**РЕЗЮМЕ.** Мақолада САД/САЕ/САМ инновацион технологиялари асосида лойиҳалаш-конструкциялаш жараёнларининг узвийлиги ҳамда валларни мустаҳкамлик ва бикрликка ҳисоблаш-лойиҳалашда MathCad дастуридан фойдаланишнинг таълимда юқори самара бериши асосланган.

**РЕЗЮМЕ.** В статье обоснована целостность процессов проектирования и конструирования на основе инновационных технологий CAD/CAE/CAM и высокая эффективность использования программного обеспечения MathCad при расчете и проектировании валов на прочность и жесткость.

**SUMMARY.** The article substantiates the integrity of the design and construction processes based on innovative CAD/CAE/CAM technologies and the high efficiency of using MathCad software in the calculation and design of shafts for strength and stiffness.

# ENSURING ELECTRICAL SAFETY IN NETWORKS WITH RESISTIVE NEUTRAL GROUNDING

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**Tayanch so‘zlar:** elektr xavfsizligi, taqsimlash qurilmalari, past qarshilikli rezistorli yerga ulash, rele himoyasi, tarmo, tok, izolyatsiya.

**Ключевые слова:** электробезопасности, распределительное устройство, низкоомном резистивном заземлении, релейная защита, линия, ток, изоляция.

**Key words:** electrical safety, switchgear, low resistance resistive grounding, relay protection, line, current, insulation.

*Introduction.* Electrical safety is a key aspect in the field of electric power industry. Proper operation of power grids with neutral resistive grounding is crucial to ensure the safety of both personnel and equipment. Let's look at this aspect in more detail. Neutral resistive grounding is used to limit the magnitude of a short circuit in the system and reduce the likelihood of a phase earth fault. This directly affects the security of the system as a whole. However, in order to ensure effective electrical safety, it is necessary to take into account such aspects as the correct selection of resistive grounding parameters, its connection to protective devices, monitoring of the grounding condition and other technical features [1].

An important aspect of ensuring electrical safety is the training of personnel and the development of clear rules for working with neutral resistive grounding. All employees working in such conditions should be aware of the possible risks and know how to safely handle the equipment.

Regular monitoring and maintenance of grounding components play an important role in ensuring the smooth operation of the system. This includes checking the condition of the resistors, the operability of the grounding and identifying potential problems that may affect the safety of the system. An analysis of world experience shows that proper electrical safety in systems with neutral resistive grounding helps to reduce production risks. losses, as the probability of downtime and damage to equipment is minimized, which directly affects the efficiency and profitability of enterprises [2].

*Formulation of the problem.* There are standardized requirements for electrical safety of electrical installations using various methods of neutral grounding [1, 2]. The norm for ensuring electrical safety is the permissible values of the contact voltage, the value of which depends on the duration of the voltage exposure. Standardization of the resistances of grounding devices of electrical installations ensures acceptable levels of contact voltage.

In networks with isolated or compensated neutral, zero-sequence current protection is often activated based on a signal, which implies the possible existence of a single-phase earth fault (SPEF) for up to two hours. In such cases, the fault current passing through the grounding device generates a prolonged voltage increase, and the corresponding resistance can be adjusted in accordance with the recommendations set out in the source [2], contributing to a deeper understanding and optimization of electrical solutions in this area.

The requirements for the parameters of grounding devices for networks with low-resistance resistive neutral grounding, i.e. with a relatively large (up to 1000 A) earth fault current, are not regulated in Uzbekistan. Meeting the requirements for the resistance of grounding devices according to [1], as $250/I_{SPEF}$ (but not more than 10 Ohms in the absence of a distribution point and a connection point with a grounding device for 0.4 kV electrical installations) and $125/I_{SPEF}$ (but not more than 4 Ohms in the presence of such a connection), for $I_R$ = 1000 A gives the values of 0.25 and 0.125 ohms for the first and second cases, respectively, which is 2-4 times lower than the permissible [1] resistances for 110 kV and higher substations with a deafly grounded neutral, which is difficult to achieve.

Since 110-220/20 kV substations must have a low-resistance resistive neutral grounding, it follows that the resistance of the grounding mechanism of the electrical installation must be determined using the specifications for the permissible contact voltage.

Relay protection is used in the urban electric network with a voltage of 20 kV to ensure prompt disconnection of short circuits on feeders. The operation occurs within a time delay of 0.7 to 1.7 seconds, depending on the network topology, demonstrating the importance of using relay protection in terms of ensuring the safety and stability of urban electric networks.

The use of the regulatory requirements for electrical safety set out in work 80, intended for networks with a voltage above 1000 V, can also be applied in networks with a voltage of 20 kV. This is possible by reducing the exposure time of industrial frequency current to humans, which contributes to improving safety and ensuring compliance of electrical systems with standards and recommendations in this field.

In the case of a blind grounding of the neutral, the same response time of single-phase short circuits is explained both in 110 kV networks and in higher-level networks. This is due to the specifics of the operation of systems in the absence of a zero sequence, which is important for evaluating and developing effective methods for protecting and stabilizing the operation of high-voltage networks.

The choice of parameters of resistors in a 20 kV network under the condition of electrical safety significantly depends on the resistance of the grounding device to the connecting point and the 20 kV transformer substation. Taking the values of the maximum permissible contact voltage from [2], the required resistances of grounding devices in a 20 kV network (Table 3.1) are estimated by the ratio:

$$R_g = \frac{U_p}{I_R} \tag{1}$$

where $R_g$-is the resistance of the grounding device, Ohms; $U_p$-is the maximum permissible contact voltage; $I_R$-is the rated current of the resistor.

*Table 1.* The values of the permissible resistances of grounding devices in a 20 kV network.

| Short circuit shutdown time, s | Permissible contact voltage, V | Permissible resistance of the grounding device, Ohms** | | | |
|---|---|---|---|---|---|
| | | $I_R$=1000A** | $I_R$=800A | $I_R$=600A | $I_R$=400A |
| up to 0.1 | 500 | 0,490 | 0,606 | 0,790 | 1,118 |
| 0,2 | 400 | 0,392 | 0,485 | 0,632 | 0,894 |
| 0,5 | 200 | 0,196 | 0,242 | 0,316 | 0,447 |
| 0,7 | 130 | 0,127 | 0,158 | 0,205 | 0,291 |
| 1 | 100 | 0,098 | 0,121 | 0,158 | 0,224 |
| 1,0-5,0 | 70 | 0,069 | 0,085 | 0,112 | 0,156 |

* According to [29], tightening the requirements for the resistance of grounding devices at a distribution point (junction point, transformer substation) to values not exceeding 0.5 ohms is not justified. This is possible only in the case of special designs and for distribution points that stand alone and are not connected to the grounding devices of other electrical installations - even combined protective grounding and neutral conductors of 0.4 kV cables for auxiliary needs.

** The resistance of the grounding devices was evaluated at a capacitive short-circuit current of 200 A. $I$=(1,12,...,1,20)$I_R$ is the highest calculated value of the total short-circuit current for a given current.

*Results.* When considering the results of Table 1, it should be borne in mind that more than 80% of the short-circuit current passes through the cable sheaths [3], which are grounded on both sides and connected to the primary grounding circuits at supply centers of 110 kV and above with a resistance of up to 0.5 ohms.

Up to 20% of the short-circuit current is distributed through the combined protective grounding and neutral conductors of the 0.4 kV network with low-resistance resistive grounding of the neutral of the medium voltage network, and up to 85% of this current is distributed through the cable sheaths of 10-20 kV. The grounding device of a 20 kV electrical installation directly accounts for no more than 2-3% of the short-circuit current of the medium voltage network. Under such conditions, the step and touch voltages with a probability of 0.95 do not exceed 5 V/kA relative to the short circuit current, and the highest values reach 20-30 V/kA, according to field measurements in urban distribution cable networks with resistance currents of 950 - 1400 A. Therefore, when using a resistor with a current of 400-700 A in the cable network, the probability that the expected values of the touch and step voltage exceed 12.5 V is only 0.05; the highest values can reach 40-75 V, which is not dangerous with a quick shutdown of damage [4].

Therefore, it is essential to consider the inclusion of additional metal connections, such as copper cable shields with cross-linked polyethylene insulation, between all substations (including transformer substations) and the grounding devices of the 110-220/20 kV power supply center when evaluating the electrical safety parameters within a specific 20 kV network. This proactive approach is pivotal in ensuring comprehensive safety measures and protecting the integrity of the electrical infrastructure, especially in high-voltage environments.

Deep grounding devices are used to achieve the required value of equivalent grounding resistance in the absence of shunt connections. Electrical safety is achieved with an equivalent resistance of grounding devices to the power center, distribution point, connecting point and transformer substation in the range of 0.1-0.2 Ohms by reducing the fault current in the network using a resistor to 400-600 A (Table 1).

The natural parallel connection of the main grounding circuits of the power supply center, as well as the distribution point, the connecting point and the transformer substation using copper shields grounded on both sides of cables with cross-linked polyethylene insulation with a linear resistance of 0.17-0.37 ohms/km per circuit, relatively successfully solves the problem of electrical safety in a 20 kV network with a low-resistance resistor at $I_R$=400-600 A. In this regard, before the introduction of one-way screen separation on single-core 20 kV cables, a feasibility study should be carried out to eliminate induced currents and losses. The issue of potential transfer to the enclosures of electrical equipment in a 0.4 kV network connected to a grounding device with transformer substations of 20/0.4 kV becomes relevant with a large number of such substations. Depending on the maximum short-circuit time ($t_{max}$) in a high-voltage network [5] in the document, restrictions on the permissible value of the voltage $U_{perm}$ for phase isolation of equipment in electrical installations with a voltage of up to 1 kv are shown in Table 2.

Table 2

| $t_{max}$, s | 0,2* | 0,4** | 0,7 | 1,3 | 1,7 |
|---|---|---|---|---|---|
| $U_{perm}$, V | 560 | 300 | 140 | 90 | 80 |

* disconnection during this time is possible if an assembly with a fuse is used as a complete switchgear (switchgear) complete 0.4 kV switchgear is used as an assembly with fuses;

** disconnection during this time is possible if a switchgear with circuit breakers is used as a 0.4 kV switchgear.

These values correspond to the European electrical safety standards [6] adopted in Denmark, Poland, Germany, Belgium, Great Britain and other countries. With a response duration of 1.7 seconds or more, the maximum permissible voltage at the contacts is 80 V (Fig. 1).

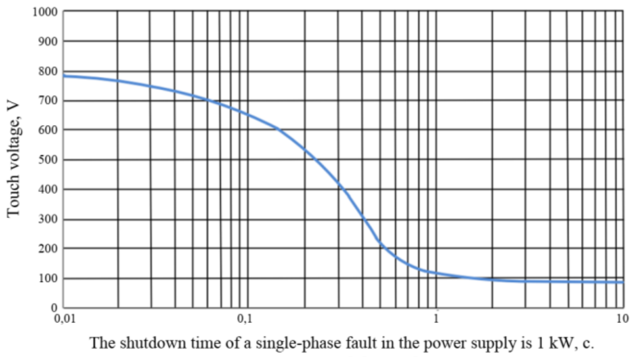


*Figure 1. Permissible voltage on equipment housings up to 1 kV*

To prevent the transmission of high potential to a 20/0.4 kV substation and a 0.4 kV network with two-way grounding of 20 kV cable lines, it is fair to use the separation of grounding elements of the high-voltage and low-voltage parts of the substation, described in [7]. An additional measure that guarantees safety conditions in case of possible dismantling is to reduce the current of the resistor in the neutral of the 20 kV network by 40-50% compared to the value of 1000 A [6, 7].

*Conclusion.* Taken together, global experience not only confirms the importance of a feasibility study for converting 6-10 kV networks into 20 kV networks to ensure electrical safety, but also provides unique ideas and best practices that are key to the development of concepts and strategies in the field of electrical safety. areas of electrical safety. Electrical safety in a 20 kV network with a low-resistance resistor in the neutral should be assessed by the normalized values of the contact voltage. Taking into account the fact that at 110-220 kV supply substations more than 80% of single-phase earth fault currents are distributed through the shells of cables grounded on both sides and connected to the main grounding circuits, at 110-220 kV supply substations, the contact voltage on the 20 kV side with a single-phase short circuit current of up to 400-700 A with a probability of 0.95 will not exceed 12.5 V.

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**REZYUME.** Ushbu maqolada energetika sohasi xodimlari va jihozlarning xavfsizligini ta'minlashda neytralni rezistorli yerga ulashning muhim roliga e'tibor qaratadi. Bunda rezistorli yerga ulash parametrlarini tanlash, ularni himoya qurilmalariga ulash va ularning holatini kuzatish bilan yagona xavfsizlik standartlariga rioya qilish muammosi ko'rib chiqiladi.

**РЕЗЮМЕ.** В этой статье основное внимание уделяется важной роли заземления нейтрали резистором в обеспечении безопасности персонала и оборудования в энергетическом секторе. В данном случае рассматривается проблема соблюдения единых норм безопасности с выбором параметров заземления резисторов, подключением их к устройствам защиты и контролем их состояния.

**SUMMARY.** This article focuses on the important role of neutral resistor grounding in ensuring the safety of personnel and equipment in the energy sector. The considers the problem of compliance with uniform safety standards with the choice of grounding parameters of resistors, connecting them to protection devices and monitoring their condition.


## Biologiya. Zoologiya. Ekologiya

# QARAQALPAQSTAN SHARAYATÍNDA SHÍǴÍS KATRANÍ (*CRAMBE ORIENTALIS* L.)NÍŃ BIO-EKOLOGIYALÍQ ÓZGESHELIKLERI


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**Tayanch so'zlar:** ontogenez, ko'p yillik o'simlik, tirichilik tsikli, tuxum, tuxum ulushi, poya, pobeg, barg, gul, ildiz sisteması, meva, onalik, yem-xashak o'simlik, gulqorǵani, tuxum ko'karuvchangligi, haqiqiy barg, o'q ildiz.

**Ключевые слова:** онтогенез, многолетнее растение, жизненный цикл, семена, семядольные листья, стебель, лист, побег, цветок, корневая система, плод, пестик, кормовой растение, околоцветник, всхожесть семян, настоящих листьев, стержневой корень.

**Key words:** ontogeny, perennial plant, life cycle, seeds, cotyledon leaves, stem, leaf, shoot, flower, root system, fruit, pistil, food plant, perianth, germination of seeds, true leaves, tap root.


Shıǵıskatran - (*Crambe orientalis* L.) – atanaq gúlliler (*Brassicaceae*) tuqımlasına kiretuǵın qımbat bahalı ot-jemlik hám pal beriwshi ósimlik sıpatında áyyemgi zamanlardan berli jergilikli xalıqlar tárepinen paydalanıp kelingen. Bul ósimlik anıq gúllegen waqtında onnan jaǵımlı, xoshpal iyisi tarqaladı. Shıǵıs katranı ayrıqsha túr sıpatında ajıralıwına shekem onı kóbinshe Respublikamızda keń tarqalǵan Kochikatranı – Crambe kotschyana Boiss sıpatında úyrenilip kelingen [6].

Botanikalıq ádebiyatlarda ósimlik túriniń ataması boyınsha túrli qarama-qarsı pikirler bar. A.Ya. Butkov hám Z.A.Maylun onı Crambe amabilis dep esaplasa [4], bul tuqımlastı jaqsı biletuǵın belgili alım B.P. Bochantsev, bul Crambe orientalis L., sonıń ushın Crambe amabilis-tı Crambe orientalisL.-tıń sinonimı dep qabıl etiw kerek degen pikirdi aytadı [3].

Bizler óz izertlewimizde S.K.Cherepanov hám B.P.Bochantsevlardıń pikirine tolıq qosılamız [5].

Joqarıdaǵılarǵa tiykarlanıp, Ózbekstan aymaǵında shıǵıs katranı- Crambe orientalis L., ósedi dep juwmaq shıǵarıwǵa boladı.

Shıǵıskatranı gúllegen waqıtta S. kocchiana-ǵa júdá usaydı. Ol keyingiden óziniń sızǵısh tárizli tilkimlengen-pár sıyaqlı hám mayda gúlleri hám miyweleri menen jaqsı parq qıladı (1-súwret).

Crambeorientalis L.-tiń gúli túwrı, gúl qorǵanı quramalı. Ol 4 jasıl reńli gúl kese japıraǵı hám gúl japıraǵınan, sonday-aq, gúltajı da 4 diagonal jaylasqan aq gúl japıraǵınan turadı. Atalıǵı altı, sonnan ekewi kelte jip penen sırtqı qatarda, al tórtewi iri olar ishki qatarda jaylasqan. Analıq qarınsha otırmalı, kelte analıq moynı hám awızshadan ibarat. Gúl formulası *⚥ $Ca_{2+2}Co_4A_{2+4}G_1$.

*1-súwret. Crambeorientalis L.-tiń ulıwma kórinis*

Uzın atalıqlar joqarı tárepinde tisshege iye, geyde tisshe bolmaydı. Shańlıq analıq awzınan alıslaǵanday, tisshe analıq awzına burılǵan boladı. Joqarǵı pal bezsheleriri, ápiwayı yamasa múyeshli-baǵanalı bolıp, hár bir jup atalıqtıń aldında birewden jaylasadı. Tómengi pal bezsheler mayda, prizmalı, olar kelte atalıqtıń ishki tárepinde jaylasadı. Analıq, shetleri birigip, bir uyalı analıq qarınshanı dúzetetuǵın kimiywe japıraqtan turadı. Analıq qarınsha otırmalı.Onıń ishinde eki tuqım búrtik, onnan tek joqarǵı tuqım rawajlanadı. Moynı kelte, otırmalı analıq awzınan turadı.

Crambe orientalis L.-tiń bioekologiyalıq ózgesheliklerin úyreniw hám onı Qaraqalpaqstan sharayatı ushın keleshegi bar ot-jemlik ósimlik sıpatında mádeniylestiriw boyınsha ilimiy izertlewler bir tájiriybe uchastkasında alıp barıldı. Ol Ájiniyaz atındaǵı Nókis mámleketlik pedagogikalıq institutınıń «Grachevaya rosha»da Botanika baǵında jaylasqan. Jumısta tájiriybe uchastkanıń ıqlım hám agroximiyalıq sıpatlaması tolıq úyrenilgen.