III International Scientific Conference "Sustainable and efficient use of energy, water and natural resources – SEWAN-2021"

Reactive power compensation and reduction of electricity losses for transit.

Authors: Alina Chetyrkina, Sergey Golobokov, Anna Tikhomirova;

Contact details: alinatchetyrkina@yandex.ru;

Scientific adviser: Tatyana Brostilova.

Affiliations: Penza State University

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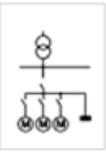
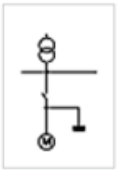
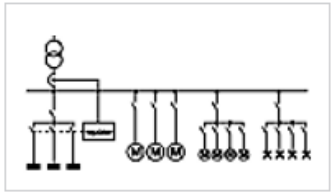
Compensation method	Application area	Effect
Centralized on the high voltage side of 6 (10) kV at the substation 10 (6) /0.4 kV or at the border of the balance sheet	Availability of high-voltage electric motors 6 (10) kV at the facility and / or a uniform load schedule, improving the quality of electricity and increasing the transmission capacity of networks in terms of active power	Possibility of connecting additional power to the busbars, improving the quality of electricity
Centralized on the low voltage side at the 110 (35) / 10 (6) kV substation if the balance sheet boundary is on the 110 (35) kV side		Reduction of active losses in transformers 110 (35) / 10 (6) kV and current-carrying cables, the ability to connect additional power
Centralized on the voltage side of 0.4 kV	In load nodes with a wide range of reactive power variation	Reduction of active losses in transformers 10 (6) / 0.4 kV and the ability to connect additional power
Group on the low voltage side 0.4 kV	Group of homogeneous consumers	Reduction of active losses in transformers and supply lines
Individual on the low voltage side of 0.4 kV	Single consumer switched by a separate switch	



group compensation



individual compensation



centralized compensation

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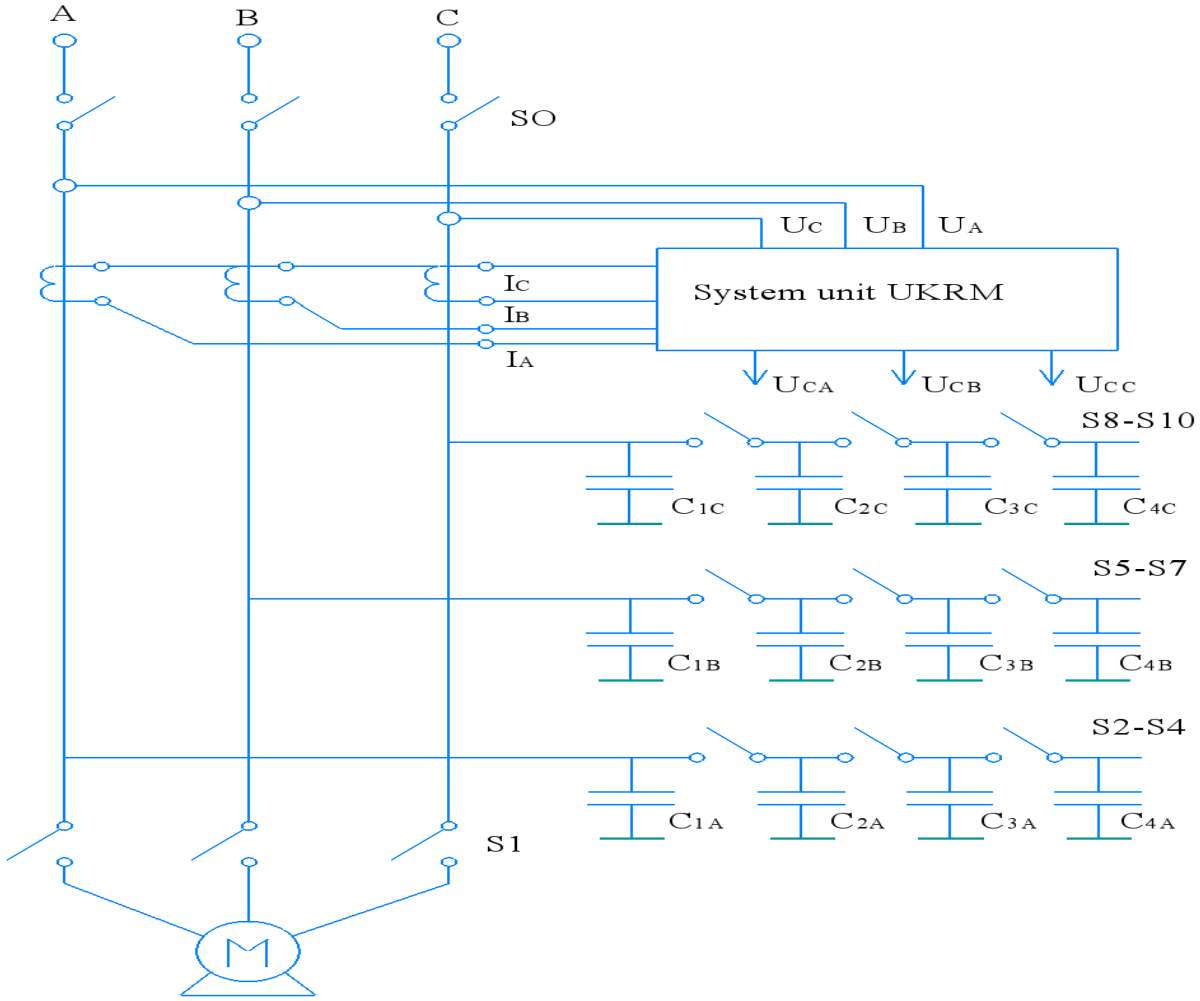
Connection diagram of the UKRM -58-400/50



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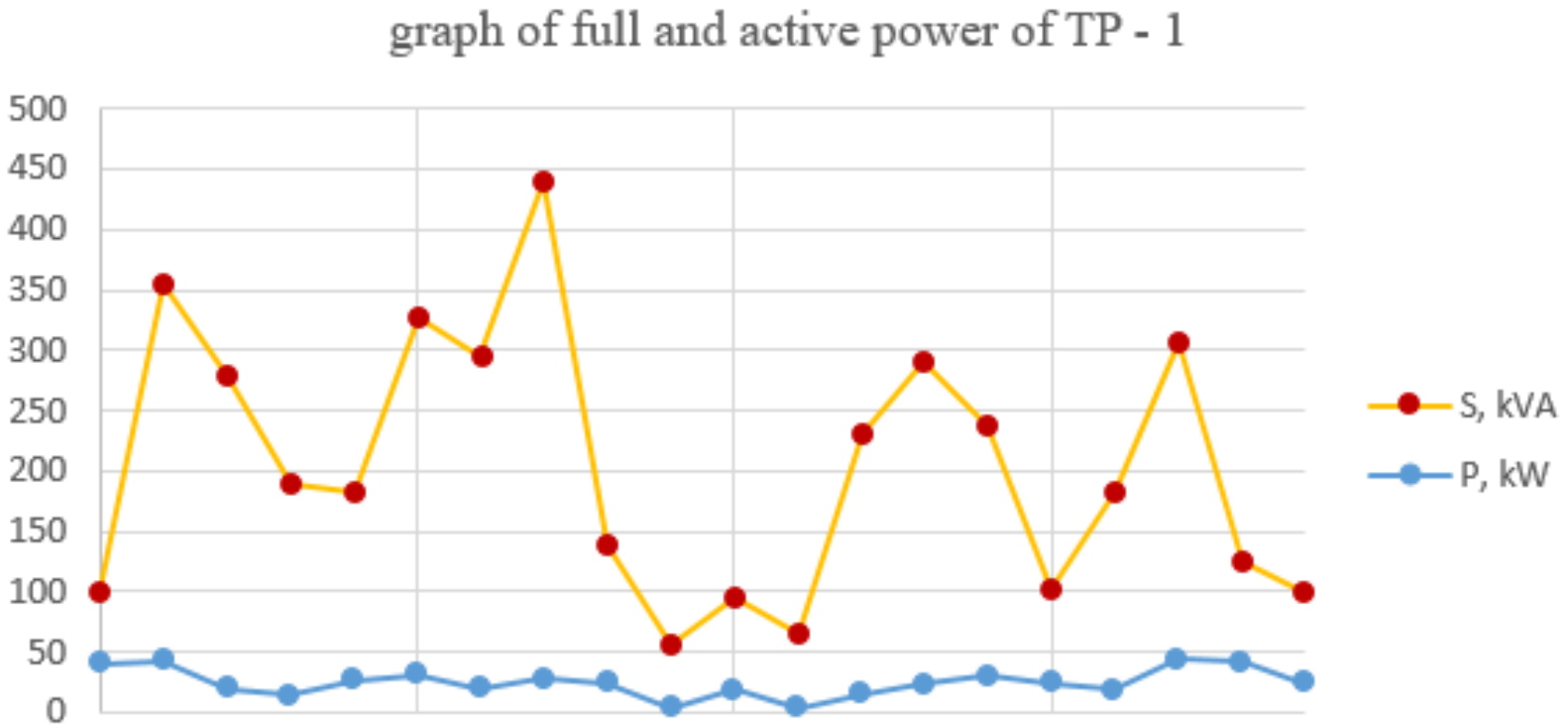
In transformer substation 1, 4 cell (crane)

$$S = 28{,}107 + j439{,}72 \text{ kVA}, \quad \cos\varphi = 0{,}064$$



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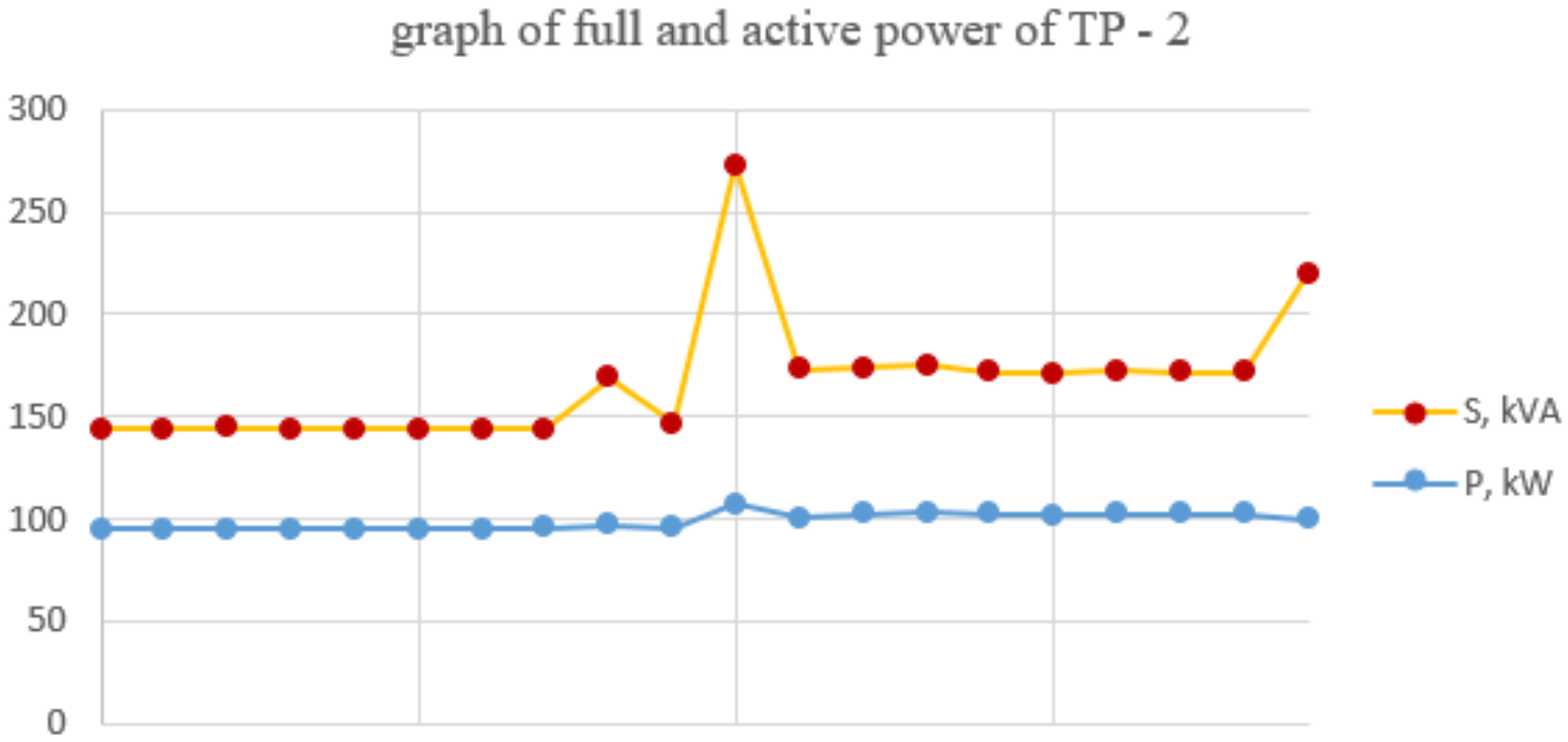
In transformer substation 2:
14,15 and 16 cells - compressors

$$S = 107{,}659 + j237{,}02 \text{ kVA}, \quad \cos\varphi = 0{,}41$$



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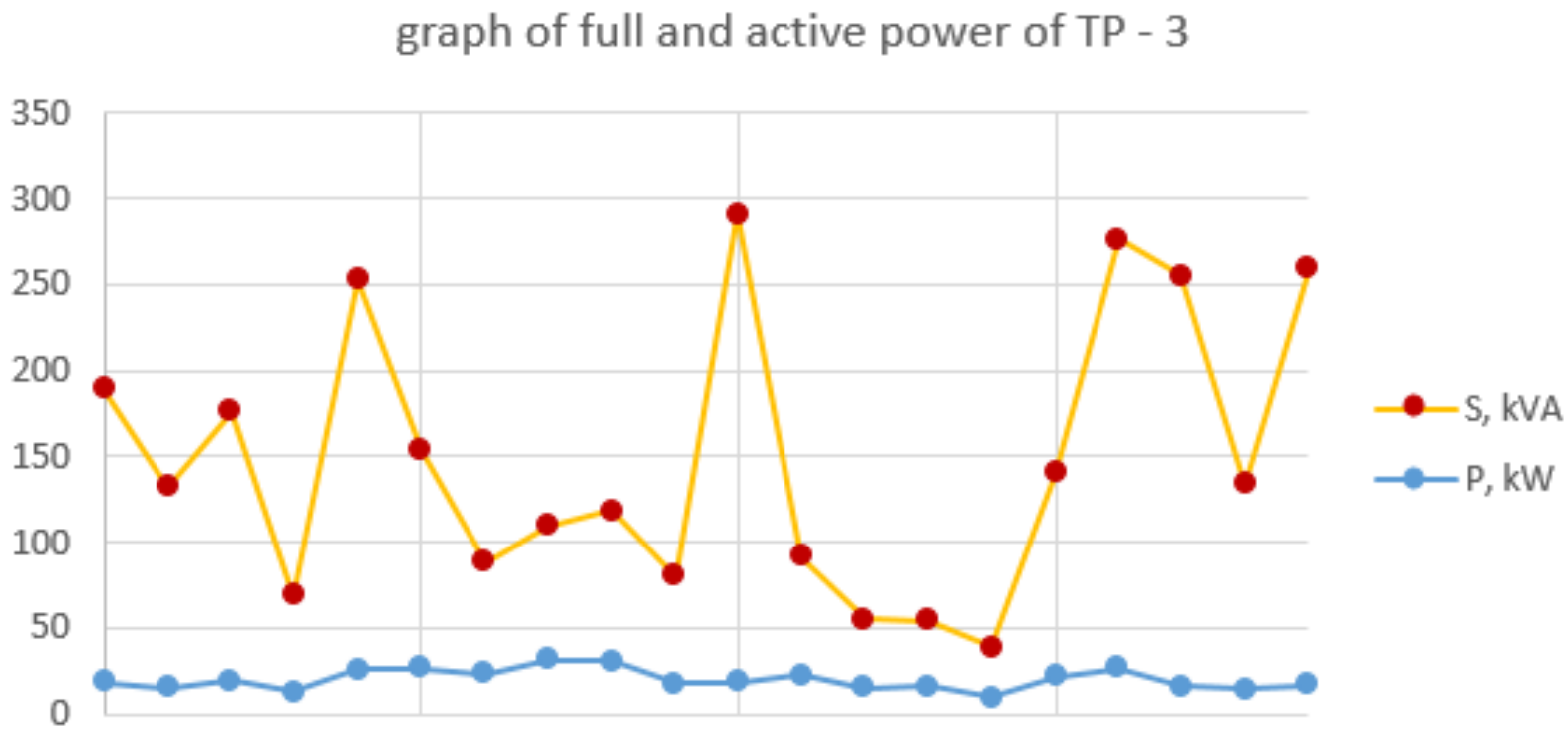
In transformer substation 3:
1 cell (automatic welder), 3 cell (ferrous metal) and 5 cell (administrative complex)

$$S = 19{,}297 + j341{,}06 \text{ kVA}, \quad \cos\varphi = 0{,}056$$



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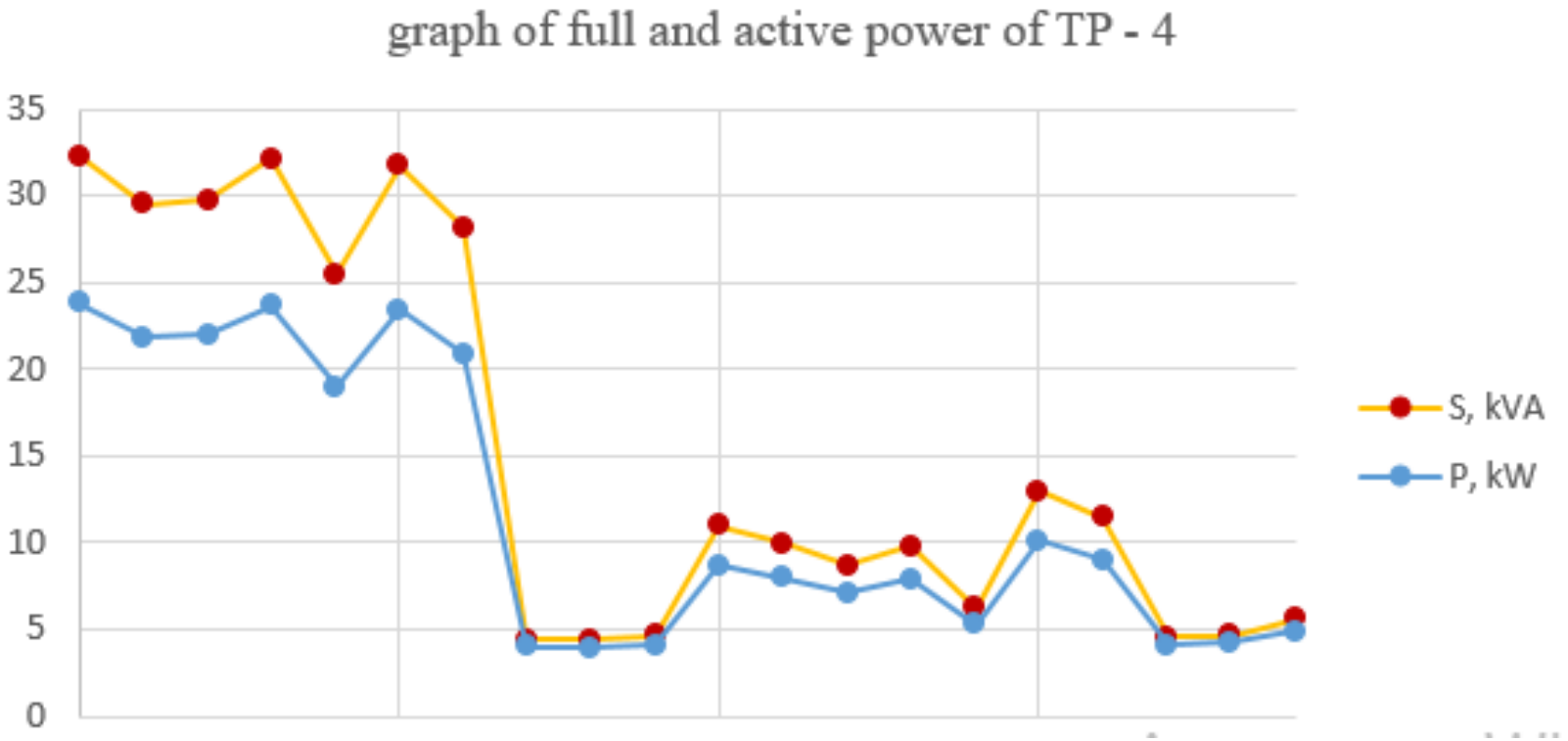
In transformer substation 4, 1 cell (solution node)

$$S = 23{,}822 + j21{,}812 \text{ kVA}, \quad \cos\varphi = 0{,}74$$



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Photos and characteristics of the
UKRM-58-400/50
Production of " KHOMOV»

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Technical characteristics of condensing units UKM 58:

Condensing unit	
Rated voltage	230/400/440/525/690 V
Rated frequency	50 Hz
Rated power	5-2000 kvar
Dielectric loss	<0.2 W / kvar
Losses in capacitors	<0.3 W / kvar
Maximum voltage	1.1 Un
Overcurrent allowable	1.3 In
Discharge resistors	two each capacitor
Regulator	Controller NOVAR / LOVATO DCRK, DCRL, DCRG / BELUK
Cosine capacitors	DWCAP, MA / C, RCT, RTF RTR ENERGIA (Spain)
Operational food	230/400 V
External current transformer	... / Option
Temperature range	-50 °C/ +50 °C
Degree of protection	IP 31 / IP 54
Place of installation	Indoor / Outdoor
Standards	GOST, IEC 60831, IEC 60439, IEC 60831, IEC 60439

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TECHNICAL AND ECONOMIC INDICATORS

Current in the cable line before switching on the UKRM $I_{befor} = \frac{S}{\sqrt{3} \cdot U} = 60$ A

Current in the cable line after switching on the UKRM $I_{after} = \frac{P}{\sqrt{3} \cdot U \cdot cos\varphi} = 10{,}87$ A

electricity volume per month:

before switching on the UKRM $W = 57\,958{,}74$ kWh

after switching on the UKRM $W = 59\,246{,}712$ kWh

The energy savings for transit will be 1288 kWh или 2,2 %.

$Э = 0{,}022 \cdot W \cdot T = 5\,667$ ruble per year $Э = 68\,000$ ruble

$T = 4$ ruble/kWh – tariff for the enterprise

payback period, years: $Tr = C \,/\, Э = 420\,000 \,/\, 68\,000 = 6$ years

where: C – cost of the condenser unit;

$Э$ – annual savings for electricity payments.

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Conclusions:

1. Reactive power compensation willreduce network losses
2. It will significantly relieve the cable lines, which will extend their service life
3. Improve the quality of the transmitted electricity in terms of the relative voltage deviation and increase the stability of the power grid.
4. Increase the transit capacity of the existing power lines and connect an additional load
5. Reduce the voltage drop in the power line
6. Reduce the number of relay protection triggers when starting a high-power load

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Thank you for your attention!

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