RENOMIA

Risk report

Enegro Pro Bulgaria - distribution

Varna Towers, tower G, Vladislav Varnenchik Blvd, 258, Varna

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1. Introduction

Energo Pro Bulgaria operates more than 42,000 km distribution network in Northeastern Bulgaria and in 2011 have supplied 5.5 billion kWh of electricity to 1.1 million customers. The preparation of this risk report was based on interviews and a physical inspection of Energo Pro (EP). We visited a representative sample of all the main technologies in use by EP in Bulgaria. We visited the substations in Kartala, Veliko Tarnovo and Čajka. We also visited the dispatching in Gorna Oriechovitsa and Varna.

Information presented within this report was obtained with the kind help of:

- Krasimir Ivanov – Director "Strategy and Development of Grid"

2. Summary and risk assessment

Energo Pro Bulgaria operates more than 42,000 km distribution network in Northeastern Bulgaria and in 2011 have supplied 5.5 billion kWh of electricity to 1.1 million customers. The distribution network is organizationally divided into two parts, western and eastern part.

Western part is operated from dispatching in Gorna Oriachovitsa, Eastern part is operated from dispatching in Varna. Both dispatching are substitutable. EP delivers the electricity to the following bigger cities in the area:

- Gabrovo
- Gorna Oriechovitsa
- Ruse
- Razgrad
- Targoviště
- Šumen
- Silistra
- Dobrič
- Varna

Chart 1: Western part description numbers

	Gabrovo	Gorna Oriachovitsa	Razgrad	Ruse	Targoviště	Šumen
Clients nm.	99 620	187 742	83 116	150 220	86 747	114 641
Middle voltage net km.	176	259	140	80	95	150
Low voltage overhead km	1 156	2 518	1 405	1 157	1 229	1 760
Low voltage underground km	310	580	229	163	130	244
Substations 110/20, 10 kV	1	4	3	5	0	0
Transformers 110/20, 10 kV	2	9	5	11	0	0
Substations (10 or 20/04 kV) nm.	1 152	2 157	662	644	832	1 543
Transformers (10 or 20/04 kV) nm.	1 363	2 410	819	739	959	1 654

Chart 2: Eastern part description numbers

	Varna	Dobrič	Silistra
Clients nm.	301 365	138 455	75 096
Middle voltage net km.	458	233	80
Low voltage overhead km	2 174	2 390	1 157
Low voltage underground km	907	568	163
Substations 110/20, 10 kV	8	2	0
Transformers 110/20, 10 kV	14	3	0
Substations (10 or 20/04 kV) nm.	2 298	1 839	644
Transformers (10 or 20/04 kV) nm.	2 960	2 191	739

Distribution is designed from 10 kV and 20 kV network. EP owns also high voltage network 100 kV with length of 54 km.

The electricity comes from state owned high voltage network owned by NEC (the state distribution company).

In our assessment the physical condition of substations and distribution network we assess as average. EP has a investment plan to enlarge the connections of new customers and to rehabilitate the network and substations which are mostly 20 - 30 years old, but well maintained. The statistics of grid and transformers age are in the appendix.

EP is going to invest following approximate amounts (2012):

- 15 mil Leva into new grids
- 7 mil Leva into new sources connection
- 8,3 mil Leva into middle voltage grids repair
- 8,1 mil Leva into distribution grids repair
- 2,7 mil Leva into electronic control
- 0,7 mil Leva into buildings reconstruction

In our assessment, maintenance of the substations is average to upper average. The maintenance is mostly outsourced.

We assess the operation as upper average. There is sophisticated control system for the distribution network operated from two dispatching centers. EP has complete overview about the distribution net and its condition.

Fire risk:
The risk of fire in this type of operation is most likely from high voltage appliances, as electricity is the generally the most frequent cause.

From a fire perspective, the risk lies mostly in the substations, especially in respect of the switchgears and transformers. On the distribution network, transformers are mostly located outside the buildings. 110 kV, 20 kV and 10 kV parts are located within the buildings. In urban areas also transformers are located within the building like in Čajka substation. Only in three locations are the 100 kV part enclosed and insulated by SF6. Those are Čajka, Trakata and Bjala. The switches in the visited substation were mostly SF6 or vacuum insulated.

Oil filled cables are also still used in the distribution system located in Ruse area. We assess the fire risk precautions as bellow average as there are only portable extinguishers in the substations and smoke detection is only installed in three substations. Only one automatic fixed extinguishing system is installed in Čajka substation. This system extinguishes the transformers by nitrogen.

Transformers are often very close to each other (about 10 m) with no fire separation (in buildings are the transformers fire separated). As one of the fire loss scenarios, we can envisage a fire in a substation (transformer) and a loss of all, or most, of the transformers in the substation. Transformer fires are often very intense and often accompanied by explosions and so can very easily spread to other transformers close by. Such a fire event could also lead to business interruption.

Picture 1: Illustration picture how can transformer burn

Explosion:
High voltage components can explode especially in the case of a short circuit or voltage overload. Where many appliances such as circuit breakers and transformers also contain insulation oil, such an explosion could be accompanied by a spread of fire.

In the case of transformers, an explosion could also be caused by the gases in the oil, especially if the oil is not tested regularly.

Flood:
Visited substations were located on elevated positions with remote risk of flood. The substations with possible flood risk are.

- Substation Devnya (it should be close to the Varna's lake)
- Substation Asparuchovo (it is on an island underв Asparuchov bridge), Varna
- Substation Sinkevitsa next to the river.

Natural peril risks:
The risk from natural perils including earthquake was assessed using the NATHAN Munich Re tool. See appendix.

Environmental accidents:
Environmental accidents, or accidental pollution, could particularly be caused by oil leaks from transformers. During our visit we observed transformers only with emergency pits designed with enough capacity to catch more than the volume of oil in one transformer. We asses the risk of environmental pollution as low.

Business interruption:
In most of the open air substation could the fire of one transformer initiate the fire of another one. The distance is about 10 m. Also the fire in switchgear 110 kV, 20 or 10 kV could shut down the whole substation. We are not sure about stability of distribution grid missing one substation 100 kV/20 or 10 kV, but we assess, that it could be partly substituted by another EP substation in the area, because those are mostly interconnected on middle voltage level and supplied from different parts of NEC grid.

EP Bulgaria has storage of significant spare parts in the middle of supplied area. We do not expect the longer business interruption except the case when NEC interrupts the electricity delivery.

3. Basic company information

Energo-Pro was established in the Czech Republic in 1994. The company's main scope of activities is in the field of management, construction, operation, maintenance and rehabilitation of hydroelectric power plants and electricity networks, as well as electricity trading.
Energo-Pro has been on the Bulgarian energy market since the year 2000 and currently owns eight hydroelectric power plants, united in three cascades - Sandanska Bistrica, Koprinka and Petrohan - which turns the company into the largest private producer of hydroelectric power in the country.

Energo-Pro is officially the new electricity distribution and electricity supply Company for Northeastern Bulgaria. The Czech energy company fortifies its position on the Bulgarian market with the acquisition of the E.ON Bulgaria group companies. The companies, based in Varna, operate more than 42,000 km distribution network in Northeastern Bulgaria and in 2011 have supplied 5.5 billion kWh of electricity to 1.1 million customers.

4. Area description

The EP operates the distribution network in provinces Gabrovo, Veliko Ternovo, Ruse, Targoviste, Razgrad, Šumen, Silistra and Varna located in north east of Bulgaria.

Substations are mostly surrounded by urban areas and are located mostly on periphery of cities. Some of substations are located within the cities like Čajka in Varna. In those cases are the substations located within the building including transformers.

Picture 2: Kartala and Čajka substation


All substations are accessible by public solid roads. All visited substations were located on flat land without the risk of landslide or rockfall.

5. Description of Activities

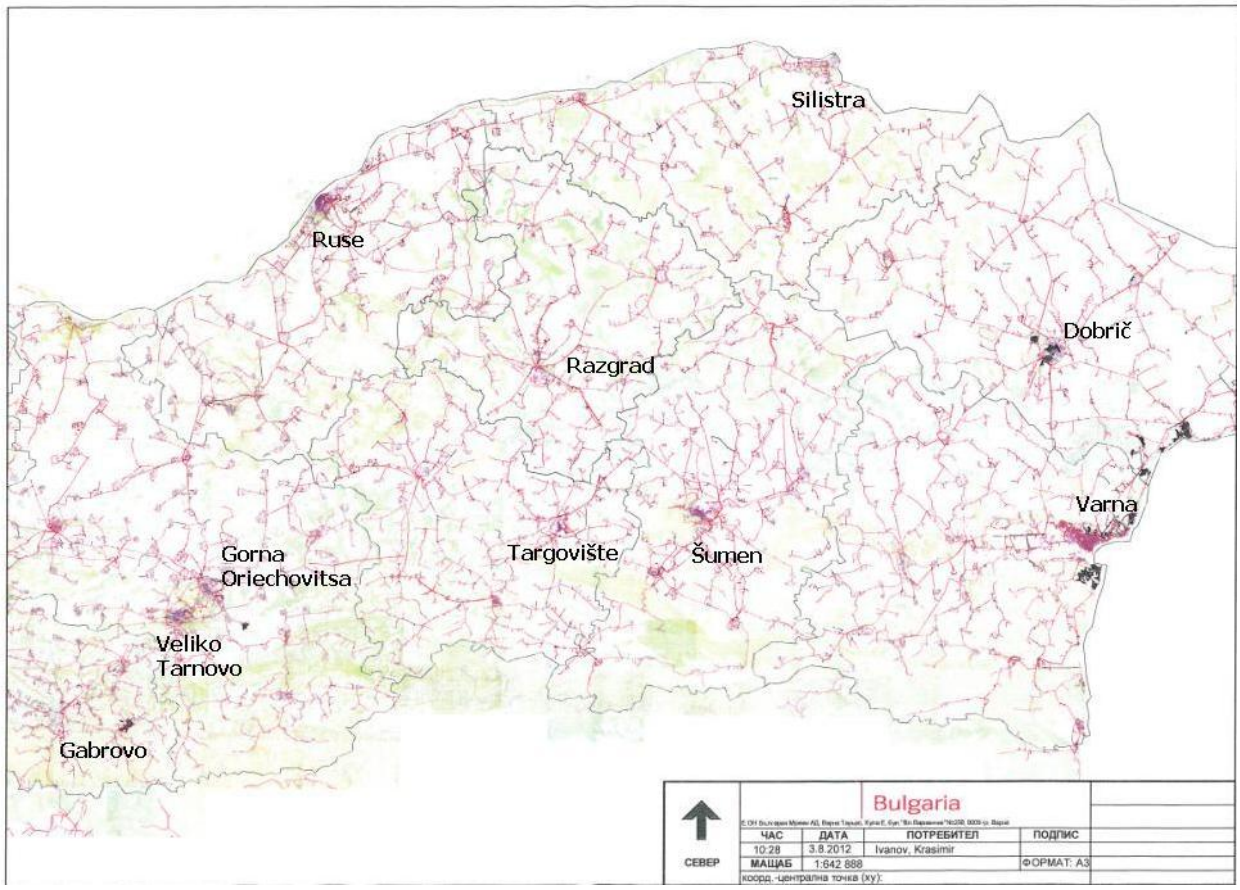
General information:

EP distribution activities in Bulgaria consist of mostly medium and low voltage distribution grid in north east Bulgaria. Also high voltage (110 kV) lines are present within the EP grid as transmission lines. About 54 km of high voltage grid is present. The total distribution grid length is about 42 124 km from which about 31 912 km is overhead. The distribution grid consists of medium and low voltage grids, the transmission high lines are 110 kV:

- High voltage (110 kV) – about 54 km total length from which about 43 km (Zvezditsa) are overhead. Perla, Briliant, Potsdam, Ruschuk, Panteon (11,45 km) are underground lines.
- Medium voltage (20 or 10 kV) – about 18 421 km total length from which 15 017 km are overhead
- Low voltage (0,4 kV) – about 23 650 km from which 16 853 km is overhead.

The total number of medium to low voltage transformers is 12 595 pcs. The distribution is divided into 9 distribution districts mentioned in table 1 and table 2 and two zones East and West. West is operated from dispatching in Gorna Oriechovitsa a East from Varna.

Picture 3: EP distribution area



Visited substations:

Kartala is the substation in Veliko Tarnovo city. Substation has been erected in 1975. Two oil filled transformers 25 MVA (each 25 t of oil) each are installed. Normal consumption of the supplied area is about 18 MW. Transformers have been manufactured in former Eastern Germany by VEB company. Transformers are located outside the building with mutual distance about 10 m. 110 kV part is open air. Manipulation is electrical. 110 kV part has oil filled switches, 10 kV part has vacuum switches. 10 kV part is located inside the building.

Picture 4: 110 kV and 10 kV part

This substation is supplied from two independent NEC substations Carevec (400/110 kV) and Gorna Oriachovitsa (220/110 kV). Kartala is one of the three substations in the Veliko Taronovo City. The other two are Dolga loka and Veliko Tarnovo. All three substations are interconnected via middle voltage grid. This substation is with remote control from dispatching in Gorna Oriechovitsa.

Picture 5: Kartala substation

The electrical backup for basic manipulation and control system is assured by batteries. Battery room has permanent ventilation.

Picture 6: Backup bateries

Veliko Tarnovo substation is located in Veliko Tarnovo city. The substation is 40 years old. Two oil filled transformers are installed 40 MVA each with 28 t of oil each. The transformers are 110/20/10 kV, manufactured in former Soviet Union. 110 kV part is open air. Switches are filled by SF_6. 20 kV and 10 kV parts are installed within the building.

Picture 7: Veliko Tarnovo substation

Manipulation with switches is electrical with backup by batteries. New type of gel batteries is installed. The substation is with remote control from the central dispatching as the most of the substations in the system. Local control system is also installed connected to central system.

Picture 8: Local control panel

Čajka substation in Varna has been built in 1994. This substation is whole enclosed in the building. Two 40 MVA transformers are installed each in its individual chamber. Bulgarian transformers Elprom are installed with 25 t of oil each. Each transformer has inside automatic gas extinguishing system called Sergi based on nitrogen agent. 110 kV part is enclosed type with SF_6 filling, produced by ABB. 10 kV part is in standard design. Manipulation is electrical with backup batteries. This substation is with remote control from Varna dispatching.

Picture 9: 110 kV enclosed part

5.1 Sources for operation

5.1.1 Raw materials

Not applicable.

5.1.2 Electricity

All systems described are designed to distribute electricity at low to high voltage levels. Most of the substation has electrical manipulation system with backup batteries. Dispatching centers in Gorna Oriachovitsa and Varna are equipped with diesel generators with automatic start. Those generators are periodically tested each week. All distribution substations are connected to state owned NEC transmission grid.

Picture 10: Diesel generators in Gorna Oriachovitsa and Varna

5.1.3 Heating

Most of the substations are heated electrically.

5.1.4 Steam

Not applicable.

5.1.5 Air pressure and air conditioning

Air pressure air is not used for substation control movements. Those movements are mostly performed electrically or manually.

5.1.6 Technical gases

Not used.

5.1.7 Water

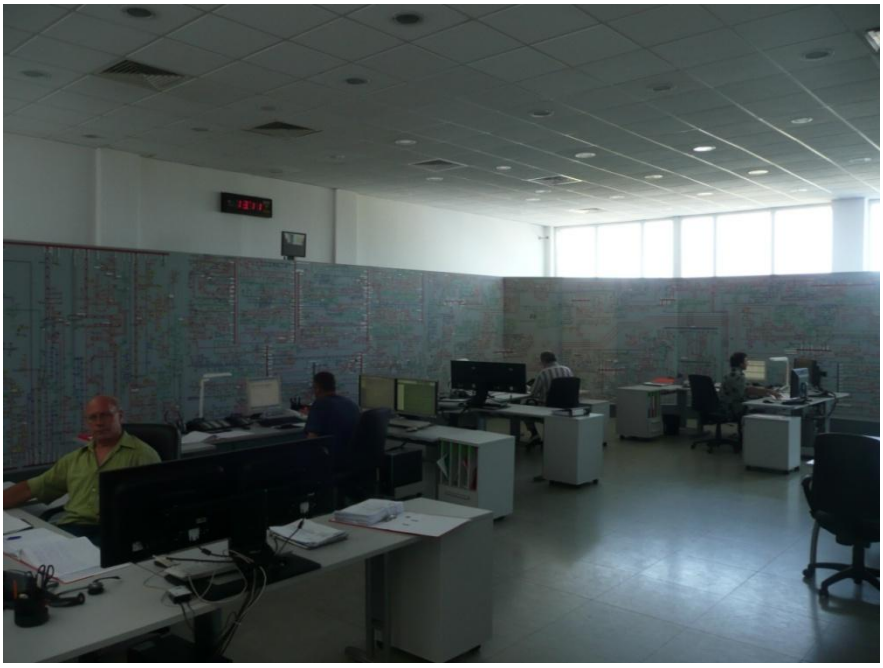
Water systems is installed in the substations just for hygiene reasons.

5.1.8 Control systems

The distribution is controlled from two independent dispatching centers located in Gorna Oriechovitsa and Varna. These dispatching are substitutable. Varna dispatching operates 6 substations, Gorna Oriechovitsa dispatching operates 5 substations. Dispatching is permanently

manned. The control system is mostly based on Schneider Monitor Pro 7.2. platform, or Siemens platform or ABB platform (older systems). The operator has complete visualization of individual substation current status. Also CCTV cameras installed in most medium to low voltage substations help the operator to see current status. Operators can remotely manipulate with the substation premises in the case of necessity or can send the field operators to solve the problems.

Picture 11: Gorna Oriechovitsa control room



5.2 Storage

5.2.1 Storage of raw materials and products

EP has a central storage of spare parts. We did not visit this storage. In individual substations, there are no significant storages.

5.2.2 Chemicals

No significant volumes of chemicals are stored in the visited areas. Quite significant volumes of oil are present inside the transformers. The volumes are about 10 – 30 t. Transformers are installed with emergency pits mostly of concrete construction.

5.3 Layout and construction

Substations are mostly designed with 110 kV part as open air with steel or concrete constructions of the poles. In three locations are the 110 kV parts enclosed. In one location from three mentioned above is 110 kV part installed within the building. Medium and low voltage parts are located inside the building. Control rooms are located inside the building, which are made from bricks or concrete.

5.4 Security

Most of substation are equipped with burglary detection. Motion detectors are installed within the buildings. Outside the buildings infrared gates are installed. The signal is routed to the dispatching which is able to send the field operators in the case of problem. Also CCTV cameras are installed in high to middle voltage substations with signal routed to dispatching.

Picture 12: Infrared gates and CCTV

Mechanical security is assured with fencing, locked door and closed windows. Mechanical security is only on basic level, but EP has no significant bad experience with burglaries.

Important issue is the security of cash money, which are collected from customers on client centers. We have visited one of these. The centre is during the day secured with two physical guards who are armed. The staff of the cash desk is equipped with panic button. We don't want to spread the detail of security in this report. In the case of individual questions, they could be answered.

6. Organization and management

6.1 Certified management systems

No certified management systems like ISO are implemented.

6.2 Employees

EP Bulgaria has about 2 000 employees. Employees are trained in EON (previous owner) standard. Substations are mostly not permanently manned and are remotely controlled from dispatching. Field operators are located within the distribution areas able to do the action after dispatching command.

6.3 Fire prevention

EP Bulgaria has written rules of fire prevention. Periodical theoretical and practical training is provided also in cooperation with state professional fire brigades. Two practical trainings per year are provided. Written procedure is also for hot works which could be done only with special permit where safety precautions for each work are set up. After finishing the hot work following guarding is provided.

6.4 Maintenance

In our assessment the maintenance of the substations are better than average. Two times per year periodical inspections are provided including infrared camera thermo vision also on transformers. The transformer oil is tested once a year with chromatography analysis. Based on inspections the plan of maintenance is provided. For each work the special work order is elaborated including the safety precautions (see appendix). The state of visited substations we assess as very good.

7. Safety components

7.1 Fire water

No fire water hydrant or basins were installed in visited substations. According the information obtained from the EP representatives, this is common condition also in other substation. In some substations public fire water hydrants are closed to the station, but without a overview about the their state and water delivery quality. This is an issue of our recommendations.

7.2 Fire smoke detection

Automatic smoke detection is commonly not installed in the substations. Only substations Byala, Trakata and Slatina are equipped with smoke detection routed to central dispatching. This is the issue of our recommendations.

7.3 Fixed fire extinguishing systems

On Čajka substation is the nitrogen system called Sergi installed. This is an automatic system with pressured nitrogen cylinders and piping routed directly to the transformer. Periodical revision are provided each year.

Picture 13: Sergi extinguishing system

7.4 Emergency ventilation

No emergency ventilation is installed.

7.5 Overpressure protection

Not applicable.

7.6 Portable extinguishers

Portable extinguishers are installed on each substation. Periodical revisions are provided once a year.

7.7 Fire brigade

Company has not its own fire brigade. Practical trainings are provided with municipal fire brigades. Professional fire brigades are located in bigger cities, so we can expect that the fire brigade could take the action. We don't know exactly the level of the professional fire brigade equipment.

8. Losses in past 5 years

No major losses in the period from 2008 – 2010. One PD loss experienced on the distribution in 2011 as a result of snow storm, approximate value of the loss EUR 400 000.

9. Loss estimation

9.1 Scenario and loss estimation

There could be many scenarios of major loss in the distribution net. Over ground grid is quite sensitive on natural perils like windstorm, icing or earthquake. It is very difficult to assess the losses caused by this type of perils. Depending on Munich Re NATHAN assessment and terrain

relief we could expect slightly elevated risk of earthquake, extra tropical storm and hailstorm. Flood risk was identified on

- Substation Devnya (it should be close to the Varna's lake)
- Substation Asparuchovo (it is on an island under Asparuchov bridge), Varna
- Substation Sinkevitsa next to the river.

During our survey we assessed two possible scenario:

1) From the local point of view and focusing on the individual substations, the representative scenario of PML could be the fire and/or the explosion of individual transformer, which could easily spread to other transformers because of the lack of fire separation. This could also cause major business interruption of the substation and also business interruption for local distribution.
   Assessing the new replacement values we see the PML scenario on Čajka substation, which is situated in Varna, whre enclosed 110 kV part from ABB is installed. All facilities of the substation including transformers are installed within the building. As the representative scenario of PML we see the fire or explosion of the transformer and the fire spread on whole substation. For the PML assessment we expect the 100% damage of installed technology, what is EUR 1 427 578 and 90% damage of the building value, what is EUR 1 077 548. Because the substation is surrounded with the private houses, there should be also the damage of surrounded property considered. The business interruption is not considered in this scenario, because we expect, that EP is able to substitute the distribution from another substation.
   The PML assessed for Čajka substation is EUR 2 397 370.

2) From the global point of view it is very hard to assess the maximum loss on distribution net caused by natural perils. So the PML is represented by maximum limit of liability offered by insurer, what is currently 18 000 000 EUR.

9.2 Loss definitions

9.2.1 PML – Possible Maximum Loss

Maximum loss (property and business interruption if is insured), which could be expected as a result of one fire (or other danger if it is limiting factor) in the case of combination of the worst possibilities.
Factors influencing the loss amount are: effective fire complex dividing; lack of combustible material; construction materials of objects; time of business interruption.

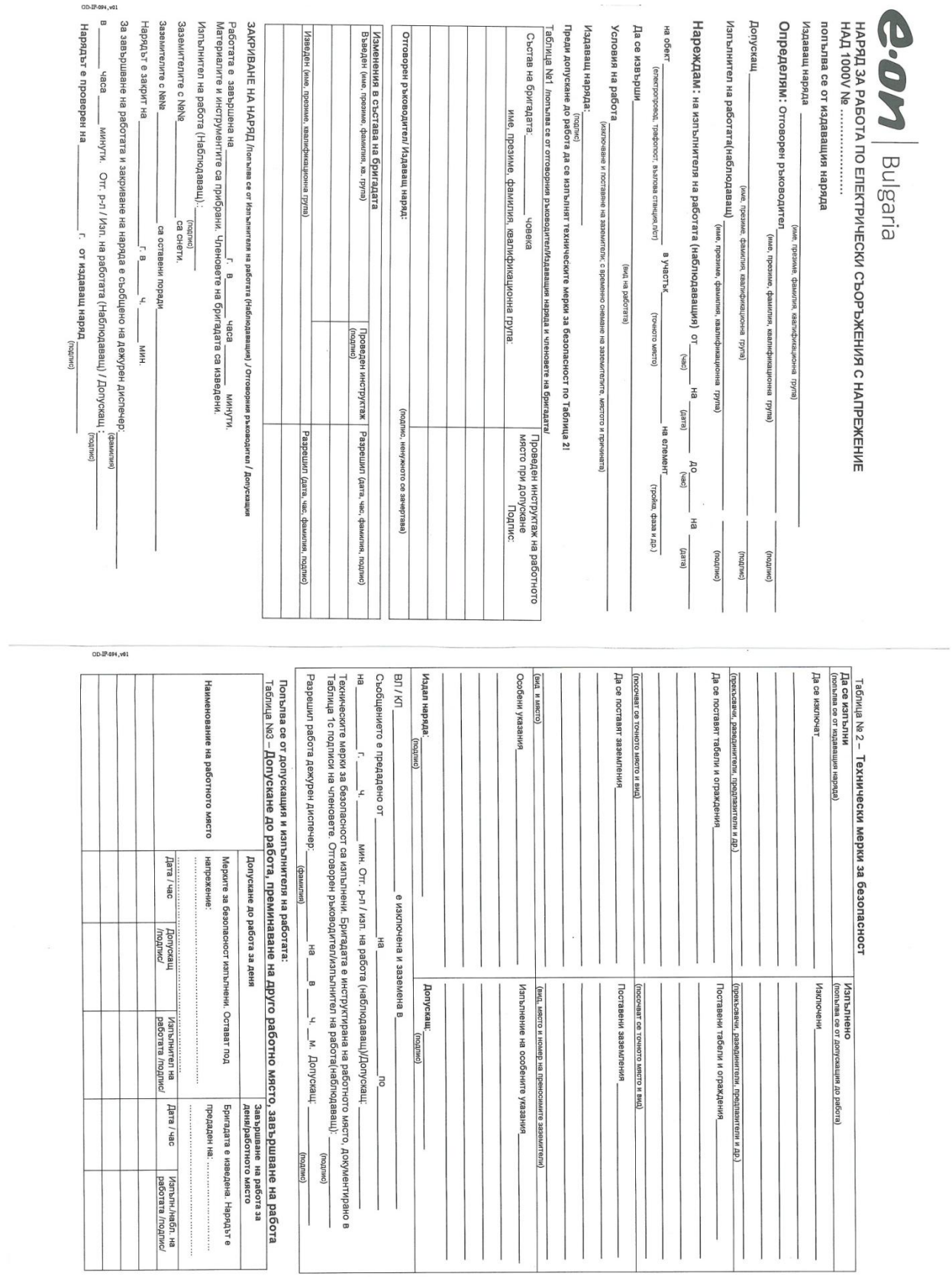
9.2.2 EML – Estimated Maximum Loss

The biggest real loss (property and business interruption if is insured), which could be expected as a result of one fire (or other danger if it is limiting factor) when all internal and external safety systems able to reduce the loss are operating.

10. Atachemets

10.1 Work order form

Picture 14: The work order form



НАРЯД ЗА РАБОТА ПО ЕЛЕКТРИЧЕСКИ СЪОРЪЖЕНИЯ С НАПРЕЖЕНИЕ НАД 1000V № .....

попълва се от издаващия наряда

Издаващ наряда _____ (име, презиме, фамилия, квалификационна група)

Определям: Отговорен ръководител _____ (име, презиме, фамилия, квалификационна група) _____ (подпис)

Допускащ _____ (име, презиме, фамилия, квалификационна група) _____ (подпис)

Изпълнител на работата(наблюдаващ) _____ (име, презиме, фамилия, квалификационна група) _____ (подпис)

Нареждам: на изпълнителя на работата (наблюдаващия) от _____ (час) на _____ (дата) до _____ (час) на _____ (дата)

на обект _____ в участък _____ на елемент _____
(електропровод, трафопост, възлова станция,пост) (точното място) (тройка фаза и др.)

Да се извърши _____ (вид на работата)

Условия на работа _____ (изключване и поставяне на заземителя; с временно снемане на заземителя, мястото и причината)

Издаващ наряда: _____ (подпис)

Преди допускане до работа да се изпълнят техническите мерки за безопасност по Таблица 2!

Таблица №1 /попълва се от отговорния ръководител/издаващия наряда и членовете на бригадата/

Състав на бригадата: _____ човека име, презиме, фамилия, квалификационна група	Проведен инструктаж на работното място при допускане Подпис:

Отговорен ръководител/ Издаващ наряд:	(подпис, ненужното се зачертава)

Изменения в състава на бригадата			
Въведен (име, презиме, фамилия, кв. група)	Проведен инструктаж (подпис)	Разрешил (дата, час, фамилия, подпис)	
Изведен (име, презиме, квалификационна група)		Разрешил (дата, час, фамилия, подпис)	

ЗАКРИВАНЕ НА НАРЯД /попълва се от Изпълнителя на работата (наблюдаващия) / Отговорния ръководител / Допускащия

Работата е завършена на _____ г. в _____ часа _____ минути.
Материалите и инструментите са прибрани. Членовете на бригадата са изведени.

Изпълнител на работа (Наблюдаващ): _____ (подпис)

Заземителите с №№ _____ са снети.

Заземителите с №№ _____ са оставени поради _____

Нарядът е закрит на _____ г. в _____ ч. _____ мин.

За завършване на работата и закриване на наряда е съобщено на дежурен диспечер: _____ (фамилия)
в _____ часа _____ минути. Отг. р-л / Изп. на работата (Наблюдаващ) / Допускащ: _____ (подпис)

Нарядът е проверен на _____ г. от издаващ наряд _____ (подпис)

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Таблица № 2 – **Технически мерки за безопасност**

Да се изпълни (попълва се от издаващия наряда)	**Изпълнено** (попълва се от допускащия до работа)
Да се изключат _____	Изключени _____
_____	_____
_____	_____
_____	_____
_____ (прекъсвачи, разединители, предпазители и др.)	_____ (прекъсвачи, разединители, предпазители и др.)
Да се поставят табели и ограждения _____	Поставени табели и ограждения _____
_____	_____
_____	_____
_____ (посочват се точното място и вид)	_____ (посочват се точното място и вид)
Да се поставят заземления _____	Поставени заземления _____
_____	_____
_____	_____
_____	_____
_____ (вид, място и номер на присъединя заземители)	_____ (вид, място и номер на присъединя заземители)
Особени указания _____	Изпълнение на особените указания _____
_____	_____
_____	_____
_____	_____
_____	_____
Издал наряда: _____ (подпис)	**Допускащ:** _____ (подпис)

ВП / КП _____ е изключена и заземена в _____ по _____
Съобщението е предадено от _____ на _____
на _____ г. _____ ч. _____ мин. Отг. р-л / изп. на работа (наблюдаващ)/Допускащ: _____
Техническите мерки за безопасност са изпълнени. Бригадата е инструктирана на работното място, документирано в Таблица 1с подписи на членовете. Отговорен ръководител/изпълнител на работа(наблюдаващ): _____ (подпис)
Разрешил работа дежурен диспечер: _____ (фамилия) на ___ в ___ ч. ___ м. Допускащ: _____ (подпис)

Попълва се от допускащия и изпълнителя на работата:

Таблица №3 – **Допускане до работа, премináване на друго работно място, завършване на работа**

Допускане до работа за деня			**Завършване на работа за деня/работното място**	
Мерките за безопасност изпълнени. Остават под напрежение:			Бригадата е изведена. Нарядът е предаден на:	
Наименование на работното място	Дата / час	Допускащ /подпис/	Изпълнител на работата /подпис/	Дата / час	Изпълн./навъл. на работата /подпис/

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10.2 Statistics of the installations and equipment age

Transformers:

date of installation	Number
up to 5 years	878
from 5 to 10 years	240
from 10 to 15 years	346
from 15 to 20 years	333
from 20 to 25 years	1183
from 25 to 30 years	2353
over 30 years	7146

Provider	Number
Bulgaria	9 050
Serbia	92
Italy	13
Korea	144
Germany	27
Romania	24
Slovakia	54
Others	17
N/a	3 058

Low voltage lines:

Type of Asset	Up to 5 years	%	Up to 10 years	%	Up to 20 years	%	From 21 to 30 years .	%	From 31 to 40 years	%	Over 40 years	%	TOTAL	Average age (in years)
Overhead lines (km)	1 187	7%	1 219	7%	3 038	18%	4 836	29%	3 663	22%	2 910	17%	16 853	**30**
Underground lines (km)	340	5%	425	6%	1 953	29%	2 561	38%	991	15%	527	8%	6 797	**27**

Medium voltage lines:

Type of Asset	Up to 5 years		Up to 10 years	%	Up to 20 years	%	Up to 30 years	%	Up to 40 years	%	Over 40 years		TOTAL	Average age (in years)
Overhead (km)	381	3%	420	3%	2 732	18%	4 935	32%	2 398	16%	4 151	28%	15 017	**34**
Underground (km)	501	15%	430	13%	1 105	32%	816	24%	435	13%	117	3%	3 404	**22**

High voltage lines:

Type of Asset	Up to 5 years	%	Up to 10 years	%	Up to 20 years	%	Up to 30 years	%	Up to 40 years	%	Over 40 years	%	TOTAL	Average age (in years)
Overhead (m)	0	0%	6 650	15%	0	0%	16 300	38%	20 000	47%	0	0%	42 950	**32**
Underground high (m)	2 556	22%	0	0%	0	0%	8 897	78%	0	0%	0	0%	11 453	**23**

10.3 Natural Perils assessment

NATHAN Single Risk Assessments Report attached.