Good practices of the online training on physical protection of nuclear materials and facility

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ABSTRACT

In the amid of COVID-19 pandemic, Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN) of Japan Atomic Energy Agency (JAEA) developed and conducted the two-week regional training course on physical protection of nuclear materials and facility (PP RTC) for Asian countries in October 19-30, 2020 as an online course.   ISCN/JAEA launched its first PP RTC in 2011, and since then, has been offering the course annually as the primary training course in nuclear security. Because stringent travel restrictions were imposed in many countries, ISCN/JAEA turned this challenge into an opportunity to develop an online course.   ISCN/JAEA developed the PP RTC with the support from U.S. Department of Energy, National Nuclear Security Administration through Sandia National Laboratories (SNL), so that it was quite natural for ISCN/JAEA to partner with SNL for online PP RTC development. The online setting solved the challenge of travel restriction; however, maintaining the quality of in-person two-week training through online platforms was another big challenge. For effective learning, ISCN/JAEA focused on securing interaction between instructors and participants as well as among participants, and such interactive learning was received quite positively by the participants. ISCN/JAEA combined e-learning (self-study) and interactive learning (virtual classroom) for its online PP RTC, and engaged participants through group exercise via Zoom meeting. The paper will describe efforts of ISCN/JAEA and SNL to develop the online curriculum of PP RTC and share lessons learned and good practices for course development and course implementation.   The paper will also explore future application of online contents in nuclear security capacity building even after COVID-19 pandemic.

INTRODUCTION

Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN), Japan Atomic Energy (JAEA), is the regional training center on nuclear nonproliferation (safeguards) and nuclear security for Asian countries.   Since its establishment in 2011,

ISCN has been organizing an annual Regional Training Course on Physical Protection of Nuclear Materials and Facility (PP RTC). It is a two-week course which invites about 24 Asian participants to Japan. PP RTC is the fundamental nuclear security training course for ISCN, and it has developed several focused training courses which derived from PP RTC. In April 2020, at the early stage of COVID-19 pandemic, ISCN started developing an online format of the PP RTC to continue offering the course despite the stringent international travel restrictions. The PP RTC was organized by ISCN in cooperation with U.S. Department of Energy, National Nuclear Security Administration (DOE/NNSA). Online PP RTC is also a joint project between ISCN and DOE/NNSA. Preparations for the Online PP RTC took 6 months, including redefining the curriculum and material for an online format, and conducting joint reviews and dry runs. In October 19-30, 2020, ISCN conducted the first Online PP RTC with a remote instructor from Sandia National Laboratories (SNL). Here, "Online" means the we-based training course using the combination of e-learning (self-study) and interactive (instructor-led virtual classroom) modules.

1. Basic Policy for Online Training Development

1.1 Course Objective

The ISCN's goal was to retain the course objectives as it was in in-person PP RTC, however; the course objectives had to be adjusted for online setting. For in-person PP RTC, the two main course objectives are to understand the basics of the performance-based methodology to design and to evaluate a physical protection system for nuclear materials and facilities through practical hands-on exercise. PP RTC teaches the design and evaluation process outline (DEPO) of physical protection system through analysis of a Hypothetical Facility; and, promotes the evaluation of physical protection systems using practical exercises using the Physical Protection Exercise Field (PP Field) a hands-on training facility. PP Field is equipped with actual physical protection equipment such as intrusion detection sensors, entry control system, prohibited item detection, and a mock central alarm station (CAS). At the PP Field, participants learn principles of operation and characteristics of each equipment and the function of CAS. However, an Online PP RTC would not be able to provide such real experience, so the ISCN decided to remove the objective for practical hands-on exercise using PP Field.

Another significant objective of ISCN PP RTC was a visit to atomic bombed-site (Hiroshima or Nagasaki) on the weekend to reconfirm the importance of nuclear security. However, it was difficult to include Hiroshima/Nagasaki visit for 2020 Online PP RTC. For Online PP RTC, ISCN was unable to include the Hiroshima/Nagasaki visit.

The ISCN aimed at meeting the primary objective of teaching the DEPO process by achieving high level of engagement between instructors and participants in an online format.

1.2   Course Structure

Table 1 illustrates the comparison of the course format of in-person and online PP RTC.

Table 1. Comparison of In-person and Online course format

	In-person	Online
Couse period	11 days (including 2 days of Hiroshima/Nagasaki visit)	10 days (without Hiroshima/Nagasaki visit)
Hours/day	6-7 hours	4 hours (2 interactive modules (45 min. each) with 2-hour interval
Accepted participants	24-32	16 (with the last-minute cancellation, 14 in total at the end)

Online PP RTC uses two different types of method: e-learning and interactive learning (virtual classroom).

1. e-learning: material is available by logging in to a Learning Management System (LMS).   No instructor, fully self-paced.
2. Interactive learning: a virtual classroom where material is presented by instructor using an online training platform.   Participants can interact with the instructor and other participants.

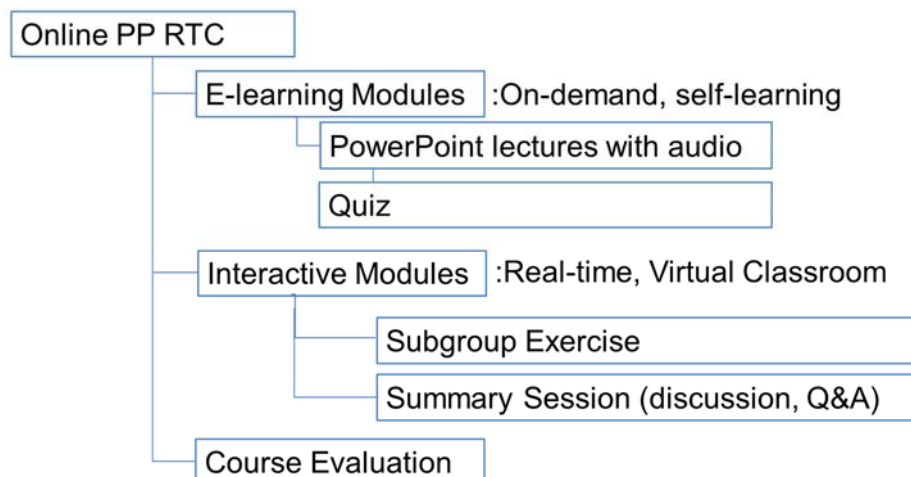Figure 1 shows the course structure of Online PP RTC.

Figure 1. Online PP RTC Course Structure

In order to achieve the course objective, it required the same two-week period to cover necessary modules. All the lectures were converted to e-learning modules, and all the subgroup exercises were converted to interactive module.

	Oct 19 Mon	Oct 20 Tue	Oct 21 Wed	Oct 22 Thu	Oct 23 Fri		Oct 26 Mon	Oct 27 Tue	Oct 28 Wed	Oct 29 Thu	Oct 30 Fri
15:00-15:45 (Japan Time)	Course Introduction	S4: Target Identification	Define Summary, Q&A	S8: Alarm Assessment, AC&D	S10: Delay		Design Summary, Q&A	S15: Nuetralization Analysis	Introduction to Final Exercise	S17: Final Exercise	Final Presentation
intermission 2h	The Online PP-RTC consists of e-Leraning Module (self-study) and Interactive Module (virtual classroom). Participants are required to complete the corresnponding e-Learning module before joining each Subgroup Exercise. S=Subgroup Exercise										Evaluation and Closing
18:00-18:45 (Japan Time)	S3: Facility Characterization	S5: Threat Definition	S7: Intrusion Detection Sensors	S9: Entry Control, Prohibited Item Detection	S11: Response		S14: Path Interruption Analysis	Evaluation Summary, Q&A	S17: Final Exercise	S17: Final Exercise	

Figure 2. Course Agenda

ISCN designed the course so that the participants only need two weeks to complete both e-learning modules and interactive modules. Each lecture is followed by the corresponding subgroup exercise, and before joining the interactive subgroup exercise, participants are required to complete the lecture module (e-learning). The Figure 2 shows the course agenda for two weeks. Each day, there are two interactive modules, and in between, there is a two-hour interval. During the interval, participants are able to complete the relevant e-learning lecture to join the subgroup exercise. At the same time, in order to make sure participants have sufficient time for questions for e-learning modules, ISCN put three interactive summary sessions other than subgroup exercises to review e-learning modules.

To set the time schedule for interactive modules was a challenge since participants were from different time zones, with maximum 6-hour difference from Japan. ISCN decided to start the course at 15:00 so that most of the participants can join the course during their normal office hours. ISCN especially thank the U.S. expert who join the course as an instructor, despite the fact that the course started at midnight in U.S.

For effective interaction between instructors and participants as well as among participants, ISCN limited the number of participants to 16, four participants per subgroup. This allowed each instructor to ensure all the participants in the group understand the contents and are engaged during the exercise.

To replace daily quiz which was offered at the in-person course, ISCN added short quiz to e-learning lecture material to make sure participants understood the material.

Table 2 summarizes the comparison of in-person and online training contents.

Table 2. Comparison of the delivery method of course contents

Contents	In-person	Online
Lecture	Instructor-led in-class lecture using PowerPoint	Self-paced PowerPoint slide with audio and Quiz
Subgroup exercise	Small group exercise	Small group exercise using breakout function of a web platform
Practical hands-on exercise	Exercise at PP Field using real equipment	N/A
Hiroshima/ Nagasaki Visit	Historical tour to atomic bombed area (two-day trip)	N/A

2. Material Development

The course materials had to be adjusted to online setting as well.

● Self-paced e-learning lecture materials: In order to keep participants' attention and motivation, slides should be clear and precise. The instructor (audio) should be paced – not rushed – for the allotted time and amount of material. The student should be able to advance to the next slide when ready and should be able to repeat the instructor explanation. This is important when English is a second language. To ensure the knowledge retention, e-learning module includes quiz at the end. These were not pass/fail quizzes, but if the correct answer rate was low, that topic would be reviewed by instructors during the relevant subgroup exercises.

● Instructor-led interactive subgroup exercise materials: exercise material and responses are shared on the screen. For effective interaction during the limited time, ISCN combined the use of the hard copy exercise material (asked participants to print them out in advance and have them handy during the interactive module) and PowerPoint slide/Excel form for screen sharing and documenting answers

3. Course Implementation (online delivery)

e-Learning Modules: ISCN used an existing JAEA e-Learning Management System (LMS) for Online PP RTC. Slides and exercises were made available to the participants one week prior to the course.

Interactive Modules:

For interactive modules, ISCN decided to use Zoom or the web platform considering available functions ISCN wanted to use, namely screen sharing, chat, breakout and white

board (annotation). Figure 3-4 illustrates Online PP RTC course implementation.

Features of course implementation are the following:

● Stable connection: All instructor and technical staff PCs and headsets used wired (not Wi-Fi) connection to the Internet.

● Back-up host PC in a different venue in case of failure of the main host computer

Figure 3. Subgroup exercise: breakout session, screen sharing

● A large conference room setup where all the instructors and technical staff gathered for smooth and direct communication

● During subgroup exercises, an instructor, co-instructor and a technical staff were assigned to each subgroup, each group was set up with a sufficient distance from other groups to minimize the interference by voices of other groups
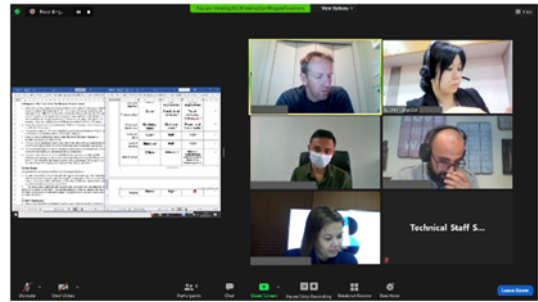

● Presence of technical staff to manage Zoom hosting and assist participants to solve any technical issues associated with Zoom

● Technical staff also supported instructors: monitor chat, reaction, or hand raised by the participants during subgroup exercises

Figure 4. a technical assistant staff (left) assists instructors during subgroup exercises

4. Findings from the Online PP RTC Course Development and Implementation

4.1 Evaluation by the participants

At the end of the course, ISCN collected feedback from the participants.   The results are summarized in Table 3.

Table 3. Summary results of the course evaluation

	Summary results of the course evaluation (total 14)
Overall Satisfaction	● I am satisfied with the course: Strongly agree: 13, Agree: 1
e-Learning/Interactive modules	● The following helped me understand the course content: e-learning (lecture): Strongly agree: 7, Agree 6 interactive modules (subgroup exercise): Strongly Agree: 10, Agree: 3
Comments	● Subgroup exercise was helpful to hear other's opinion and

	Summary results of the course evaluation (total 14)
	experience ● Instructors encouraged participants' engagement ● Summary sessions (interactive) were helpful to remember the contents of e-learning
Disadvantage of Online	● Interrupted by normal work at the office ● The course time was difficult (out of regular office hour) ● e-Learning materials need more visual improvement (use of animation, picture, etc.)

All the 14 participants either strongly satisfied or satisfied with the course, and would recommend the course to the others.

4.2　　　Good practices and Lessons Learned

ISCN identified good practices and drew lessons learned from curriculum design, material development, course implementation and evaluation of Online PP RTC.

More experts involvement in online than in-person course

Since it was a joint endeavor of ISCN and DOE/NNSA, ISCN organized material review meetings and dry-runs with DOE/NNSA via Zoom.　DOE/NNSA invited several experts from U.S. National Laboratories, i.e., Sandia National Laboratories (SNL) and Pacific Northwest National Laboratory (PNNL).　When PP RTC was conducted in-person in Japan, one or two experts from SNL came to Japan and joined the course as instructors; however, since it was online, more experts were able to join the material review and dry-run to provide very valuable comments and inputs to the materials. It was an advantage when modifying the material for online training.

Importance of qualified technical assistant

ISCN's training team consists of training instructors and technical assistant staffs. Instructors are responsible for the course content including needs analysis, curriculum/material development, implementation, and evaluation of a training course, while technical assistants are responsible for administrative support and assisting instructors during the course implementation.　Once ISCN decided to develop online training courses, the technical assistant staff quickly obtained necessary skills for and became efficient in operating online platform.　They found the way to effectively host Zoom meeting including determining the optimum Zoom settings for the various operating systems, determining the optimum physical venue layout, developing a Zoom guide (how to use key

functions), and providing support for any technical issues associated with online platform to the participants.   Meanwhile, instructors were able to focus on the contents of the course and effective facilitation during the subgroup exercise, which resulted in very positive feedback from the participants.

Dry-run

Offering an online course may require more preparation than an in-person course.   Of course, dry-run is important for any in-person course; however, due to the limited time participants can stay focused and limited interaction during the interactive subgroup exercises, dry-run became the key to successful conduct of online PP RTC.   Instructors need to be very familiar with the functions of web platform to be used during the exercises, and technical assistant staff also need to know the flow of each interactive module to expect what to come next.   As mentioned earlier, ISCN conducted dry-runs with U.S. experts, and among ISCN staff prior to the training.

Time allocation for effective e-learning and interactive module

Time allocated for e-learning and interactive module is important.   Each e-learning module should have sufficient time so that participants understand the contents well but at the same time motivate participants to complete the module all while keeping their attention. Balance is required between how long the participant needs to understand and complete the exercise, and the time/effort required for the instructor to facilitate the exercise. The ability to replay all or portions of the module is important. ISCN designed each e-learning module to be completed in approximately 30 minutes, and interactive module in 45 minutes. After the course, ISCN realized that for some exercises, 45 minutes for the interactive modules was too short. Participants stayed well focused and paid full attention to the exercise, and as shown in the course evaluation, they enjoyed interactive exercises very well. As participants get more familiar with online training activities, time allocation for interactive module can be extended.

5.   Future Improvement for ISCN training activities

ISCN has decided to keep the online format for PP RTC for 2021, which is scheduled to October 18-29. ISCN will best use the participants' feedback and lessons learned from the previous online PP RTC to improve Online PP RTC 2021.   ISCN also gained more experience in online training development since last Online PP RTC, and such experience will be useful for further improvement.

5.1   Hands-on learning:

As mentioned earlier, Online PP RTC 2020 did not include practical hands-on learning at

PP Field using real physical protection equipment.   By using video or other technical content, such hands-on learning in an in-person course can be adapted in an online format as well.   For example, ISCN developed virtual tour capability which uses still images of a real facility (not virtual reality) to navigate inside the facility as if participants are visiting that facility.   Also, for an online safeguards training, ISCN used a video demonstration of some equipment. For 2021 or beyond, ISCN may be able to adopt such hands-on learning into Online PP RTC.

5.2   Hiroshima/Nagasaki Tour:

One of the disadvantages of Online PP RTC 2020 was the inability to travel to Hiroshima or Nagasaki, atomic bombed area, for understanding/experiencing the importance of protecting nuclear material and facilities.   For 2021, ISCN is planning to include a virtual Hiroshima visit during the two-week training period.   The detailed program of the visit will be determined in the future; however, ISCN is convinced from the past experience that the visit to Hiroshima/Nagasaki will reconfirm participants' motivation to strengthen nuclear security in their own countries.

5.3   Increasing options for future training activities:

The experience of Online PP RTC in 2020 added new portfolio to ISCN's training activities. For the future PP RTC or any other training courses, ISCN can use in-person, online or hybrid of in-person and online.   For example, an introductory course can be offered by e-learning only.   Intermediate course can be offered using e-learning and interactive learning as ISCN did for PP RTC in 2020.   An advanced course can be offered either in-person or hybrid of in-person and online (e-learning and/or interactive learning).   ISCN will explore the best training method for its future training activities.

CONCLUSION

Online PP RTC was the first online training experience for ISCN. Since then, ISCN has developed several online training courses and accumulated good practices and lessons learned. ISCN will effectively use online learning tools and platforms for training into the future, defining or modifying course curriculums to include both the new and old training platforms and methods.   Online training activities have great advantage to lift the geographical limit so that broader range of participants can take the course than in-person course. Self-paced e-learning enables participants to take as much time as needed to read the slides repeatedly and may translate into their native language for better understanding. Interactive learning such as subgroup exercise encourages participants to engage with instructors and other participants to learn regional and global perspective.   At the same time, some participants may be distracted by their environment (daily chores when joining from home and normal office duties when joining from the office).   There are also certain

percentage of participants who prefer in-person training over online training. COVID-19 gave ISCN a new opportunity to expand its options for training activities. ISCN will continue to contribute to strengthen nuclear security in Asia through capacity building support activities through training, using all available methods and tools.