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Technical and Legal Aspects of Critical Infrastructure Protection

1. INTRODUCTION

The safety and security of critical infrastructure plays important role in running of the country. One of the most sensitive, and crucial parts of critical infrastructure are nuclear power plants (hereinafter ‚NPPs'). Nuclear power plants have been the subject of many studies[1]. The particular features of types of NPPs are considered with the aim to assure regular operation[2]. However, NPPs consist of critical infrastructure which could be affected by lightning. These not demand occurrences are mainly a result of their locations and spatial configuration. The consequences of lightning very depending on many factors, e.g. the point of lightning strike, the type of discharge or features of NPPs. It is important to stress that this natural endanger has a random character and cannot be prevented. In principle, all components of NPPs can be affected by lightning[3]. The external components, like

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1 *International Atomic Energy Agency: Modern Instrumentation and Control for Nuclear Power Plants: A Guidebook*, Technical Reports Series No. 387 Vienna 1999; *International atomic Energy Agency, Safety Assessment of Proposed Improvements to RBMK Nuclear Power Plants*, IAEA-TECDOC-694, Vienna 1993; *International Atomic Energy Agency, Advanced nuclear plant design options to cope with external events*, IAEA-TECDOC-1487, Vienna 2006; *International Atomic Energy Agency, Safety of Nuclear Power Plants: Design*, Safety Standards Series, No. NS-R-1, IAEA, Vienna 2000; *International Atomic Energy Agency, External Events Excluding Earthquakes in the Design of Nuclear Power Plants*, Safety Guide, IAEA Safety Standards Series, No. NS-G-1.5, IAEA, Vienna 2003; *International Atomic Energy Agency, Safety Assessment and Verification for Nuclear Power Plants*, IAEA Safety Standards Series, No. NS-G-1.2, IAEA, Vienna 2001; *International Atomic Energy Agency, Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage*, IAEA Nuclear Security Series No. 4, Vienna 2007.

2 T. Anegawa et al., *Development of ABWR-II and its safety design* [in:] *Advanced Nuclear Reactor Safety Issues and Research Needs. Workshop Proceedings*, NEA/OECD, Paris 2002, p. 153; P.D.W. Bottomley, C.T. Walker, D. Papaioannou, S. Bremier, P. Pöml, J.-P. Glatz, S. van Winckel, P. van Uffelen, D. Manara, V.V. Rondinella, *Severe accident research at the Transuranium Institute Karlsruhe: A review of past experience and its application to future challenges*, "Annals of Nuclear Energy" March 2014, Vol. 65.

3 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis for guidance on lightning protection for nuclear power plants*, Fourth American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Controls and Human-Machine Interface Technologies (NPIC&HMIT

structures, are fully exposed to the lightning threat, however internal components are endangered, too. In particular the internal apparatus can be affected by direct or indirect effects of lightning current. The modern digital apparatus provides many benefits in NPPs operation e.g. much more appropriate system control. However, due to their typically low voltage withstand, these apparatus are much greater risk failure caused by lightning overvoltage that can appear in the power feeder and /or in the signal network.

The natural endanger of lightning could be the cause of critical events, especially in the NPP's safety-related instrumentation and control system, not only in case of direct lightning strike, but also in case of nearby strikes, which can couple with instrumentation and control systems by lightning electromagnetic pulse field ('LEMP').

During the past twenty years, many surveys have been done and the data collected by U.S. Nuclear Regulatory Commission ('NRC') in a dedicated database suggests that lightning damages can be severe[4].

Of course protection is key to avoid component failures which can lead to reactor trips or other dangerous outcomes. Therefore protection measures to avoid damage induced by lightning or resistive overvoltages contribute to NPP safety. In fact the most severe damage is that affecting instrumentation and control systems, resulting in inoperability of safety systems or causing false alarms, thus triggering automatic actions which may destroy critical equipment or delay safety-related functions.

The criteria for design, installation and maintenance of lightning protection measures can be divided into two different groups: the first one concerns protection measures to reduce physical damage and life hazard in a NPP; while the second group concerns protection measures to reduce failures of electrical and electronic systems within NPP ancillary facilities. For both cases a risk management concept can be helpful to achieve an adequate protection level. Although the IEC 62305 series standards on lightning protection have not been developed specifically for nuclear power plants, the suggested method and requirements can be usefully applied. After a summary of the NRC damage report, an overview follows of some aspects of lightning protection on which IEC standards focus.

2. PROBLEMS OF SERVICE CONTINUITY PROVISION

In early 1990s the U.S. Nuclear Regulatory Commission engaged Oak Ridge National Laboratory ('ORNL') to develop a technical basis in order to design a lightning protection system for NPPs.

2004), Columbus, Ohio, September 2004; T. Kisielewicz, C. Mazzetti, Z. Flisowski, B. Kuca, F. Fiamingo, *Natural danger of nuclear power plants due to lightning strokes*, International Nuclear Energy Congress 2012, Warsaw, Poland; IEC 62305–3: Protection against lightning – Part 3: Physical damage to structures and life hazard, Ed. 2.0, December 2010; IEC 62305–4: Protection against lightning – Part 4: Electrical and electronic systems within the structures, Ed.2.0, December 2010.

[4] P.D.W. Bottomley, C.T. Walker, D. Papaioannou, S. Bremier, P. Pöml, J.-P. Glatz, S. van Winckel, P. van Uffelen, D. Manara, V.V. Rondinella, *Severe accident research at the Transuranium Institute Karlsruhe: A review of past experience and its application to future challenges*, 'Annals of Nuclear Energy', March 2014, Vol. 65; NUREG/CR-6866 ORNL/TM-2001/140: Technical Basis for Regulatory Guidance on Lightning Protection in Nuclear Power Plants, Oak Ridge National Laboratory Managed by UT-Battelle, LLC Oak Ridge, TN 37831–6472, January 2006.

The report, written by ORNL, describes many events of failure, damage or false alarm related to lightning[5]. It is important to mention reactor trip/SCRAM, ventilation isolation damage, containment isolation damage or other kinds of damage[6]. The results show that among many recorded events (about 87) only 30 were responsible for the relevant damage or failure: 11 events involved reactor trips, 9 concerned a loss of power or other outcomes that caused the backup and diesel generator to start, 2 involved ventilation or containment isolation, and 6 were miscellaneous events[7]. According to the analysis[8] the probability of fire protection system damage and simultaneous fire due to lightning strike can be estimated at about $3–10^4$, while the core damage probability is estimated to be two orders of magnitude lower. Although this probability does not seem high enough to cause concerns about safety, the losses brought about by the event can be very high, therefore the resulting risk cannot be neglected. Furthermore, most of the data considered in the report were collected in surveys at operating plants with older, analog electronic and electromechanical systems, which are less susceptible to lighting damage[9].

Lightning can generate a cascade of critical events that result in false instrumentation and control signals, while simultaneously damaging plant components. For example, an overvoltage due to direct lightning impact can damage a subsystem by inductive coupling and, at the same time, initiate a fire. In is reported a remarkable event occurred in a nuclear power station in June 1991[10]. A direct flash struck the NPP. During the event the 'plant operating power was 89 percent of full power […]. The event was initiated by a lightning strike (possibly multiple strikes) that disabled both off-site power sources, started a transformer fire, and disabled communication systems. The turbine and reactor automatically tripped at the event onset. The cascade of failures delayed restoration of off-site power for about 12 hours'.

3. TECHNICAL STANDARDS OF RISK ASSESSMENT

Risk assessment can be performed on the basis of technical standards and recommendations[11]. From the practical point of view, in order to select the optimum protection against lightning overvoltages and electromagnetic field, a risk analysis based on probabilistic approach should be performed. The lightning hazard to which a NPP is exposed is a random process involving a set of effects which

5 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis…*; NUREG/CR-6866 ORNL /TM-2001/140: Technical Basis…
6 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis…*
7 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis…*
8 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis…*
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10 R.A. Kisner, J.B. Wilgen, P.D. Ewing, K. Korsah, M.R. Moore, *A technical basis…*
11 IEC 62305–2: Protection against lightning – Part 2: Risk management, Ed. 2.0, December 2010; C. Mazzetti, T. Kisielewicz, F. Fiamingo, B. Kuca, Z. Flisowski, *Rational Approach to Assessment of Risk Due to Lightning for Nuclear Power Plants*, „Przegląd Elektrotechniczny", R. 88, No. 6, 2012, pp. 72; A. Tofani, D. De Carli, G. Mosti, V. Montarese, C. Mazzetti, *Lightning protection in nuclear and radiological environments according to IEC/EN 62305–2:2012*, International Conference on Lightning Protection (ICLP), Shanghai, China, October 2014.

are correlated with the parameters of the lightning discharge, the characteristics of the NPP, its content, the installations inside the facility, the transmission lines and other services entering the facility[12]. An example of lightning risk assessment is presented by P. Duqueroy et al.[13]

If the time of observation is fixed (usually $t = 1$ year), it is possible to demonstrate that the risk, defined as the probability of annual loss in a NPP due to lightning, may be expressed using N, P, L variables in the formula $R = 1 - e^{(-N x P x L)}$ in accordance with[14]. N is the average annual number of flashes influencing the NPP and its content. P is the probability of damage to the NPP due to single flash. L is the average amount of loss, with consequential effects, due to single flash. The value of NPL is the level of risk or the number (or frequency) of annual loss in a NPP caused by lightning. It is evident that if NPL<< 1 (in practice NPL < 0.1), the risk (as probability) and the level of risk are coincident.

The International Standard defines the risk as the probable annual loss in a structure due to lightning ($R = N x P x L$) in accordance with[15].

4. TECHNICAL STANDARDS OF PROTECTION MEASURES

The components of NPP may be influenced by whole or partial lightning current flowing to the earth in case of direct flashes. Internal electronic and electrical apparatus may be affected by the lightning current flowing to the earthing system causing overvoltages by resistive coupling. The inductive coupling of the lightning current can result in dangerous overvoltages in internal wiring or can have a direct influence on sensitive devices. Flashes to the ground near buildings can introduce overvoltages due to inductive coupling of the lightning current with internal wiring or the impulsive electromagnetic field can have a direct influence on sensitive devices. When lightning flashes strike NPP incoming lines, the instrumentation and control can be affected by the lightning current, which may cause overvoltages, sparks, thermal and mechanic effects. Lightning flashes striking near incoming lines can affect the plant by inducing overvoltages in the line conductors, which may cause failure or malfunctioning of the connected electrical and electronic systems.

Designers should consider protection of an NPP's external and internal components as well as services entering the structure in order to reduce the risk due to lightning to a tolerable level. The possible protection measures are given in IEC 62305 series standards[16].

Protection measures to reduce physical damage are achieved by the lightning protection system ('LPS'), which includes the following features: air termination system; down conductor system; earth termination system; lightning equipotential

[12] C. Mazzetti, T. Kisielewicz, F. Fiamingo, B. Kuca, Z. Flisowski, *Rational approach…*
[13] P. Duqueroy, C. Miry, P. Seltner, *Lightning risk assessment evaluation on French nuclear power plants*, International Conference on Lightning Protection (ICLP), Shangai, China, October 2014.
[14] IEC 62305–1: Protection against lightning – Part 1: General principles, Ed. 2, December 2010; IEC 62305–2: Protection against lightning – Part 2…
[15] IEC 62305–2: Protection against lightning – Part 2…
[16] IEC 62305–3: Protection against lightning – Part 3: Physical damage to structures and life hazard, Ed. 2.0, December 2010; IEC 62305–4: Protection against lightning – Part 4: Electrical and electronic systems within the structures, Ed. 2.0, December 2010.

bonding ('EB'); electrical insulation (and hence separation distance) against the external LPS. In principle, LPS is designed and installed with the aim to intercept, conduct and disperse the lightning current into the earth; bonding measures to minimise potential differences, and to limit surges using a meshed bonding network and bonding all-metal parts or conductive services directly or by suitable surge protective devices ('SPDs') which are included in internal LPS.

Protection measures to reduce failures of electrical and electronic systems include: earthing and bonding measures; magnetic shielding; line routing; isolation interface; coordinated surge protective device ('SPD') system. In principle, the core of protection measures to reduce failure of electrical and electronic apparatus consists of an SPD system, defined as a coordinated set of SPDs properly selected and erected to protect electrical and electronic systems against surges. An SPD at the point of entry of incoming services reduces essentially the risk related to overvoltages by resistive coupling due to direct flashes to the structure and/or the overvoltages transmitted through the lines[17]. An SPD at the point of entry of equipment reduces essentially the risk related to the overvoltages by inductive coupling due to direct and/or nearby flashes[18]. Spatial shielding serves to reduce the impulsive magnetic field due to lightning current from direct or nearby lightning flashes. Total or partial shielding of the structure and/or of the internal circuits by using shielded cables or cable ducts are effective measures to mitigate the penetration of magnetic field. Line routing and shielding serves to minimise voltages and currents induced into electrical and electronic system using minimised loop area by adjacent routing of power and signal lines[19].

Moreover, protection measures such as LPS, shielding wires, magnetic shields and SPDs determine lightning protection zones ('LPZ')[20].

LPZs downstream of the protection measure are characterised by significant reduction of LEMP than that upstream of the LPZ. With respect to the threat of lightning, the following LPZs are defined:

- LPZ 0A zone where the threat is due to the direct lightning flash and the full lightning electromagnetic field. The internal systems may be subjected to full or partial lightning surge current; crucial parts of LPZ OA of NPPs can be identified using the rolling sphere method, as suggested by the international standard[21];
- LPZ 0B zone protected against direct lightning flashes, but where the threat is the full lightning electromagnetic field. The internal systems may be subjected to partial lightning surge currents;
- LPZ 1 zone where the surge current is limited by current sharing and by SPDs at the boundary. Spatial shielding may attenuate the lightning electromagnetic field;

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[17] M. Marzinotto, F. Fiamingo, C. Mazzetti, G.B.L. Piparo, *A tool to evaluate the need of protection against lightning surges*, "Electric Power Systems Research" April 2012, Vol. 85.

[18] T. Kisielewicz, G.B. Lo Piparo, F. Fiamingo, C. Mazzetti, B. Kuca, Z. Flisowski, *Factors affecting selection, installation and coordination of surge protective devices for low voltage systems*, "Electric Power Systems Research" August 2014, Vol. 113.

[19] IEC 62305–4: Protection against lightning – Part 4…; IEC 60364–5 Ed. 3.0, Electrical installations of buildings, August 2001.

[20] IEC 62305–1: Protection against lightning – Part 1…

[21] IEC 62305–3: Protection against lightning – Part 3…

- LPZ 2,..., n zone where the surge current may be further limited by current sharing and by additional SPDs at the boundary. Additional spatial shielding may be used to further attenuate the lightning electromagnetic field.

As a general rule, the object to be protected shall be in a LPZ whose electromagnetic characteristics are compatible with the capability of the object to withstand stress the damage to be reduced (physical damage, failure of electrical and electronic systems due to overvoltages).

Protection measures can be also combined with different complex solutions in relation to the peculiarity of the structure and its content, of the internal and external systems: e.g. if a very effective spatial shield is used, line routing and shielding may not be required, or vice versa.

To find the optimum combination of protection measures it is necessary to validate each separate protection measure as well as the resulting combination of several protection measures.

5. LEGAL FRAMEWORK

Technical challenges relating to critical infrastructure, to which NPPs belong, should take into account the legal milieu and legal tools which can enhance and promote the best practices in the analysed area[22]. The legislator is usually interested in regulating the nuclear power sector in order to ensure protection against radiation[23]. In 2016, the IAEA published, as part of its Safety Standards Series, a revised version of the Governmental, Legal and Regulatory Framework for Safety[24]. It was updated after the 2011 accident at the Fukushima Daiichi NPP in Japan. As the document states in point 1.6, the framework is designed to protect safety of nuclear installations, radiation safety, the safety of radioactive waste management and safety in the transport of radioactive material. The issue of lightning protection for NPPs comes into the spotlight of the legal framework as far as damage caused by lighting can lead to radiation jeopardy. Legal regulations on lightning protection already appear in many legal instruments from the field of building regulations or regulations on occupational safety and health, since it deals with protecting life and property[25]. However, even there legislation is only one of the factors. Others include: specifications defined either by institutions responsible for safety in the workplace or in internal regulations of a given entity, and guidelines prepared by insurance companies to be followed by those insured[26]. In the case of NPPs, the role of lightning protection standards and best practices is even more crucial. Legal regulations can enhance lighting protection by promoting and endorsing technical

[22] G. Blicharz, T. Kisielewicz, *Prawne aspekty zarządzania commons wobec technicznych wyzwań rozwoju* smart city, „Forum Prawnicze" 2017, No. 1 (39), pp. 34–54.
[23] International Commission on Radiological Protection, 'The 2007 Recommendations of the International Commission on Radiological Protection', ICRP Publication No. 103, Annals of the ICRP, 2007, Vol. 37(2–4).
[24] *Governmental, Legal, and Regulatory Framework for Safety*, General Safety Requirements No. GSR, Part 1 (Rev. 1), International Atomic Energy Agency, Vienna, February 2016.
[25] IEC 62305–3: Protection against lightning – Part 3: Physical damage to structures and life hazard…
[26] *Lightning protection guide*, Building Connections-OBO, Bettemann Menden 2017, p. 22.

measures considered as state of the art in science and technology to prevent damage in NPPs. Since legislation usually uses broad legal terms directly indicating a technical standard, it goes out of the typical legislative toolbox, abandoning specific legal definitions and indicating specific names and numbers of technical standards created by professional bodies. Thus regulation becomes more flexible, and takes into account the ongoing development of technology. One of the key elements is the method of introducing best practices into the sphere of lightning protection of NPPs, and encouraging NPPs headquarters to update lightning protections systems. In order to take a broader perspective on the legislative framework, one should look at IAEA standards, and analyse what role the legislator should play, and how to formulate the legal regulations concerning NPPs in order to properly tailor the lightning protection solutions.

IAEA standards place the burden of creating legal regulations on two levels: firstly on each national legislator, and secondly on the global scale, involving international cooperation. The IAEA does not offer a draft of legal rules, but rather limits itself to showing what should be regulated in NPPs and what goals should be achieved. However, the Standards offer some substantial solutions on the structure of applying the law to the management of nuclear power. The IAEA standards contain 36 requirements for the national legislator. The main idea is to create an interplay between the legislator – or regulatory body – and the person or organisation responsible for a nuclear facility or a nuclear activity. According to requirements 3, 4 and 5, the legislator should create a regulatory body which is 'effectively independent' in its decision-making process. Its activity should focus on the safety of nuclear power facilities and activities. Independence of the regulatory body is crucial for maintaining safe conditions, and for having a controlling power over NPPs. IAEA standard 2.10 specifies that '[t]he staff of the regulatory body shall have no direct or indirect interest in facilities and activities or authorised parties'. Moreover, it shall have direct access to 'all necessary safety related information' even if it deems it to be 'proprietary' information, reserved by the operator of the NPP (2.13a). Interestingly enough, requirement 2.13 b states that the regulatory body has to have access to conduct inspections of the operator (authorised party) or any 'designer, supplier, manufacturer, constructor, contractor or operating organisation associated with the authorised party'. Broad insight of the regulatory body into the NPP operation sets up safeguards of the NPP's security and protection.

The other aspect which is highlighted by IAEA standards concerns assigning 'prime responsibility for safety'. According to requirement 5 responsibility should be assigned 'to the person or organisation responsible for a facility or an activity'. Within this responsibility, the authorised party should not only follow the rules imposed by regulatory body, but also should prove that it is following the established rules. Moreover, prime responsibility is not waived from the authorised party even if it has followed the established rules (2.14). Thus, IAEA standards are shifting risk burden on the person or organisation running the NPP. It requires such authorised party to be responsible throughout the lifetime of facility 'until their release from regulatory control' (2.15). The authorised party is expected to actively develop the protection of the NPP. It should follow the developments in science and technology, take advantage of the experiences of other parties and NPPs. The same approach should be applied to lighting protection of NPPs analysed in this paper: it should be treated as one of the elements that – if covered properly – can help avoid unexpected danger.

This short insight into the guidelines concerning the legal framework shows the importance of cooperation between the government, regulatory body and private or public entities running the NPPs. Even though IAEA standards are merely guidelines, they today can be called soft law which governs not by power of the state, but by power of reason. Obviously, even in statutory law it is always good faith – *bona fides* – that is required to fulfill the legislative purpose[27]. It is so particularly in cases where lack of laws leads to disaster. The danger that can be created by irresponsible use of NPPs urges authorised parties, government, and regulatory bodies to follow best practices, and achieve outcomes desirable for the society as a whole. IAEA standards gain more authority due to international cooperation, and the 1994 Convention on Nuclear Safety. It is quite useful for the governments, regulatory bodies and parties running the NPPs to take into account not only the best practices set up for technological issues, but also for legal regulations on NPP safety. The outcome of IAEA legal standards and guidelines is a demand for cooperation within the nested structure of government, regulatory body, and parties running NPPs. Just like in the case of governing the commons, cooperation seems to be the only way to successful management[28]. Otherwise, any abuse of the resource can lead to a big disaster affecting the whole community. What is enacted is not always what is seen in practice. Having this in mind, regulatory bodies should not only put pressure on the technological development, but also on qualified staff in terms of both expertise and human virtues, which are essential for following legal precepts, and make NPPs beneficial for the communities[29].

6. CONCLUSIONS

The present paper contains basic considerations on selected aspects of service continuity provision in case of critical infrastructure. The legal and technological issues are presented on the background of NPP and lightning protection problems. A multidisciplinary approach to service continuity provision has been highlighted. The question of NPP protection is introduced by the results of NRC studies. The statistics obtained by the NRC shows that lightning phenomena can result in unexpected critical outcomes. Moreover, NRC database can be helpful in understanding lightning protection needs for NPPs. However these events clearly demonstrated that protection measures aimed to reduce damage and apparatus failure at NPPs, and to limit overvoltages caused by resistive and inductive coupling of the lightning current with such electronic and electrical apparatus are needed and have to be

[27] W. Dajczak, F. Longchamps de Bérier, *Prawo rzymskie w czasach dekodyfikacji*, „Forum Prawnicze" 2012, No. 2(10), pp. 8–22.

[28] G. Blicharz, *Commons – dobra wspólnie użytkowane. Prawnoporównawcze aspekty korzystania z zasobów wodnych*, Bielsko-Biała 2017.

[29] D. 1,1,10 (Ulpian, „Rules", book 2): *Iuris praecepta sunt haec: honeste vivere, alterum non laedere, suum cuique tribuere*. See: G. Blicharz, T. Kisielewicz, *Service continuity of critical energy systems in the light of present legal experience* [in:] *Decisions In Situations Of Endangerment. Research Development*, D. Kuchta, M. Popławski, D. Skorupka, S. Stanek (eds.), Wrocław 2016, pp. 221–236.

out in place. The recommendations provided by IEC 62305 standard are a good basis to achieve this aim and to deal with other lightning protection issues, even though this standard is not strictly dedicated to NPPs. In addition, the fundamental elements included in these documents can be helpful in performing a more accurate study on lightning protection dedicated to such critical systems. The lightning risk assessment and management should be carefully adopted for application to NPPs. However, some modifications aimed at creating a reliable procedure are needed. In particular, some studies on the probability of damage (*P*) and amount of loss (*L*) at the NPP due to flashes are strongly advised. This conclusion underlines that the critical power systems need to have an individual approach for the provision of safety and security, with the legislator engaged. The growing importance of soft law within almost any technological sector, from international transport to smart cities, should be taken into account by national legislators also in case of NPPs protection. Even though international technical standards provide a good basis for preparing an adequate safety level, the government agencies have a crucial impact on the final shape of regulations and, finally, on the safety and security of citizens.

Abstract

Tomasz Kisielewicz, Grzegorz Blicharz, Carlo Mazzetti, Giorgio Mosti, Alessandro Tofani, Davide De Carli, Valentina Montarese,
Technical and Legal Aspects of Critical Infrastructure Protection

The present paper discusses the mutual relations between technical aspects and legal solutions in the case of operation of nuclear power plants. To this aim principles of critical infrastructure safety and legal aspects are taken into account. The problem of service continuity provision in the face of natural dangers like lightning is reported. The article refers to nuclear power plants (NPP) with the aim of underlining the problem's importance. The discussion includes selected aspects of safety needs. The problem is discussed using a multidisciplinary approach. The role of international and national standardisation bodies is emphasised. Selected technical standards are quoted. The role of the legislator for service continuity provision is underlined. The present contribution gives a holistic overview on selected aspects of service continuity provision in case of critical infrastructure.

Keywords: *critical infrastructure, safety, natural endanger*

Streszczenie

Tomasz Kisielewicz, Grzegorz Blicharz, Carlo Mazzetti, Giorgio Mosti, Alessandro Tofani, Davide De Carli, Valentina Montarese,
Prawne i techniczne aspekty bezpieczeństwa infrastruktury krytycznej

W niniejszym artykule omówiono wzajemne powiązania aspektów technicznych i rozwiązań prawnych w przypadku prowadzenia elektrowni jądrowych. Praca uwzględnia zagadnienia ochrony i bezpieczeństwa infrastruktury krytycznej. Problematyka została podjęta w kontekście zapewnienia ciągłości usług w świetle naturalnych zagrożeń, jakimi są wyładowania atmosferyczne. Artykuł w szczególności odnosi się do elektrowni jądrowych (NPP) w celu podkreślenia ważności podejmowanej tematyki. Dyskusja dotyczy wybranych *aspektów bezpieczeństwa. Problem omawiany jest w podejściu multidyscyplinarnym. Artykuł przybliża rolę międzynarodowych i krajowych organów normalizacyjnych. Wybrane standardy techniczne zostają przywołane wraz z podaniem krótkiej charakterystyki. Podkreślono rolę ustawodawcy w kontekście zapewnienia ciągłości usług. Artykuł stanowi przegląd wybranych zagadnień związanych z ciągłością usług infrastruktury krytycznej.*

Słowa kluczowe: *infrastruktura krytyczna, bezpieczeństwo, zagrożenie naturalne*

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7. *Digesta Iustiniani* (D.) – Justinian's Digest;
8. P. Duqueroy, C. Miry, P. Seltner, *Lightning risk assessment evaluation on French nuclear power plants, International Conference on Lightning Protection (ICLP)*, Shangai, China, October 2014;
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