ITWG
Nuclear Forensics
International Technical Working Group

ITWG
NUCLEAR FORENSICS
UPDATE

No. 15 June 2020

CHAIRPERSONS' ADDRESS

Welcome to the Nuclear Forensics International Technical Working Group (ITWG) newsletter. This issue has been produced and is being circulated while many of us are not physically at our offices or laboratories, but teleworking instead. The spread of SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) has had dramatic impacts all around the world and led to an exceptional situation. Obviously, this pandemic is also affecting the work of the ITWG in the year of its 25th anniversary. Our annual meeting, which was initially scheduled for June, has had to be postponed until later in the year. It is currently envisaged that it will be held in the week beginning 16 November 2020. We appreciate the additional efforts of our colleagues at Lawrence Livermore National Laboratory in rearranging the annual meeting. It is anticipated that collaborative material exercise 7 (CMX-7) will still take place in September 2021. Registration will open in late 2020/early 2021. If you are interested in participating in CMX-7, please contact Jon Schwantes or Olivia Marsden.

We recently learned of the passing of Dr Lothar Koch, a founding member of the ITWG and long-standing co-chair of the group. We are deeply saddened by the loss of a visionary and astute leader in nuclear safeguards and nuclear forensics. He had a tremendous impact on the shape of scientific programmes in these areas. Dr Koch was a pioneer in nuclear forensic science and a champion of the Nuclear Forensics ITWG.

This edition of the newsletter contains details of ITWG contributions to the International Conference on Nuclear Security (ICONS 2020), a contribution from the International Atomic Energy Agency on the nuclear forensics aspects of ICONS 2020 and an article on the nuclear forensics capabilities of the Japan Atomic Energy Agency. We also present an updated version of the calendar of coming nuclear forensics-related events.

With best regards,
Klaus Mayer and Michael Curry

ITWG SURVEY

The ITWG leadership is eager to keep members engaged in our work during the COVID-19 outbreak. On 16 June 2020, we will open a survey on the ITWG website (www.nf-itwg.org/) to better understand your interests, priorities, and preferred means of communication as we consider the form and content of future virtual engagements that advance our work in nuclear forensics. The survey will be open until 7 July 2020. We look forward to your input.

ITWG'S CONTRIBUTION TO THE INTERNATIONAL CONFERENCE ON NUCLEAR SECURITY, 2020

MICHAEL CURRY AND KLAUS MAYER

Nuclear forensics and the ITWG were both important elements of International Conference on Nuclear Security (ICONS 2020), which was held in February 2020. Ministers from several countries highlighted the investments and developments their states are pursuing in the area of nuclear forensic science, while experts shared updates on their work in the field. In many cases, ITWG activities helped to inform this shared knowledge and growth within the discipline.

The ITWG held a side event at the conference, was featured in an article in the International Atomic Energy Agency (IAEA) Bulletin produced for the conference and briefed attendees on its activities.

One topic—different formats

The Technical Session of the conference included over 25 presentations on nuclear forensics as well as two dedicated panel discussions and an interactive

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session. One of the panels addressed efforts to create and sustain nuclear forensics capabilities. The other, which was conducted in 'Davos style', discussed efforts at international collaboration. The presentations, including those in the interactive session, discussed a range of nuclear forensics techniques and national programmes, as well as focus areas such as national nuclear forensics libraries.

The ITWG side event featured an interactive activity about the decisions investigators and technical experts face when processing a radiological crime scene. Naomi Marks (Lawrence Livermore National Laboratory, LLNL) and Jim Blankenship (US Federal Bureau of Investigation, FBI) introduced and moderated the activity, which was based on the Galaxy Serpent 3 exercise. Event participants were asked to determine whether three samples of uranium ore were consistent and how to prioritize the processed evidence using traditional and nuclear forensics techniques. Participants provided real-time feedback on the questions, which was shared with the audience. This provided an opportunity for deeper discussion and sharing of the knowledge gained from ITWG exercises. In addition to highlighting the work of the ITWG, the side event reinforced the close connection between the ITWG and the IAEA. A reception hosted by the European Commission's Joint Research Centre (JRC) complemented this highly interactive session.

ITWG activies

In one of the sessions on nuclear forensics, a dedicated paper presented an overview of the activities of the ITWG. The presentation placed particular emphasis on the informal character of the group. It also emphasized the group's outputs produced with a view to developing and promoting best practices:

- a considerable list of published guidelines on conceptual, technical and operational topics;
- an extended series of collaborative materials exercises;
- a series of virtual exercises and related guidance on national nuclear forensics libraries;
- regular information sharing through a dedicated newsletter;
- advice on training and expert elicitation;
- the linking of law enforcement specialists with scientific experts to promote the value of evidence and testimony;
- exchanges of the latest research results and experience from case work to advance the science.

Nuclear Forensics Collaborative Efforts

The ICONS 2020 session on Nuclear Forensics Collaborative Efforts was run as a Davos-style panel. The ITWG was well represented on the panel. Klaus Mayer (European Commission and JRC) chaired the meeting and Maria Wallenius (European Commission and JRC), Kerri Treinen (LLNL) and Ali El-Jaby (Canadian Nuclear Safety Commission) were panellists. Additional panellists were Naoko Noro (Japan Atomic Energy Agency, JAEA) and Kaitlin Oujo (US Department of Energy, DOE/ National Nuclear Security Administration, NNSA/ National Security Decision Directive). Among the topics discussed were needs-based regional training programmes, the Global Initiative to Combat Nuclear Terrorism self-assessment tool, bilateral US–Canadian cooperation, the IAEA residential assignment programme, regional capacity building efforts in the Georgia, Ukraine, Azerbaijan, Moldova (GUAM) region and the IAEA Technical Meeting on nuclear forensics held in 2019. The key conclusion of the panel discussion was that the development and sustainability of nuclear forensics capabilities is contingent on international collaboration in nuclear forensics, and that the IAEA should therefore consider organizing more frequent Nuclear Forensics Technical Meetings.

ITWG activities such as the Galaxy Serpent and CMX series were referenced in several ICONS 2020 presentations and continue to influence the work of the broader nuclear forensics and nuclear security communities. We look forward to readers' input and feedback as the ITWG continues to refine and grow its activities in ways that strengthen relationships between investigators and technical experts responsible for investigating illicit uses of nuclear and other radioactive materials. •

IAEA PERSPECTIVES ON THE INTERNATIONAL CONFERENCE ON NUCLEAR SECURITY, 2020

HENRIK HORNE AND DAVID KENNETH SMITH

The International Atomic Energy Agency (IAEA) convened the International Conference on Nuclear Security (ICONS 2020) in Vienna on 10–14 February 2020. This was the third in a series of ministerial level conferences on nuclear security. ICONS 2020 raised awareness on maintaining and further strengthening national nuclear security regimes and international cooperation, reviewed the current state of nuclear security efforts and promoted the sustainability of nuclear security practices. The conference provided a forum for ministers, policymakers, senior officials and nuclear security experts to formulate and exchange views on experiences and achievements, as well as current approaches to, future directions of and priorities for nuclear security. It attracted over 1900 delegates and a record number of 53 ministers from 141 IAEA member states, four non-member states and 25 international organizations, making it the largest scientific conference ever to have been organized by the IAEA. In the Ministerial Declaration, government ministers and high-level representatives reaffirmed their commitment to sustaining and strengthening nuclear security globally and announced contributions of over $20 million to the IAEA Nuclear Security Fund.

A decade of technical collaboration

Nuclear forensics is recognized globally for its role in preventing or responding to nuclear security events involving nuclear and other radioactive material outside of regulatory control (MORC). It featured prominently in the conference programme. Over the week, more than 25 presentations on nuclear forensics were delivered in the interactive and thematic sessions, drawing considerable attention from the conference participants. The conference also coincided with the 25th anniversary of the Nuclear Forensics ITWG, and marked a decade of technical collaboration between the ITWG and the IAEA Division of Nuclear Security. This partnership and these milestones were highlighted in a number of events during ICONS 2020, which successfully demonstrated the intertwined nature and the importance of the work done by the ITWG and the IAEA.

Create and sustain

The technical sessions focused on national nuclear forensics programmes and the importance of partnerships for the development and sustainability of nuclear forensics capabilities in an international context. ‘Nuclear Forensics: Create and Sustain’, chaired by Éva Kovacs-Széles of the Centre for Energy Research in Hungary, a designated IAEA collaboration centre, allowed member states to share and discuss best practices on and experience of the development and maintenance of nuclear forensics capabilities in national nuclear security infrastructures. ‘Nuclear Forensics Collaborative Efforts’, a Davos-style interactive session chaired by Klaus Mayer of the JRC, highlighted the robust, comprehensive and growing partnerships that have fostered the development and sustainability of nuclear forensics globally (see figure 1). A common and consistent application of nuclear forensics

Figure 1. Panellists and organizers at the dedicated session on Nuclear Forensics Collaborative Efforts (Left to right: Frank Wong, USA; Klaus Mayer, European Commission; David Kenneth Smith, IAEA; Kerri Treinen, USA; Kaitlin Oujo, USA; Maria Wallenius, European Commission; Naoko Noro, Japan; and Ali El-Jaby, Canada)

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NUCLEAR FORENSICS CAPABILITY BUILDING EFFORTS BY THE INTEGRATED SUPPORT CENTER FOR NUCLEAR NON-PROLIFERATION AND NUCLEAR SECURITY AT THE JAPAN ATOMIC ENERGY AGENCY

YOSHIKI KIMURA, YOSHIKI MATSUI AND HIROFUMI TOMIKAWA

Any nuclear security event involving nuclear and other radioactive materials outside of regulatory control (MORC) has the potential to have severe consequences for public health, the environment, the economy and society. Each state has a responsibility to develop national nuclear security measures to respond to such an event, and this includes a nuclear forensics capability. In Japan, national nuclear forensics capability building efforts mainly based on research and development (R&D) have been conducted since 2010. Most of that work is undertaken at the Integrated Support Center for Nuclear Non-proliferation and Nuclear Security (ISCN) at the Japan Atomic Energy Agency (JAEA) in close cooperation with the National Research Institute of Police Science (NRIPS). The JAEA is Japan's only comprehensive nuclear research institution. The NRIPS is an agency attached to the national police organization. These institutes from different research backgrounds cooperate on activities such as information exchange and joint research projects. The joint research results improve national capabilities and enhance international nuclear security.

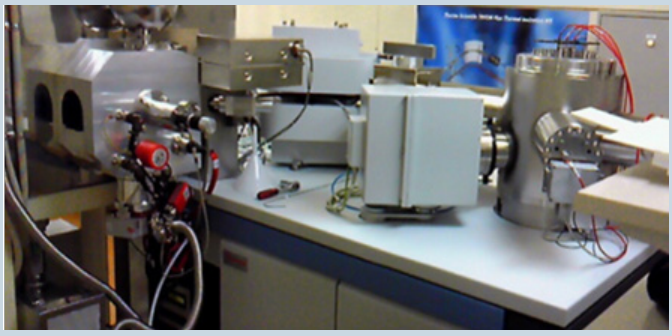

Figure 1. Thermal ionization mass spectrometry in the ISCN laboratory for Nuclear Forensics R&D

Figure 2. Transmission electron microscopy in the ISCN laboratory for Nuclear Forensics R&D

Past R&D achievements in the ISCN–JAEA

At the first Nuclear Security Summit in Washington, DC, in 2010, the Japanese Government issued a national statement on developing nuclear security technologies related to nuclear forensics and nuclear detection, and to information sharing for the purpose of enhancing international nuclear security. The ISCN was established within the JAEA to fulfil this mission and has been carrying out nuclear forensics-related R&D since 2011. The ISCN is currently conducting R&D on nuclear forensics technology for responding to a radiological dispersion event (post-dispersion

Figure 3. Sample preparation in bench-top glovebox at the ISCN laboratory during CMX-6

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examination techniques in response to a nuclear security event is essential as it enhances confidence in the analytical results and the confidence of nuclear forensics practitioners. This is best achieved by putting bilateral and regional partnerships in place to inform methodologies, the use of professional development assignments in the leading nuclear forensics laboratories and the implementation of frequent nuclear forensics technical coordination meetings by the IAEA and its partner institutions. The kind of information sharing and interpersonal communication facilitated through these two sessions is seen as a key component of promoting and advancing the nuclear forensics work of the IAEA and the ITWG as part of strengthening the global nuclear security regime.

Technical papers

A significant number of technical papers were submitted to ICONS 2020, many of them were authored by ITWG members. Some of these were selected to be featured in an interactive content presentation chaired by Brett Isselhardt of the Lawrence Livermore National Laboratory (LLNL). This first attempt to engage the audience on a more personal level proved successful and allowed participants to interact with the presenters to learn about the science of nuclear forensics signatures and their analytical methods.

Side events

Side events showcased the operational side of nuclear forensics, as well as the accomplishments of the ITWG and its activities to advance nuclear forensic science capabilities in the context of national nuclear security obligations. In the first side event, Peter Burton, IAEA Division of Nuclear Security, and Éva Kovacs-Széles demonstrated a simulated safe response at a radiological crime scene and subsequent evidence collection. This allowed participants to witness a team of Hungarian specialist law enforcement officers and scientists conduct a full radiological crime scene exploration, from specialist response through to securing the evidence for subsequent examination in the laboratory. James Blankenship (US Federal Bureau of Investigation, FBI) and Naomi Marks (LLNL) led a side event sponsored by the ITWG on the handling of evidence retrieved from a radiological crime scene. This interactive demonstration was based on lessons learned from ITWG exercises involving national nuclear forensics libraries. It allowed the audience to actively engage by 'voting' in real time on the priorities for processing evidence and by interpreting forensics data based on queries within the framework of national nuclear forensics libraries.

Conclusions

The outcomes from ICONS 2020 demonstrate that recent technical forums, training events, self-assessment tools, and bilateral and regional cooperation have been impactful and successfully promoted the international standing of nuclear forensics globally. The IAEA Crime Scene Management and Nuclear Forensics Unit, which began work on 1 January 2020, acknowledges the contributions of all the participants and wants to thank its valued partners who ensured the success of nuclear forensics at ICONS 2020. •

Nuclear Forensics Capability Building Efforts by the ISCN–JAEA... *continued from page 4*

forensics) and the application of emerging technologies for nuclear forensics purposes, based on past R&D achievements in relation to basic nuclear forensics analytical technologies and their improvement.

Several new pieces of analytical equipment have been introduced to the JAEA laboratory for nuclear forensics R&D purposes (see figures 1 and 2). There have also been improvements to signature measurement capabilities for uranium isotope ratios, and impurity profiles and the morphology of nuclear materials. The analytical capabilities developed through R&D on basic measurement technologies were evaluated on the occasion of the international material analysis Collaborative Material Exercise 6 (CMX-6) organized by the ITWG (see figure 3). The ISCN has also developed a prototype nuclear material reference database for a planned national nuclear forensics library. The database is based on materials data in the possession of the JAEA collected during past nuclear fuel cycle research activities, from uranium mining and reprocessing to mixed oxide (MOX) fuel fabrication, and to various types of nuclear reactors.

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Nuclear Forensics Capability Building Efforts by the ISCN–JAEA... *continued from page 5*

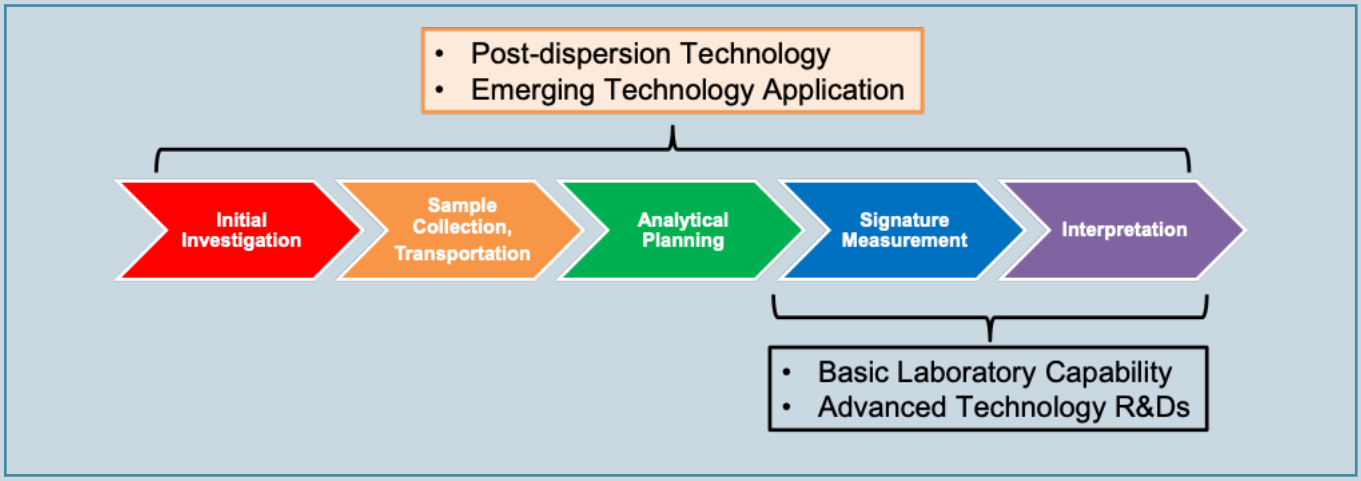

Figure 4. Past and future nuclear forensics R&D in ISCN

Technologies aimed at improving laboratory measurement and nuclear forensics interpretation have been studied based on the capabilities developed by the ISCN–JAEA. R&D to improve technology has mainly focused on increasing the speed of and confidence in laboratory analysis to enable effective support of investigations. The ISCN has developed leading-edge technologies, such as an in-situ method of uranium age dating without spiking standard materials, a materials identification methodology based on the distribution of microstructure characteristics using computational image analysis software, and a sample comparison methodology for nuclear forensics interpretation using a multivariate analysis approach. This R&D was based on collaborative research projects with the US Department of Energy, DOE/National Nuclear Security Administration and the European Commission's Joint Research Centre.

Future R&D for implementation of nuclear forensics

More recently, the ISCN has based its R&D on the technical needs identified in communications with the competent authorities. Nuclear forensics technical capability building regularly focuses on the technological development of laboratory analysis, targeting MORC samples before they are used in terrorist acts. While there has never been a successful radiological terrorist attack, the development of a national nuclear security capability for post-dispersion response and investigation remains a key requirement. First responders need to be able to quickly identify the radionuclides involved and accurately locate contamination at a crime scene. The ISCN is carrying out R&D on radiation measurement technology coupled with the development of low-cost, small radiation detectors that use machine-learning algorithms, and will enable fast, autonomous radionuclide identification to support first responders who do not have sufficient knowledge and experience with radiation measurement and spectrum analysis. Laboratory measurement and analysis of samples collected at a post-dispersion crime scene are also among the important technical issues studied at the ISCN. Such analysis should be able to overcome possible complications, for example the degradation of signatures in post-dispersion samples that can be

Figure 5. Nuclear Forensics Regional Training Course organized by the ISCN in 2019

Figure 6. Nuclear Forensics Regional Training Course organized by the ISCN in 2019

caused by contamination from existing materials in the environment or detonation of the chemical explosives used in a 'dirty bomb'.

The application of emerging technologies to nuclear forensics has also been studied at the ISCN. This includes the application of artificial intelligence to nuclear forensics interpretation to enable more confident and objective sample comparison analysis, and the application of radiography techniques to the screening of contaminated seized items to determine appropriate analytical plans in collaboration with conventional forensics processes.

These more recent R&D activities by the ISCN are mainly based on the needs of domestic first responders and investigators, and aim to develop technology for the implementation of nuclear forensics by the national nuclear security capability covering the entire spectrum of nuclear forensics processes from crime scene investigation to laboratory measurement and interpretation (see figure 4).

Capability building cooperation with Asian states

The ISCN has been conducting multilateral cooperation with Asian states to improve the international nuclear forensics capability. A nuclear forensics questionnaire was prepared by the ISCN for Forum for Nuclear Cooperation in Asia (FNCA) member states in 2017. The aim of the questionnaire was to share information about the current status of the national nuclear forensics capabilities in each member state, and to identify the need for collaborative activities to build national capabilities. The questionnaire was designed to identify the gaps between the current situation and ideal conditions for national nuclear forensics capabilities in each state, based on the national core capabilities referred to in IAEA Nuclear Security Series no. 2-G (Rev. 1). Analysis of the questionnaire results has identified gaps that most of the FCNA member states must address in areas such as their national regulatory frameworks in relation to nuclear forensics, materials characterization in the laboratory and nuclear forensics interpretation. Based on the gaps identified, the ISCN organized a regional training course on nuclear forensics in 2019 (see figure 5 and 6) and an advanced training course was planned to be held in 2020 in cooperation with the Office of Atoms for Peace in Thailand. This has since been postponed due to coronavirus disease 2019 (COVID-19). •

UPCOMING TRAININGS AND MEETINGS*

- INMM Annual Meeting, Baltimore, MD, 12–16 July 2020 (Virtual meeting)
- STCU Project Review, Baku, 15–17 September 2020 (TBC)
- GUAM Project Review, Kyiv, 28 September 2020 (TBC)
- IAEA Practical Introduction to Nuclear Forensics Course, Budapest, 5–9 October 2020 (TBC)
- GICNT Implementation & Assessment Group (IAG), Rabat, Morocco, 21–22 October 2020 (TBC)
- ITWG Annual Meeting (ITWG-25), San Francisco Bay, CA, 16–19 November 2020 (TBC)
- 12th International Conference on Methods and Applications of Radioanalytical Chemistry (MARC XII), Kailua-Kona, HI, USA, 21–26 March 2021 (TBC)
- ITWG Collaborative Material Exercise (CMX-7), September 2021 (TBC)

*Please check directly with the event organizer. TBC = To be confirmed.

Dates and locations of IAEA training and meetings will be officially confirmed with host member states; participation in IAEA training and meetings is by nomination and in accordance with established IAEA procedures.

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NUCLEAR FORENSICS

Nuclear forensics is an essential component of national and international nuclear security response plans to events involving radioactive materials diverted outside of regulatory control. The ability to collect and preserve radiological and associated evidence as material is interdicted and to conduct nuclear forensics analysis provides insights to the history and origin of nuclear material, the point of diversion, and the identity of the perpetrators.

THE NUCLEAR FORENSICS INTERNATIONAL TECHNICAL WORKING GROUP

Since its inception in 1995, the Nuclear Forensics International Technical Working Group (ITWG) has been focused on nuclear forensic best practice through the development of techniques and methods for forensic analysis of nuclear, other radioactive, and radiologically contaminated materials. The objective of the ITWG is to advance the scientific discipline of nuclear forensics and to provide a common approach and effective technical solutions to competent national or international authorities that request assistance.

ITWG PRIORITIES AND ACTIVITIES

As a technical working group, the priorities for the ITWG include identifying requirements for nuclear forensic applications, evaluating present nuclear forensic capabilities, and recommending cooperative measures that ensure all states can respond to acts involving illicit trafficking and unauthorized possession of nuclear or other radioactive materials. An objective of the working group is to encourage technical peer-review of the nuclear forensic discipline. These goals are met through annual meetings, exercises, and informal and formal publications.

Outreach is a primary goal of the ITWG. The working group disseminates recent progress in nuclear forensic analysis and interpretation with the broader community of technical and security professionals who can benefit from these advancements. Affiliated international partner organizations include the International Atomic Energy Agency (IAEA), the European Commission, the European Police Office (EUROPOL), the International Criminal Police Organization (INTERPOL), the Global Initiative to Combat Nuclear Terrorism (GICNT) and the United Nations Interregional Crime and Justice Research Institute (UNICRI).

ITWG MEMBERSHIP

Nuclear forensics is both a technical capability as well as an investigatory process. For this reason the ITWG is a working group of experts including scientists, law enforcement officers, first responders, and nuclear regulators assigned by competent national authorities, affiliated contractors, and international organizations. The ITWG is open to all states interested in nuclear forensics.

ITWG participating states and organizations recognize that radiological crimes deserve thorough investigation and, when warranted, criminal prosecution. The ITWG encourages all states to possess the basic capability to categorize nuclear or other radioactive materials to assess their threat. As an international group, the ITWG shares its expertise through its membership to advance the science of nuclear forensics as well as its application to nuclear security objectives.

http://www.nf-itwg.org/

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