

Optimization of Training Effectiveness of Physical Protection Course for Asian Region: Best mix of
in-person and virtual methodologies

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Abstract

During the COVID-19 pandemic, ISCN has developed several online training courses on nuclear non-proliferation and nuclear security for the regional participants to minimize the impact of global travel restriction. Those courses consisted of on-demand e-Learning and interactive live lecture and group exercises. ISCN has also developed virtual tour program for site visit and video materials for online courses, and designed courses using these tools in various combinations to enhance the effectiveness of the training.

ISCN gradually resumed in-person international/regional training courses in summer 2022; however, instead of going back to the in-person style before the pandemic, it explored the best mix of in-person and virtual methodologies it has developed for the past 2 years. ISCN and U.S. DOE/NNSA through Sandia National Laboratories (SNL) jointly restructured the ISCN annual Regional Training Course on Physical Protection of Nuclear Material and Facility (PP-RTC) and the conducted the Course as in-person in October 2022. By combining in-person and virtual methodologies, ISCN and SNL successfully designed the 2022 PP-RTC to optimize its curriculum.

This paper reports on the development, implementation, and feedback from participants of PP-RTC to share ISCN's experience and contributes to further enhancing effectiveness of capacity building in nuclear security. This paper also reports on the ability to expand the in-person learning experience because of the implementation of the virtual tools and on the advantages and disadvantages of each methodology. The conclusions will provide information such that courses can be further improved to maximize effectiveness of both methodologies.

Introduction

The Japan Atomic Energy Agency's (JAEA's), Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN), is a regional training center to support countries mainly in Asia. The goal of ISCN training is to achieve high quality and uniqueness. Since its establishment in December 2010, ISCN has been providing Regional Training Course on Physical Protection of Nuclear Material and Facility (PP-RTC) annually. PP-RTC is a two-week training course to cover the design and evaluation process for physical protection systems and, typically, 25-30 participants from 13-15 countries join PP-RTC each time the course is held.

The PP-RTC was originally developed based on the IAEA's three-week International Training Course (ITC) which was developed and is regularly conducted at Sandia National Laboratories (SNL). Since established in December 2010, the ISCN has received strong support from U.S. Department of Energy, National Nuclear Security Administration (DOE/NNSA) to build capability as a training center, and the ISCN jointly developed the PP-RTC with experts from Sandia National Laboratories (SNL). Together the ISCN provided its first PP-RTC in October 2011.

Since then, ISCN has continuously improved the PP-RTC adding emerging topics and technologies; incorporating more hands-on opportunities; and incorporating content and exercises pertinent to Asian interests. The ISCN introduced a 3-D, immersive virtual reality (VR) system and Physical Protection Exercise Field (PPEF) as training facilities in 2012, and incorporated exercises using those facilities into the training. The PP-RTC uses a hypothetical nuclear research facility for post-lecture exercises. The ISCN created a model of that facility in the VR system, so participants are able to become familiar with the facility prior to completing the subgroup exercises based on the hypothetical facility. PPEF is equipped with real physical protection devices including intrusion detection sensors, surveillance cameras, entry control and prohibited item detection systems, and a mock central alarm station (CAS) system, where the participants learn characteristics of those devices by actually using them. Over the weekend, the participants also visited one of the atomic-bombed city (either Hiroshima or Nagasaki) to reaffirm the importance of nuclear security. PP-RTC has routinely received very positive feedback on the course lectures, exercises, facilities, and other learning opportunities from the participants every year.

When COVID-19 rapidly spread globally in early 2020, ISCN quickly made a decision to develop an online PP-RTC. The ISCN worked together with SNL to convert all the lecture materials into e-learning modules, and re-designed exercises into interactive live classroom modules. The first online and interactive PP-RTC was conducted in 2020 with SNL experts who joined remotely. In 2021, the ISCN added live remote Hiroshima visit to online PP-RTC. With these efforts, the ISCN successfully provided a high-quality PP-RTC even during the COVID-19 pandemic.

Other than PP-RTC, the ISCN also developed several online courses with the variety of combinations of the following learning methods: e-learning using presentation slides with audio, video materials, remote lecture, virtual facility tour, sub-group exercise using breakout function of web-based platform, and live remote tour.

Basic policy for the new in-person PP-RTC

In early 2022, when the Japanese government gradually lifted travel restrictions due to COVID-19, the ISCN decided to resume in-person regional training courses for JFY2022. However, for the PP-RTC, the ISCN did not want to return to the traditional 2019 PP-RTC format, after identifying lessons learned and good practices from developing and implementing the online training. Based on the experiences, the ISCN

then became committed to develop a new in-person PP-RTC that would optimize training effectiveness by combining both in-person and online (virtual) methodologies, and again, worked together with SNL experts for such endeavor. The new course format incorporated the following eight improvements.

1. Use of e-Learning Modules

The ISCN's PP-RTC is very interactive, which requires active engagement by the participants. The course is offered in English. The ISCN strives to reach a broad range of participants from regulators and inspectors to response forces to system designers and maintainers. However, given the broad range of experience, there are often gaps in understanding of basic terms and concepts used in nuclear security. As a result, some participants have needed more time than others to complete sub-group exercises.

By using e-learning modules to introduce terminology and basic concepts as prerequisites to attend the course, ISCN and SNL managed to solve that issue. The ISCN added three e-learning modules to 2022 PP-RTC: (1) introduction to nuclear security (Figure 1); (2) introduction to the hypothetical facility, and (3) IAEA nuclear material categorization table. (1) and (3) were already available from 2021 online PP-RTC so the ISCN only had to update and modify them, and (2) was added using VR images of the hypothetical facility. In order to complete the sub-group exercises effectively, completing all three modules were critical. E-learning modules are for self-study and are self-paced so the participants were able to access the material as many times as they needed to understand the contents.



Figure 1. e-learning module on “Introduction to Nuclear Security”

2. Better presentation of course materials

For the online PP-RTC, the ISCN converted all the lecture materials (PowerPoint slides) into e-learning, for self-study. Therefore, e-learning materials had to be self-explanatory, easy to read and easy to follow without instructors. ISCN and SNL worked diligently to modify the slides to achieve such goal by changing wording, adding images,

improving explanation, and avoiding use of small fonts (Figure 2). For the 2022 PP-RTC, ISCN was able to use those more-sophisticated slides for lectures for better understanding.

The ISCN also incorporated the simplified but interactive exercise materials from online PP-RTC. The simplified yet interactive materials resulted in more rapid assimilation and retention of the lecture material.

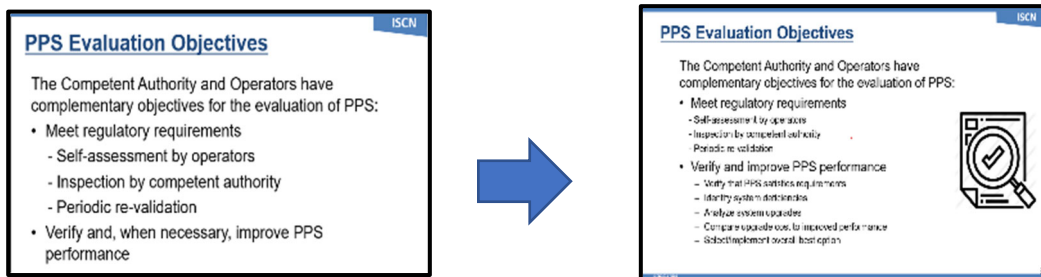


Figure 2. comparison of the same slide, 2019 (left) and 2022 (right).

3. Improving VR demonstration to introduce hypothetical facility

As mentioned above, the 2022 PP-RTC added an e-learning module to introduce the hypothetical facility used for group exercises throughout the course. There is an Exercise Databook that describes the hypothetical facility used in the subgroup exercises. The course participants need to understand the physical characteristics of the facility, the physical protection features, the geographical condition, the security measures and all other details to complete the sub-group exercises. In 2019 PP-RTC, the ISCN sent the Databook to the participants in advance asking them to read it through before coming to Japan and used VR system to walk-through the hypothetical facility on the first day of the training; however, it was hard for the participants to capture every detail.

By combining the e-learning and VR walk-through, ISCN received feedback from the participants that they were to better able to understand the important features of the facility.

4. Increased number of subgroup exercises

One of the advantages of in-person training over online training is the high level of engagement among the participants. The PP-RTC is a regional course where the participants from different countries, organizations, responsibilities, experiences and opinions, gather and spend two weeks together. During that two-week period, they learn a lot from each other. Sub-group exercises facilitate engagement by the participants, therefore, for the online PP-RTC, the ISCN designed the course to have all the exercises as live interactive classroom exercises, not for self-study. As the ISCN did during the in-person PP-RTC before the COVID-19 pandemic, the online PP-RTC divided the participants into four sub-groups to conduct exercises, using a breakout function of the web-based training platform. The ISCN and SNL instructors conducted dry-runs to be effective, and as a result, communication between instructors and the participants were

very smooth and active during the online PP-RTC; however, communication among the participants themselves was not as active as it was during the in-person PP-RTC.

From that experience, the 2022 PP-RTC added two sub-group exercises to facilitate the participants to understand better by discussing with other participants. SNL experts led the new exercise development for (1) insider threat and (2) alarm communication and display. Insider threat mitigation is one of the hardest challenges of nuclear security for many Asian countries. Before the 2022 PP-RTC, there was a lecture module on insider threat but not a sub-group exercise. The 2022 PP-RTC added a new, facilitator-led discussion exercise using a real case example. Participants appreciate and become very engaged in discussing real case examples. Therefore, it is very effective to learn from guided discussion of real cases.

For alarm communication and display exercise, SNL experts designed the exercise to use the mock CAS at the PPEF (Figure 3). By combining sub-group discussion and hands-on experience using real devices, the exercise facilitated the participants to better understand the good features of alarm communication and display system.



Figure 3. Alarm communication and display exercise at the PPEF mock CAS

5. Extended hands-on experiences at the PPEF

One of the most significant features of ISCN's PP-RTC is hands-on experience at PPEF. As mentioned earlier, PPEF is equipped with the real physical protection devices which are used at real nuclear facilities. For example, participants are able to set off an alarm by simulating an intrusion, and learn the principles of operation, timing of alarm, cause of nuisance alarms and so on. In order to design and evaluate the effectiveness of physical protection system, participants need to learn how to select, design, and implement physical protection devices. The PPEF design provides a unique learning environment where participants can actively interact with operational systems.

In 2019 PP-RTC, the ISCN set three stations at PPEF: (1) exterior intrusion detection sensors and fences; (2) Mock CAS; and (3) Entry control and prohibited item detection system. The participants spent about 60 minutes at each station (Table 1). There were many devices and characteristics introduced at each station, the participants enjoyed the

experience but commented that they would have liked more time to learn about each of the systems at each station.

Station	Devices/functions	Time
1	Laserr sensor Buried sensor Taut wire sensor Fence-vibration sensor Infrared sensor Microwave sensor E-Field fence sensor Dual sensor Fences	50 min.
2	Interior passive IR sensor CAS functions Camera visibility Video motion sensor Nuisance alarm video	50 min.
3	Metal detector (portal, hand-held) Explosive detectors (bulk, trace) Entry control gate Circle gate	50 min.

Table 1. PPEF stations in 2019

For 2022 PP-RTC, ISCN and SNL increased number of stations from three to nine by breaking down three stations into smaller pieces. By increasing the number of stations, shortening the time at each station from 60 minutes to 30-40 minutes and allowing more time to explain each device and system, the participants were able to observe how the systems worked and ask questions (Table 2). DOE/NNSA generously dispatched two instructors from SNL to support the demonstrations at the additional stations. As a result, the hands-on experience at the PPEF was extended from 170 minutes (3 stations plus 20-minute video material) during the 2019 PP-RTC to 300 minutes during the 2022 PP-RTC.

Station	Devices/functions	Time
1	Infrared sensor Microwave sensor Dual sensor	40 min.
2	Camera visibility	40 min.

Station	Devices/functions	Time
3	Metal detector (portal, hand-held) Explosive detector (bulk, trace)	40 min.
4	E-field sensor Fence vibration sensor Taut wire sensor	30 min.
5	Laser sensor Buried sensor Fence	30 min.
6	Interior passive IR sensor Ceiling sensor Magnetic switch	30 min.
7	(indoor) Entry control system: gate	30 min.
8	(outdoor) Personnel gate Vehicle gate	30 min.
9	Alarm communication and display	30 min.

Table 2. PPEF stations in 2022

6. Remote but Live Hiroshima Tour

One of the best sessions from the online PP-RTC in 2021 was the introduction of the remote live visit to Hiroshima. The ISCN contracted with a tour company to provide a virtual, guided tour inside the Hiroshima Peace Memorial Museum, view of the Atomic Bomb Dome, hear a testimony of a survivor of atomic bomb, and offer flowers at the Peace Memorial Park, all via Zoom. The tour, especially listening to the atomic bomb survivor, left a strong impression and many commented that the tour reaffirmed their responsibility for nuclear security. Based on this response, the virtual tour was as well received as were prior in-person tours.

During planning of the 2022 PP-RTC, there were still many cases of COVID-19 in Japan, and, since the virtual tour had been so well received, the ISCN decided to again conduct the visit to Hiroshima virtually to reduce the risk of COVID infection.

Remote live visit also allowed ISCN to allocate more time on exercise and PPEF experiences mentioned earlier.

7. Added content

Another improvement of the 2022 PP-RTC was the addition of new modules. As mentioned above, the online course only conducted sub-group exercises during the live classroom sessions and, with the exception of three summary lecture modules, all lectures were converted into self-study e-learning modules. The contents of the PP-RTC can be

divided into three sections; (1) define physical protection system requirements; (2) design physical protection system; and (3) evaluate physical protection system. The ISCN wanted to make sure the participants sufficiently learned from e-learning so new interactive modules were added to summarize each section, define, design and evaluate. The new modules were successful as offered in the online PP-RTC, so the ISCN added them to the 2022 PP-RTC.

Since networking and participant interaction is important to learning, the ISCN also requested short country presentations from several participants on the physical protection regime in their countries. The participants of the PP-RTC come from different countries and they are each at different stages of introducing nuclear energy, so there are a wide variety of national regimes. By sharing country experiences, the participants may identify common challenges and possible solutions. Additionally, by doing research on their own national regime, the participants can deepen their understanding as well.

8. Material development and dry-runs

Development and implementation of the online PP-RTC was a big challenge; however, the advancements and ease in holding virtual meetings identified the opportunity for continued collaboration using virtual platforms. Since the first PP-RTC in 2011, DOE/NNSA provided SNL experts as instructors. However, since collaboration required physical travel to Japan, it was difficult to conduct dry-runs prior to the course with SNL experts. During 2020-2021 development of the online PP-RTC, the ISCN and SNL experts were easily able to meet quite often virtually for material review and dry-runs. Moreover, other experts in virtual training were able to join the material review and dry-run to provide very valuable comments and inputs to the revised material. Subsequently, for development of the 2022 PP-RTC material, the ISCN and SNL experts frequently used virtual meetings to discuss material updates, develop new exercises, and complete dry-runs. The ISCN and SNL experts even did the last-minute dry-run at PPEF during the course to improve effectiveness.

Result

After the 2022 PP-RTC, all 18 participants from 14 countries answered either “Strongly agree” or “Agree” to the question of “I am satisfied with the course overall.” The 2022 PP-RTC was an effective mix of both in-person and online methodologies, developed based on the lessons learned from online training development during COVID-19 pandemic. The level of participant engagement was very high, especially during sub-group exercises and PPEF experience. Moreover, the participants networked closely during the break and after the class, which is the advantage of in-person event.

Conclusion

The goal of ISCN training is to achieve high quality and unique training. For high-quality training, the ISCN has been working closely with U.S. DOE/NNSA, especially

with SNL experts, to continue to advance training capabilities. PP-RTC is a good example of ISCN-DOE/NNSA successful collaboration. At the same time, ISCN eagerly explores how to add uniqueness to its training activities, such as improvements by implementing state-of-the-art systems at the training facilities and defining training activities that, based on training experiences and feedback, enhance the learning experience for retention of concepts. The 2022 PP-RTC implementation of both online and in person activities was a success. And, the ISCN will continue improving the course with DOE/NNSA and SNL experts.