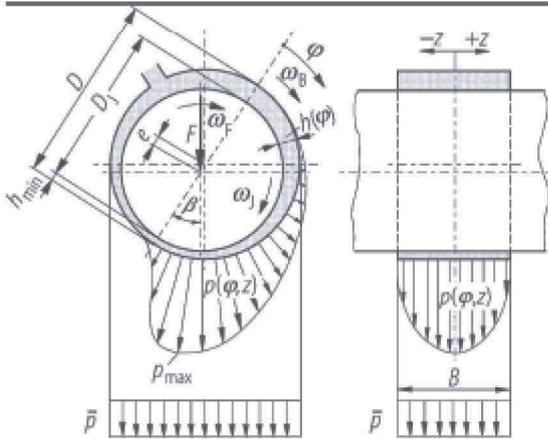


Figure 1: Principal pressure (temperature) distribution in a slide bearing (steady state in operation)

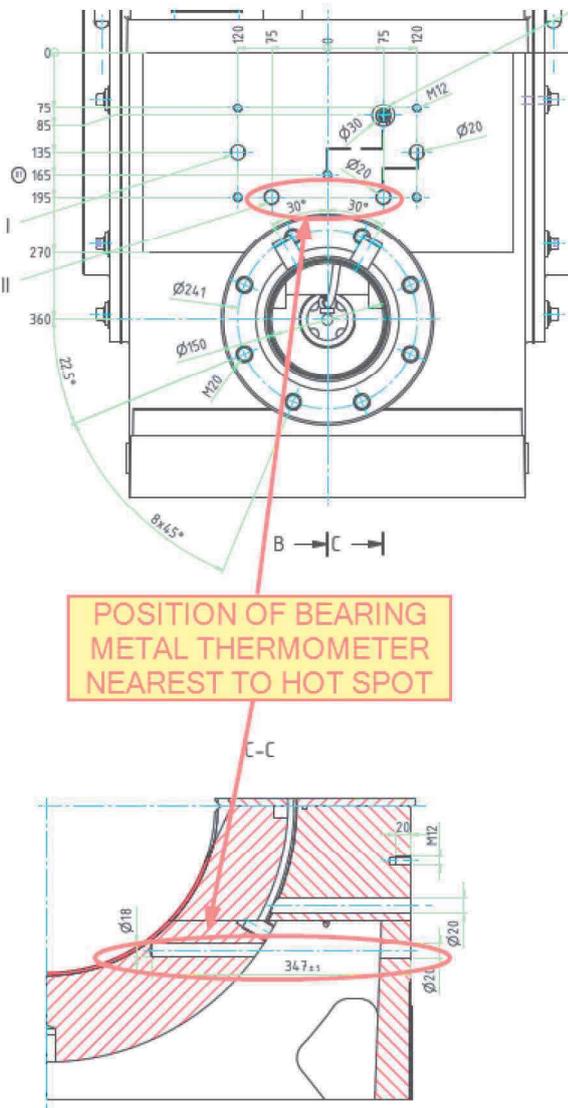


Figure 2: Location of bore holes for bearing thermometers in the bearing housing (from bearing drawing)

2. Specification of the offered solution

Siemens Energy uses for Synchronous Condenser and Flywheel its standard and proven bearing technology solution from GTW (Gleitlagertechnik Weissbacher GmbH).

Measurement method):

According to C0012677 Synchronous Condenser Technical Specification, the operating surface temperatures of the bearings shall not exceed 90°C. Customer's specification refers to a measuring method using RTD (resistance temperature detector) with unspecific depth and unspecific contact in the bearing shell.

Recommendations according to manufacturer's manual are:

- 80°C if thermometer (simple model) measures the oil drain temperature only
- 110°C if the thermometer (advanced model) is placed with unspecific depth but with metallic contact to the bearing shell
- 125°C if the thermometer (advanced model) is placed with max. 3 mm distance to the location of temperature maximum and with metallic contact

The advanced calculation method of GTW allows to determine the maximum bearing shell temperature very accurate (by value and location). With placing the bore hole for the thermometer nearest to the calculated location one prerequisite is fulfilled in order to classify the Siemens Energy proven design in the 125°C category. The over prerequisite is fulfilled by using advanced model thermometers (triplex PT100 elements WQ232 in 4 wire connections).

The max. bearing shell temperature is calculated by advanced methods for each bearing individually.

The Siemens Energy and bearing manufacturer standard is in accordance with general standard for sleeve bearings DIN 31657-4.

4 Betriebsrichtwerte zur Vermeidung thermischer und mechanischer Überbeanspruchung

Im Nennbetrieb bei $h_{\min} \gg h_{\lim, \text{tr}}$ treten Maximalwerte von Druck und Temperatur in den Gleitflächen auf, die von den eingesetzten Werk- und Schmierstoffen im Dauerbetrieb ohne Schädigung aufgenommen werden müssen.

Die Festigkeit der Lagerwerkstoffe ist abhängig von der Temperatur. Deshalb können die Grenzwerte p_{\lim} für den Nennbetrieb (siehe Tabelle 1) nur in Abhängigkeit vom Grenzwert T_{\lim} für die maximale Schmierfilmtemperatur gegeben werden.

Tabelle 1

Lagerwerkstoff-Gruppe ^{*)}	p_{\lim} (bei T_{\lim}) N/mm ²
Blei-Legierungen Zinn-Legierungen	16 (100 °C) bis 25 (50 °C) 25 (130 °C) bis 40 (50 °C)
Kupferlegierungen (Bronzen)	25 (150 °C) bis 50 (50 °C)
*) Werkstoffe siehe DIN ISO 4381, DIN ISO 4382-1, DIN ISO 4382-2 und DIN ISO 4383	

Below translation from ISO/TS 31657-4:

5 Operational guide values for avoiding thermal and mechanical overloading

In nominal operation at $h_{\min} \gg h_{\lim, \text{tr}}$ maximum value of pressure and temperature occur on the sliding surfaces, which must be tolerated by the materials and lubricants used in continuous operation without damage.

The strength of the bearing materials depends on the temperature. Therefore, the limit values, p_{\lim} , for the nominal operation (see Table 1) can only be given in relation to the limit value, T_{\lim} , for the maximum lubricant film temperature.

Table 1 — Temperature-dependent maximum admissible lubricant film pressure for different bearing materials

Bearing material group ^a	p_{\lim} (at T_{\lim}) N/mm ²
Lead alloys	16 (100 °C) to 25 (50 °C)
Tin alloys	25 (130 °C) to 40 (50 °C)
Copper alloys (bronzes)	25 (150 °C) to 50 (50 °C)
^a For materials, see ISO 4381, ISO 4382-1, ISO 4382-2 and ISO 4383.	

Babbitt material

The used babbitt material is GTW 81 ZnAg (Ecka Tegostar Therm 81 Ag) which has Sn (tin) as base material:

Chemische Zusammensetzung [%]	Bezeichnung					
	GTW 89 LgSn89 Auto 99 Tegotenax	GTW 80 LgSn80 WM 80	GTW V80 LgSn80Cd Ergon 751 Tego V738	GTW V 90 LgSn88Cd Auto 90R Tegotenax S	GTW V6 LGPbSnCd Glycotherm Thermit	GTW 81 ZnAg Ecka Tegostar Therm 81Ag
Sn	Basis	Basis	Basis	Basis	5-7	Basis
Sb	7-8	11-13	11-13	7-8	13-16	11-13
Cd	≤ 0,01	≤ 0,8	1-1,6	0,6-1,2	0,8-1,2	≤ 0,03
As	≤ 0,06	≤ 0,8	0,3-0,7	≤ 0,2	0,3-0,7	≤ 0,06
Ag	-	-	-	-	-	0,05-0,15
Bi	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,06
Zn	≤ 0,02	≤ 0,02	≤ 0,02	≤ 0,02	≤ 0,02	0,3-0,7
Cu	3-4	5-7	5-6	3-4	0,8-1,4	5,5-6,5
Ni	≤ 0,06		0,2-0,5	0,1-0,3	0,2-0,8	≤ 0,06
Fe	≤ 0,05	≤ 0,1	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,03
Pb	≤ 0,15	≤ 3	≤ 0,15	≤ 0,15	Basis	≤ 0,06
Al	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01
Sonstige	≤ 0,2	≤ 0,5	≤ 0,2	≤ 0,2	≤ 0,2	≤ 0,2

According to the Sn base of the material a limit of 25 MPa and 130°C is permissible according to DIN 31657-4. Siemens Energy confirms that these limits are not exceeded in operation. Please note that the 2-stage setting values for alarm are 5K resp. 10K above the calculated value and therefore also within the 130C (125C) limit. Please be informed furthermore that the 0,2% offset yield strength for GTW81ZnAg is app. 50 MPa (@calculated babbitt temperature, safety factor min. 2) and the lowest melting point is 235C and the highest melting point is 360C.

This philosophy for state-of-the-art bearing design is proven practice for Siemens Energy and his bearing suppliers since many years and a lot of machines in the field.

Rev01: It is assumed that the Technical Specification meant the average bearing shell temperature (see table 1). According to the calculation, this temperature corresponds to the average oil film temperature and is almost the same to the oil drain temperature. The temperature at the measuring point for the bearing metal shows a higher value, which comes closest to the hot spot value (hot spot value can only be determined by calculation). The average value of the bearing (shell) metal temperature corresponds to the specification (smaller than 90degC).

Lube Oil

Last but not least Siemens Energy will use lube oil according to SE standard TLV 901305 (many mineral oil suppliers give approval to this Siemens Energy standard) which permit 130°C for max. contact temperature of the oil and max. 80°C for average drain temperature of the lube oil. As explained above

the calculated max. contact temperature has a margin of nearly 20 K (regarding the permissible 130°C according to DIN) resp. 15 K (regarding the permissible 125°C according to GTW standard). The oil drain temperatures for the individual bearings are calculated to 71°C ... 77°C). Permanent installed and monitored oil drain thermometers are foreseen in order to verify the prediction.

Oil viscosity class ISO VG 32 is used in accordance with DIN ISO 3448. Only turbine oils shall be used which have been approved with Technical Purchasing Specification TLV/TPS 9013 05. Such are mineral oils on a paraffin basis, containing additives to increase protection against corrosion and resistance to aging.

Test Criteria		Value	Unit	DIN Test	ASTM Test
Air-separation ability at 50 °C	max.	5	min	DIN ISO 9120	D3427
Neutralization number	max.	0.20	mgKOH/g	51558	D974
Water content	max.	0.1	weight-%	51777	D1744
Foam behavior at 25 °C					
Foam formation	max.	400	cm ³	-	D892
Foam stability 0 cm ³	max.	450	s		
Water-separation ability	max.	300	s	51589	-
Kinematic viscosity at 40 °C	min. max.	28.8 35.2	mm ² /s (cSt)	53019	D445
Density at 15 °C	max.	0.900	g/cm ³	51757	D1298
Flash point	min.	160	°C	ISO 2592	D92
Pour point, equal to or lower than		-5	°C	ISO 3016	D97
Degree of purity according to ISO 4406	min.	17/15/12	Code	ISO 4406	-
De-emulsification capability	max.	20	min.	DIN ISO 6614	D1401
Color	max.	2	-	ISO 2049	D1500
Corrosive effect on copper	max.	2-100A3	-		
Corrosive effect on steel	max.	O-B	-		
Aging behavior					
Increase of neutralization number after 2500 h	max.	2.0	mgKOH/g	51587	D943

Siemens-Energy strictly recommend using turbine oil according to TLV/TPS 901305. In order to make it easy for the customer to choose an appropriate brand the TLV/TPS 901305 has an approval list of many brands with high availability by vendors worldwide.

3. Impact on project and operation

The offered technology is Siemens Energy standard technology for generators in this class. It is result of many years of experience and product development to offer their customers a cost efficient and a state-of-the-art product.

Considering mentioned facts, our state-of-the-art technology will ensure cost efficient operation for Litgrid.

As stated in this document, the temperature margin of the babbitt material and the appropriate oil is suitable for state-of-the-art temperature level. The use of an approved brand of turbine oil makes it possible to have long lasting periods of oil exchange driven by samples and not by fixed hours. This lowers the operating costs for the customer This combination lowers friction losses in the bearing and leads to lower operating cost than operating bearings with lower temperatures but higher friction losses due to higher friction coefficient at lower temperature.

This variation (above described and offered solution) will not affect time schedule nor cost.

4. Conclusion

As Siemens Energy uses higher quality material for babbitts than have been requested by specification and as limits of the modern oils are higher than requested, Siemens Energy request to consider offered technology as equivalent or higher than specified by Litgrid specification.

To: Siemens Energy Oy Lithuanian Branch

22/11/2022 No.



LITGRID AB



VARIATION ORDER NO. 1 UNDER THE CONTRACT NO. 21VP-SUT-244

LITGRID AB (hereinafter – **Employer**) and the group of suppliers acting on the basis of the joint activity contract, Siemens Energy Oy Lithuanian branch and Siemens Energy Global GmbH & Co KG (hereinafter – **Contractor**) concluded a contract No. 21VP-SUT-244 ‘Design, Manufacture and Installation Works of the Installation of New Synchronous Compensators in the Lithuanian Power System’ (hereinafter – **Contract**) on the 29th of December 2021.

On 19th of July 2022, the Contractor submitted a letter No 22GD-3222 “Change request 01: bearing shell temperature for synchronous condenser and flywheel“, which contains a proposal to change the bearing temperature provided for in the Employer’s Requirements. The Engineer informed the Contractor by the letter No 22SD-3411 of 12th of August 2022 that the requirement submitted by the Contractor does not meet the provisions of Chapter 13 [Amendments and Corrections] of the General and Particular Terms of the Contract, and requested to provide additional information and fully prepared E3 book of the technical design, in which information related to the bearing temperature is indicated. The Contractor on 31st of August 2022 by the letter No 22GD-3722 of provided additional information needed for the variation. The Engineer on 22th of September 2022 by letter No. 22SD-3858 have informed the Contractor that the requirement for bearing temperature, which has been submitted in variation request, was not included in E3 book of the technical design, and that this information is necessary to make a decision according to the Clause 3.5 of the General and Particular conditions of the Contract, also instructed the Contractor to provide the E3 book which would be approved by the Employer. On 10th of October 2022, the Contractor provided the final iteration of E3 book for the Employer’s review and approval. On 10th of November 2022, the Engineer received the Employer’s approval of the variation proposal (document No 22S-KDD-334). On 11th of November 2022, the Engineer received conclusions of the technical consultant (CESI) of the Employer regarding the variation of bearing temperature proposed by the Contractor,

which says that proposed bearing material and expected temperature rise quoted are better than what was specified in Employer's Requirements.

In accordance with the provisions of Sub-Clause 3.5 of the General and Particular Conditions of the Contract, Engineer evaluated:

1. Contractor's variation request (Annex 1), dated 31st of August 2022;
2. Conclusion of the Employer's consultant (CESI), regarding the proposed variation, dated 11th of November 2022;
3. Employer's approval of the proposed variation dated of 10th of November 2022,

and made a decision:

It is necessary to change Employer's Requirements for a bearing temperature of 90°C, set in the Technical Specifications for Synchronous Condensers C0012677point 11.3.5 "Bearings" of the Technical Specification <... The operating surface temperatures shall not exceed 90°C, measured by embedded RTDs...> to 111°C (complete information is included in Annex 1).

By making a decision regarding this variation, the Engineer confirms that the possibility of changing the Employer's Requirements has been provided for in the Contract, and the variation have been assessed in accordance with the provisions of Sub-Clause 13.1 [Right to Vary] of the General and Particular Conditions of the Contract:

- "Variations may be made only in case if (vi) the Contractor furnishes the Employer with a written proposal the implementation of which would expedite completion of the Works or decrease the costs of performance, maintenance or operation of the Works result incurred by the Employer or would increase the efficiency and value of the accomplished Works or would be otherwise useful to the Employer";
- "Variations may include the following issues (the list is non-exhaustive): (a) amendment of the Employer's Requirements, however, in so far as such a variation does not alter the general nature of the Contract; (d) change of the nature of the Works, quality or characteristics of the Works, the Materials or the Plant; "
- "Variations may be carried out for the following reasons (the list is non-exhaustive): (a) inability to use the Materials and/or the Plant indicated in the Contract due to the circumstances beyond control of the Contractor (for example, are not manufactured or supplied in the market any longer) or replacement of the Materials and/or the Plant by similar Materials and/or the Plant which must meet the Employer's Requirements and be of the quality not lower than indicated in the Tender and be characterised by performance not lower than indicated in the Tender;"
- "The Contract shall provide the possibility for making Variations so that the Employer willing to achieve the necessary purpose for which the Contract was concluded avoided the need for conclusion of a new contract with the Contractor or another contractor and, consequently, incur additional costs of purchase of new

works, possible increase in the prices, delay or problems which may be caused by the work of several contractors in one project, limitation of their responsibility and workmanship warranties”

By this decision, Engineer confirms that this variation does not create conditions for the change in the Contract price.

By this decision, Engineer confirms that this variation does not affect the deadline for the completion of the Contract work and it remains unchanged.

Considering the above information, Engineer in accordance with the Sub-Clause 3.5 of the General and Particular Conditions of the Contract determinates, to make the change of the Contract. The Parties shall enter into an additional agreement for formalization of this variation according to the terms set in the Contract.

ENCLOSED:

Annex 1 - Change request 01: bearing shell temperature for synchronous condenser and flywheel No 22GD-3722;

FIDIC Engineer



Litgrid AB
Project Litgrid SynCon

Karlo Gustavo Emilio Manerheimo g. 8,
LT-05131 Vilnius
Lithuania

Name
Department

Mob.telephone

E-mail

Your Contract
Our reference
Date

21VP-SUT-244
P-020063
30.08.2022

21VP-SUT-244

Project Litgrid Synchronous Condenser Change request 01: bearing shell temperature for synchronous condenser and flywheel

Dear [REDACTED],

with reference to the Notice "220715_LitSC_CR01_bearing shell temperature" of Siemens Energy Oy Lithuanian Branch and Siemens Energy Global GmbH & Co KG (hereinafter: Contractor) dated 19 July 2022 and to the answer of LITGRID AB (hereinafter: Employer) and [REDACTED] (hereinafter: Engineer) "ANSWER TO THE CHANGE REQUEST 01" dated 12 August 2022, the Contractor would like to respond as follows:

The Engineer pointed out, that the submitted documents submitted by the Contractor "Change request 01: bearing shell temperature for synchronous condenser and flywheel" do not meet the requirements set out in Clause 13 of the General Conditions of the Contract. Pursuant to Sub-Clause 13.1 of the Particular Conditions of the Contract Variations may be initiated only if one of the requirements determined in 13.1 of the Particular Conditions in the Contract are met. The Contractor would like to point out, that the proposed Variation is useful to the Employer, so that the requirement to initiate a Variation according to Sub-Clause 13.1 (vi) of the Particular Conditions of the Contract is fulfilled.

Furthermore, the Contract requires according to Sub-Clause 13.3 of the General Conditions of the Contract

- a) a description of the proposed design and/or work to be performed and a programme for its execution,
- b) the Contractor's proposal for any necessary modifications to the programme according to Sub-Clause 8.3 [Programme] and to the Time for Completion, and
- c) the Contractor's proposal for adjustment to the Contract Price.

The Contractor already submitted a detailed description of the proposed Variation (see proposal "220715_LitSC_CR01_bearing shell temperature" dated 19 July 2022). The Engineer also required the technical design book E3 (Electrotechnical part. SC's equipment) which is essential to understand the technical solution. The Contractor submitted the technical design book E3 on 19.08.2022 (see iTwo communication "P-020063 - SAG-LITGRID-DT-00190 - Elektrotechnical part. SC's equipment").

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As already pointed out in Contractor's proposal on 19 July 2022 (see "220715_LitSC_CR01_bearing shell temperature") the variation will not affect the time schedule nor the costs.

Consequently, the Contractor provided all necessary information as stipulated in the Contract and by the Engineer. If the Engineer needs still more information for the evaluation of Contractor's proposal, please submit in detail which information is missing.

Sincerely yours,

On behalf on Consortium

Siemens Energy Oy Lithuanian branch

i.V. Signature	Signature
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Change request 01

SynCon and Flywheel **Bearing shell temperature**

Contract No. 21VP-SUT-244

Substations Alytus, Telšiai, Neris
Synchronous Condenser project

by

Siemens Energy Oy Lithuanian Branch

and

Siemens Energy Global GmbH & CO KG

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1. Current situation

Siemens Energy offered standard bearing solution for generators in this class. It is result of many years of experience and product development to offer their customers a cost efficient and a state-of-the-art product.

Requirement:

According to “C0012677 Synchronous Condenser Technical Specification” chapter 11.3.5 “Bearings”:
“The operating surface temperatures shall not exceed 90°C, measured by embedded RTDs”

Offered solution:

The advanced Method of bearing calculation demonstrate with regards of temperatures the following results (the 4 individual bearings have individual values but with very small spreading of app. 1 K and maximum values are shown here).

Table 1: Calculated bearing and oil temperatures

Item	value (max. of 4 individual bearings)	unit
Oil inlet temperature (input value)	50	°C
Max. oil film temperature	112	°C
Max. bearing shell temperature	111	°C
PT-100 (thermometer) temperature	102	°C
Average oil film temperature	74	°C
Oil outlet temperature	72	°C

For illustration of the above calculated temperature values see figure 1 and figure 2.

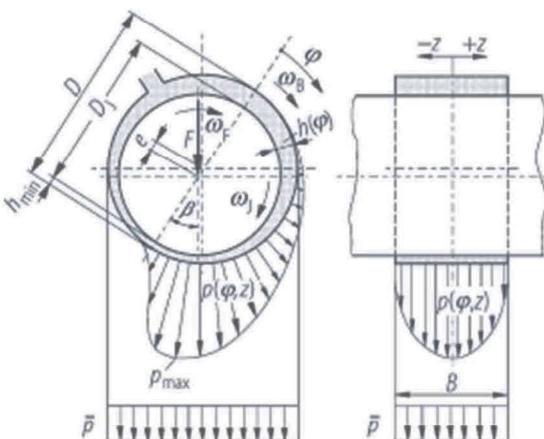


Figure 1: Principal pressure (temperature) distribution in a slide bearing (steady state in operation)

Recommendations according to manufacturer's manual are:

- 80°C if thermometer (simple model) measures the oil drain temperature only
- 110°C if the thermometer (advanced model) is placed with unspecific depth but with metallic contact to the bearing shell
- 125°C if the thermometer (advanced model) is placed with max. 3 mm distance to the location of temperature maximum and with metallic contact

The advanced calculation method of GTW allows to determine the maximum bearing shell temperature very accurate (by value and location). With placing the bore hole for the thermometer nearest to the calculated location one prerequisite is fulfilled in order to classify the Siemens Energy proven design in the 125°C category. The over prerequisite is fulfilled by using advanced model thermometers (triplex PT100 elements WQ232 in 4 wire connections).

The max. bearing shell temperature is calculated by advanced methods for each bearing individually.

The Siemens Energy and bearing manufacturer standard is in accordance with general standard for sleeve bearings DIN 31657-4.

4 Betriebsrichtwerte zur Vermeidung thermischer und mechanischer Überbeanspruchung

Im Nennbetrieb bei $h_{\min} \gg h_{\lim, tr}$ treten Maximalwerte von Druck und Temperatur in den Gleitflächen auf, die von den eingesetzten Werk- und Schmierstoffen im Dauerbetrieb ohne Schädigung aufgenommen werden müssen.

Die Festigkeit der Lagerwerkstoffe ist abhängig von der Temperatur. Deshalb können die Grenzwerte p_{\lim} für den Nennbetrieb (siehe Tabelle 1) nur in Abhängigkeit vom Grenzwert T_{\lim} für die maximale Schmierfilmtemperatur gegeben werden.

Tabelle 1

Lagerwerkstoff-Gruppe*)	p_{\lim} (bei T_{\lim}) N/mm ²
Blei-Legierungen	16 (100 °C) bis 25 (50 °C)
Zinn-Legierungen	25 (130 °C) bis 40 (50 °C)
Kupferlegierungen (Bronzen)	25 (150 °C) bis 50 (50 °C)
*) Werkstoffe siehe DIN ISO 4381, DIN ISO 4382-1, DIN ISO 4382-2 und DIN ISO 4383	

Below translation from ISO/TS 31657-4:

5 Operational guide values for avoiding thermal and mechanical overloading

In nominal operation at $h_{min} \gg h_{lim,tr}$ maximum value of pressure and temperature occur on the sliding surfaces, which must be tolerated by the materials and lubricants used in continuous operation without damage.

The strength of the bearing materials depends on the temperature. Therefore, the limit values, p_{lim} , for the nominal operation (see Table 1) can only be given in relation to the limit value, T_{lim} , for the maximum lubricant film temperature.

Table 1 — Temperature-dependent maximum admissible lubricant film pressure for different bearing materials

Bearing material group ^a	p_{lim} (at T_{lim}) N/mm ²
Lead alloys	16 (100 °C) to 25 (50 °C)
Tin alloys	25 (130 °C) to 40 (50 °C)
Copper alloys (bronzes)	25 (150 °C) to 50 (50 °C)

^a For materials, see ISO 4381, ISO 4382-1, ISO 4382-2 and ISO 4383.

Babbitt material

The used babbitt material is GTW 81 ZnAg (Ecka Tegostar Therm 81 Ag) which has Sn (tin) as base material:

Chemische Zusammensetzung [%]	Bezeichnung					
	GTW 89 LgSn89 Auto 90 Tegotemas	GTW 80 LgSn80 WM 80	GTW V80 LgSn80Cd Ergon 791 Tego V738	GTW V 90 LgSn88Cd Auto 90R Tegotemas 5	GTW V6 LgPbSn6Cd Glycotherm Thermit	GTW 81 ZnAg Ecka Tegostar Therm 81Ag
Sn	Basis	Basis	Basis	Basis	5-7	Basis
Sb	7-8	11-13	11-13	7-8	13-16	11-13
Cd	≤ 0,01	≤ 0,8	1-1,6	0,6-1,2	0,8-1,2	≤ 0,03
As	≤ 0,06	≤ 0,8	0,3-0,7	≤ 0,2	0,3-0,7	≤ 0,06
Ag	-	-	-	-	-	0,05-0,15
Bi	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,08	≤ 0,06
Zn	≤ 0,02	≤ 0,02	≤ 0,02	≤ 0,02	≤ 0,02	0,3-0,7
Cu	3-4	5-7	5-6	3-4	0,8-1,4	5,5-6,5
Ni	≤ 0,06		0,2-0,5	0,1-0,3	0,2-0,8	≤ 0,06
Fe	≤ 0,05	≤ 0,1	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,03
Pb	≤ 0,15	≤ 3	≤ 0,15	≤ 0,15	Basis	≤ 0,06
Al	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01	≤ 0,01
Sonstige	≤ 0,2	≤ 0,5	≤ 0,2	≤ 0,2	≤ 0,2	≤ 0,2

According to the Sn base of the material a limit of 25 MPa and 130°C is permissible according to DIN 31657-4. Siemens Energy confirms that these limits are not exceeded in operation. Please note that the 2-stage setting values for alarm are 5K resp. 10K above the calculated value and therefore also within the 130C (125C) limit. Please be informed furthermore that the 0,2% offset yield strength for GTW81ZnAg is

app. 50 MPa (@calculated babbitt temperature, safety factor min. 2) and the lowest melting point is 235C and the highest melting point is 360C.

This philosophy for state-of-the-art bearing design is proven practice for Siemens Energy and his bearing suppliers since many years and a lot of machines in the field.

Lube Oil

Last but not least Siemens Energy will use lube oil according to SE standard TLV 901305 (many mineral oil suppliers give approval to this Siemens Energy standard) which permit 130°C for max. contact temperature of the oil and max. 80°C for average drain temperature of the lube oil. As explained above the calculated max. contact temperature has a margin of nearly 20 K (regarding the permissible 130°C according to DIN) resp. 15 K (regarding the permissible 125°C according to GTW standard). The oil drain temperatures for the individual bearings are calculated to 71°C ... 77°C). Permanent installed and monitored oil drain thermometers are foreseen in order to verify the prediction.

Oil viscosity class ISO VG 32 is used in accordance with DIN ISO 3448. Only turbine oils shall be used which have been approved with Technical Purchasing Specification TLV/TPS 9013 05. Such are mineral oils on a paraffin basis, containing additives to increase protection against corrosion and resistance to aging.

Test Criteria		Value	Unit	DIN Test	ASTM Test
Air-separation ability at 50 °C	max.	5	min	DIN ISO 9120	D3427
Neutralization number	max.	0.20	mgKOH/g	51558	D974
Water content	max.	0.1	weight-%	51777	D1744
Foam behavior at 25 °C					
Foam formation	max.	400	cm ³	-	D892
Foam stability 0 cm ³	max.	450	s		
Water-separation ability	max.	300	s	51589	-
Kinematic viscosity at 40 °C	min.	28.8	mm ² /s	53019	D445
	max.	35.2	(cSt)		
Density at 15 °C	max.	0.900	g/cm ³	51757	D1298
Flash point	min.	160	°C	ISO 2592	D92
Pour point, equal to or lower than		-5	°C	ISO 3016	D97
Degree of purity according to ISO 4406	min.	17/15/12	Code	ISO 4406	-

Test Criteria		Value	Unit	DIN Test	ASTM Test
De-emulsification capability	max.	20	min.	DIN ISO 6614	D1401
Color	max.	2	-	ISO 2049	D1500
Corrosive effect on copper	max.	2-100A3	-		
Corrosive effect on steel	max.	O-B	-		
Aging behavior Increase of neutralization number after 2500 h	max.	2.0	mgKOH/g	51587	D943

Siemens-Energy strictly recommend using turbine oil according to TLV/TPS 901305. In order to make it easy for the customer to choose an appropriate brand the TLV/TPS 901305 has an approval list of many brands with high availability by vendors worldwide.

3. Impact on project and operation

The offered technology is Siemens Energy standard technology for generators in this class. It is result of many years of experience and product development to offer their customers a cost efficient and a state-of-the-art product.

Considering mentioned facts, our state-of-the-art technology will ensure cost efficient operation for Litgrid.

As stated in this document, the temperature margin of the babbitt material and the appropriate oil is suitable for state-of-the-art temperature level. The use of an approved brand of turbine oil makes it possible to have long lasting periods of oil exchange driven by samples and not by fixed hours. This lowers the operating costs for the customer This combination lowers friction losses in the bearing and leads to lower operating cost than operating bearings with lower temperatures but higher friction losses due to higher friction coefficient at lower temperature.

This variation (above described and offered solution) will not affect time schedule nor cost.

4. Conclusion

As Siemens Energy uses higher quality material for babbitts than have been requested by specification and as limits of the modern oils are higher than requested, Siemens Energy request to consider offered technology as equivalent or higher than specified by Litgrid specification.