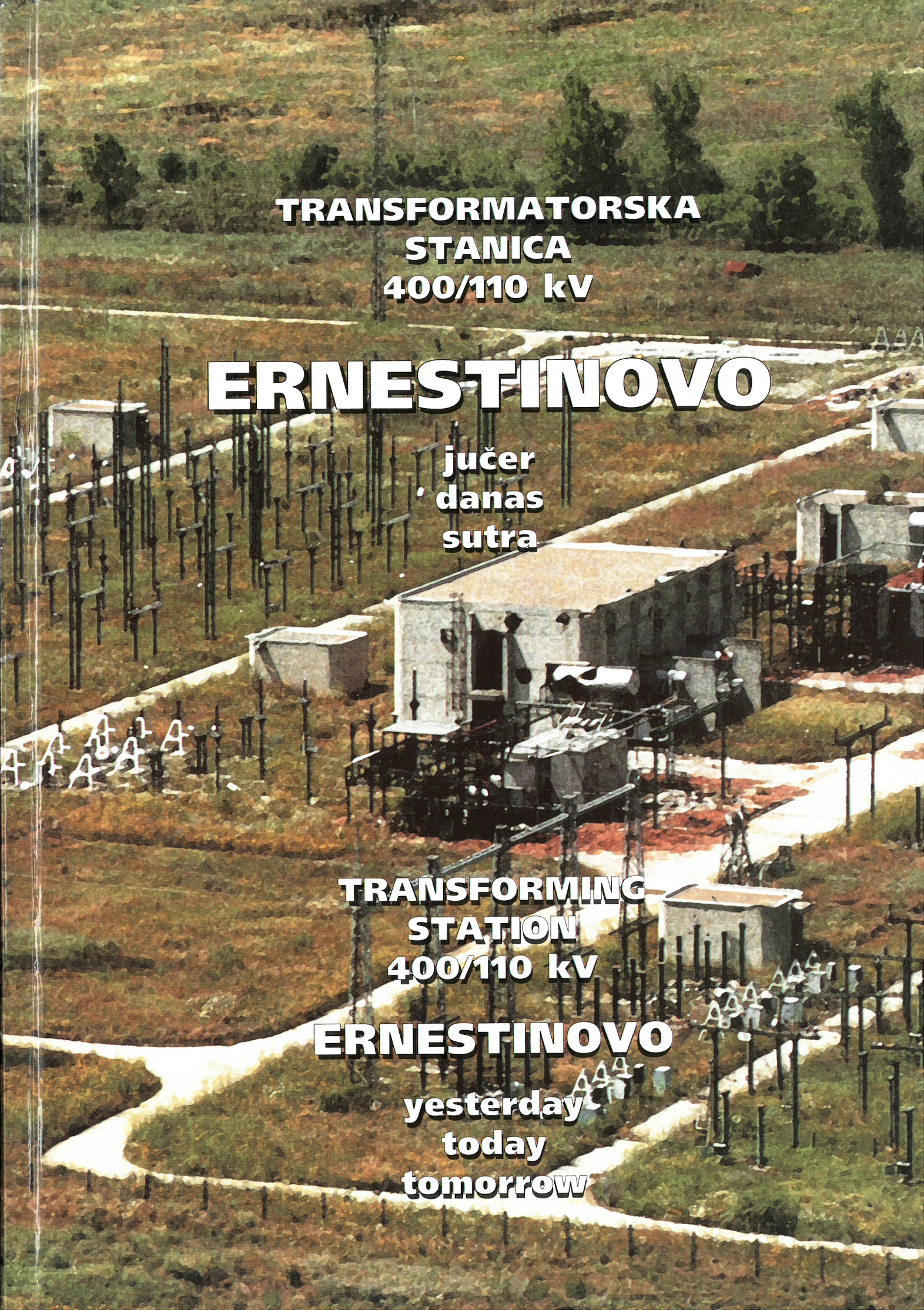




**TRANSFORMATORSKA
STANICA
400/110 kV**

ERNESTINOVO

**jučer
' danas
sutra**

**TRANSFORMING
STATION
400/110 kV**

ERNESTINOVO

**yesterday
today
tomorrow**

HRVATSKA ELEKTROPRIVREDA

Direkcija za prijenos

TRANSFORMATORSKA

STANICA

400/110 kV

ERNESTINOVO

JUČER

DANAS

SUTRA

TRANSFORMING

STATION

400/110 kV

ERNESTINOVO

YESTERDAY

TODAY

TOMORROW

Zagreb, 2001





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Transformatorska stanica Ernestinovo opet će služiti ljudima

Republika Hrvatska, nakon Domovinskog rata, na svom području ima još puno nezacjeljenih rana koje će još dugo liječiti. Nastale su u sukobu civilizacija, a tisuće izgubljenih života i tragičnih sudbina ne mogu se ičim nadoknaditi. Uništeni infrastrukturni objekti koji su koristili ljudskoj zajednici unutar same države i bili čak međudržavno signifikantni, predstavljaju nedjelo posebne vrste koje bi se pred zakonom trebalo tretirati kao najteži zločin protiv čovjeka i civilizacije.

Elektroenergetski sustav i svi objekti koji ga čine imaju u osnovi jednostavnu funkciju - opskrbu potrošača električnom energijom i predstavljaju dobrobit za sve članove pojedine zajednice. Kako elektroni ne poznaju državnu pripadnost, povezani elektroenergetski sustavi omogućuju dobrobit široj ljudskoj zajednici u vidu bolje i sigurnije opskrbe električnom energijom, bez koje je danas teško zamisliv život.

Transformatorska stanica 400/110 kV Ernestinovo, izgrađena i puštena u pogon 1977. godine kao dio

Transforming station Ernestinovo will serve people's purpose again

The Republic of Croatia, after the war, has many unhealed wounds in its area, which will have to be healed for a long time. These wounds arose from the conflict of civilizations, and thousands of lost lives and tragic destinies cannot be compensated in any way. The destroyed infrastructure objects that were used by the human community within the state itself and that were even internationally significant represent a misdeed of a particular kind that should be treated, in the eyes of the law, as the most severe crime against human civilization.

The electric-power system and all its objects basically have one simple function - the electric-power supply of the consumers and the well being of all members of an individual community. As electrons know no state bias, the connected electric-power systems enable the well being of a wide human community by means of a better and more secure electric-power supply, without which our present lives would seem almost impossible.

400/110 kV transforming station Ernestinovo, built and put into operation in 1977, as a part of the 400 kV ring "Nikola Tesla", was one of the node points in the distri-

prstena 400 kV "Nikola Tesla", bila je jedna od glavnih čvornih točaka u prijenosnoj mreži, te uzorni primjer tehnologije i ponos elektroprivrednika toga vremena. Njezina visoka opterećenja ukazivala su na vrlo dinamične energetske aktivnosti velikog broja sudionika u svim smjerovima, i važnu ulogu u elektroenergetskom sustavu.

Uništenje TS 400/110 kV Ernestinovo 1991. godine značilo je trenutni gubitak glavne opskrbe točke električnom energijom istočnog dijela Hrvatske, te razdvajanje mreže UCPT-a na dvije sinkrone zone koje se na žalost zadržalo sve do današnjih dana.

Strateško opredjeljenje Hrvatske je priključenje Europskoj uniji i ulazak u punopravno članstvo njezinih asocijacija. Hrvatski parlament je 2001. godine prihvatio paket energetske zakone i tako pokrenuo reformu energetskega sektora u skladu s Direktivama 96/92 Europske unije, pri čemu je temeljni cilj reforme liberalizacija tržišta električne energije i postupni put otvorenom tržištu. Svi stručni autoriteti slažu se da u tome ključnu ulogu ima tehnički stabilan i pouzdan elektroenergetski sustav u kojem je prijenosna mreža jedna od glavnih sastavnica.

Stoga je Hrvatska elektroprivreda odlučila obnoviti TS 400/110 kV Ernestinovo i pripadajuće priključne dalekovode, te izgraditi novu TS 400/220/110 kV Žerjavinec pokraj Zagreba kojima će se bitno ojačati interkonekcijska komponenta u prijenosnoj mreži. Hrvatski elektroenergetski sustav time će ostvariti bitne preduvjete za siguran, pouzdan i stabilan pogon, a spajanjem prve i druge sinkrone zone UCPT-a - velikim doprinosom Hrvatske - jedinstveno europsko tržište električne energije će se bitno proširiti.

Izgradnjom i puštanjem u pogon obnovljene TS 400/110 kV Ernestinovo napokon će prestati opskrba Slavonije električnom energijom samo jednim dalekovodom iz hrvatskog elektroenergetskog sustava u pogonu pod naponom 220 kV, koja je trajala punih deset godina i koja će se jednog dana činiti kao ružan san, a nova TS 400/110 kV Ernestinovo opet će služiti ljudima.

Mr. sc. Ivica Toljan, dipl. ing.
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Hrvatske elektroprivrede

bution network, as well as a model example of the technology and pride of the electric-power work force of that time. Its high loads pointed at very dynamic power activities of a great number of participants in all directions, as well as an important role in the electric-power system.

The destruction of the 400/110 kV transforming station Ernestinovo in 1991 meant the permanent loss of the main electric-power supply point of the eastern part of Croatia, as well as the division of the UCPT network in two synchronous zones that has unfortunately been sustained until today.

The Croatian strategic preference is the connection to the European Union and the entrance in the full membership of its associations. The Croatian Parliament has, in 2001, accepted a package of power-supply laws and by doing that initiated the reform of the power sector in accordance to European Union Directives 96/92, by which the fundamental goal of the reform is the liberalization of the electric-power market and a gradual movement towards the open market. The expert authorities agree on the fact that a technically stable and reliable electric-power system, in which the distribution grid is one of the main components, has a key role in that process.

Therefore, the Croatian Power Industry has decided to reconstruct the 400/110kV TS Ernestinovo and its belonging lines, as well as to build a new 400/220/110 kV TS Žerjavinec near Zagreb, both of which should significantly strengthen the interconnecting component of the distribution network. The Croatian electric-power system will therefore achieve all the necessary prerequisites for a safe, reliable and stable operation, and by connecting the first and the second synchronous UCPT zones - by the great Croatian contribution - a united European electric-power market will be significantly expanded.

By building and putting into operation the reconstructed 400/110 kV TS Ernestinovo the supply of Slavonia by only one line from the Croatian electric-power system in operation under 220 kV, which has lasted for full 10 years and that will one day seem like a bad dream, will finally be stopped, and the new 400/110 kV Ernestinovo will serve people's purpose again.

M. S. Ivica Toljan, graduate electrical engineer,
Director of Transmission division
Croatian Power Industry



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Posvećeno uspomeni na ljude koji su se izborili za lokaciju transformatorske stanice Ernestinovo, zamislili je i projektirali, konstruirali i proizveli svakovrsnu opremu, izveli građevinske i montažne radove, ispitati je i pustili u pogon, davne 1977. godine.

Posvećeno uspomeni i na ljude koji su, tijekom godina korištenja transformatorske stanice Ernestinovo, vodili njezin pogon, dograđivali je i održavali, i koji su proživjeli njezina razaranja, brutalno istjerani iz nje 1991. godine, nakon čega je još i sustavno opljačkana.

Posvećeno i onim ljudima koji su se 1998. godine okupili na ruševinama transformatorske stanice Ernestinovo, da bi je iznova uzdigli, s nadom i vjerom da više nikada neće biti razorena... Posvećeno - konačno - i ljudima koji su 2000. godine preuzeli čast i obvezu obnove.

Marijan Kalea, dipl. el. ing.
 autor teksta

U Osijeku, 21. studenog 2001. - na
 10. obljetnicu napuštanja TS Ernestinovo

Dedicated to the memory of people who fought for the location of transforming station Ernestinovo, planned and designed it, constructed and manufactured all kinds of equipment, conducted construction and mounting work, tested and put it into operation, in the distant 1977.

Dedicated to the memory of the people who, during the years of transforming station Ernestinovo utilization, supervised its operation, added on and maintained it, and who survived its destruction, and were brutally evicted from it in 1991, after which this transforming station was systematically robbed.

Dedicated - finally - to those people, who gathered at the ruins of transforming station Ernestinovo in 1998, in order to re-build it, hoping and believing that it would never be destroyed again...

Marijan Kalea, graduate electrical engineer,
 the author of the text

In Osijek, December the 21st 2001 - at the
 10th anniversary of abandoning TS Ernestinovo

Ernestinovo danas

Ernestinovo today



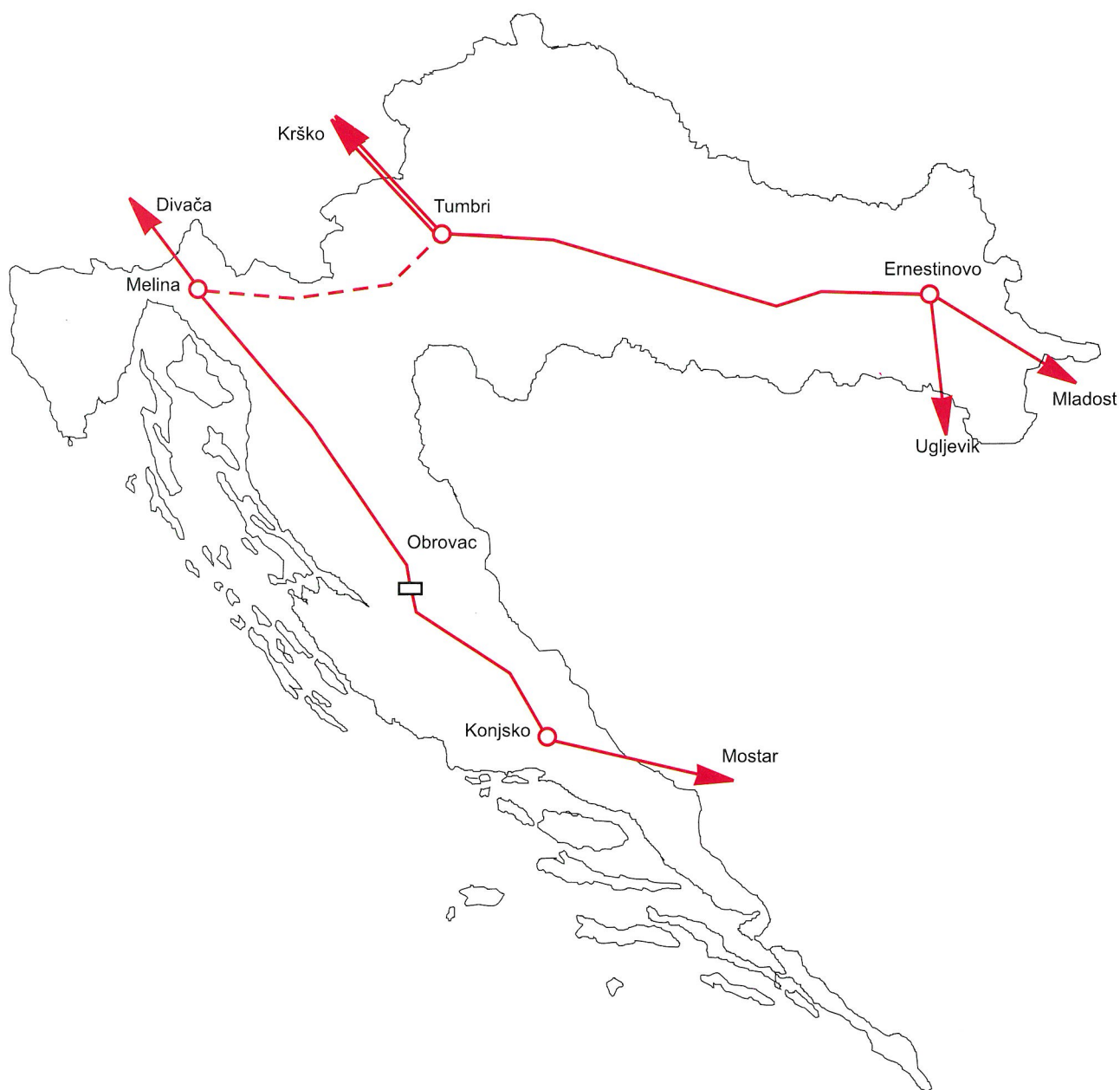












Mreža 400kV Hrvatske pred Domovinski rat

Croatian 400kV grid before of war

Mreža 400 kV Hrvatske pred Domovinski rat

Mreža 400 kV Hrvatske elektroprivrede (HEP), pred Domovinski rat 1991/92. godine, sadržavala je četiri transformatorske stanice gornjeg napona 400 kV. Svaka od tih transformatorskih stanica locirana je u blizini središta potražnje električne energije u četiri glavne makroregije Hrvatske:

- TS 400/110 kV Ernestinovo, u blizini Osijeka
- TS 400/110 kV Tumbri, u blizini Zagreba
- TS 400/220/110 kV Melina, u blizini Rijeke
- TS 400/220/110 kV Konjsko, u blizini Splita.

Te transformatorske stanice međusobno su bile povezane vodovima 400 kV unutar Hrvatske: Ernestinovo-Tumbri i Melina-Velebit-Konjsko. Rasklopna stanica 400 kV Velebit je čvor kojim je na mrežu 400 kV priključena pumpno-akumulacijska hidroelektrana Velebit. Prema susjedima postojali su vodovi 400 kV: Ernestinovo-Mladost (prema Srbiji), Ernestinovo-Ugljevik i Konjsko-Mostar (prema Bosni i Hercegovini), te dvostruki vod 400 kV Tumbri-Krško i vod 400 kV Melina-Divača (prema Sloveniji).

Transformatorske stanice Ernestinovo, Tumbri, Melina i Konjsko puštene su u pogon pod naponom 400 kV u razdoblju 1977-1979. godine, kao i svi spomenuti vodovi 400 kV. Vod 400 kV Melina-Tumbri pušten je u pogon 1992. godine.

U ratu 1991/92. godine, sustavno su razarani - uz sve druge - i objekti prijenosne mreže u Hrvatskoj. TS 400/110 kV Tumbri i TS 400/220/110 kV Konjsko oštećivane su avionskim napadima u jesen 1991. godine, a sanacije učinjenih razaranja su u međuvremenu završene.

TS 400/110 kV Ernestinovo bila je izložena najtežim ratnim razaranja, a otpočela su avionskim raketnim i mitraljeskim napadom 18. rujna 1991. godine, višekratno nastavljana avionskim, tenkovskim i minobacačkim napadima, da bi dana 21. studenog

Croatian 400 kV grid before the war

Before the war from 1991 to 1992, 400 kV grid of Croatian Electric Power Industry (HEP), contained four transforming stations of ceiling voltage of 400 kV. Each of those transforming stations was located in the vicinity of the demand centers of electric power in four main Croatian macro regions:

- 400/110 kV TS Ernestinovo, in the vicinity of Osijek
- 400/110 kV TS Tumbri, in the vicinity of Zagreb
- 400/220/110 kV TS Melina, in the vicinity of Rijeka
- 400/220/110 kV TS Konjsko, in the vicinity of Split

These transforming stations were interconnected by 400 kV lines inside Croatia: Ernestinovo-Tumbri and Melina-Velebit-Konjsko. The switching station Velebit is a node by which the pumped storage power station Velebit is connected to the 400 kV grid. Towards the neighbours there were 400 kV lines: Ernestinovo-Mladost (towards Serbia), Ernestinovo-Ugljevik and Konjsko-Mostar (towards Bosnia and Herzegovina), as well as the double 400 kV line Tumbri-Krško and 400 kV line Melina-Divača (towards Slovenia).

Transforming stations Ernestinovo, Tumbri, Melina and Konjsko, were put into operation under 400 kV voltage in the period from 1977 to 1979, as well as all previously mentioned 400 kV lines. The 400 kV line Melina-Tumbri was put into operation in 1992.

During the war from 1991 to 1992, all the transmission grid objects in Croatia - among other objects - were continuously being destroyed. 400/110 kV TS Tumbri and 400/220/110 kV TS Konjsko were being damaged by air attacks in the fall of 1991, and the reconstruction has, up to the present time, been finished.

400/110 kV TS Ernestinovo was most severely damaged, by air bomb and machine-gun attacks, which started on September the 18th 1991 and which

1991.godine posada Hrvatske elektroprivrede bila primorana napustiti objekt, od kada se on nalazi na privremeno okupiranom području. Nedostupan Hrvatskoj elektroprivredi do sredine 1998.godine.

Stanje TS 400/110 kV Ernestinovo krajem 2001. godine

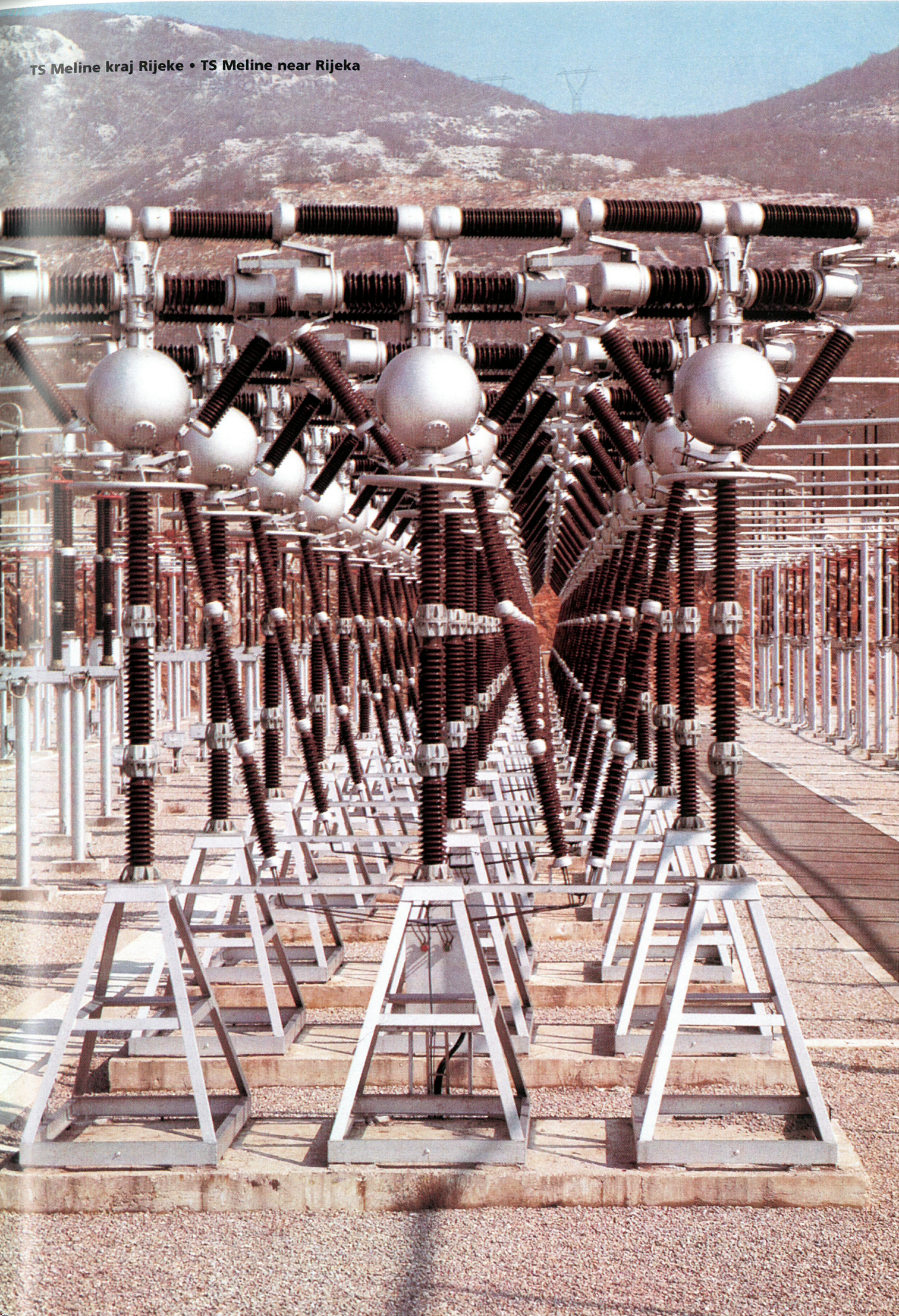
Načinjen je glavni projekt obnove TS Ernestinovo i ponudbena dokumentacija za obnovu, te je objavljen međunarodni javni natječaj za obnovu. Godine 1999. obavljeni su radovi nulte etape obnove: raskrčivanje vanjskog i unutrašnjeg prostora i odvoz razorenog materijala, ograđivanje i uzemljenje ograde, uspostava električnog, vodoopskrbnog i kanalizacijskog priključka. Gradilište je time pripremljeno za obnovu.

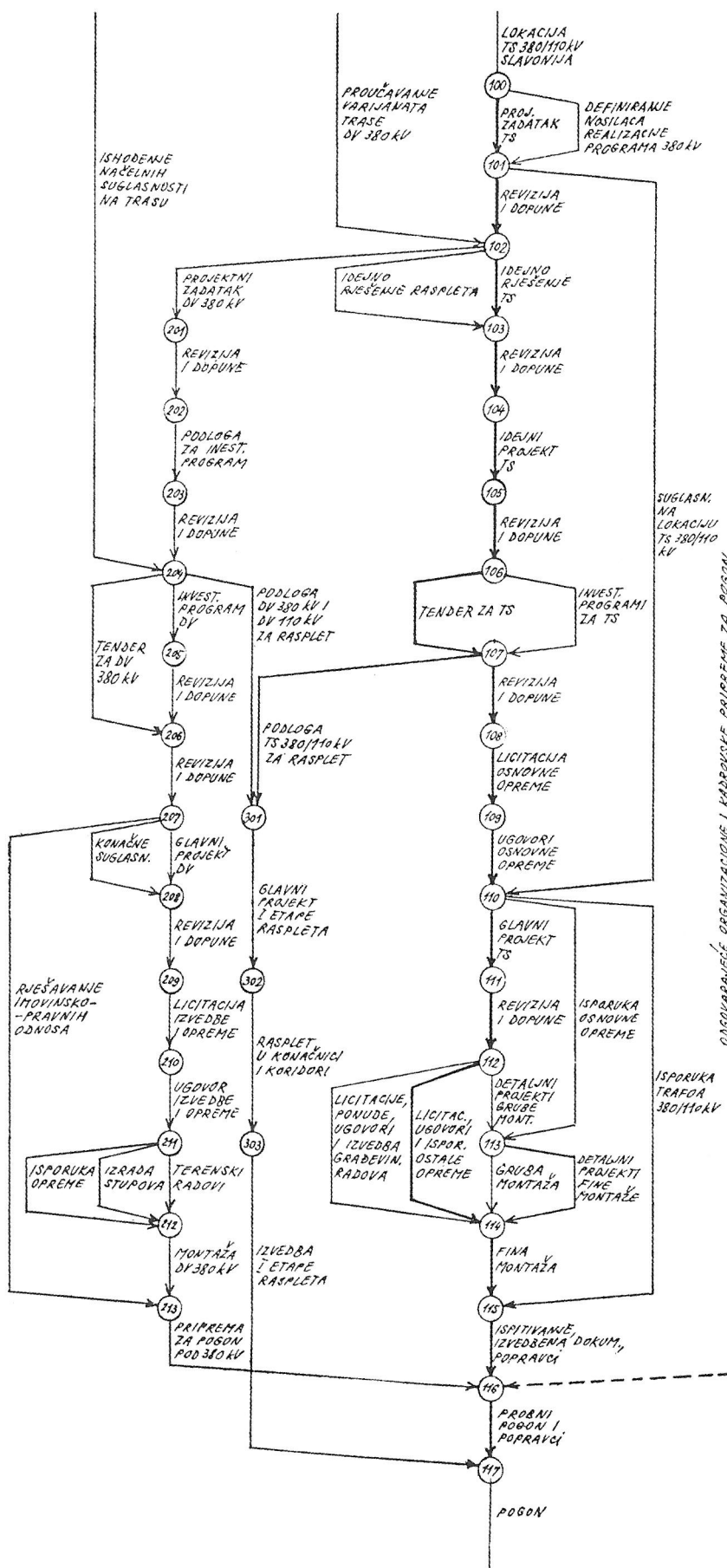
were followed by a series of air, tank and mortar attacks. On November the 21st 1991 the crew of the Croatian Electric Power Industry was forced to abandon the object. This object was inaccessible until mid 1998.

The status of TS 400/110 kV Ernestinovo at the end of the year 2001

The main project for the reconstruction of TS 400/110 kV Ernestinovo was composed, as well as the offer documents, and the international competitive bidding for reconstruction was announced. In 1999 the work of the stage zero was accomplished: unclogging the outer and inner area, carrying off the destroyed material, fencing and grounding the fence, re-establishment of the electric, water-supply and sewerage lines. The building site was thereby prepared for the reconstruction.

TS Meline kraj Rijeke • TS Meline near Rijeka





Pripreme za izgradnju TS 400/110 kV Ernestinovo

Godine 1970., na savjetovanju CIGRE u Dubrovniku prihvaćena je inicijativa o izgradnji mreže 380 kV tadašnje Jugoslavije ("prstena" 380 kV, kako se tada govorilo), ukupne duljine dalekovoda od oko 2700 km s odgovarajućim brojem transformatorskih stanica tog napona.

Godine 1971. grupa stručnjaka tadašnje Elektroslavonije-Osijek obišla je dalekovode i transformatorske stanice napona 380 kV koji su već bili u korištenju, od HE Đerdap do Beograda, radi upoznavanja tehničkih osobitosti.

Godine 1972. utvrđene su osnove rješenja mreže 380 kV u Slavoniji i Baranji, te formulirani projektni zadaci za projektiranje TS 380/110 kV Ernestinovo i tri dalekovodne dionice 380 kV ukupne duljine trasa oko 200 km na tom području. Načinjen je mrežni plan aktivnosti, a u ožujku je objavljeno da će izgradnja (projektiranje, dobava opreme, građevinski i montažni radovi) trajati 68 mjeseci. (Zavidno točna procjena: do puštanja u pogon početne etape izgradnje proći će 64 mjeseca.)

Tijekom godine došlo je do namjenskog povećanja cijene električne energije, što će osigurati domaći udjel u financiranju izgradnje, a Međunarodna banka za obnovu i razvoj odobrila je zajam od 75 milijuna US-dolara (to je bilo oko 1/3 ukupne planirane vrijednosti mreže 380 kV u tadašnjoj Jugoslaviji).

Godine 1973. obavljen je detaljni helikopterski obilazak potencijalnih varijanata trase voda 380 kV od Ernestinova prema Zagrebu, radi utemeljenog izbora najpovoljnije. Raspisane su međunarodne licitacije za krupnu opremu i oglašeno je prikupljanje ponuda za domaću opremu. Obavljeno je aerofotogrametrijsko sni-

Preparations for the construction of the TS 400/110 kV Ernestinovo

In 1970, at CIGRE counseling in Dubrovnik, the former Yugoslavia initiatives, for the construction of 380 kV grid, 2700 km long and containing the adequate number of transforming stations, (referred to as the 380 kV "ring") were accepted.

In 1971, a group of experts from Elektroslavonija-Osijek visited the lines and the 380 kV transforming stations, which were already being utilized, from hydroelectric power plant Đerdap to Belgrade, in order to get familiarized with the technical features.

In 1972, the basic solutions for the 380 kV grid in Slavonia and Baranya were established and the project assignments for the design of 380/110 kV TS Ernestinovo and three 200 km long, 380 kV line sections were drawn up. The network schedule of activities was completed and it was declared in March that the construction (design, equipment, supply, building and mounting work) would last 68 months, from that moment. (Enviably precise assessment: until putting the first part of the building into operation 64 months passed.)

During the year there was a specific purpose increase in the cost of electric energy, which insured the domestic part in financing the building, and the International Bank for Reconstruction and Development approved a loan of 75 million US-dollars (that was roughly one third of the overall planned value of the 380 kV grid in former Yugoslavia).

In 1973, a detailed helicopter tour of the potential variants of the 380 kV line route from Ernestinovo to Zagreb was made, in order to choose the most agreeable one. The international auctions for massive equipment were officially announced, as well as the invitation of tenders for domestic equipment.

manje recentnog stanja na lokaciji TS Ernestinovo. U tijeku je projektiranje TS Ernestinovo i vodova 380 kV. Stručnjaci Elektroslavonije i projektanti iz poduzeća Elektroprojekt-Zagreb obišli su nekoliko postrojenja u Švicarskoj i Italiji, radi stjecanja iskustava pri izgradnji, pogonu i održavanju.

U ožujku 1974. godine, nakon dvije godine tehničkih, imovinsko-pravnih, novčanih i organizacijskih priprema, izjavljujemo u novinama: "Izgradnja može početi!". Odjel za izgradnju mreže 380 kV, koji je to vodio, imao je tada 6 ljudi, da bi do intenziviranja radova narastao na 14 ljudi.

Na dalekovodima će se iskopati 20 tisuća kubika tla i ugraditi 4600 tona čelično-rešetkaste konstrukcije stupova, koji će nositi fazne vodiče i zaštitnu užad ukupne mase oko 2800 tona, a TS Ernestinovo imat će površinu veću od 10 hektara. Na 200 kilometara vodova 380 kV riješit će se ukupno oko 1000 imovinsko-pravnih slučajeva.

Furthermore, the aerophotographical shooting of the recent state at the TS Ernestinovo was published. The design of TS Ernestinovo and the 380 kV lines was in progress. The experts from Elektroslavonija and the planning engineers from Elektroprojekt-Zagreb visited several facilities in Switzerland and Italy, in order to acquire experience in building, operation and maintenance.

In March 1974, two years after the technical, proprietary-legal, financial and organizational preparations, we announced in the newspaper: "The Construction Can Start!" The department in charge of the 380 kV grid construction, counted 6 people back then, but this number increased to 14 up to the intensification of the work.

On the lines, 20 thousand cubic meters of soil were dug out and 4600 tons of steel wire-netting pillar construction to carry phase conductors and earth wires of the overall mass of 2800 tons were built in. Moreover, TS Ernestinovo took up an area larger than 10 hectares. On 200 kilometers of 380 kV lines, around 1000 proprietary-legal cases were solved.

Izgradnja TS 400/110 kV Ernestinovo i dionica vodova 400 kV

Radovi na terenu počeli su u travnju 1974. godine, a 8. lipnja polaže se kamen temeljac na radilištu prvog stupa dalekovoda 400 kV. Mreža dobiva novo ime: 400 kV, umjesto 380 kV. Do kraja godine podignuto je prvih 50 stupova.

Pred Božić 1974. godine, može se prvi put prijeći izgrađenim pristupnim mostom preko kanala Seleš do radilišta TS Ernestinovo. Građevinske radove, započete 17. listopada, izvodi u potpunosti poduzeće Gradnja-Osijek.

Godine 1975. razvijaju se građevinski radovi na TS Ernestinovo, a u Pomoćnim djelatnostima Elektroslavo-nije-Osijek počinje izrada čeličnih postolja aparata i priprema montaže. U studenom, poduzeće Dalekovod-Zagreb potpuno je dovršilo izgradnju dalekovodnog poteza Šid-Ernestinovo-Kamensko, ukupne duljine oko 150 km. Počela je izgradnja posljednje dionice mreže 400 kV na području Slavonije i Baranje: Ernestinovo-Sava, još daljnjih 50 km. Glavne projekte svih dalekovodnih dionica 400 kV, kao i raspleta vodova 110 kV oko TS Ernestinovo izradio je Dalekovod-Zagreb.

U ožujku 1976. godine, na gradilište TS Ernestinovo, pristigao je prvi transformator 400/110 kV, 300 MVA proizvodnje Končar-Zagreb. Transportnu masu od oko 200 tona svladala je željeznica od Zagreba do Brijesta u blizini Osijeka, a potom cestovni tegljač Hidromontaže-Maribor od Brijesta do Ernestinova.

Glavni projekt TS Ernestinovo izradio je Elektroprojekt-Zagreb, a izvedbene projekte izrađuje Elektroslavonijaprojekt, sukladno dobavljenoj opremi i potrebama gradilišta.

The construction of TS 400/110 kV Ernestinovo and 400 kV lines' sections

The fieldwork began in April 1974, and on June 8th the foundation stone was laid down, at the construction site of the first 400 kV line tower. The grid was given a new name: 400 kV grid, instead of 380 kV. By the end of the year the first 50 towers were mounted.

Just before Christmas in 1974, it was possible to cross the finished access bridge over the Seleš channel, to get to the construction site of TS Ernestinovo. All the construction work, which started on October 17th, was conducted by the company Gradnja-Osijek.

In 1975, the construction work at TS Ernestinovo was progressing, and in Ancillary Activity Departments of Elektroslavonija-Osijek the steel bases were being built and the mounting was being prepared. In November, the company Dalekovod-Zagreb completely finished the construction of line section Šid-Ernestinovo-Kamensko, 150 km long. The construction of the last section of the 400 kV grid in the area of Slavonia and Baranya was on track: Ernestinovo-Sava, another 50 km. The main projects of all 400 kV lines sections, as well as 110 kV lines outcome around TS Ernestinovo, were built by Dalekovod-Zagreb.

In March 1976, at the TS Ernestinovo construction site, the first 400/110 kV transformer, 300 MVA, manufactured by Končar-Zagreb, arrived. The transport mass of 200 tons was mastered by the railway from Zagreb to Brijest, near Osijek, and from there on by road tow of Hidromontaža-Maribor from Brijest to Ernestinovo.

The main project TS Ernestinovo was made by Elektroprojekt-Zagreb, and the implementation projects by Elektroslavonija-projekt, according to the equipment furnished and the requirements of the

Primarnu opremu isporučio je skoro u potpunosti Končar-Zagreb. Montažu svih primarnih i sekundarnih postrojenja izvode Pomoćne djelatnosti Elektroslavonije-Osijek (ukupno je na razne načine angažirano stotinjak radnika i stručnjaka tog pogona), osim portala za zavješanje vodova 400 i 110 kV, koje izvodi Dalekovod-Zagreb, te dijelova postrojenja 0,4 kV koje je izvelo poduzeće Elos-Osijek.

U lipnju 1976. godine dovršena je dalekovodna dionica Ernestinovo-Sava.

Dana 26.srpnja 1977.godine puštena je u pogon početna etapa ("mini-etapa", tako smo je zvali) izgradnje TS 400/110 kV Ernestinovo: vod 400 kV iz TE Obrenovac, jedan transformator 300 MVA i dio priključenih vodova 110 kV. Nadzor i upravljanje poljima koja su tada u korištenju izvodi se iz relejnih kućica, "na telefon". Građenje i opremanje komandne zgrade nije još okončano.

Tijekom 1978. godine, uz pogon TS Ernestinovo postupno se građevinski i montažno zgotovljuju pojedine podcjeline, tvoreći projektirano cjelovito rješenje. Ostvaruje se pogon voda 400 kV Ernestinovo-Tumbri (maksimalno ostvareno opterećenje u prvoj godini pogona je 436MW) i Ernestinovo-Ugljevik. Montiran je drugi transformator 300 MVA. Daljinsko upravljanje iz Centra daljinskog upravljanja Osijek ostvarit će se 1980.godine.

Ukupna okončana vrijednost objekata mreže 400 kV na području Slavonije i Baranje je oko 30 milijuna US-dolara.

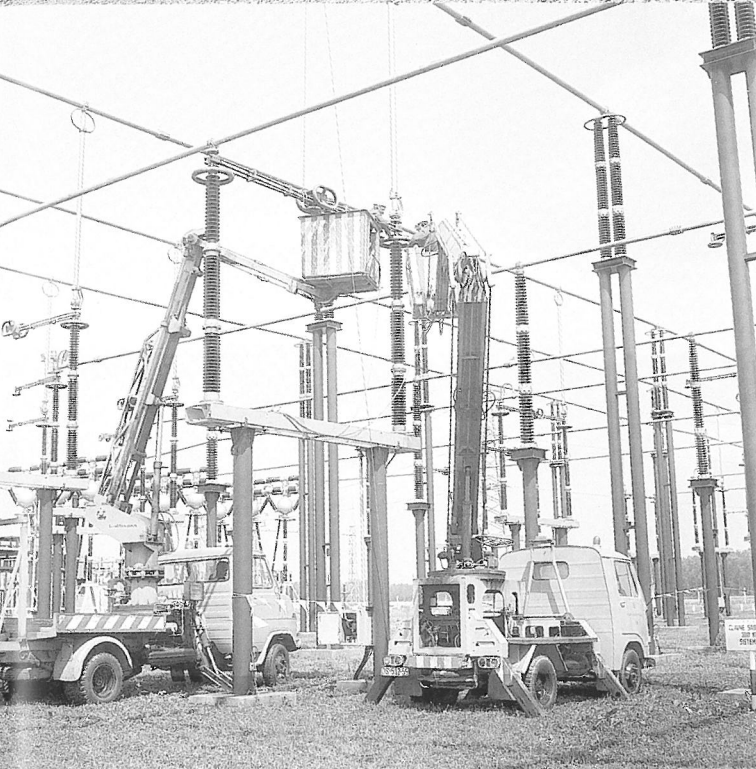
construction site. The primary equipment was almost entirely provided by Končar-Zagreb. The mounting of all primary and secondary facilities was conducted by Ancillary Activity Departments of Elektroslavonija-Osijek (altogether, about a hundred of workers and experts of that department were engaged), except for the portal for the suspension of 400 and 110 kV lines, done by Dalekovod-Zagreb and the parts of 0,4 kV facilities, done by the company Elos-Osijek.

In July 1976 the power-transmission line section Ernestinovo-Sava was finished.

On the 26th of July 1977, the initial phase (referred to as the "mini-phase") of the 400/110 kV TS Ernestinovo construction was put into operation: 400 kV line from TPS Obrenovac, one 300 MVA transformer and a part of the connected 110 kV lines. Supervision and control of the feeders in use were conducted from the relay stations "over the phone". The construction and fitting of the command building was still not finished.

Through 1978, together with TS Ernestinovo, individual subsections were being constructed and mounted, creating the complete designed result. The operation of 400 kV line Ernestinovo-Tumbri (the maximum load achieved in the first year of operation was 436MW) and Ernestinovo-Ugljevik was accomplished. The second 300 MVA transformer was mounted. The remote control from the Center for Remote Control in Osijek was realized in 1980.

The total end value of the 400 kV grid facilities in the area of Slavonia and Baranya was around the then 30 million US-dollars.





Korištenje TS 400/110 kV Ernestinovo do Domovinskog rata

TS Ernestinovo koristi se u razdoblju 1977. do 1991. godine uz redoviti pogon i održavanje, te uz dogradnju 5 novih vodnih polja na strani 110 kV.

U doba malog opterećenja (ljeti) uključuju se prigušnice za sniženje napona, priključene na tercijarne namote 30 kV glavnih energetske transformatora 300 MVA. Jedna priključena prigušnica od 50 Mvar snizuje napon za oko 3,5 kV, a dvije takve prigušnice za oko 7 kV na strani 400 kV.

Maksimalno ostvareno opterećenje transformatora 2x300 MVA u TS Ernestinovo je 346MW (1988. godine). Maksimalno opterećenje voda 400 kV Ernestinovo-Mladost bilo je 1,25GVA. Karakteristično za prienosnu mrežu u Slavoniji i Baranji bilo je to da je na jedan kilovatsat dobavljen radi potrošnje na vlastitom području, još jedan do dva kilovatsata tranzitirano za druga područja preko prienosne mreže u Slavoniji i Baranji.

Korištenje TS Ernestinovo, u razdoblju od 1977. do 1991. godine, proteklo je uz dvije velike havarije: požar transformatora 400/110 kV u 1980. godini i unutrašnji proboj transformatora 400/110 kV u 1984. godini. Obnova TS Ernestinovo temelji se i na poukama iz tih havarija (viši stupanj izolacije tercijarnog namota transformatora 300 MVA, izostanak vanjskog korištenja tercijarnih namota, obilazni put za vatrogasna vozila oko transformatora).

The utilization of TS 400/110 kV Ernestinovo before the war

TS Ernestinovo was utilized in the period from 1977 to 1991 along with the regular operation and maintenance, and with an additional building of 5 new line feeders on the 110 kV side.

During minor load (in summer) the reactors for the voltage regulation, which are connected to the 30 kV tertiary windings of the 300 MVA power transformers, are turned on. One connected 50 Mvar reactor lowers the voltage for about 3,5 kV, and two such reactors for about 7 kV on the 400 kV side.

The maximum accomplished 2x300 MVA transformer load of the TS Ernestinovo was 346MW (in 1988). The maximum load of the 400 kV line Ernestinovo-Mladost was 1,25GVA. Typical of the transmission grid in Slavonia and Baranya was the fact, that in one supplied kilowatt-hour, for the consumption in the own area, another one to two kilowatt-hours were transited to other areas through the transmission grid in Slavonia and Baranya.

The utilization of TS Ernestinovo, in the period from 1977 to 1991, went by with two big damages: fire of the 400/110 kV transformer in 1980, and the internal breakdown of the 400/110 kV transformer in 1984. The reconstruction of the TS Ernestinovo is based on the knowledge drawn from these damages (higher degree of 300MVA transformer tertiary winding isolation, absence of the outer utilization of the tertiary windings, a roundabout way for the fire brigade vehicles, round the transformers).

Pred Domovinski rat, 1991.godine, stanje opremljenosti TS Ernestinovo prikazano je tablicom.

Dio postrojenja	400 kV	110 kV	35 kV	30 kV
Vodna polja	3	12	3	-
Trafo-polja	2	2	2	4
Spojna polja	2	1	1	1
Kompenzacijska polja	-	-	-	2
Mjerna polja	-	-	1	1
Ukupno opremljena polja	7	15	7	8
Ukupno mogući broj polja	13	23	7	10
Transformatori (MVA)	2x300	-	2x1	2x0,8
Prigušnice (Mvar)	-	-	-	2x50
Dizel-električni agregati	2x240 kVA			
Akumulatorske baterije	2x(220V,240Ah)+2x(48V,240Ah)			
Kompresorsko postrojenje	4 kompresora 200bara			
Telekomunikacije	14 VF-veza sa 16 kanala 1 usmjerena radio-veza 1 VF-veza u zaštitnom užetu 1 automatska telefonska centrala			

The quantity of equipment of TS Ernestinovo before the war, in 1991, is shown in the chart.

Part of the switchgear	400 kV	110 kV	35 kV	30 kV
Line feeders	3	12	3	-
Transformer feeders	2	2	2	4
Bus couplers	2	1	1	1
Shunt reactor feeders	-	-	-	2
Measuring feeders	-	-	1	1
Total of equipment feeders	7	15	7	8
Total of possible number of feeders	13	23	7	10
Transformers (MVA)	2x300	-	2x1	2x0,8
Reactors (Mvar)	-	-	-	2x50
Diesel-electric agregats	2x240 kVA			
Accumulator batteries	2x(220V,240Ah)+2x(48V,240Ah)			
Compressor gear	4 units of 200bar compressors			
Telecommunications	14 powerline carrier with 16 channels 1 usmjerena radio-veza 1 VF-veza u zaštitnom užetu 1 automatska telefonska centrala			

Ratna razaranja TS 400/110 kV Ernestinovo

U ratu 1991/92. godine zbili su se brojni avionski, tenkovski i minobacački napadi na TS Ernestinovo. Navodimo samo one za koje postoje zapisnici o razaranju iz onoga vremena.

- 18.09.1991 - avionsko razaranje u 11.37 sati raketama i mitraljiranjem platoa postrojenja na kojem su radili radnici; jedan radnik ranjen. Glavna oštećenja u postrojenju 400 kV: jedan energetski transformator 400/110 kV, šest od ukupno sedam prekidača, 16 od ukupno 25 rastavljača, 30 potpornih izolatora, 3 strujna mjerna transformatora, 1 naponski mjerni transformator, 1 odvodnik prenapona.
- 19.09.1991 - u trafostanici boravilo oko 40 ljudi radi sanacije jučerašnjih oštećenja, oko 16.30 sati ponovno avionsko razaranje s ukupno 16 projektila: oštećenje drugog transformatora 400/110 kV i komandne zgrade, 5 rastavljača 400 kV, 35 potpornih izolatora 110 kV, jedan rasvjetno-gromobranski stup slomljen, izgorjelo vozilo s hidrauličkom korpom, oštećeno terensko vozilo.
- 13.10.1991 - snažno minobacačko razaranje iz okolice, otpočelo oko 17.30 sati. Velika oštećenja dva polja 400 kV, jednog transformatora 400/110 kV, sabirnica 110 kV i 6 polja 110 kV. U pogonu ostalo samo 5 vodova 110 kV.
- 28.10.1991 - prijeteće avionsko nadlijetanje oko 14 sati dok je na objektu bilo više radnika, zaposlenih sanacijskim radovima, i avionsko mitraljesko djelovanje izvan trafostanice.
- 05.11.1991 - minobacački pogoci oko 9,23 sata u blizini komandne zgrade. Oštećenja antenskog stupa, telefonske centrale, komandne ploče, akumulatorskog prostora. Jedini preostali 110 kV vod prema Osijeku ispaao iz pogona.
- 21.11.1991 - žestoke borbe u neposrednoj okolini, prisilno napuštanje trafostanice.

Od tada se TS Ernestinovo nalazi na privremeno okupiranom području. Razaranja se nastavljaju,

War destructions of TS 400/110 kV Ernestinovo

During the war from 1991 to 1992 a number of air, tank and mortar attacks on TS Ernestinovo took place. We are listing only those, which were recorded in writing.

- 18.09.1991 - air-raid destructions at 11.37 by air bombs and shooting at the plateau of the switchgear on which workers were working; one worker was wounded. Main damage in the 400 kV switchgear: one 400/110 kV power transformer, six of seven circuit breakers, sixteen of twenty-five isolators, thirty supporting insulators, three current measuring transformers, 1 voltage measuring transformer, 1 surge arrester.
- 19.09.1991 - in the transformer station there were about forty people repairing the damage done the previous day. Around 16.30 h another air bomb destruction by altogether sixteen missiles took place: damage of the other 400/110 kV transformer and the command building, five 400 kV isolators, thirty-five 110 kV supporting insulators, one light and lightning-conductor tower was torn down, a vehicle with a hydraulic basket was burned, one field vehicle was damaged.
- 13.10.1991 - a severe mortar destructions from the nearby area, started at 17.30 h. Great damage of the two 400 kV feeders, one 400/110 kV transformer, a 110 kV busbar and six 110 kV feeders. There were only five 110 kV lines in operation.
- 28.10.1991 - threatening overflights around 2 p.m. while there were many workers on the site, working on the repair works, followed by a series of machine-gun actions outside the transforming station.
- 05.11.1991 - mortar hits around 9.23 h in the vicinity of the command building. Damage of the antenna tower, telephone exchange, command board and the battery room. The only left 110 kV line towards Osijek was now out of operation.
- 21.11.1991 - severe fights in the immediate vicinity, forced abandonment of the transforming station.





do smirivanja 1992.godine, kada je područje došlo pod zaštitu snaga Ujedinjenih naroda, u UNPA-zoni E. Nakon toga, daljnja devastacija odvija se pljačkom materijala i opreme s objekta. Do 15. siječnja 1998. godine TS Ernestinovo nalazilo se pod upravom Prijelazne administracije UN za istočnu Slavoniju (UNTAES).

Utvrđena razorenost i opljačkanost objekta je oko 85%, te za njegovu obnovu treba uložiti skoro isto toliko sredstava kao za izgradnju novog objekta.

Potpuno je uništena ili opljačkana doslovno sva električna oprema. Čelična konstrukcija je devastirana bezbrojnim pogocima raspršenih projektila, temelji aparata i uzemljivačka mreža su uglavnom ušćuvani, a zgrade imaju približno 25%-tnu oštećenost osnovne strukture, uz potpunu devastaciju unutrašnjeg uređenja. Niti metar od ukupno oko 100 kilometara signalnih kabela nije ostao u kabelskim kanalima. Svi bakreni zemljovodi odrezani su do ulaska u tlo, a u zgradama čupani su dijelovi električnih instalacija iz zidova.

Praktički: ušćuvan je tlocrt, ušćuvan je prostor raspleta vodova 400 i 110 kV (uz mnoge srušene stupove u tom raspletu), saobraćajnice (osim srušenog glavnog pristupnog mosta preko kanala Seleš) i dijelom ono što je bilo ispod razine tla.

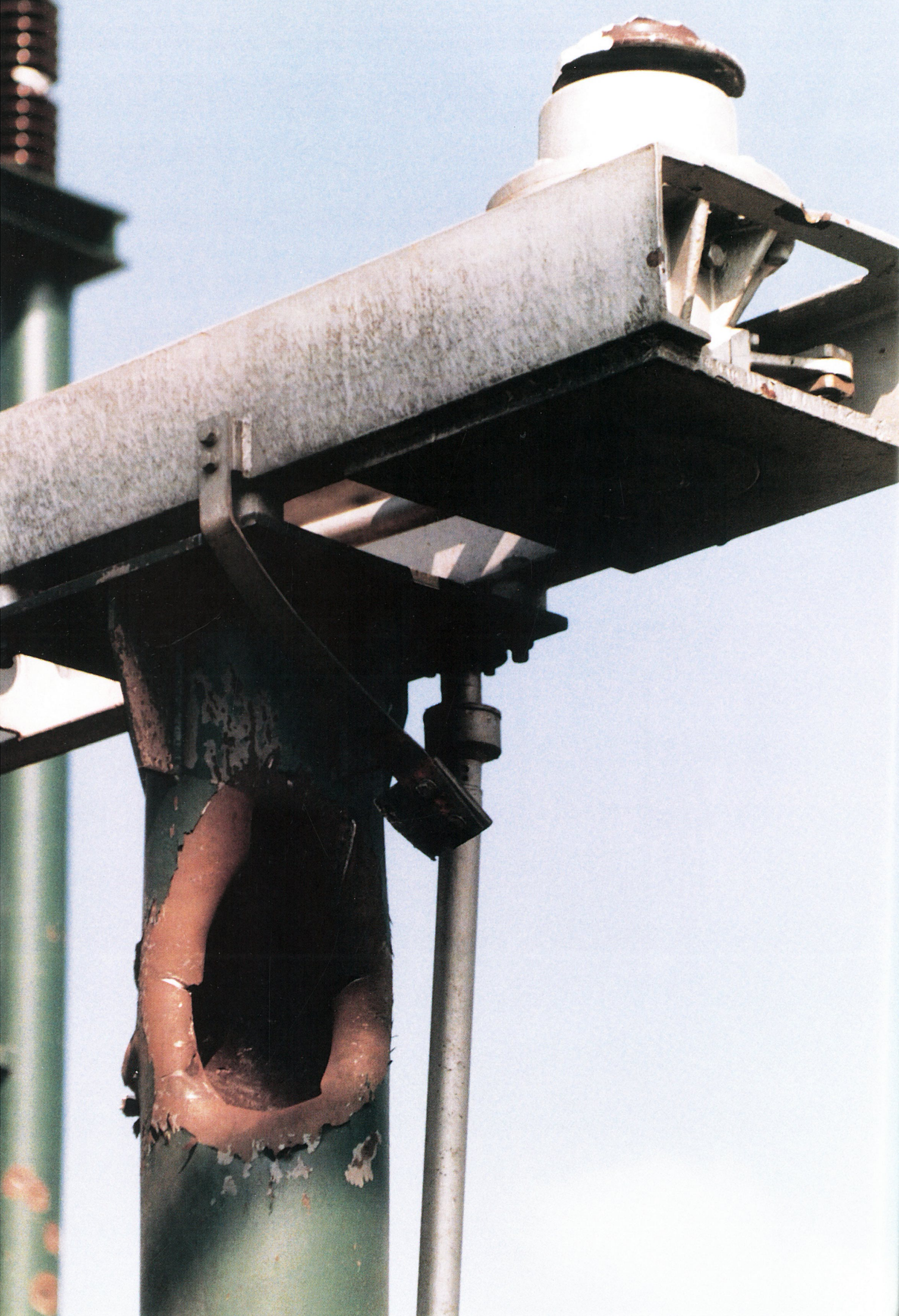
Since then, TS Ernestinovo was located in the temporarily occupied area. The destructions went on, until the pacification in 1992, when this area was put under the protection of UN forces, in UNPA-zone E. After that, further devastation took place, i.e. plundering of the equipment and the material from the object. Until the 15th of January 1998 TS Ernestinovo was under the management of the UN Transitional Administration for Eastern Slavonia (UNTAES).

The determined destruction and devastation of the object was 85%, and for its reconstruction as many means, as for the construction of a new object, should thus be invested.

Almost all electric equipment was destroyed and/or stolen; the steel construction was devastated by innumerable hits by missile pieces; the device foundation and the grounding network were mostly preserved, and the buildings showed about 25% damage of the main structure, followed by a complete devastation of the interior space. Not even a meter of the total 100 kilometers of signal cables was left in the cable channels; all copper grounding connectors were cut to the point of entering the ground, and in the buildings, the parts of the electrical installations were torn out of the walls.

Basically: the layout was preserved, as well as the area of 400 and 110 kV lines outcome (among many broken towers in that outcome), the roads (except the destroyed main access bridge over the Seleš channel) and partly what was under the ground level.



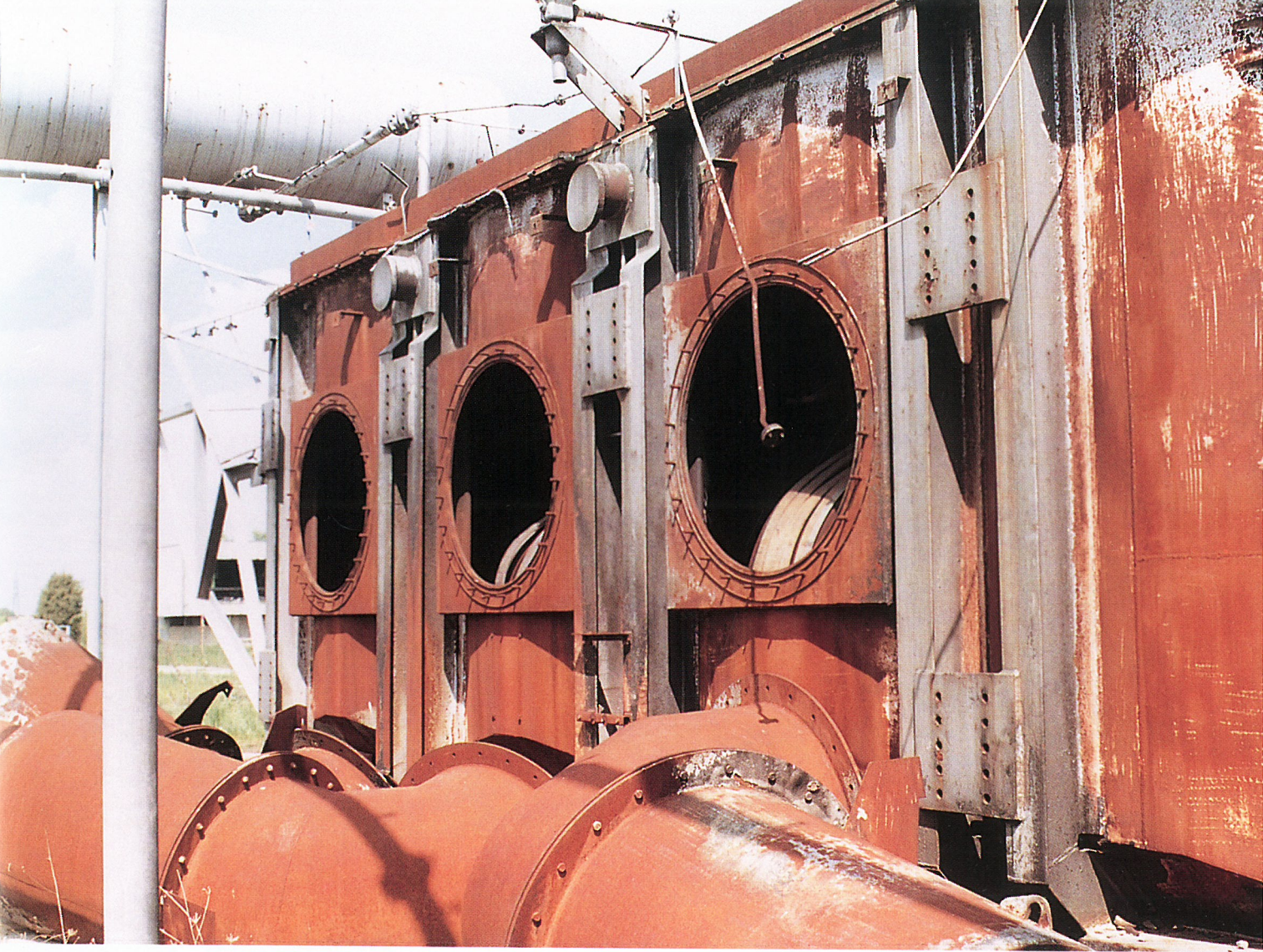




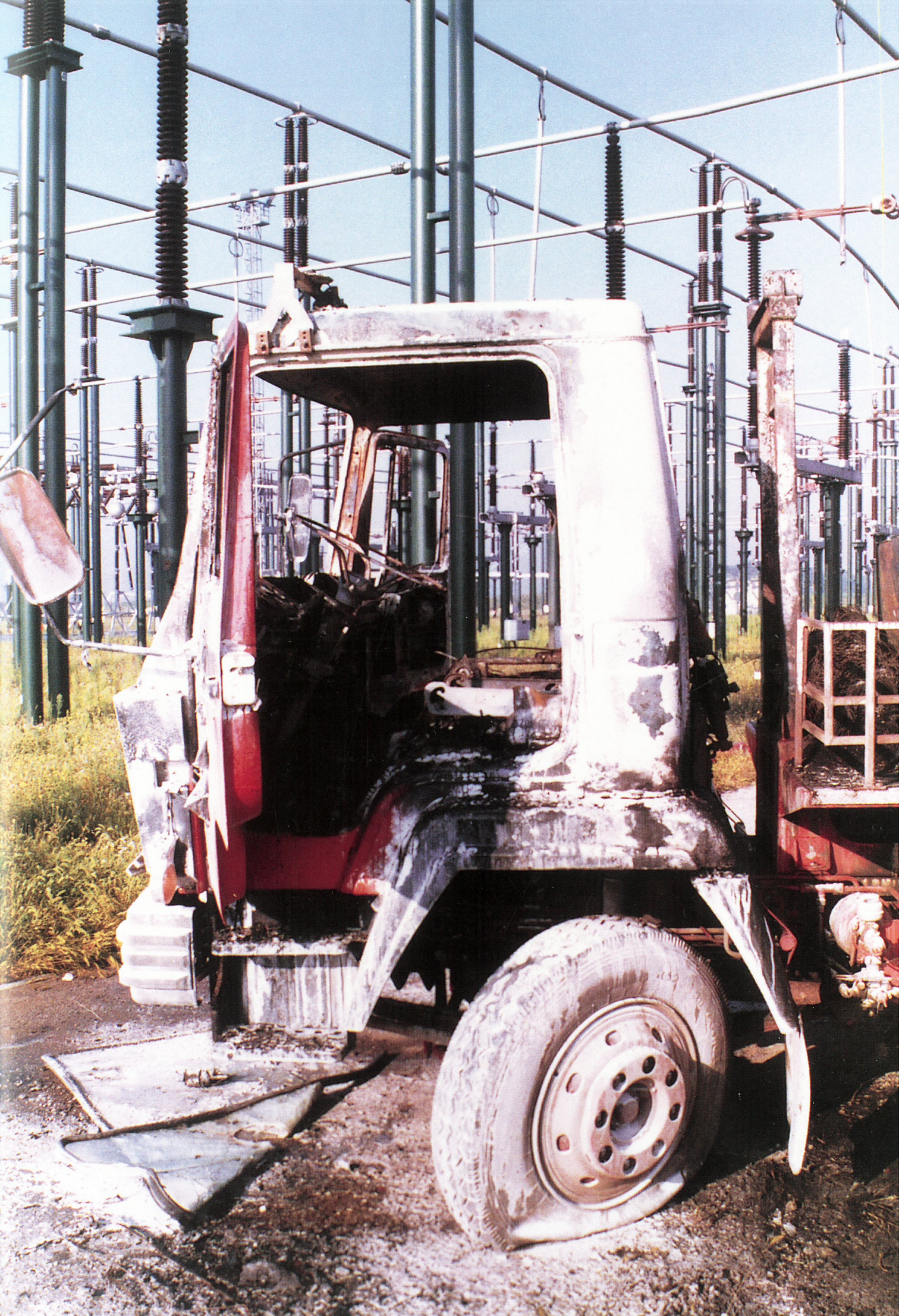






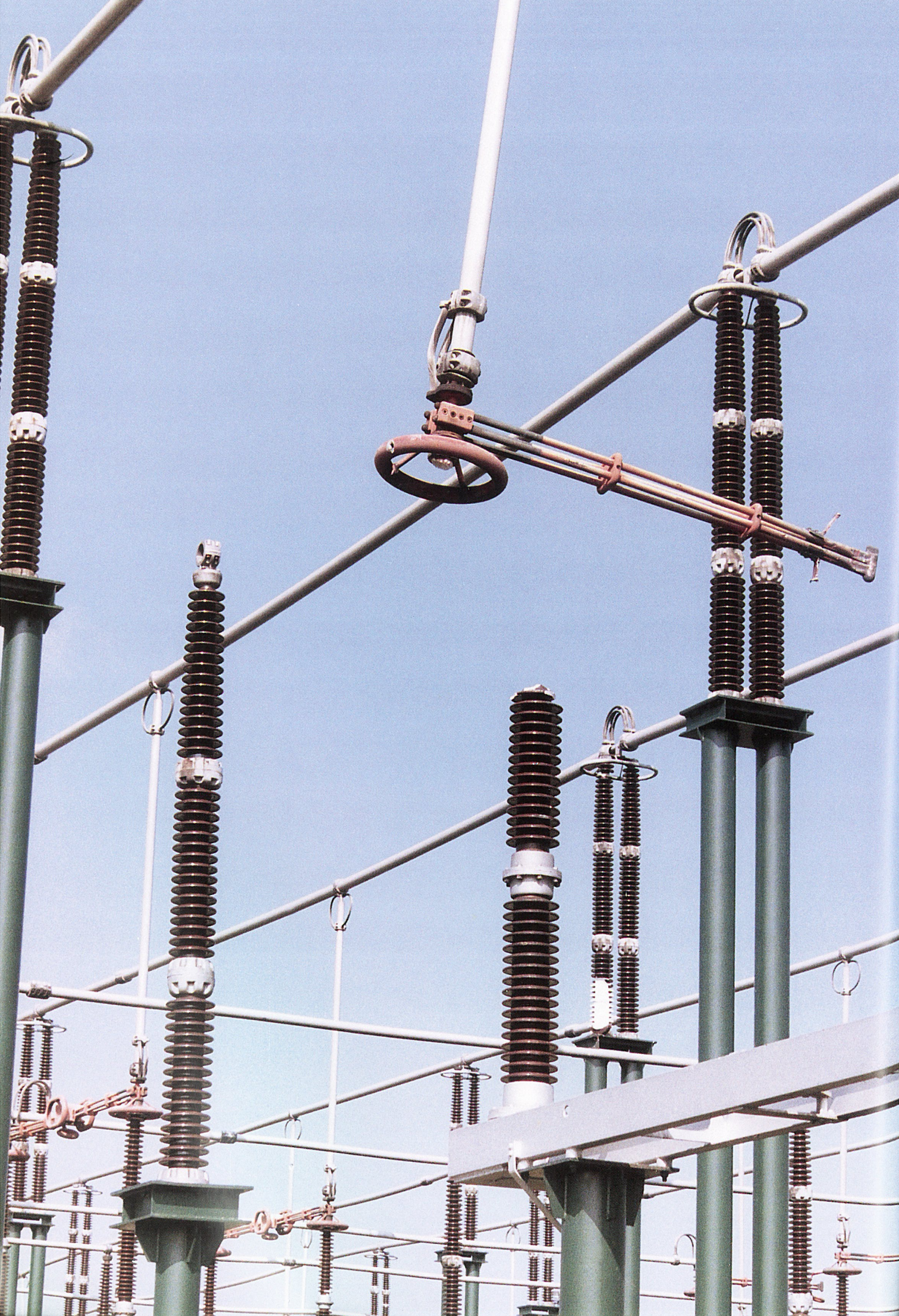




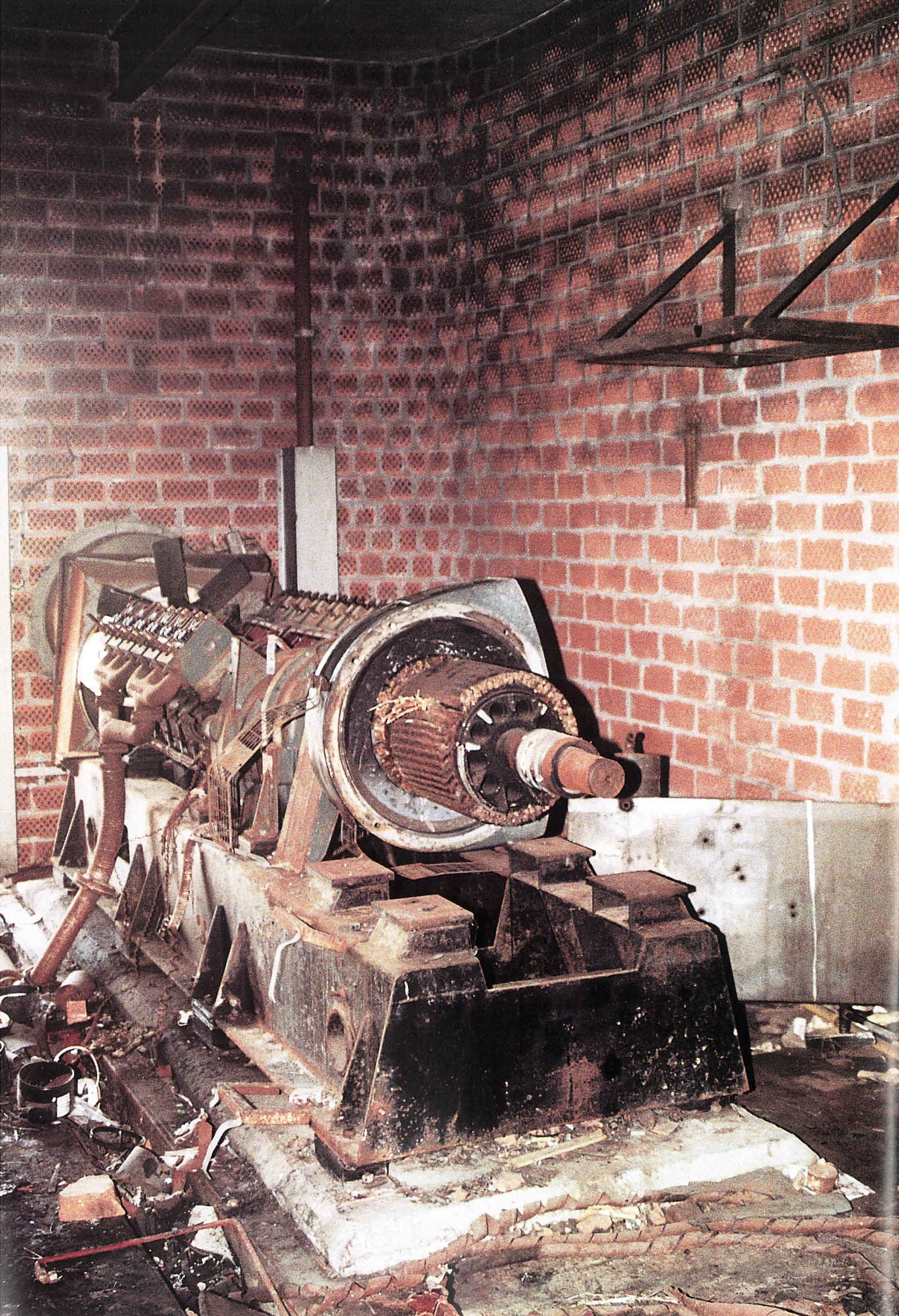


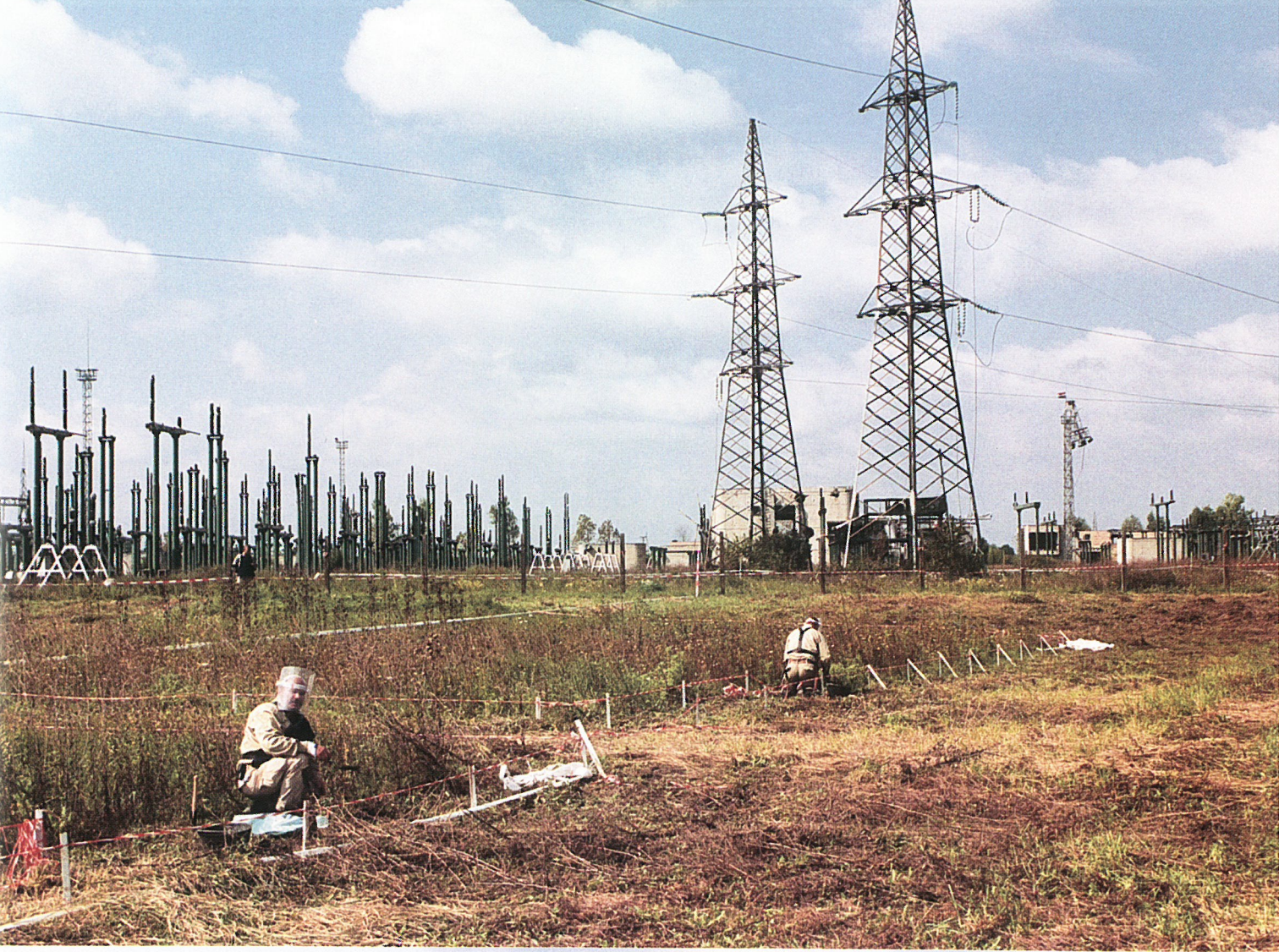
















Prijenosna mreža na području Slavonije i Baranje nakon obnove TS 400/110 kV Ernestinovo

Prijenosna mreža u Slavoniji i Baranji bit će povezana s elektroenergetskim sustavom Hrvatske vodom 400 kV Ernestinovo-Žerjavinec. Također, obnovit će se vodovi na razini 400 kV prema Srbiji (Mladost) i prema Bosni i Hercegovini (Ugljevik). Izgradit će se dvostruki vod 400 kV Ernestinovo-Pecs.

Na razini 220 kV, TS 220/110 kV Đakovo povezana je s dva voda 220 kV, prema Tuzli i prema Gradačcu.

Na razini 110 kV mreža je povezana s jedinom javnom elektranom na tom području - Termoelektranom-toplanom Osijek, instalirane snage 95 MW. Također postoje vodovi prema središnjoj Hrvatskoj: Virovitica-Slatina i Nova Gradiška-Požega, prema Mađarskoj vod 110/120 kV Donji Miholjac-Siklos, prema Bosni vodovi: Slavonski Brod 2-Bosanski Brod i Županja-Orašje, te vodovi Nijemci-Šid i Beli Manastir-Apatin, prema Srbiji.

Karakteristično za mrežu 110 kV jeste to da su sve transformatorske stanice 110/35 kV priključene s barem dva voda 110 kV, da je ukupna instalirana snaga transformatora 110/35 kV skoro dva puta veća od sadašnje vršne potražnje, te da je ukupna snaga moguće dobave u mrežu 110 kV oko tri puta veća od sadašnje vršne potražnje, dakako nakon obnove TS Ernestinovo.

U dalekoj, ali sagledivoj budućnosti, treba razmišljati o mogućoj dogradnji mreže 400 kV između Drave i Save s posavskim ili podravskim dvostrukim vodom 400 kV, eventualno udvostručenje vodova prema jugu i istoku (pored sadašnjih Ugljevik i Mladost), te dva voda za priključak eventualno izgrađene snažne elektrane u Osijeku ili na Dunavu. U tako udaljenijem vremenu, moguće je sagledavati i prelazak TS

Slavonian and Baranyan transmission grid after the reconstruction of TS 400/110 kV Ernestinovo

The transmission grid in Slavonia and Baranya will be connected to the electric power system of Croatia with the 400 kV line Ernestinovo-Žerjavinec. Furthermore, the lines at the 400 kV level towards Serbia (Mladost) and Bosnia and Herzegovina (Ugljevik) will be restored. A double 400 kV line Ernestinovo-Pecs will be constructed.

At the 220 kV level, 220/110 kV TS Đakovo is connected by two 220 kV lines, towards Tuzla and towards Gradačac.

At the 110 kV level, the grid is connected with the only public power plant in that area - District heating power plant Osijek, of the installed power of 95 MW. There are also lines towards central Croatia: Virovitica-Slatina and Nova Gradiška-Požega, a 110/120 kV line Donji Miholjac- Siklos towards Hungary, the following lines towards Bosnia: Slavonski Brod 2-Bosanski Brod and Županja-Orašje, and the lines Nijemci-Šid and Beli Manastir-Apatin, towards Serbia.

It is typical for a 110 kV grid that all 110/35 kV transforming stations are connected by at least two 110 kV lines, and that the overall installed power of the 110/35 kV transformer is almost twice as big as the present peak demand, and that the overall power of the possible 110 kV grid supply is about three times bigger than the present peak demand, after the reconstruction of TS Ernestinovo, of course.

In the further future, a possible adding to the 400 kV grid between Drava and Sava with double 400 kV Sava- or Drava-valley line should be considered, as well as the possible doubling of the lines towards South and East (over the current Ugljevik and Mladost), as well as two lines for connecting possibly built powerful power plants in Osijek or on Dunav. In that far future, it is possible to consider the transition

Đakovo na korištenje pod primarnim naponom 400 kV, te njezin priključak na TS Ernestinovo.

Za takve prilike omogućena je dogradnja postrojenja 400 kV prema istoku, za novih do pet polja 400 kV, izvan postojeće ograde, uz dva rezervna vodna polja unutar postojeće ograde.

Vodovi 110 kV koji se priključuju prilikom obnove TS Ernestinovo su: pet vodova prema Osijeku, dva voda prema Đakovu, te po jedan vod prema Našicama, Vukovaru i Vinkovcima. Pri fatalnoj neraspodivnosti svih 110 kilovoltnih sabirničkih sistema TS Ernestinovo, Osijek i Baranja snabdijevaju se ograničeno vodom Valpovo-Osijek 4, te vodom Našice-Osijek 1, uz maksimalni angažman TE-TO Osijek, a posavski dio Slavonije i Vukovar iz TS 220/110 kV Đakovo. Pri isto takvoj potpunoj neraspodivnosti sabirnica 110 kV u TS 220/110 kV Đakovo, područje Požege i Slavanskog Broda mora se ograničeno snabdijevati vodom Nova Gradiška-Požege i eventualno vodom Slavonski Brod 2-Bosanski Brod.

Vodovi 110 kV, koji se u sagledivoj budućnosti dodaju postojećim vodovima priključenim na TS Ernestinovo, su novi vodovi prema Vinkovcima, Vukovaru i Osijeku, za čiji priključak se predviđaju rezervna polja 110 kV (ukupno 8 vodnih polja).

of TS Đakovo to utilization under 400 kV primary voltage, and its connection to TS Ernestinovo.

For such times, the additional building of 400 kV switchgear towards East is enabled, for up to five new 400 kV feeders, outside the existing fence, with two back up line feeders inside the existing fence.

The 110 kV lines, which will be connected during the reconstruction of TS Ernestinovo are: five lines towards Osijek, two lines towards Đakovo, and one line towards Našice, Vukovar and Vinkovci, respectively. In the case of completely fatal unavailability of all 110 kV busbar systems of TS Ernestinovo, Osijek and Baranya will be limitedly supplied by Valpovo-Osijek 4 line, and Našice-Osijek 1 line, with the maximum engagement of power plant Osijek, and the Sava-valley area of Slavonia and Vukovar from 220/110 kV TS Đakovo. In the case of exactly the same unavailability of 110 kV busbars in 220/110 kV TS Đakovo, the area of Požega and Slavonski Brod must be limitedly supplied by Nova Gradiška-Požega line and possibly by Slavonski Brod 2-Bosanski Brod line.

110 kV lines, which, in the near future, will be added to the existing lines connected to the TS Ernestinovo, are new lines towards Vinkovci, Vukovar and Osijek, for whose connection back up 110 kV feeders are planned (overall of 8 line feeders).

Osnovna shema TS 400/110 kV Ernestinovo

Osnovna shema postrojenja 400 kV s dva sekcioni-rana sistema glavnih sabirnica i sekcioniranim pomoćnim sabirnicama, omogućuje pogonsku fleksibilnost i pouzdanost kakva se očekuje od postrojenja s toliko učvorenih vodova za unutardržavnu i međunarodnu razmjenu. Sekcioniranjem, omogućuje se veća raspoloživost u slučaju dogradnje, održavanja ili kvarova.

Nazivna struja sabirnica 400 kV je 4000 A, a početna struja trofaznog kratkog spoja na koju je dimenzionirana sva oprema je 40 kA. Nazivne struje vodnih polja su 2000 A, usklađeno sa strujnom opterećivosti faznih vodiča 2xAl/C 490/65 mm².

Tri regulacijska transformatora 400/110 kV od po 300 MVA, u konačnici, omogućuju opterećenje TS Ernestinovo od 900 MVA, što predstavlja više od udvostručenja sadašnjeg vršnog opterećenja područja Slavonije i Baranje. Dva transformatora, u prvoj etapi izgradnje, predstavljaju oko 150% sadašnjeg vršnog opterećenja, uz redundanciju iz TS 220/110 kV Đakovo, 2x150 MVA.

Osnovna shema postrojenja 110 kV s tri sekcioni-rana sabirnička sistema omogućuje da se razdvo-jeni pogon vodova i transformatora ostvari grupi-ranjem koje je neovisno od sekcija, a i potpuni pogon uz neraspoloživost bilo koje sabirničke sekcije.

Nazivna struja sabirnica 110 kV je 2000 A, a početna struja trofaznog kratkog spoja na koju je dimenzionirana sva oprema je 40 kA. Nazivne struje vodnih polja, odgovaraju strujnoj opterećivosti faznih vodiča Al/C 240/40 mm². Polje prigušnice 110 kV, 100 Mvar, za sniženje pogonskog napona pri malim opterećenjima, bit će opremljeno preki-dačem sa sinkronim sklapanjem.

Osnovna shema postrojenja 35 kV s jednostrukim sekcioniranim sabirnicama omogućuje da se ost-

The basic diagram of TS 400/110 kV Ernestinovo

The basic diagram of an 400 kV switchgear with two sectionalized systems of main busbars and sectionalized ancillary busbars, enables the operations flexibility and reliability, which could only be expected of a switchgear with so many nodedded lines for national and international exchange.

The nominal current of 400 kV busbars is 4000 A, and the initial current of the three-pole short circuit, on which the whole equipment is dimensioned, is 40 kA. The nominal currents of the line feeders are 2000 A, attuned to the current load of the 2xACSR 490/65 mm² phase conductors.

Three 400/110 kV-regulating transformers of 300 MVA, ultimately enable the TS Ernestinovo load of 900 MVA, which represents more than the double of the present peak load of Slavonia and Baranya. Two transformers, in the first phase of the construction, represent about 150% of the present peak load, with the redundancy from 220/110 kV TS Đakovo, 2x150 MVA.

The basic diagram of the 110 kV switchgear with two sectionalized busbar systems enables the realization of separate operation of the lines and the transformer by grouping, which is independent of the sections, as well as the complete operation with the unavailability of any busbar section.

The nominal current of the 110 kV busbars is 2000 A, and the initial current of the three-pole short circuit, on which the whole equipment is dimensioned, is 40 kA. The nominal currents of the line feeders correspond to the current load of the phase conductors ACSR 240/40 mm². The 110 kV reactor feeder, 100 Mvar, for regulating the operation voltage under minor loads, will be equipped with a switch with synchronous switching.

The basic diagram of the 35 kV switchgear with single sectionalized busbars enables the accomplishment of

vari razdvojeni pogon vodova i kućnih transformatora eventualno potrebnim sekcioniranjem, te pogon jedne sekcije uz nerazpoloživost druge sabirničke sekcije. Snaga jednog kućnog transformatora 35/0,4 kV od 1000 kVA dovoljna je za pokriće svih potreba u konačnoj veličini izgradnje, tako da je osigurana redundancija od 100%.

Nazivna struja sabirnica 35 kV je 800 A, a početna struja trolejnog kratkog spoja na koju je dimenzionirana sva oprema je 16 kA. Nazivne struje vodnih polja, odgovaraju strujnoj opteretljivosti faznih vodiča Al/Č 120/20 mm².

Dovodni vodovi 35 kV su iz dvije različite transformatorske stanice 110/35 kV (Osijek 1 i Osijek 2). Ipak, za slučaj potpune nerazpoloživosti oba dovoda, predviđena su dva dizel-električna agregata od po 240 kVA.

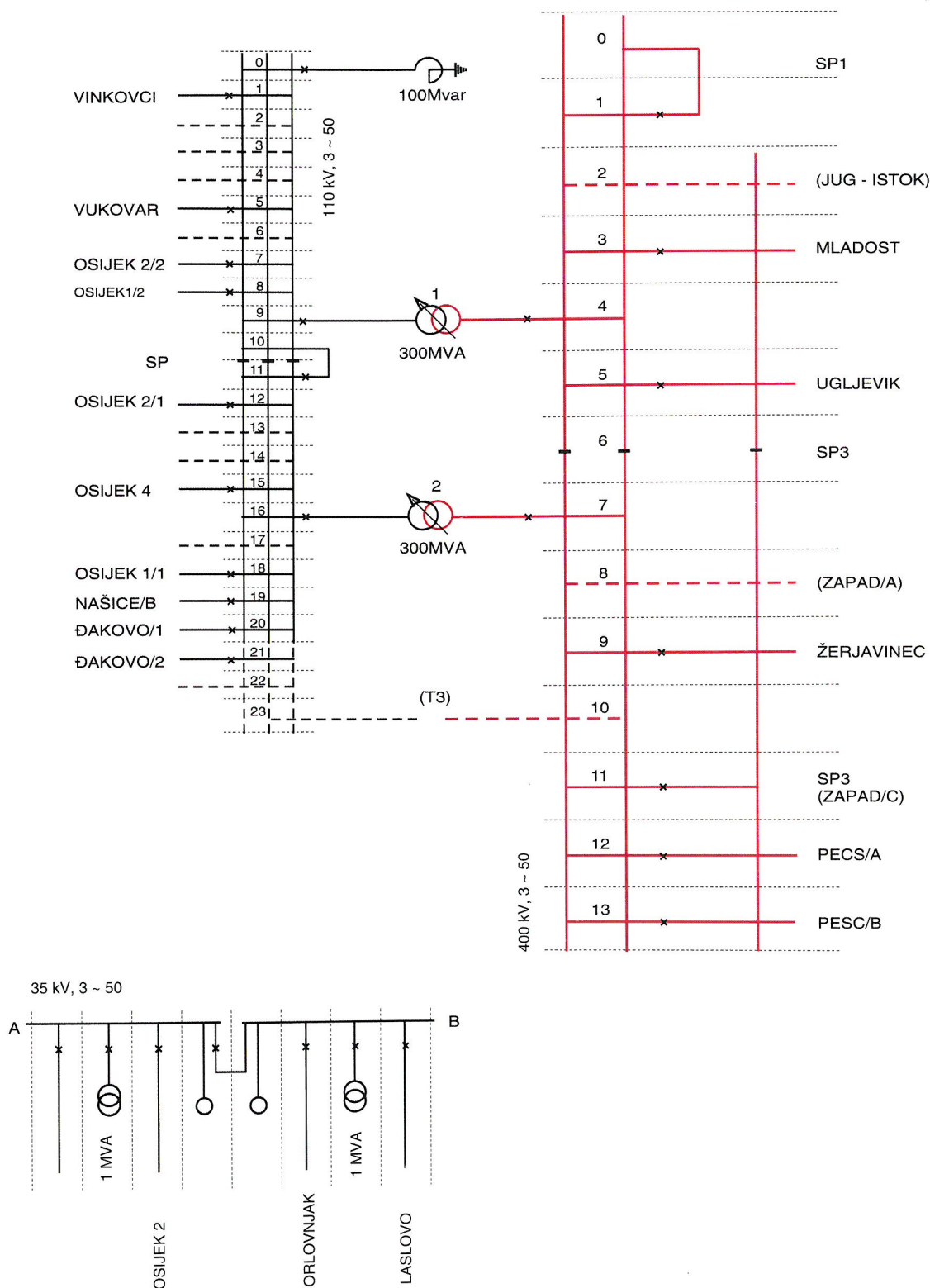
Uz takva svojstva primarnog postrojenja, izabrano je sekundarno postrojenje TS Ernestinovo koje je riješeno primjenom distribuiranog mikroprocesorskog sustava s koordiniranim funkcijama zaštite, nadzora, upravljanja i mjerenja, primjenom numeričkih zaštitnih uređaja i optoelektrične komunikacije. Omogućeno je daljinsko upravljanje iz Centra daljinskog upravljanja Osijek i iz Nacionalnog dispečerskog centra, za što su primjenjena odgovarajuća telekomunikacijska rješenja.

the separate operation of the lines and the home transformers by possible separate sectioning, as well as the operation of one section with the unavailability of some other busbar section. The power of one 35/0,4 kV home transformer of 1000 kVA is sufficient for the whole demand in the final size of the building, so that the 100% redundancy is secured.

The nominal current of 35 kV busbars is 800 A, and the initial current of the three-pole short circuit, on which the whole equipment is dimensioned, is 16 kA. The nominal currents of the line feeders correspond to the current load of the phase conductors ACSR 120/20 mm².

35 kV line feeders come from two different 110/35 kV transforming stations (Osijek 1 and Osijek 2). Nevertheless, in case of complete unavailability of the both lines, two 240 kVA diesel-electric aggregates are planned.

With such characteristics of the primary switchgear, a TS Ernestinovo secondary system was chosen, which was arranged by applying the distributed microprocessor system with coordinated functions for protection, monitoring, control and measurement, using the numerical protective devices and optical-electrical communication. Remote control from the Center For Remote Control in Osijek and from the National Dispatcher Center was enabled by appropriate telecommunication solutions.



Osnovna shema TS 400/110kV Ernestinovo
Basic diagram of TS 400/110kV Ernestinovo



TS Ernestinovo danas • TS Ernestinovo today

Opskrba pomoćnim izmjeničnim i istosmjernim naponom TS 400/110 kV Ernestinovo

Osnovna opskrba električnom energijom izmjeničnog napona 0,4 kV za vlastite potrebe riješit će se instalacijom dva kućna transformatora 35/0,4 kV, 1000 kVA, priključena na postrojenje 35 kV, povezano vodovima 35 kV iz dvije TS 110/35 kV (Osijek 1 - preko Orlovnjaka i Osijek 2).

Opskrba gradilišta i rezervna opskrba zgrade komande iz distribucijske mreže riješit će se instalacijom stupne TS 10/0,4 kV, 100 kVA i njezinim priključkom na vod 10 kV u blizini trafostanice.

Opskrba električnom energijom u nuždi ostvarit će se instalacijom dva dizel-električna agregata 240 kVA, 0,4 kV. Svaki agregat pokriva potražnju kritičnih potrošača konačne veličine izgradnje. Baterije za start agregata su primjerene višekratnom startu pri nepovoljnoj temperaturi.

Opći potrošači električne energije izmjeničnog napona su oni, izostankom čijeg napajanja ne dolazi do ugrožavanja pogona TS Ernestinovo.

Kritični potrošači električne energije priključit će se na izdvojene sabirnice čiji napon kontrolira automatika i povezuje ih s dizel-električnim agregatom, uz prethodno odvajanje od sabirnica općih potrošača i automatski start dizel-električnog agregata.

Vrlo kritični potrošači su oni čije je stalno funkcioniranje nužno osobito u prilikama poremećaja, a izvorno im je napajanje izmjeničnim naponom. Ti potrošači na razini stanice, opskrbljivat će se trajno iz udvojenih pretvarača DC/AC, koji s DC strane imaju dva dovoda iz dvije baterije s automatskim prebacivanjem na rezervni.

Postrojenje 35 kV, postrojenje 0,4 kV kritičnih potrošača i postrojenje 0,4 kV općih potrošača

AC and DC supply of TS 400/110 kV Ernestinovo

The basic 0,4 kV AC supply for own needs will be done by installation of two 35/0,4 kV, 1000 kVA home transformers, connected to the 35 kV switchgear, joined by 35 kV lines from two 110/35 kV TS (Osijek 1 - over Orlovnjak and Osijek 2).

The construction site supply and the backup supply of the command building from the distribution grid will be accomplished by the 10/0,4 kV, 100 kVA tower transforming station installation and its connection to the 10 kV line in the vicinity of the transforming station.

Emergency electric power supply will be accomplished by the installation of two 240 kVA, 0,4 kV diesel-electric aggregates. Each aggregate will cover the demand of the critical consumers of the final size of the building. The batteries for starting the aggregate are suitable for a multiple start at unfavorable temperature.

The main consumers of AC are those, who, when left without power supply, do not endanger the operation of TS Ernestinovo.

The critical electric power consumers will be connected to separate busbars, whose voltage is controlled by automatic devices, and who are connected to the diesel-electric aggregate, preceded by the detachment from the general consumers' busbars and the automatic start of the diesel-electric aggregate.

Very critical consumers are those, whose continuous function is necessary, especially at disturbance instances, and, whose original power supply is by AC. Those consumers, at the level of the station, will be permanently supplied from the doubled DC/AC converters, which, on the DC side, have two feeds from two batteries with automatic switching to reserve.

izvedena su s jednostrukim sekcioniranim sabirnicama (sekcije A i B) s prekidačem za sekcioniranje, tako da je omogućeno sklapanje pod opterećenjem i daljinsko upravljanje.

Opskrba električnom energijom istosmjernog napona 220V riješit će se primjenom akumulatorskih hermetičkih baterija s odgovarajućim ispravljačima, razmještenih decentralizirano, po relejnim kućicama i pogonskim zgradama. Svaka će jedinica imati sa strane opskrbe izmjeničnim naponom dvostruku povezanost, a na strani istosmjernog napona redundancija će se riješiti povezivanjem sa susjednim mjestom opskrbe.

U relejnim kućicama izvedene su sabirnice kritičnih potrošača (K) i općih potrošača (O) izmjenične struje, te osnovne sabirnice (A) i rezervne sabirnice (B) potrošača istosmjerne struje. U svakoj relejnoj kućici je blok ispravljač-baterija, priključen između sabirnica K i A u toj kućici. Svaka kućica ima trofazni dovod od glavnih sabirnica kritičnih potrošača, dimenzioniran za potrebe dvije kućice, i poprečnu rezervnu vezu prema susjednoj kućici, dimenzioniranu za potrebe jedne kućice. Ta je veza normalno izvan pogona. Jednako je riješeno povezivanje sabirnica općih potrošača.

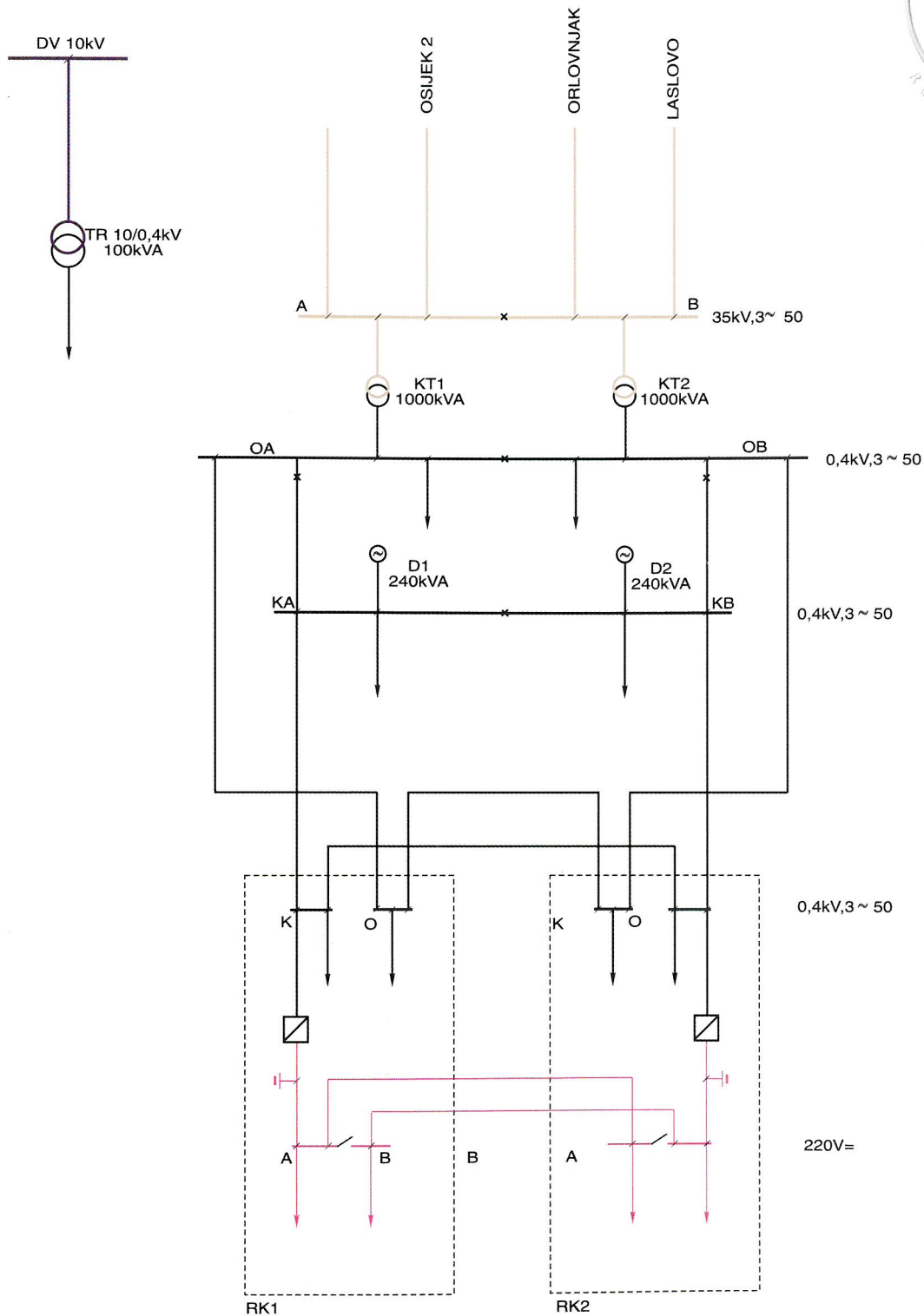
Osnovne sabirnice A istosmjernog napona služe opskrbi osnovne zaštite, upravljanja i ostalih potreba u relejnoj kućici, a rezervne sabirnice B služe opskrbi rezervne zaštite u toj kućici. Normalno su sabirnice B priključene na osnovne sabirnice A iz susjedne kućice, a omogućeno je i međusobno spajanje sabirnica A i B iste kućice.

35 kV switchgear, 0,4 kV critical consumers switchgear and 0,4 kV general consumers switchgear are made with single sectionalized busbars (A and B sections) with a sectionalizing switch, so that switching under pressure and remote control are enabled.

The 220V DC electric power supply will be done by applying accumulator hermetic batteries with appropriate rectifiers, positioned without centralization, in relay stations and operation buildings. Each unit will have, from the AC supply side, a double connection, and on the DC side, a connection to a nearby supply location will solve the redundancy.

There are critical (K) and general (O) consumers' busbars in relay stations, as well as basic (A) and reserve (B) DC consumers' busbars. There is a block rectifier-battery in each relay station, connected between K and A busbars in that station. Each station has a three-phase feed from the main critical consumers' busbars, dimensioned for the needs of two stations, and a cross reserve connection to a nearby station, dimensioned for the needs of one station. This connection is normally out of operation. The connecting of the general consumers' busbars is accomplished in the same way.

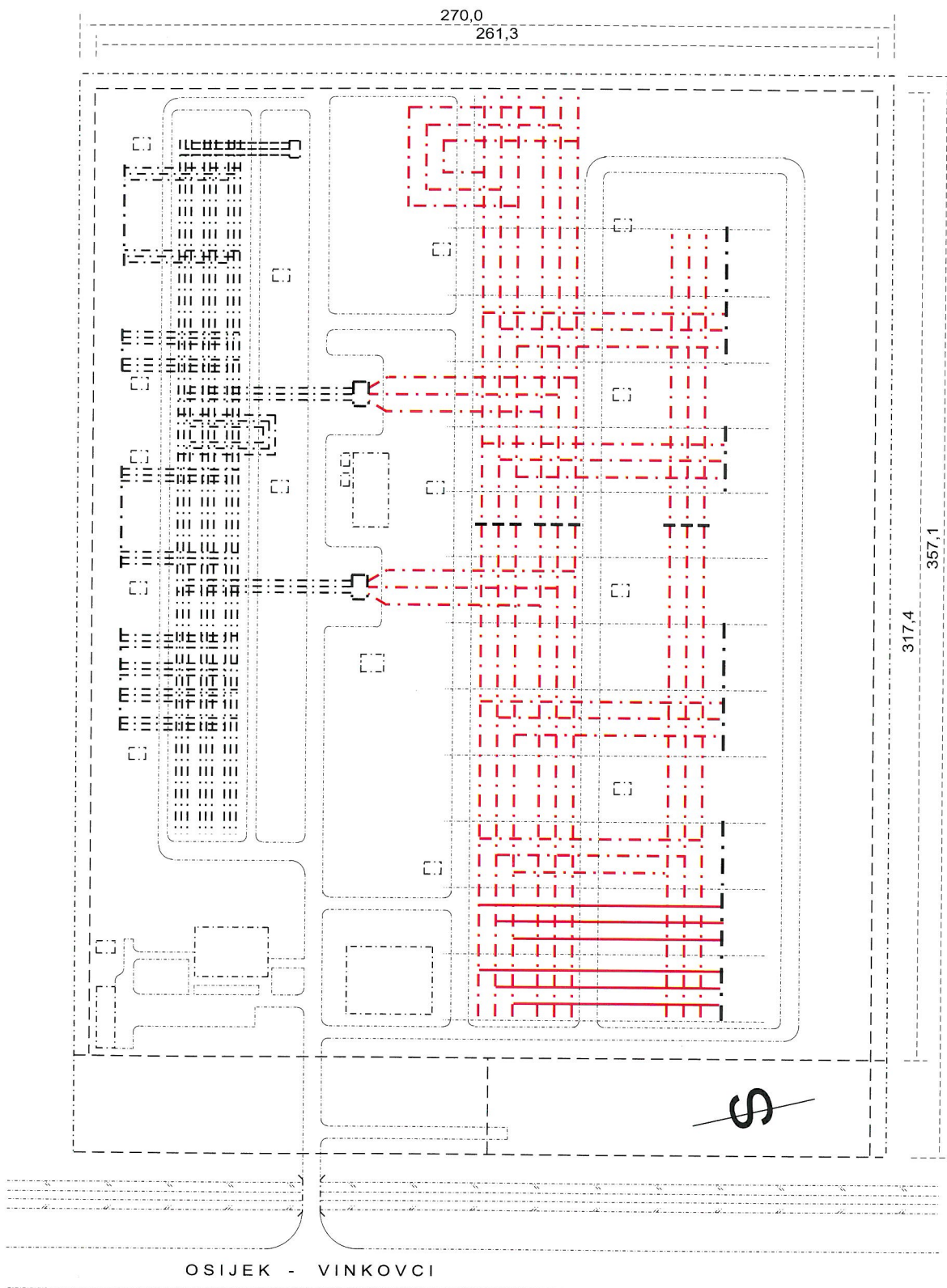
The basic A busbars of DC enable the necessary basic protection supply, control and other needs in the relay station, and the reserve B busbars enable the reserve security supply in that station. Generally, the B busbars are connected to the basic A busbars from the nearby station, and the mutual connecting of the A and B busbars of the same station is also enabled.



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Dispozicija TS 400/110kV Ernestinovo
Situation plan of TS 400/110kV Ernestinovo

Prostorna dispozicija i rješenje TS 400/110 kV Ernestinovo

Lokacija TS Ernestinovo je između ceste Osijek-Vinkovci i željezničke pruge Osijek-Vinkovci, na dijelu južno od Antunovca, a istočno od Ivanovca, na zemljištu koje je u vlasništvu Hrvatske elektroprivrede. Ime je prema mjestu Ernestinovo, koje se nalazi južno od objekta.

Prostor na kojem je izveden plato objekta je približnih dimenzija 260x320 metara, unutar ograde. Izgrađeni plato je na nadmorskoj visini od 86,10 metara. Uzdužna os platoa je približno u pravcu istok - zapad. Maksimalna temperatura okoline je +40°C a minimalna temperatura okoline je -25°C.

Prostor istočno od zaposjednute lokacije, koji bi se koristio za buduću dogradnju postrojenja (do pet polja 400 kV), sada se koristi kao oranica. Detaljno rješenje korištenja parcela za smještaj polja obnovljenog i dograđenog postrojenja, projektirano je u interakciji s projektom raspjela vodova - kako bi bio omogućen raspjela vodova u sagledivoj budućnosti.

Postrojenje 400 kV izvedeno je u južnom sektoru platoa, a postrojenje 110 kV duž sjevernog sektora platoa. Ta dva sektora odijeljuje glavna pristupna cesta uz čiji južni rub su postavljeni transformatori 400/110 kV, 300 MVA, a uz sjeverni rub prigušnica 110 kV, 100 Mvar. U središnjem dijelu platoa je zgrada postrojenja srednjeg (35 kV) i niskog napona, s dva kućna transformatora 35/0,4 kV od po 1000 kVA. Južno od ulaza je zgrada pomoćnih pogona, gdje su smještene dva dizel-električna agregata od po 240 kVA. Sjeverno od ulaza je zgrada komande, kamo je smještena prostorija lokalnog upravljanja i uređaji telekomunikacija. U blizini te zgrade je antenski stup za smještaj antena usmjerenih radio-veza. U postrojenju 400 kV i u postrojenju 110 kV podignuto je po 7 relejnih kućica. U njih smješteno je sekun-

Area plan and solution of TS 400/110 kV Ernestinovo

The location of TS Ernestinovo is between the road Osijek-Vinkovci and the railway Osijek-Vinkovci, in the south part of Antunovac, and eastward from Ivanovac, on the land, which is the property of Croatian Electric Power Industry. It is named after the village, positioned to the south from the object.

The space, where the plateau is positioned, is 260x320 meters big, inside the fence. The built plateau is 86,10 meters above sea surface. Longitudinal axis of the plateau is positioned, approximately, in the direction east-west. The maximum temperature in the area is +40°C, and the minimum temperature is -25°C.

The area eastward from the occupied location, which would be used for the future additional building of the switchgear (up to five 400 kV feeders), is now being used as a plough-land. A detailed plan of the use of the parcels for the position of the feeders of the renewed and attached building of the switchgear, is designed in the interaction with the lines outcome project - in order to enable the outcome of the lines in the near future.

The 400 kV switchgear is positioned in the south sector of the plateau, and the 110 kV switchgear along the north sector of the plateau. These two sectors are divided by the main access road, along whose south margin 400/110 kV, 300 MVA transformers are positioned, and along the north side there is a 110 kV, 100 Mvar reactor. In the middle part of plateau is the medium (35 kV) and low voltage switchgear building, with two 35/0,4 kV home transformers, 1000 kVA respectively. To the south from the entrance there is the ancillary operations building, where two 240 kVA diesel-electric aggregates, are placed. To the north from the entrance is a command building, where the local control chamber and the telecommunication devices are positioned. In the vicinity of that building there is an antenna tower, for the placement of the

darne postrojenje, za po dva polja 400 kV odnosno za po četiri polja 110 kV. Također, u svaku relejnu kućicu smješta se i ispravljač s akumulatorskom baterijom za opskrbu pomoćnim istosmjernim naponom te relejne kućice.

Vanjska rasklopna postrojenja 400 i 110 kV izvedena su cijevnim vodičima, prekidačima u sumporheksafluoridnoj izvedbi i okretnim rastavljačima. Spojevi između aparata izvedeni su u pravilu užadnim vodičima. Nosači aparata su iz čeličnih pocinčanih cijevi, pričvršćeni uz betonske temelje sidrenim vijcima. Postrojenje 35 kV izvedeno je sklopnim blokovima s vakuumskim izvlačivim prekidačima. Uzemljivačka mreža izvedena je bakrenim užetom 120 mm².

Priključci na vodove 400 kV usmjereni su prema jugu, a na vodove 110 kV prema sjeveru, što odgovara glavnini vodova jednog i drugog napona. Priključci na nadzemne vodove 35 kV bit će riješeni kabelski, tako da je onemogućena kolizija s vodovima 400 i 110 kV.

Glavna pristupna cesta dimenzionirana je za transport najtežeg transformatora, a osigurana je kružna vožnja vatrogasnih vozila oko transformatora.

Na sjeverozapadnom uglu platoa, izvan ograde, postavljena je stupna transformatorska stanica 10/0,4 kV, 100 kVA, za opskrbu gradilišta i rezervnu opskrbu zgrade komande TS Ernestinovo.

Zapadno od postojeće ograde i južno od glavne pristupne ceste izgrađeno je vanjsko skladište s ogradom, pristupom i kapijom s glavne ceste, nasutim terenom i neposrednom odvodnjom u kanal Seleš.

routed radio-link. In the 400 kV and 110 kV switchgears seven relay stations are placed. They have a secondary system, for two 400 kV feeders, i.e. for four 110 kV feeders. Furthermore, in each relay station a rectifier with an accumulator battery is placed, to supply the same station with the ancillary DC.

The outdoor 400 kV and 110 kV switchgears are equipped with tube conductors, sulfurhexafluoride switches and rotary isolators. Stranded conductors usually make connections between the apparatuses. Apparatus supports are made of galvanized tubes, attached to the concrete foundations by anchor bolts. 35 kV switchgear is made with pullout vacuum circuit breaker. The grounding network is made with a 120 mm² copper rope.

Connections to the 400 kV lines are southward directed, and the connections to the 110 kV lines are northward directed, which suits the most of the lines of the both voltages. Cables will make connections to the 35 kV overhead lines, so that the collision with the 400 and 110 kV lines is impossible.

The main access road is dimensioned for the transport of the heaviest transformer, and the circular drive of the fire brigade vehicles around the transformers is ensured.

On the northwest corner of the plateau, outside the fence, 10/0,4 kV, 100 kVA tower transforming station is positioned - for the construction site and the command building of TS Ernestinovo emergency supply.

West to the existing fence and south to the main access road, an outer fenced storage is built, with a driveway and a main road gate, with macadamized terrain and immediate drainage to the Seleš channel.



← Osijek
Vinkovci →

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Opremljenost TS 400/110 kV Ernestinovo nakon obnove

Nakon obnove TS Ernestinovo uspostaviti će se pri-
jeratno stanje, uz neke preinake. Ponajprije, izosta-
je u potpunosti postrojenje 30 kV kojim je bilo
omogućeno korišćenje tercijara transformatora 300
MVA, a dodaje se kompenzacijsko polje na strani
110 kV na koje se priključuje prigušnica 100 Mvar,
za sniženje napona pri malim opterećenjima.

Na strani 400 kV dodaju se dva vodna polja za
priključak dvostrukog voda 400 kV Ernestinovo-Pecs.

Izostaju također kućni transformatori 30/0,4 kV ali
se dodaje još jedan vod 35 kV za vlastitu opskrbu TS
Ernestinovo izmjeničnim naponom. Izostaje kom-
presorsko postrojenje, jer će se primjeniti
sumporheksafluoridni prekidači 400 i 110 kV.

Spomenimo još jednom da će se postrojenje 400 kV
izvesti s dvostrukim sekcioniranim glavnim i sekcioni-
ranim pomoćnim sabirnicama, postrojenje 110 kV s
trostrukim sekcioniranim sabirnicama, a postrojenje
35 kV s jednostrukim sekcioniranim sabirnicama.

Stanje opremljenosti TS Ernestinovo, nakon obnove, prikazuje tablica.

Dio postrojenja	400 kV	110 kV	35 kV
Vodna polja	5	10	4
Trafo-polja	2	2	2
Spojna polja	3	1	1
Kompenzacijsko polje	-	1	-
Mjerna polja	-	-	2
Ukupno opremljena polja	10	14	9
Ukupno mogući broj polja	13	24	9
Transformatori (MVA)	2x300	-	2x1
Prigušnica (Mvar)	-	100	-
Dizel-električni agregati		2x240 kVA	

TS 400/110 kV Ernestinovo after the reconstruction

After the TS Ernestinovo reconstruction, the pre-
war state, with some alterations, will be re-instated.
To begin with, the 30 kV switchgear, by which the
utilization of the tertiary of the 300 MVA trans-
former was enabled, is completely left out, and the
shunt reactor feeders on the 110 kV side is added,
to which a 100 Mvar reactor is connected, for regu-
lating the voltage at minor load.

On the 400 kV side, two line feeders are added, for
connecting the double 400 kV line Ernestinovo-Pecs.

Furthermore, the 30/0,4 kV home transformers are
left out, but another 35 kV line is added, for the
own AC supply of TS Ernestinovo. The compressor
gear is also not present, as the sulfurhexafluoride
400 and 110 kV circuit breakers will be used.

Once again, the 400 kV switchgear will be made
with the double main and ancillary busbars; the 110
kV switchgear will be done with triple sectionalized
busbars, and the 35 kV switchgear with single sec-
tionalized busbars.

The quantity of equipment of TS Ernestinovo after the rebuilding is shown in the chart.

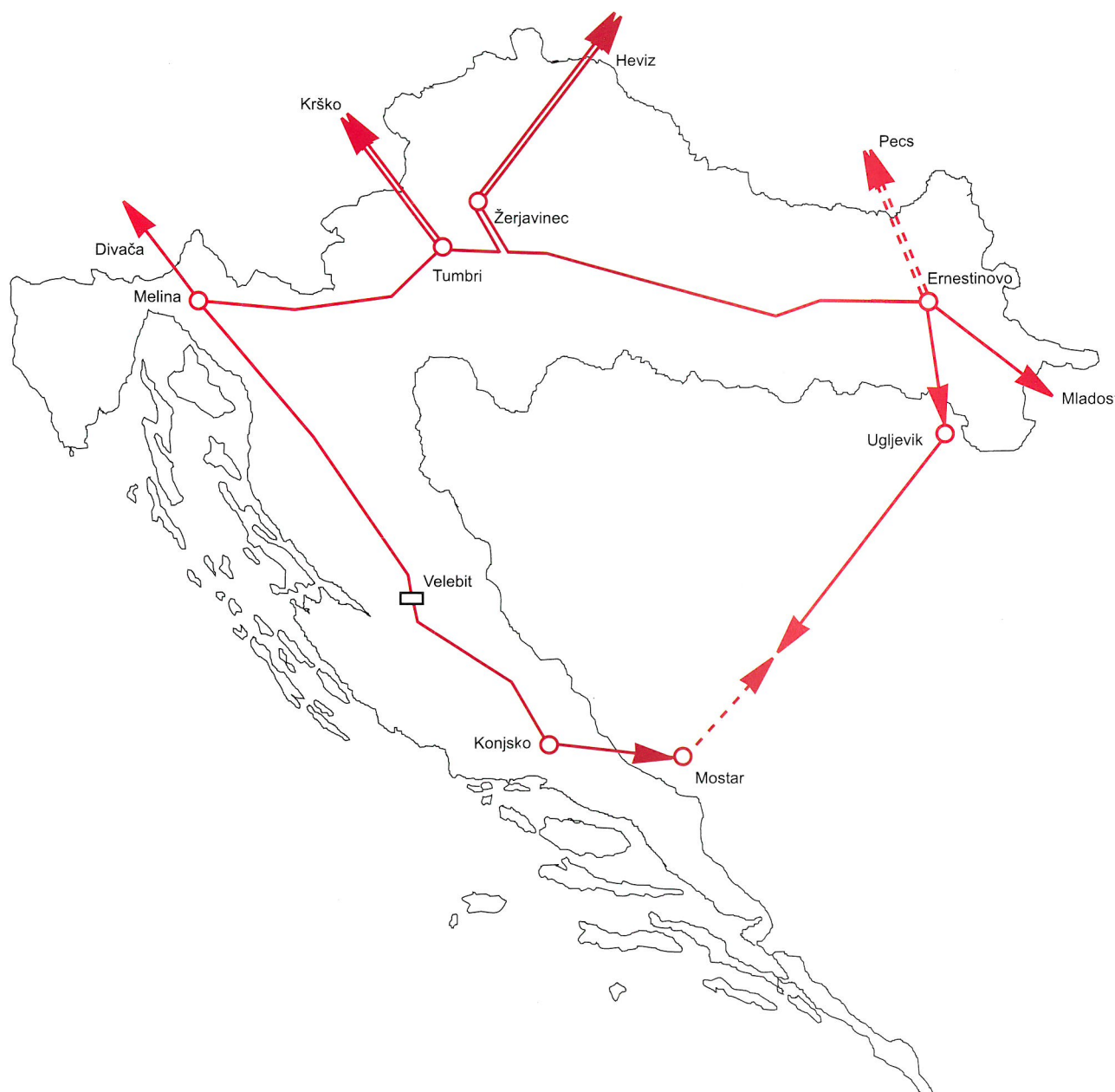
Part of the switchgear	400 kV	110 kV	35 kV
Line feeders	5	10	4
Transformer feeders	2	2	2
Bus couplers	3	1	1
Shunt reactor feeders	-	1	-
Measuring feeders	-	-	2
Total of equipped feeders	10	14	9
Total of possible number of feeders	13	24	9
Transformers (MVA)	2x300	-	2x1
Reactor (Mvar)	-	100	-
Diesel-electric aggregates		2x240 kVAa	

Dakako, takvoj opremljenosti primarnog postrojenja sukladno će se opremiti sekundarno postrojenje, radi zaštite, nadzora, lokalnog upravljanja i mjerenja, te radi komunikacije s Centrom daljinskog upravljanja Osijek i Nacionalnim dispečerskim centrom, za što će se primjereno izvesti i telekomunikacijski sustav.

Surely, with such fittings of the primary switchgear, the secondary system one will be equipped in the same way, because of the protection, monitoring, local control and measurements, and because of the communication with the Center for Remote Control in Osijek and with the National Dispatcher Center. For that purpose, the telecommunication system will be designed in an appropriate manner as well.



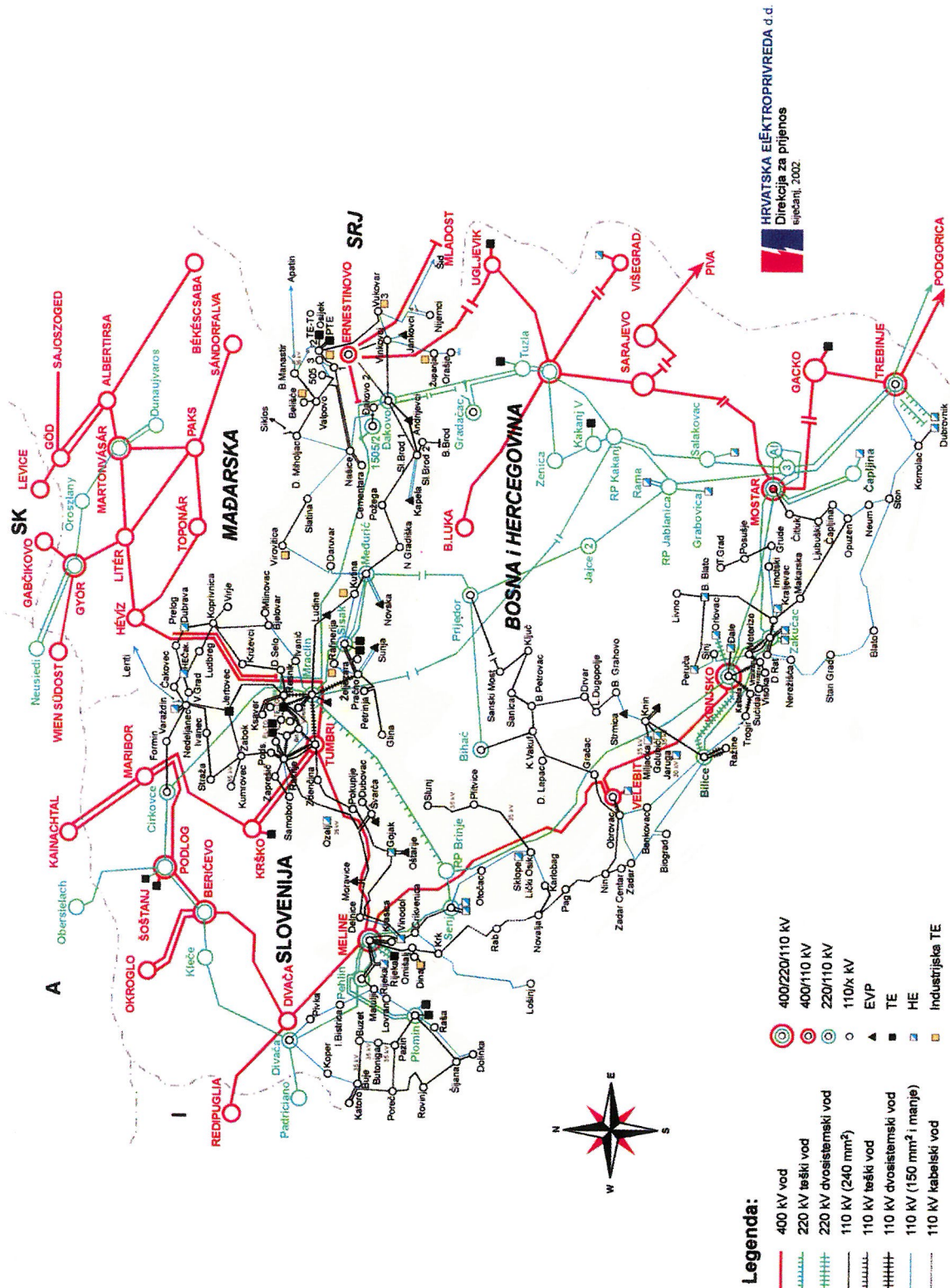
U TS Tumbri • At TS Tumbri



Mreža 400kV Hrvatske nakon obnove TS 400/110kV Ernestinovo
Croatian 400kV grid after the TS 400/110kV Ernestinovo reconstruction

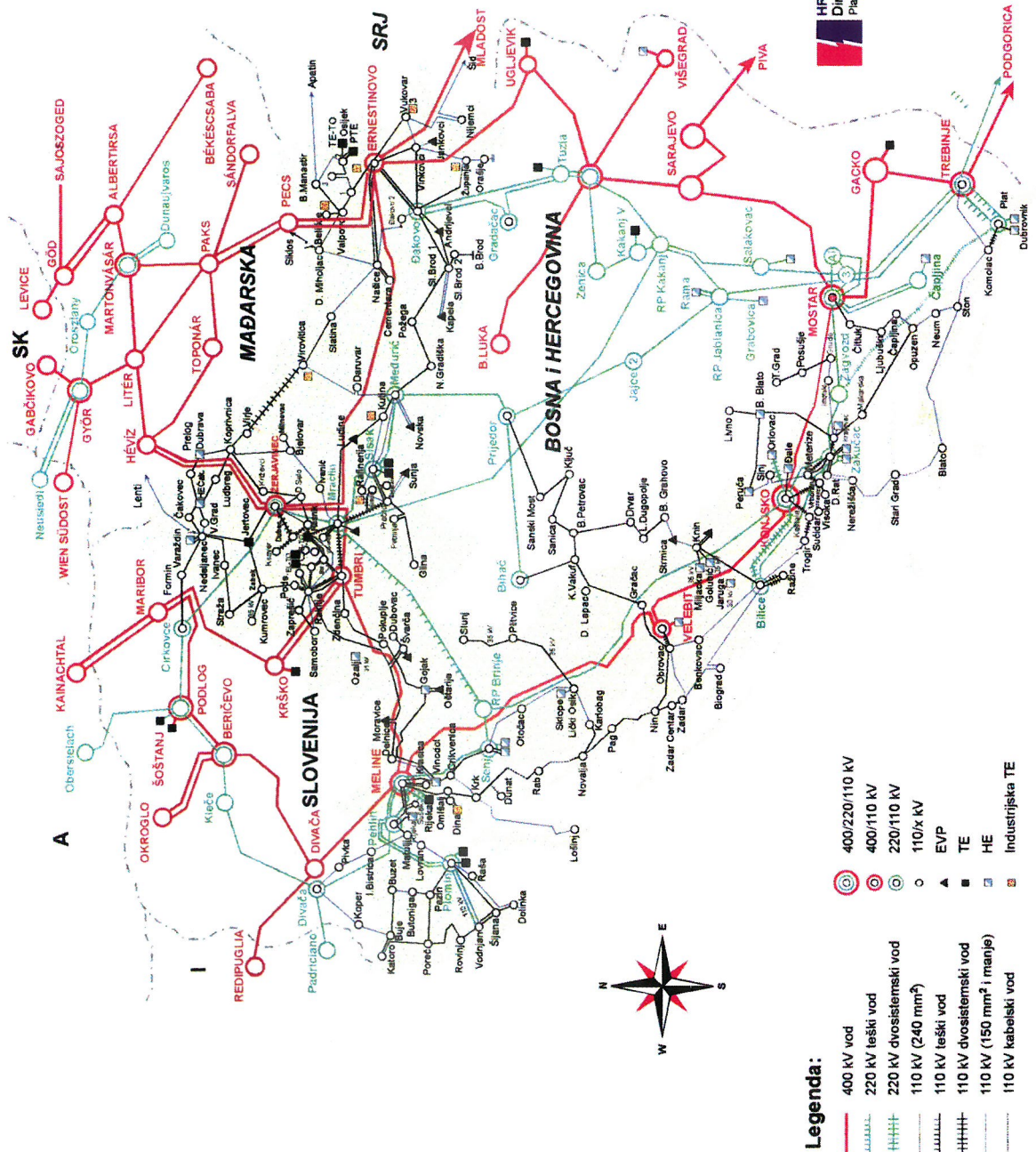
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CROATIAN POWER SYSTEM AND ADJACENT SYSTEMS



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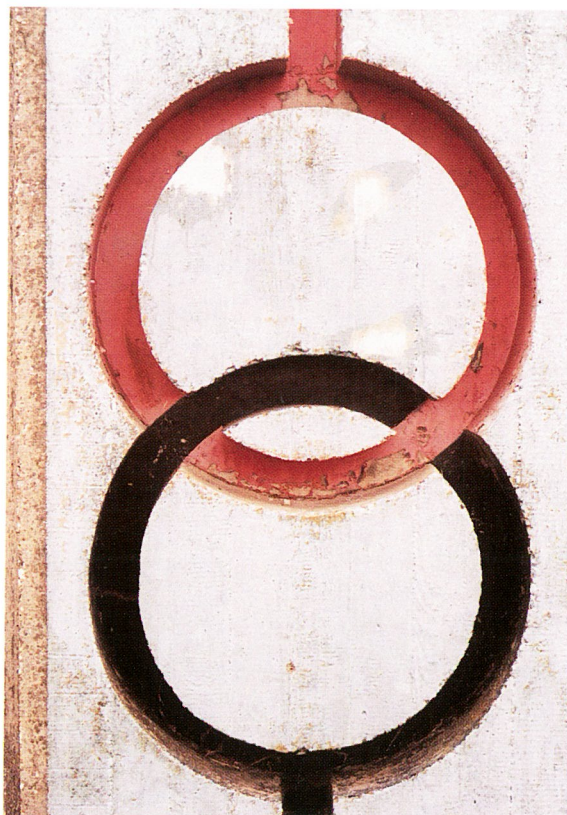
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