NATECH 2021

The 5th International Symposium on Natural and Technological Accident Risk Reduction at Large Industrial Parks

March 10

March 11

Abstract Proceedings

京都大学 KYOTO UNIVERSITY

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The 5th International Symposium on

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March 10-11, 2021

Organized by:
Kyoto University
Osaka University

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Ana Maria Cruz
Shin-ichi Aoki

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Preface

The 5th International Symposium on Natural and Technological Accident Risk Reduction at Large Industrial Parks (5th Natech Symposium - NATECH 2021) aimed to promote scientific exchange from interdisciplinary fields to share experiences, risk assessment methods and innovative risk reduction measures on various accident hazards triggered by large-scale natural disasters at industrial parks. The symposium gathered thirty-five oral presentations regarding current research advances, as well as challenges regarding all aspects of Natech risk management and risk governance. The symposium also offered a space for multistakeholder discussion and cooperation regarding Natech risk reduction.

The 5th Natech Symposium follows a series of international symposiums. The first, second and third Natech symposiums were hosted by Osaka University in cooperation with the Disaster Prevention Research Institute of Kyoto University, Japan, in 2015, 2016, and 2017. The 4th Natech symposium was hosted at the Joint Research Centre, European Commission, Italy in September 2018. The 2019 event, which was to be held in Kyoto in March 2020 (as part of the 2019 academic year in Japan) had to be postponed due to the ongoing coronavirus pandemic.

This year's symposium, held virtually on 10-11 March, offered new possibilities to reach out to stakeholders who would otherwise not be able to attend due to time and resource constraints. We hope that the symposium may contribute to collaboration among researchers, administrative bodies, industries and communities, which we hope can ultimately lead to safer and more resilient territories.

Ana Maria Cruz

Shin-ichi Aoki

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ABSTRACT NO. 1.1

SAFETY AND EQUIPMENT INTEGRITY IN PROCESS INDUSTRY OF JAPAN UNDER THE THREAT OF NATURAL DISASTER AND PANDEMIC

Hiroshi Ishimaru
Osaka University

On February 13, 2021, just one year after the Great East Japan Earthquake that occurred on March 11, 2011, the Tohoku region was hit by a major earthquake of Magnitude 7.3 again. But fortunately, the epicenter of this earthquake was deep (55km), so no tsunami was observed.

In addition, the earthquake countermeasures taken with reference to the damages caused by the 2011 earthquake were effective, so the damage caused by the earthquake motion could be suppressed to a limited extent.

However, at this time, Japan was seriously affected by the spread of COVID-19. If many people were affected by the earthquake and needed to evacuate, it would be necessary to rescue the evacuated people and prevent infection by the virus at the same time, which would have caused many difficulties.

It is also fortunate that the spread of covid-19 infection in the Tohoku region was not so serious. And local governments have prepared infection control measures such as simple bulkheads and rubbing alcohol for evacuees.

If a company is hit by a natural disaster under a pandemic, it is expected that there will be great difficulty in securing work force, resources, utility, logistics, etc. to maintain the safety of processes and operation. It is required to make a crisis management system and BCP on the premise of the possibility of such a complex disaster.

Natural disasters and pandemics appear to be similar threats to societal and industrial systems in terms of “externality, but have different characteristics in their continuity and hazard manifestation process.

Also, especially in a pandemic, measures to prevent its spread will become a new harm for corporate activities, so a new work system is needed to mitigate the new harm.
In this report, these complex threats are discussed, and the 2 indicators evaluation method as a method for evaluating the risk of NATECH and the 4 steps method for protecting against virus infection are referred briefly.

ABSTRACT NO. 1.2

GUIDING PRINCIPLES FOR NATECH RISK MANAGEMENT

Amos Necci, Elisabeth Krausmann
European Commission Joint Research Centre (JRC), Ispra, Italy

Natural hazards can trigger major accidents involving fires, explosions and toxic releases at establishments that process, store or transport dangerous substances. Although occurring frequently, the potential impacts of natural hazards on industrial operations and infrastructure are often overlooked because of a general lack of guidance on how to manage the risk. Prevention of Natech accidents in chemical hazard sites has been recognised as a critical objective in Natech risk management. For this reason, in 2012, modifications to the EU Seveso Directive on the control of major-accident hazards involving dangerous substances explicitly introduced Natech risks as an important component of a hazardous site's overall risk management strategy in the safety documents. However, the Directive does not provide guidance on how to analyse and manage Natech risk.

In collaboration with European Union member state authorities responsible for the inspection of Seveso sites, we discussed the guiding principles of Natech risk management to allow inspectors to ascertain the effectiveness of the site's Natech risk management approach. This study describes the general requirements of the Seveso Directive for operators in the EU, including the relevant documentation, and highlights the steps where Natech risk is a key factor. The study also discusses the minimum information that is needed for a clear description of Natech hazards and a complete assessment of Natech risks. In particular, the study highlights the challenges in finding the correct type of natural hazard information for use in Natech risk analysis, in analysing the vulnerability of equipment units, in assessing the probability of Natech scenarios, and in preparing Natech scenarios that are consistent with the available natural hazard information.

Finally, measures to prevent Natech accidents, mitigate their consequences, and successfully manage the Natech risk at industrial establishments are broadly discussed. Natech risk management measures concern a wide array of different topics including equipment design, preparedness for natural hazards, emergency planning, and procedures for emergency shut down and restart. Natech risk management is particularly challenging for industry operators because all known Natech specific characteristics should be adequately considered to effectively reduce Natech risk.

ABSTRACT NO. 1.3

DEVELOPMENT OF A NATECH RISK MANAGEMENT AND RATING SYSTEM FRAMEWORK FOR EVALUATING THE PERFORMANCE OF INDUSTRY AND ENHANCING TERRITORIAL RESILIENCE

Suarez Paba María Camila[a], Cruz Ana María[b]

[a]Graduate School of Engineering, Kyoto University, [b] Disaster Prevention Research Institute, Kyoto University

It is well known that the number of reported natural disasters around the world has been on the rise. Less well known is the fact that the number of technological disasters has also been on the increase. Thus, it is not surprising that the so-called Natechs - natural hazard triggered technological accidents - involving the release of hazardous materials have also shown an increasing trend. These facts and the severe consequences that Natech accidents entail have heightened the concern of the international community on how to better understand and manage these types of events. In this sense, although efforts have been made to develop methodologies that can strengthen Natech risk assessment and management, there are currently no methodologies with a holistic and area-wide perspective that consider the influence of the facilities' external environment in its risk assessment. Thereupon, we have proposed a comprehensive area-wide risk management and rating system framework for evaluating the level of performance of industry when faced with Natech scenarios. By looking at both the industrial facilities and their interaction with the external environment, the framework can be used to evaluate improvements towards risk reduction in urbanized industrial areas prone to natural hazards, and in this way contribute to territorial resilience.

The development of the framework and rating system included a literature review, an analysis and comparison of industrial risk assessment methodologies and building rating systems. The latter have been used to measure the performance of buildings towards a certain goal. This process led to the identification of the framework's main categories and category components. Thereupon, we have proposed four main categories for the framework as follows: 1) Infrastructure; 2) Organization and management; 3) Risk governance and risk communication; and 4) External environment. By determining these categories, we acknowledge the need to consider the interaction between the infrastructure systems present at industrial parks, the technical and organizational systems, governance, risk communication, and community participation.

The framework also contemplates –category components – that specify the main aspects of each category to be evaluated. The evaluation is carried out by considering the contribution of each – category component – to the performance of an industrial facility. This is done by defining the corresponding evaluation criteria which allows to determine those aspects that have an influence on the probability of a hazardous material release. Such probability is calculated by the proposed

rating system, premised on a probabilistic risk assessment methodology. This output together with the probability of consequences allows determining the facility's level of Natech risk. Finally, according to the Natech risk outcome, an award (i.e. platinum, gold, silver, and bronze) is given to the facility.

This approach allows the estimation of the facilities' vulnerability to the natural hazards' impacts, as well as the risk to neighboring community's due to the secondary scenarios. All in all, the proposed risk management and rating system framework constitutes a first approach to help strengthen prevention and mitigation measures by enhancing facilities' and governments' abilities to manage Natech risk comprehensively.

ABSTRACT NO.1.4

FLEXIBLE AND ADAPTABLE STRATEGIES TO MANAGE INDUSTRIAL SYSTEMS SUBJECTED TO NATURAL EVENTS

Mauricio Sánchez-Silva
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The design and management of complex industrial systems are usually based on strong assumptions about future demands and its performance. Traditional operation and management approaches define, at the outset, intervention programs under the assumption that all future scenarios are known – at least in probability –; thus, leaving little room to accommodate significant deviations from expected design criteria and unplanned events. In practice, the success of real projects depends on assertive stakeholders' decisions that better accommodate changes in demand, the system properties or the management strategies, which unravel as systems evolve with time. This paper is aimed at examining the value of incorporating flexibility/adaptability in the design and management of industrial systems, specially in areas where natural hazards play an important role. These ideas are illustrated with an example, which shows that incorporating flexibility and adaptability has a significant impact on costs and opens new possibilities for defining better management strategies.

SESSION Ⅱ: UNDERSTANDING NATECH IMPACTS, RISK FACTORS AND FUTURE TRENDS

ABSTRACT NO.2.1

FEATURES OF NATECH EVENTS IN THE CHEMICAL AND PROCESS INDUSTRY: ANALYSIS OF AN EXTENDED COLLECTION OF PAST ACCIDENTS

Federica Ricci, Valeria Casson Moreno, Ernesto Salzano, Valerio Cozzani
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Natural events triggering technological scenarios (Natech events) are an increasing concern for regulatory authorities and industry, in particular in areas prone to natural disasters. A dataset of 9100 past accidents that took place in the last 70 years was compiled. The data collected were analysed, assessing the accident sequences, the final technological scenarios, and the consequences with respect to human losses and asset damages. The analysis of the data allowed the identification of the natural events that more frequently caused Natech scenarios. Substances more frequently involved in Natech events were identified. Quantified event trees were obtained, and specific figures were calculated for the conditional probability of ignition of flammable substances released as a consequence of different types of natural events. The societal risk corresponding to the selected accidents was calculated, evidencing the relevance of extremely severe accidents (> 100 deaths).

ABSTRACT NO.2.2

THE INFLUENCE OF SAFETY BARRIER DEGRADATION ON THE EVOLUTION OF NATECH ACCIDENTS

Alessio Misuri[1], Gabriele Landucci[2], Valerio Cozzani[1], Ernesto Salzano[1]
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[2]Department of Civil and Industrial Engineering, University of Pisa, Largo Lucio Lazzarino 2, 56126, Pisa, Italy.

The interaction between natural hazards and technological installations has the potential to cause complex accidental scenarios, particularly if hazardous substances are involved. These events, defined as Natech accidents in the literature, are nowadays a matter of serious concern for industrial practitioners and regulators. This peculiar interest is motivated by the fact that Natech accidents go beyond the features of typical industrial accidents to the point that it is particularly difficult to provide an exhaustive description of these phenomena by the current risk assessment approaches, since these are based on assumptions that might be oversimplified to fully describe complex systemic events. Indeed, most of these methodologies do not account for the possible impact of natural hazards at plant systemic level, and in particular on safety systems implemented to prevent and mitigate accidents, that is, safety barriers, thus leading to an optimistic evaluation of their expected performances in the event of Natech scenarios. The notorious Fukushima NPS accident (2011) is a clear example of the insufficient understanding of the interaction between natural disasters and the safety systems. There is an urgent call for effective approaches addressing the quantification of safety barrier performance during Natech events. The present contribution illustrates a novel methodology based on performance modification factors, which can be included in quantitative approaches to assess the risk related to Natech events. The method relies on performance modification factors developed to tailor baseline safety system performance. The methodology is applied to a test case study showing that the specific depletion of safety barrier performance induced by the impact of the natural event in Natech scenarios may strongly affect overall risk figures.

ABSTRACT NO. 2.3

WILL TROPICAL STORMS CAUSE MORE NATECH EVENTS DUE TO CLIMATE CHANGE? AN ANALYSIS BASED ON VARIOUS CLIMATE SCENARIOS IN THE UNITED STATES

Xiaolong, Luo[1]; Ana Maria Cruz[2]*

[1]Kyoto University, Graduate School of Engineering, Urban Management, Japan [2]Kyoto University, Disaster Prevention Research Institute, Japan *Corresponding author

Meteorological-related natural hazards are becoming more intense and frequent due to climate change. As a result, several experts observed that the frequency and intensity of related Natechs (natural hazards triggered technological accidents) may also increase. However, only limited studies have been conducted to determine the effects of climate change on Natech occurrence. Especially, no efforts have been made to estimate the probability of Natech events for the future decades based on climate simulation data. In order to fill this research gap, this study proposed an empirical methodology to estimate the probability of Natech events induced by tropical storms (TS) based on wind energy in the United States during the hurricane season (July to October) of the Atlantic Ocean for the periods of 1990-2017 and 2021-2100. By extracting TS-related Natech reports from the National Response Center (NRC) database, the fragility curves which could describe the relationship between the probability of Natech events and wind energy were found for 1990-2017 in different study areas. Subsequently, a 1000-times Monte Caro Simulation was implemented to estimate the probability of TS-related Natech events for 2021-2100 according to the wind energies which were calculated by using the climate simulation data of the 5th and 6th versions of the Coupled Model Intercomparison Project Phase (CMIP) climate scenarios. The results suggest that the probability of TS-related Natech events may increase in the period 2021-2100 as compared to the period 1990-2017 in the all employed climate scenarios. In addition, the CMIP 5 scenarios revealed much higher probabilities of TS-related Natech events than the CMIP 6 scenarios. Another finding of this study is that the probabilities of TS-related Natechs may follow a very weak decreasing trend in the period 2021-2100 of all scenarios, which could be attributed to the decreasing trend of wind energies. However, the decreasing intensity and the number of extreme probabilities could be indicated in different characteristics with the changes of radiation forcing level among different climate scenarios. In summary, the main findings of this study provide some evidence that climate change may have strong effects on the occurrence of TS related Natechs. Risk managers and facility owners as well as local governments should consider climate change as an important factor when making risk management plans and when deciding risk reduction strategies. The results point to a higher increase in TS-Natech probabilities in the northern East Coast of the United States, indicating that facilities located in or near TS active coastal areas in middle to high latitude regions should be especially careful.

ABSTRUCT NO. 2.4

NATECH EVENTS CAUSED BY WILDFIRE IN WILDLAND-INDUSTRIAL INTERFACE

Federica Ricci, Giordano Emrys Scarponi, Ernesto Salzano, Valerio Cozzani
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The frequency of occurrence of wildfires is increasing, and specific concern is generated by fires in in Wildland-Urban interfaces (WUI) and Wildland-Industrial Interfaces (WII). The heat radiation and the flames generated by wildfires are capable of damaging industrial installations, and in particular storage tanks. These equipment items are the most vulnerable, since they have huge inventories of hazardous substances, usually are located in the proximity of the plant boundary and may have a high structural vulnerability. Consequence escalation may follow from the release of hazardous substances from the damage of storage tanks. In the present contribution, radiation intensities from wildfires are assessed, and safety distances from vegetation needed to prevent tank failure are calculated. On the basis of the available data on the wildfire, on the lay-out and on the tanks that are likely to be affected, a methodology that may be applied to design fringes around industrial facilities is obtained. A comparison with the safety distances of industrial installations from vegetation recommended by current regulations and guidelines is also provided.

ABSTRACT NO. 2.5

CONSIDERATIONS ON TECHNOLOGICAL ACCIDENT RISK REDUCTION AT INDUSTRIAL PARKS IN ROMANIA

Alexandru Ozunu[1], Zoltan Torok[1], Cristian Malos[1], Andrei Radovici[1], Adriana Calapod[1]
[1]Babeș-Bolyai University of Cluj-Napoca, ISUMADECIP Institute

The history of the industrial evolution in Romania has known a similar course to the states from Eastern Europe, being characterized by a strong decentralization. Considered underperforming and resource-consuming, many of the publicly traded industries have been privatized. As a result of this process, a significant part of the industrial platforms were abandoned or their utility was oriented towards other sectors of activity. Local authorities and private investors have made efforts to ensure that some of these industrial platforms can acquire the title of industrial park by meeting legal requirements so that they become instruments of regional development. The law regulating the establishment and operation of industrial parks was drafted only in 2013, the substantive conditions necessary to obtain the title of industrial park referring especially to the legal status of the administrator and the facilities that must be present in the park. Within this law, no norms have been enunciated in order to analyze the natural hazards present at the site or regarding the way in which they can trigger a technological accident. Since in Romania there are currently a number of ninety-four entities that have acquired the status of industrial park in different degrees of development, the present study aims to create an inventory of the locations of these industrial parks and to compare them with the results of the disaster risk assessment at national level in order to identify the degree of their exposure to earthquakes, forest fires, floods or landslides (the natural hazards most likely to cause a NaTech accident in Romania). Through this study, an analysis was also made for the sites in Romania where large quantities of dangerous substances are present and falls within the provisions of the SEVESO directive and are located in the area of industrial parks. Out of the total of three hundred SEVESO sites, twenty-four are located in or in the immediate vicinity of industrial parks, as defined by law.

SESSION Ⅲ: NATECH RISK MANAGEMENT IN PRACTICE: MULTI-STAKEHOLDER EFFORTS

ABSRTACT NO. 3.1

NATECH RISK MANAGEMENT IN THE ABURRA VALLEY

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Aaron Arias [1], M.I. - Water Resources
Shirley Arenas [1], Chemical Engineer
Gustavo Londoño [1], Chemical Engineer
Julieta Gómez[1], Geologist
[1]Área Metropolitana del Valle de Aburrá
[2]Sistema de Alerta Temprana de Medellín y el valle de Aburrá SIATA

The Metropolitan Area of Medellin and the Aburrá Valley (AMVA) is a governmental institution composed of 10 cities that has a supportive role for comprehensive risk management of this Colombian region, located in the northern of South America.

The AMVA has engaged the priority actions provided by the Sendai framework for disaster risk reduction and the sustainable development goals.

In the last 10 years, the institution has worked side by side with the country's universities to build maps that allow the identification and understanding of the main natural hazards affecting the region, which relate to flash floods, flooding, mass movements and seismic hazard and the knowledge of this natural hazards has been included in the planning of the cities. Additionally, technological risks are approach which are represented by chemical risks map that are derived from information from 400 industries that operate in the region, including data about hazardous materials, the quantity in storage and the critical equipment.

Since 2019, the Natech risk group was formed in the AMVA with the intention of bringing together knowledge about these issues, the approach to risk management by the industrial sector and to build the regional vision of potential Natech risks in the region. To achieve the goal was necessary a multidisciplinary team with knowledge of the region.

The results presented here are a first approach to the superposition of these maps for the identification of zones that require more attention from the management agencies. These will improve the perception and better handling to potential disasters in each one of those cities and their system upgrade for emergency response.

ABSTRACT NO. 3.2

GEOTECHNICAL REAL-TIME MONITORING APPLIED TO NATECH RISK. CASE OF STUDY: LANDSLIDE LOCATED IN COPACABANA, COLOMBIA.

Pérez-Hincapié, A.M[1]; Larios, M.A[1]; Cardona, S[1]; Ochoa-Isaza, M.A[1]; Hoyos, C.D[1]
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NATECH risks are a complex challenge, not just for the industries, also for the cities and their system for emergency response. This case represents Copacabana, Colombia's municipality near Medellín, a big emergency that risks a large population, infrastructure for the country, and significant potential cascade effects. The NATECH incident was triggered by a landslide located in the narrow canyon of the Aburra-Medellin river situated in the Aburra valley.

In the zone, the system of risk management of the region identified these technological risks: the pipeline of fuel that supplies the northwest of the country, the gas pipeline for one of the third first populated cities of Colombia, one of the four principal ways to evacuate the region, and a fuel station. The zone includes a neighborhood with more than 30 families and a mental hospital. The scenario consists of a steam flow, an active mass movement, and a river controlled by a non-erodible rock in the opposite bank.

The early warning system of Medellin and the Aburra valley (SIATA), as a project of the metropolitan area of the Aburra valley (AMVA), designed and installed a real-time geotechnical network to assist the municipality and activate the system of disaster management in the metropolitan area. The geotechnical real-time monitoring system consists of sensors to identify the surface movements, particularly in the landslide features around the fuel and gas pipeline. Additionally, recognizing the evolution of the damaged infrastructure in the area and throwing the use of different techniques can follow in real-time the advance of the failure surface located around 28 meters deep, with an accumulated displacement of 15.81 cm in 17 months, represented in several meters in the surface infrastructure.

The geotechnical monitoring network has had data since May 2019. It has allowed the local authorities to know the landslide evolution, especially in the reactivation stages in the rainy season and the rate of evolving structures such as the gas and fuel pipeline, the fuel station, the houses, and the highway affected.

ABSTRACT NO. 3.3

STUDY ON DISASTER PREVENTION MEASURES IN SMALL AND MEDIUM-SIZED ENTERPRISES LOCATED IN AN INDUSTRIAL PARK, SAKAI-SENBOKU AREA IN OSAKA

Yudai Tsutsumi and Shin-ichi Aoki
Osaka University

In this study, I focused on SMEs (small and medium-sized enterprises) located in the industrial complex in Osaka prefecture and investigated their disaster prevention efforts related to NATECH. Although SMEs in an industrial complex are extremely susceptible to natural disasters and NATECH, there are few studies focusing on their disaster prevention activities, and it cannot be said that their activities are fully evaluated. Therefore, we conducted a questionnaire survey to find out the actual situation of disaster prevention activities of SMEs. The questionnaire target is a part of Sakai-Senboku coastal area in Osaka Prefecture, and we asked about the risks that they are being perceived and the responses and anxieties to the risks. Based on the results, we conducted a hearing survey of some companies. As a result, it was found that although risk perception differs depending on the company, they do not fully understand how to respond flexibly to NATECH, and they are worried about it. However, it was also found that they are reluctant to work together on disaster prevention with other companies and depended on the prefectural and local governments for disaster prevention. Since there is a limit to what the government can do, it is necessary for SMEs to break away from excessive dependence on the government and improve their relationships within the complex. A particular problem is related to risk/crisis communication, and even among SMEs, there is no place for communication, and an environment for "mutual assistance" between companies in the event of a tsunami evacuation or NATECH has not been created. If communication between companies is improved, it will be very useful for improving risk communication with neighboring residents and improving disaster prevention capabilities.

ABSTRACT NO. 3.4

MEASURES TO PREVENT DISASTER AT THE PETROLEUM COMPLEX IN OSAKA PREFECTURE

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In Japan, “the Law on the prevention of Disasters in Petroleum Industrial Complexes and other Petroleum facilities” was legitimated in 1975 and put into force in 1976 for the purpose of protecting lives and properties of citizens from both accidents and disaster in areas, where massive quantities of oil and high pressure gas are accumulated.

Based on that law, 84 areas of 33 prefectures are designated as “special disaster prevention area of a petroleum complex”, and a facility, which handles above the certain amount of oil and high pressure gas, are stipulated as “specified facility”.

There are 3 areas designated (Osaka-Hokko, Sakai-Senboku, and Kansai international airport) and 50 designated facilities in Osaka.

In accordance with the Fire Service Act and the High Pressure Gas Safety Act, disaster prevention measures, including earth quake proof standards for Oil tanks and spherical high pressure gas tanks, have been strengthened in areas of petroleum complexes in Japan.

In addition, according to a disaster prevention plan that is stipulated by the Law on the prevention of Disasters in Petroleum Industrial Complexes and other Petroleum facilities, the disaster prevention center formed by Osaka prefectural government, city authorities, public organizations such as fire departments, national coast guards and specified facilities are doing disaster prevention activities in a body, Governor of Osaka prefecture being as a director. Fire Prevention and Safety Affairs Division works as the bureau of the disaster prevention center.

A disaster prevention plan is made in each prefecture, where special disaster prevention area of petroleum complex lies. In Osaka, unique activities, which are not seen in other prefectures, have been performed, according to the disaster prevention plan of Osaka prefecture.

Firstly, the specified facilities have been tackling with disaster prevention measures in terms of Voluntary Safety on their own since FY 2015, which lie beyond provisions regulated by laws, the bureau managing its progress, summarizing their activities and considering and discussing the next prevention measures with them. Through those activities, remarkable results are obtained. For example, the volume of oil outflow was reduced by approximately 83% in the whole areas, by following Tsunami when Nankai (Southern Sea) Trough earthquake occurs. Measures for important facilities like establishment of water stop plate and transferring emergency generators

to a higher place against inundation are conducted, and emergency shut-off valves have been installed to oil tanks below 10,000kL,which are not enforced by the Fire Service Act.

In addition, as disaster prevention measures towards small and medium sized businesses except for specified facilities, we promote them to make a tsunami evacuation plan, not only through holding a workshop for Tsunami evacuation, but also in cooperation with a private company and universities.

RISK ASSESSMENT, CONTROL AND COMMUNICATION IN A PIPELINE/LANDSLIDE INTERACTION CASE

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Near the right of way of one of the pipelines operated by the hydrocarbon pipeline operator, Cenit Transporte y Logística de Hidrocarburos, a large-scale landslide was identified at the end of 2018, in a populated area and near a river. At the beginning, the depth of the landslide did not represent a hazard to the pipeline due to the horizontal directional drilling technique applied when the pipeline was built. A monitoring program was developed through inclinometers and piezometers and in-line inspections were carried out to identify any disturbance in the alignment of the pipeline.

From the monitoring program and in-line Inspection data, it was possible to confirm interaction between the landslide and the pipeline. Landslide interact with the pipeline along a length of 170 m. The depth of the landslide failure surface was in between 17 to 22 m, and the pipeline was about 15 m deep.

Due to this interaction, it was necessary to develop a risk assessment to identify a safe limit displacement and a risk communication program with government authorities and community. For a while, this allowed us to design both a temporal innovative solution considering a flexible pipeline and a definitive solution to build the new segment of the pipeline which was deeper than the last one, through the horizontal directional drilling technique.

ABSTRACT NO. 4.2

COMMUNICATIVE SPACES WILL BE CRITICAL TO EFFECTIVE NATECH RISK MANAGEMENT IN INDUSTRIAL PARKS, PART I: A SYSTEMIC RISK PERSPECTIVE

Rob Goble, Clark University
Norio Okada, Kyoto University

Two years ago, at this meeting, we gave presentations on systemic risks that emphasized human aspects of systemic risks. We now present a follow up to that discussion. This time we pay particular attention to communication as a basis for action and to the situation of industrial parks. Our concern is with practical approaches that can improve coping capabilities and reduce risk at industrial parks. As with our previous presentations, we hope to encourage discussion among participants in the meeting.

A key feature of systemic risks, as people create, encounter, and attempt to manage them, is the diversity of players, people and their organizations; they have many differing concerns, interests, knowledge and perceptions, responsibilities and capabilities. They act under conditions of uncertainty, and, to act effectively, they need to be able to learn and adapt to changing circumstances. Because of the diversity of players and because coping always takes time, some coordination and cooperation among them will be a key to efforts at coping with such risks. Recent and on-going experiences around the world with the covid-19 pandemic show clearly the importance of coordination and cooperation in managing a systemic risk; they also show that harmful consequences can follow from failures to coordinate.

Coordination and cooperation require communication; thus, they require that channels or spaces for communication exist and that they be suitable. Communication, however, can serve many purposes and will be used by different players for multiple and diverse purposes. As the covid-19 experiences show, misleading communications or communication blockage can be serious threats. Existing communication arrangements can fail to be adequate for supporting collaborative efforts. To mark its distinct purpose, we use the term “communicative space” to describe suitable arrangements for communication which facilitate collaboration on constructive activities. The creation and maintenance of “communicative spaces” is a key element in risk management for an industrial park; those spaces may also prove useful in realizing other kinds of opportunities.

ABSTRACT NO. 4.3

COMMUNICATIVE SPACES WILL BE CRITICAL TO EFFECTIVE NATECH RISK MANAGEMENT IN INDUSTRIAL PARKS, PART II: LOOKING BACK AND LOOKING FORWARD

Norio Okada, Kyoto University
Rob Goble, Clark University

The distinguishing characteristic of a communicative space is that it should facilitate constructive collaborative action. Its effectiveness will depend both on meeting some general requirements and on its conformity with the specific nature of the industrial park, the community and regional setting, and the history of the park. Some general requirements seem ordinary. Coping with systemic risks such as NaTech takes place over time; so continuity is needed; this might be achieved by having regular meetings and a process for maintaining the communicative space. However, matching the particular circumstances of an industrial park and maintaining a useful agenda may prove challenging. The initial steps may be especially challenging: first to recognize the need for communicative space and then to put forth the effort to create it.

We present an example of the creation and functioning of a communicative space in practice. From this example, we draw lessons about what seems to work, what doesn't, and some considerations that appear to support or hinder success. We conclude by discussing how industrial parks can include the creation and maintenance of communicative space in their planning for NaTech risk management and give some recommendations for how that planning and use of communicative space might proceed.

ABSTRACT NO. 5.1

SEISMIC-INDUCED FAILURES AND CORROSION ASSESSMENT OF ONSHORE PIPELINES

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Industrial parks are commonly supplied with flammable, explosive, or even toxic materials using underground pipelines. These pipelines are subjected to an aging or corrosion process favored by the aggressive conditions where the pipe is located and operated. Corrosion defects reduce the wall thickness and could lead to a leak, burst, or full-bore rupture due to an overwhelming load from the internal pressure or complete metal loss. Pipelines are also prone to fail if a natural disaster occurs, like in the case of earthquake loadings, which are associated with transient (TGD) or perma-nent ground deformations (PGD) such as a landslide or soil liquefaction. For instance, in a continuous pipeline, a tension failure could be expected, whereas, in a segmented pipe, an axial pull-out scenario has been widely recorded. In any case, these scenarios trigger a complete loss of containment that is susceptible to end in a fire or explosion scenario. This work proposes a combined reliability assessment for a corroded pipeline subjected to TGD using Monte Carlo simulations. For this purpose, it contemplates simulated seismic activity using two Poisson Processes based on historical records. One of them addresses the occurrence of the natural event and a Poisson Point Process to simulate their spatial distribution. This seismic activity is used with an attenuation law to evaluate a tension failure along the pipeline. The corrosion degradation implements a continuous Levy´ Process based on information recollected from consecutive In-Line Inspections (ILI), with the possibility of new defects appearing between inspections and the formation of corrosion colonies to determine a rupture of the pipeline. The proposed approach is illustrated using a real case study, showing that the proposed approach could be used to support further Natech (Natural Hazard Triggering Technological Disasters) risks as an alternative to repair rates approaches.

ABSTRACT NO. 5.2

A MECHANICAL MODEL TO EVALUATE RAIN-INDUCED DEBRIS FLOW IMPACTS ON PIPELINES.

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Prolonged heavy rain may dramatically lead to the occurrence of debris flows (Shallow landslide), which can cause damage to people, property and the environment. In some cases, oil and gas transportation pipelines, which traverse long distances, are exposed, and can be damaged causing the release of hazardous materials. These accident scenarios are called natural hazard triggered technological accidents (known as Natechs). In a previous study a simplified quantitative-mechanistic model was proposed to estimate the probability of landslides and the probability of failure of the pipeline due to landslides. In their study, the authors used a simplistic slope stability analysis method to determine the stability of each node from the provided Digital Elevation Model (DEM), and then estimated the subsequent strains on the pipeline due to the landslide in the far-field. However, the model did not consider landslide dynamic processes. The aim of the current study is to develop a mechanical model which allows the evaluation of rain-induced debris flow impacts on pipelines considering landslide dynamic processes. In this study, a slope stability model combined with a Green-Ampt infiltration model (Soil water infiltration model), and the DEBRIS FLOW module of RAMMS (rapid mass movement simulation), are used to simulate the dynamic process of debris flow. Through a pipeline failure model, the pipeline response to the debris flow can be known. The methodology can show the cascade process of the disaster chain from the initial heavy rainfall to the pipeline damage. The results of the preliminary trial through the methodology will be presented.

ABSTRACT NO. 5.3

NUMERICAL ESTIMATION OF THE BEHAVIOR OF OIL STORAGE TANK UNDER TSUNAMI INUNDATION BY USING FLUID-STRUCTURE INTERACTION ANALYSIS

Youhei Takagi, Sana Numata, and Takanori Hino
Yokohama National University

A large earthquake and accompanying tsunami such Nankai trough earthquake may be occurred at Japan in near future. At the 2011 Japan earthquake, the oil storage tanks at the Kesen-numa bay area were almost broken and flowed into sea, and the tsunami-triggered fire disaster caused a heavy damage on the Tohoku costal area. In order to estimate the risk and damage due to such fire disaster, the hybrid simulation with generic tsunami calculation and fire simulation based on discrete oil parcel model has been developed recently. However, this simulation method includes an uncertain estimation, that is, the initial amount of spilled oil from broken tanks. In this study, we focused on the improvement of this estimation for the initial amount of oil used in a previous hybrid analysis. We carried out a three dimensional simulation for predicting the motion of single storage tank under tsunami inundation. A fluid-structure interaction (FSI) analysis was introduced in our simulation method, and the local stress and hydrodynamic force acted on the tank side were investigated. The present simulation code was developed based on the OpenFOAM and Calculix softwares. The OpenFOAM was used for calculating the hydrodynamic motion of tsunami in fluid region, on the other hand, the Calculix was used for the mechanical structure analysis in the solid tank region. These two solvers used for different regions were coupled with preCICE library. The analysis model was 1/100 scale to actual tank at Japan coastal area, and a corresponding experiment with tsunami tank was carried out for the validation of our simulation code. In the present numerical analysis, the tank stiffness and tightness to the ground were parametrically changed and these dependency were investigated. From numerical results, it was found that the relationship between these two parameters gave a significant effect on the buckling risk and the oil spill due to the side buckling was not avoidable under some conditions.

ABSTRACT NO. 5.4

REDUCTION OF TSUNAMI WAVE FORCE ON CYLINDRICAL STORAGE TANK CAUSED BY ADJACENT CYLINDRICAL TANK

Susumu Araki and Ryota Sumi
Osaka University

Storage tanks located in coastal areas can be damaged by tsunami. The damage can lead a spill of gas or oil, which cause an extensive fire. Another huge tsunami triggered by earthquake is predicted to strike Japan in the near future. Therefore, tsunami wave force on storage tanks has to be investigated. In this study, the reduction of tsunami wave force on a cylindrical storage tank caused by adjacent cylindrical storage tank was experimentally and numerically investigated.

The reduction of tsunami wave force on a cylindrical storage tank caused by adjacent cylindrical storage tank depended on the distance between the two cylindrical storage tanks, the diameter of the cylindrical storage tank, the incident tsunami height and so on. The reduction of tsunami wave force was investigated using two cylindrical storage tanks located in a row along the direction of the propagation of tsunami inundation flow. The reduction of tsunami wave force was estimated by comparing the tsunami wave force on a single cylindrical storage tank with the tsunami wave force on the cylindrical storage tank on the inland side, which was reduced by the presence of the other cylindrical storage tank on the seaside. In the estimation of the reduction, time-averaged tsunami wave force was used.

ABSTRACT NO. 5.5

SIMULATION OF TSUNAMI DEBRIS IN OSAKA BAY, JAPAN: INFLUENCE OF DEBRIS TYPES AND CURRENTS ON TRACKS

Masayasu Irie and Taishi Yoshino
Osaka University

In the 2011 Great Tohoku Tsunami, large amount of tsunami debris filling up harbors led to serious delays in transportation of relief supplies and fuels. Tsunami debris consists of several objects such as containers, ships, vehicles, etc. drifted or sank in the harbors, hindering the navigation of ships. Similarly, in the Nankai Trough Great Earthquake, which is predicted to have a probability of 70~80% occurrence within 30 years, there will be a risk of tsunami debris damages. In particular, since Osaka Bay is shallow, it is highly likely that ships sailing will be significantly restricted by sunken tsunami debris. Behavior analysis and distribution prediction of tsunami debris are therefore urgent tasks.

Numerical modeling and behavior analysis of tsunami debris have been conducted for more than 30 years (i.e. Goto, 1983, Kumagai et al., 2008; Kamohara et al., 2016). However, most of the conventional studies utilize two-dimensional (2D) flow models and only the tsunami was considered as an external force. Therefore, the three-dimensional (3D) effect of freshwater, wind and other forces on the tsunami debris transportation in coastal areas is still unknown.

In this talk, we present the simulation of debris transportation by prospective tsunami under the external forcing in Osaka Bay, Japan. We first connect the conventional 2D tsunami calculation into the 3D flow calculation and perform a 3D tsunami simulation with the consideration of density. From the result, the contribution magnitude of the tsunami, the river inflow and the wind were estimated at each phase: the tsunami dominant phase, the sub-vibration dominant phase and tsunami convergence phase. Furthermore, we performed the tsunami debris tracking using 3D tsunami simulation and compared it with the conventional analysis to estimate the 3D effects on debris transportation.

ABSTRACT NO. 6.1

DEVELOPMENT OF BODY FORCE MODEL TO EXPRESS THE EFFECT OF FLEXIBLE PIPES FOR A NEW TSUNAMI COUNTERMEASURE

Tatsuki Nagai, Hiroyoshi Suzuki, Hiroki Bunno,(Osaka University)
Masaya Nakao, Katsuhiko Azuma， *Hiroshi Tsuzuki and Yoichi Nimura*(Ashimori Industry co., ltd.)

It is estimated that Tsunami generated by Nankai Trough earthquake will attack Osaka bay area. Based on the report of Osaka Prefecture Petrochemical Disaster Prevention Cabinet Headquarters, 237 oil tanks are installed in Osaka North Port area. Therefore, it is necessary to introduce effective tsunami countermeasures that don't disturb maritime traffic and landscape. Regarding that, our group has invented new Tsunami countermeasure named "Flexible Pipes". This is an aggregation of soft cylindrical structures, which is installed under seabed in calm condition and they will be expanded by injecting compressed gas before Tsunami reaches to the shorelines.

In the previous research, a numerical calculation model has been established to evaluate the performance of "Flexible Pipes" on the actual sea scale. In constructing the numerical calculation model, there were two problems that increase the calculation cost in large scale analysis conducted on Osaka North Port area and do not consider the deformation of the "Flexible pipes". To solve these problems, it is considered that the porous body force model which expresses a behavior of the flow around Flexible Pipes is introduced. In this study, by comparing numerical calculation results with experimental results at the scale of model experiment, the accuracy of a numerical calculation model is confirmed.

Utilizing porous body force model to express the effect of the "Flexible Pipes" introduces the drag force and the inertia force to the Navier-Stokes equations as the additional terms. In the accelerated flow, the inertial force can be obtained by measuring the force applied to the "Flexible Pipes" at a certain flow velocity and subtracting the drag force at a comparison of CFD and experimental results. In the model experiment, as the towing carriage with "Flexible Pipes" moves, water flows in at a flow velocity equivalent to the moving velocity. CFD results and experimental results are compared from the viewpoint of the momentum flux.

In the experiment, the deformation of the pipes to act like a wall causes a larger water level difference between the front and back of the "Flexible Pipes". Due to this difference, CFD applied previous porous body force model show underestimation of the performance of "Flexible Pipes". Therefore, the correction of drag force model is estimated from experimental results by the comparison of CFD and experimental result. From this, a modified porous body force model which expresses the effect of "Flexible Pipes" can be constructed.

Tsunami analysis with porous body force model which express the effect of “Flexible pipes” is performed. From the geometry data of Osaka North Port area including seabed, the computational mesh is generated. And the inflow velocity and wave height assuming Nankai Trough earthquake is set. To determine the most efficient installation position and arrangement of “Flexible pipes”, Tsunami simulations are conducted and the reduction of the flow velocity, wave height, and momentum flux are evaluated.

木材瓦礫と自己消化性油吸着材を含む水面油燃焼のふく射熱評価

EVALUATION OF RADIANT HEAT OF WATER SURFACE OIL COMBUSTION WITH WOOD RUBBLE AND SELF-EXTINGUISHING OIL ADSORBENT

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Osaka University

日本語：
木材瓦礫を含む水面油火災を模擬したビーカーレベルの小規模な燃焼実験に基づき，種々の油吸着材（ユトラス K-3, PVC）を用いた際のふく射熱および燃焼時間を測定し，油吸着材が燃焼挙動に与える影響および減災効果を評価した．その結果，K-3 を添加した場合は油吸着後の沈殿による減災効果を示し，PVC を添加した場合，炭化膜の形成によるガスバリア性と自己消火性による減災効果を示した．PVC は油吸着後も水面に残り続けることから回収が容易であり，実際の火災現場において有用であることが示唆された．

英語：
Based on a beaker-level small-scale combustion experiment simulating a water surface oil fire containing wood rubble, the radiant heat and combustion time when various oil adsorbents (K-3, PVC) were used were measured. Based on these results, the effect of the oil adsorbent on combustion behavior and disaster mitigation was evaluated. As a result, in the case of K-3, the disaster mitigation effect was confirmed by the precipitation after oil adsorption. In the case of PVC, the disaster mitigation effect was confirmed by the gas barrier property and self-fire extinguishing property due to the formation of the carbonized film. Since PVC remains on the water surface even after oil adsorption, it is easy to removal, suggesting that it is useful in actual fire sites.

ABSTRACT NO. 6.3

INTELLIGENT SYSTEM FOR THE DESIGN OF NATECH RISK MITIGATION STRATEGIES

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Social, environmental, and economic impacts of industrial accidents triggered by natural disasters have been increasing during the last decades, exacerbated by the concentration of people and industrial infrastructure in hazard-prone areas. The aim of this research study is to assist in minimizing disaster impacts by introducing a methodology that finds optimal strategies for disaster countermeasures considering the vulnerabilities caused by the lifespan of social, environmental, and technological systems.

This research study employs a combination of intelligent computational systems, such as machine learning and neuro-fuzzy inference. The merit of employing these systems is their synergistic capacity for estimating risk values subjected to the span and complexities of the interrelations of industrial infrastructure with other critical systems, such as neighboring facilities, lifelines, and emergency response systems.

The system developed is implemented employing a multilayer network of information for the determination of Natech risk values for multiple industrial parks located in Japan. This procedure was carried out by processing the combination of the main inputs (Hazard Attributes and Consequence Attributes) with the interdependency variables (Interrelation with other infrastructure, Lifeline Disruptions, and Emergency Response).
The main contribution of this research was the basis of autonomous risk management systems able to minimize the effect of catastrophes triggered by natural disasters, as well as the simulation of factors that determine the time-span of vulnerabilities.

The results obtained from the study case show a clear variation of Natech mitigation investment strategies (Protection, Risk Transfer, Containment) according to the life-time span of vulnerabilities of 30 years for the top five Japanese petroleum refineries.

ABSTRACT NO. 6.4

RISK ASSESSMENT OF PROCESS PIPING AFFECTED BY EARTHQUAKE

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Process piping is an essential yet complex network of pipes that is used inside petrochemical facilities for loading or unloading of units with liquid or gaseous substances. In contrast to linear transport pipelines, process piping outfits long pipe racks and runs from one unit to another. Piping failure has mostly been observed at fittings, e.g. elbows or t-joints and pipe connections, not only during major earthquake events, but also due to inundations and landslides. When it comes to seismic hazard in particular, the differential displacement between adjacent structures or supports and the rigidity of supporting structure-to-pipe connections are the most common failure modes of piping, excluding failure due to debris impact [1]. Equipment items and structures such as reactors, tanks, vessels and racks present different vibration modes during an earthquake, thus the piping should be designed to withstand such differential movements.

Even though the seismic vulnerability is high, the risk assessment of piping systems is still based on generalised fragility models e.g. from HAZUS [2] without addressing specifically the idiosyncrasies of piping dynamic interaction with other structures. To this effect, the presentation will address the risk assessment of two existing piping configurations included in large industrial areas, namely an ethylene terminal and an oil refinery. The fragility derivation follows a number of steps that will be described in detail, namely 3D model configuration, description of operating loads and material properties, determination of seismic hazard and appropriate selection of seismic records and fragility analysis method. The damage to piping is expressed in terms of pipe strain and is correlated with the seismic intensity. Finally, fragility curves that are tailored to the two specific cases analysed and that can be easily implemented in risk assessment methodologies were produced. The derived fragility curves are used for the calculation of the Natech probability, which accounts for the probability of release given a state of damage, using the JRC's in-house RAPID-N system [3]. Overall, typical failure modes of piping are confirmed and flexible piping-to-pipe rack connections that rely on modern seismic code design present considerable lower probability of damage. The dynamic coupling between equipment items and pipe rack is also evaluated.

This work has implications on the robustness of seismic risk assessment for industry when the fragility curves are tailored to realistic piping configurations compared to generalised fragility functions proposed by HAZUS. Briefly, these implications pertain to:

1) The high reduction of seismic risk at industrial sites, when more flexible piping configuration is achieved.

2) The importance of accounting for a high number of records with far- and near-field conditions.
3) The importance of taking dynamic coupling effects into account. Usually, pipe racks and piping are analysed separately in the industrial sector, which may result in under/over-estimation of seismic forces. Pertinent examples from the ethylene pipe rack and ULSD unit will be demonstrated.

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ABSTRACT NO. 6.5

LESSONS LEARNED FROM FOUR NATECH CASES IN JAPAN FOR COMMUNITY-BASED NATECH RISK MANAGEMENT

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Global climate and environmental changes aggravate natural hazards and amplify varying disaster risks. The trend of recent disaster events suggests that disasters embody more complexity, unpredictability, and uncertainty. These trends are further exacerbated by the more frequent occurrence of technological accidents triggered by natural disasters, a phenomenon we call Natech. Consequently, more and more government agencies, experts, industrial managers, and citizen groups are waking up to the importance of better understanding and managing Natech risks.

Natech accidents are regarded as low-probability but high consequence events. Also, the coupling of natural and technological hazards occasionally overwhelms the capacity for conventional disaster preparedness and response as well as the expectations of relevant stakeholders. Despite efforts to manage and reduce Natech risks, residents living near areas exposed to these risks may have limited information on how they can manage and prepare for these types of interconnected and cascading disasters. Thus, we have examined recent accidents in and near four communities in Japan. This study aims to identify gaps in 1) understanding of the mechanisms of Natech occurrence; 2) improving Natech risk management, and 3) minimizing the potential impacts of Natech accidents. Also, it suggests lessons-learned for better Natech risk management that brings local stakeholders together.

The four cases consist of 1) an explosion at an aluminum recycling factory induced by heavy rain and floods in Soja city, Okayama prefecture in 2018; 2) a toxic gas (H2S) release at a carpet manufacturing company triggered by a typhoon, including heavy rain, storm, and high tide, in Izumi city, Osaka prefecture in 2018; 3) an oil spill at an ironworks company caused by floods in Omachi town, Saga prefecture in 2019; and 4) a phreatic explosion and fire in a graphitization furnace at a carbon manufacturing factory in Ashikita district, Kumamoto Prefecture in 2020. The lessons learned include 1) improving land use of chemical facilities and local communities to secure safety; 2) establishing flexible Natech risk management strategies based on the natural and chemical accident event chains (e.g., natural hazard-natural hazard-technological accidents; natural hazard-technological accident-natural hazards); 3) developing flood-related Natech hazard and risk maps that provide both natural hazard (such as damage levels expected for floodwater depths and water flow velocities) and chemical hazard risk information, and 4) the need for enhanced risk communication and information sharing among all local stakeholders based on stakeholder participation and interactive cooperation. Finally, it is expected that the lessons learned from these Natech events could be applied to manage Natech risks in other areas and contribute to promoting a safer and resilient society to multi-hazards.

ABSTRACT NO. 7.1

ANALYSIS OF RISKS DUE TO NATECH EVENTS IN THE OIL & GAS INDUSTRY

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Natural hazards affecting chemical and process facilities have deserved particular attention since they can cause the release of hazardous materials from installations or infrastructures possibly resulting in major accidents (severe fires, explosion and/or environmental pollution). The increasing frequency of some natural events with a particularly high severity also raised a growing concern in the Oil & Gas industry for the asset integrity and for the consequences of major accident scenarios triggered by natural events at operational sites. Such cascading events are termed as NaTech (Natural Hazards triggering Technological Disasters). In parallel with the awareness of these events, Legislations require Operators to consider the risk due to NaTech scenarios in their Process Safety Management System.

The Eni S.p.A. in collaboration with University of Bologna have developed an operational methodology to support the implementation of Eni's Professional Operating Instruction related to the Analysis of the NaTech Risk. Such an instruction addresses both the management of Natech scenarios and the planning of emergencies and the protection of assets from the natural events. In the present contribution, an overview of the developed methodology for the analysis of and management of NaTech accidents is proposed as well as an application to a case study.

In the proposed methodology, four types of natural events were considered, i.e. earthquake, flood, tsunami, lightning. For each natural event a site-specific characterization of natural hazards is performed, which allows determining to which natural hazards the site of interest is potentially exposed. A method based on multi-criteria indexes (level 0 analysis) is applied to each equipment in the plant to assess its vulnerability with respect to the natural event of relevance, as identified in the previous site-specific ranking. This qualitative method supports the identification of the equipment resulting in the highest risk ranking with respect to human, assets and environmental targets, which shall be further analyzed. A level 1 method based on Quantitative Risk Analysis (QRA) is applied to the identified critical equipment in order to account for the NaTech scenario contribution to the overall risk. The results from the case study demonstrated that the methodology is a useful tool for preliminary screening of the natural hazards in the site and the prioritization of plant criticalities requiring allocation of resources to manage Natech accidents effectively.

ABSTRACT NO. 7.2

DAMAGE ASSESSMENT IN RESIDENTIAL AREA OF AN EXPLOSION OF ALUMINUM FACTORY CAUSED BY WESTERN JAPAN HEAVY RAIN IN 2018

Nobuhito OHTSU, Akihiko HOKUGO, Ana Maria CRUZ and Hyejeong PARK

Due to the heavy rains in western Japan in July 2018, a steam explosion occurred at an aluminum factory in Soja City, Okayama Prefecture, causing injuries to residents, collapse of houses, and four simultaneous fires. We conducted a field survey in July 2018 and an interview survey to the Soja City Fire Department and the Crisis Management Office in December 2018. As a result, we clarified below. The aluminum factory where the explosion occurred had not violated the firefighting regulations regarding hazardous materials handling factories before the flood. Aluminum could be a cause of steam explosion when it is heated up for normal operation to become high-temperature liquid and in case flooded water comes into the furnace. But aluminum is not designated as a hazardous material in the fire regulations in Japan, so it is difficult to monitor the risk of this kind of situation related to aluminum by the fire administration office who are responsible to the factories handling hazardous materials. Therefore, it is important to provide timely information from the factory for residents to evacuate appropriately. As a result of estimating the blast pressure from the damage distribution in the residential area, it was estimated that the blast pressure within a radius of 600 m from the explosion source was about 7 to 14 kPa or more. The explosion brought 7 vulnerable people's injury. If employees notified in advance that there was a possibility of an explosion to residents and fire department, estimated number of vulnerable people's injury due to the explosion would decrease from the current 7 to 4. In the event of a future disaster, when employees of industrial facilities recognize the danger of an accident caused by natural disaster, it has become clear that prompt notification to residents and the fire department may reduce the human damage.

ABSTRACT NO. 7.3

EFFECT OF NATECH ACCIDENTS ON RESIDENTS' PERCEPTIONS OF RESIDENTIAL PROPERTY VALUES AND THEIR LOCATION PREFERENCES: THE CASE OF ICHIHARA CITY

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This research investigated residents' perceptions concerning the effects of a natural hazard triggered chemical accident (known as a Natech) on residential property values and their location preferences after experiencing a Natech accident. Data was collected through a stratified random household survey of residents within three kilometers of the Chiba industrial park in Ichihara City, Japan. Real estate transaction data of the towns near the Chiba industrial park was also collected from the official website of the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) Japan. The household survey focused on residents' experience and perceptions of the impact of the Natech accident on property values, their trust in safety management of the industrial park, their perception regarding the effect of risk information disclosure on property values, and their preferences in case of location choices after experiencing the Natech accident. Furthermore, the difference in differences modeling was applied toselected towns' land price data before and after the accident. The household survey findings indicate that residentsconsider chemical accidents a threat to their lives and property. They are concerned that the chemical accident mayhappen again at the Chiba industrial park and that chemical accidents have the potential to decline property valuesin the future. The household survey findings indicate that the land price did not decline due to the chemical accidentin 2011.

In contrast, the difference in differences estimation shows that the land price of the towns near the Chiba industrialpark has decreased 27.4% after the chemical accidents when controlled for few factors that determine the land price.Having witnessed the Natech accident, residents offer more importance to natural hazards and chemical risk information in their future housing location preferences than other factors like affordability and accessibility. They want the government to disclose chemical risk information, but they are also worried that the disclosure might affectthe property values. The survey results highlight the need to take risk communication seriously to avoid participants'exodus because they distrust both the industry and the local government. The study results have implications on Natech risk governance and urban planning at the community and industry level.

ABSTRACT NO. 7.4

HOW DO CITIZENS COMMUNICATE ABOUT NATECH RISK INFORMATION DISCLOSURE?

FINDINGS FROM JAPAN AND S. KOREA

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Risk communication issues have started to gain more academic interest recently in light of the risk from technological accidents triggered by natural hazards, known as Natech. In cases where chemical risk communication is limited, individuals may find themselves in lack of necessary information crucial for their effective preparedness against and appropriate response during a potential accident. Therefore, this information deficiency creates a secondary problem for individuals that stems from that initial problem, the exposure to the underlying Natech accident risk itself. Risk perception studies have so far dealt with understanding how that initial risk is socially perceived and experienced, however, this study focuses on investigating individuals' attitude towards this secondary communication problem.

The research aim is to explore and understand the differences in the communicative behaviours of citizens in Japan and S. Korea concerning the issue of Natech risk information deficiency. We look at these two countries because they share a relatively similar collectivistic sociocultural background considering Hofstede's (2001) cultural dimensions, but they are characterised by an essential difference in policy regarding chemical and Natech risk communication. In contrast to Japan, S. Korea has recently reformed their regulatory framework pertaining to the management of technological accidents, i.e. Chemical Controls Act (amended in 2018), introducing provisions for public disclosure of chemical information from local governments and companies.

This study approached the analysis of the public's communicative behaviour through the interpretative framework of the Situational Theory of Problem Solving (STOPS) (Kim & Grunig, 2011). Conceptually, the individuals' motivation to communicate about the problem is determined by their recognition of the severity of the situation, their perceived personal connection to it, and the perceived barriers that limit one's ability to solve it. Along with any available relevant experiences, subjective knowledge or expectations, this situational motivation defines the individuals' communicative action in problem-solving, namely the actions of acquisition, selection and transmission of information. Complementary to STOPS, we explored individuals' perceptions concerning the Natech risk, as well as their relationships with governments and companies in terms of trust and decision-making power. In order to collect field data from households exposed to potential Natech accidents, self-administered, anonymous questionnaire surveys were carried out in 2018 (Japan) and 2020 (S. Korea) targeting residential, urban districts near prominent industrial parks in both countries: more specifically, districts in Higashinada (Kobe) and Sakai-

Senboku (Osaka) in Japan, and areas in Yeosu, Suncheon, Gwangyang and Ulsan in S. Korea.

Our findings show that, even though households from both countries acknowledge Natech risk information deficiency as a serious issue, Japanese respondents are notably more constrained in dealing with it. Furthermore, S. Korean respondents exhibited higher communicative activeness, and appeared more confident in responding to potential Natech accidents. This study ventured to provide some basic empirical evidence for risk managers to pursue and promote chemical and Natech risk information disclosure as a way of addressing the secondary risk communication issue, but further research is required to further understand and exclude any potentially omitted sociocultural influences.

ABSTRACT NO. 7.5

INDUSTRY AND GOVERNMENT WORK TO KEEP CHEMICAL HAZARD SITES SAFE DURING THE COVID-19 PANDEMIC

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The current Covid-19 pandemic has been a challenge for high hazard sites to maintain high levels of safety on site while reducing exposure of personnel to the risk of contracting the virus. It has equally been a challenge to achieve meaningful government oversight, verifying that sites are appropriately managing potentially high risk situations and planning how to manage potential changes to come. In addition to lockdowns, the staff protection measures in particular necessitate a dramatic departure from normal operations. This creates a risk of a life-threatening situation if they are not sufficiently preventive of fires, explosions or dangerous releases. The Major Accident Hazards Bureau (MAHB) of the European Commission's Joint Research Centre (JRC) has implemented a number of initiatives to foster exchange and spread information on good practices among authorities and operators on risk management and enforcement on hazardous sites during the pandemic. In May 2020 the JRC published an alert, in collaboration with the OECD Working Group on Chemical Accidents, on pandemic measures and chemical process safety. This publication followed two serious incidents (one in India and one in Italy) that occurred during start-up of chemical plants after shutdown necessitated by pandemic lockdowns in those countries. From July to September, the JRC conducted a survey of government authorities in EU, OECD and UNECE Member States on experiences and learnings from the Covid-19 pandemic in overseeing risk management of high hazard sites in the first 6 months of the pandemic. Most recently, on 9 February 2021, the JRC hosted a webinar for over 100 EU representatives from environment, labour and civil protection authorities as well as neighbouring countries. This presentation will summarise the JRC's findings and recommendations on threats to the safety of hazardous sites posed by the pandemic and the strategies that have been developed to address them.