Project Concept Template

Project Proposals for the RCA Programme 2024/2025

Part 1: Information Sheet

Project proposals for the RCA Programme 2024/2025 are to be prepared using the attached template and submitted BEFORE 31ST OF DECEMBER 2021. Completed templates will be reviewed by the RCA PAC in January 2022.

Resource documents required for developing Project Concepts can be found in the RCA web-site – (RCA Regional Office (rcaro.org)), under Projects/Resource Documents. (see below for the list of resource documents.

The Project Concept should be prepared in consultation with the stakeholders of the other participating GPs. Information on RCA stakeholders can be found in the RCA web-site (RCA Regional Office (rcaro.org)), under Projects/Project Information.

Please request access to the RCA Members Only web-site from RCARO (email: rcaro@rcaro.org) through your National RCA Representative if you do not already have access.

A proposal will be evaluated against the following criteria:

- Alignment of the objectives with priorities set out the RCA Regional Programme Framework (RPF) for 2024/25.
- Whether the project addresses a regional need.
- Whether nuclear technology is an essential component of the project.
- Whether outcomes and achievements of previous projects in this area of technology are considered.
- Does the proposal overlap or duplicate current or previous RCA projects?
- Is a convincing case made to justify further projects in this area?
- Is there a strong TCDC component?
- If the proposal is essentially an extension of previous projects in this area that have been implemented for more than 2 TC Cycles, does the proposal include arrangements for the transfer of project leadership to another GP?

List of Resource Documents on RCA web-site (www.rcaro.org)

1. Timeframe for preparation, review and approval of Project Concepts
2. Brochure on Logical Framework Matrix (Quick Reference Guide on Designing IAEA TC Projects)
3. RCA Regional Programme Framework for 2024-29
4. Details of RCA TC Projects implemented in 2007-2019
5. List of TC Projects being implemented in 2020/21 and projects approved for 2022/24
6. Recommendations on Technical Cooperation among Developing Countries (TCDC)

Please note that your National Representative will be reviewing the concept document to ensure that it has been prepared in compliance with the RCA and IAEA Criteria for TC Projects

Please contact the Chair of the RCA Programme Advisory Committee, Dr. Prinath Dias at prinathd@yahoo.com if you need assistance.

Part 2: Concept Template[1]

Title:

The title should be as concise as possible and should summarize the objective of the project.

Enhancing regional capabilities in industrial radiography testing technique by applying artificial intelligence (AI) in image interpretation process.

Analysis of gaps / problems / needs as applied to the RCA region:

Outline the major gaps /problems/specific needs to be addressed by the project (~ max 300 words):

Over the years, the Regional Cooperation Agreement (RCA) has helped Member States (MSs) proactively respond to rapid technological developments, and successfully implement a number of most advanced non-destructive testing (NDT) methods through technical cooperation projects, with a focus on radiography testing (RT).

The capacity of countries in the field of performing NDT services; however, is gradually approaching the limit if it is still conducted in the traditional approach. With increasingly strict requirements for accuracy, economic efficiency and an increasing demand for using NDT techniques, advanced NDT techniques and supporting tools have been being developed and applied in practice. The application of these advanced techniques and tools will increase the capacity of countries in the field of NDT.

Quality assurance in radiographic interpretation has been a continuous issue that needs to be focused on, particularly in the training of human resources for interpreting RT images. An incorrect classification may result in rejection of a part in good conditions or acceptance of a part with defects exceeding the limit defined by relevant standards. Lack of competent interpreters due to the limitation of training infrastructure, especially the lack of NDT level III human resources, is the main gaps to promote the application of NDT techniques in general and RT technique in particular. These difficulties might not be fixed in the short term, so cooperation and support from developed countries and other members in the region is needed.

In recent years, artificial intelligence (AI) has emerged as one of the effective solutions to assist interpretation, in RT and other NDT techniques (ET, PAUT), in resolving existing obstacles such as: the process of interpretation is laborious and time-consuming; human interpretation is subjective, inconsistent, and often biased; the additional problems are caused by the insufficient quality of utilized signals or images. AI not only helps the interpretation process to be automated, quickly, stably, economically, and reducing manual efforts - detection, but also offers opportunities including increased cross-modality training and inspection, and technology expertise improvement... However, this approach has not been addressed in previous RCA projects.

[1] If you have not been involved in drafting a concept before and if you are not fully acquainted with the RCA and its Programme you are encouraged to support advice and assistance from your RCA National Representative.

As a promising technique in raising the limit of inspection capacity by NDT techniques in the industry of member countries, AI needs to be given proper attention and implemented soon to help Asia and the Pacific region exchange knowledge, expertise, products and services to proactively respond to the rapidly changing inspection technology demands.

Review the resource documentation and list any past RCA projects that have addressed similar problems/needs in this area of technology. Consider outcomes and achievements of previous projects, and avoid any overlap or duplication.

Previous RCA projects on advanced NDT i.e. RAS8100, RAS8105, RAS1013, RAS1020 RAS 1022 had given the emphasis on Digital Industrial Radiology (DIR) and Computed Tomography (CT) to promote the utilization of DIR by the industries, this has resulted in better understanding and comprehensive coverage of the technology. And the on-going RAS 1022 project is intended to build regional capacity to produce DIR trainers in accordance with ISO 9712 (Qualification and certification of NDT personnel), including the preparation of syllabus and training documents. The RAS 1029 project, which has been approved for TC Cycle 2022-2023 will focus on the qualification and certification requirements of Level 2 personnel in NDT for civil structures and composite materials.

As a result of previous RCA projects, a large number of interpreted images in RT (or data with labeled), including RT-D and RT-F, has been created at participated GPs. Due to this availability of data for training and testing of AI models, at the initial phase of AI application, a specific NDT technique should be focused on, namely RT. Knowledge gained from this project, knowledge on AI algorithms and their applications in particular, will be propagated for other NDT techniques such as ET or PAUT.

This RCA 2024/2025 project will focus on enhancing the capacity of NDT experts on applying AI in the interpretation process of RT images at participating GPs.

What are the major additional capabilities/skills in this area of technology that will be provided through this project (~ max 200 words).

AI technique requires a very large dataset of images of defects that have already been correctly interpreted to train and test AI models. With the results of RT promotion and capacity building projects over the past few decades, especially in digital radiography technology in recent years, GPs already have a very rich database of the RT method. Under this new project, intensive training courses on interpretation of RT images will be provided for experts of GPs to re-check, format and label existing data. As the result, a large shared dataset is expected to be consistently created by the contribution of GPs to develop various AI models.

Under this project, training courses on machine learning and deep learning are also delivered for both Programming experts and NDT experts of GPs, focusing on existing AI algorithms which are applicable for interpretation of RT images, such as object detection algorithm (Mask R-CNN, Pyramid Networks/FPN, G-RCNN, RetinaNet, YOLO, YOLOR…) or semantic segmentation algorithm (UNet, DeepLab, Mask R-CNN…) basing on the convolutional neural network (CNN). No new AI algorithms will be developed in this project.

Based on established large shared dataset and knowledge gained from AI training courses, each GP will develop its own AI models for interpretation of selective types of defects from RT images, and share information and experiences within the project framework.

Algorithm-based for interpretation of NDT images and training on using this tool(s) is also expected to be provided for GPs.

Advanced GPs will be expected to assist aspiring countries and their stake-holders through expert missions and technical consultant meetings.

Overall Objective: (Required for the preparation of the IAEA Regional Programme Note)

State the overall long-term objective to which the project will contribute. This should reflect an impact related to the RCA Regional Programme Framework for 2024/29.

After implementation of this project, the countries in the region will not only benefit from the adoption of AI as outlined above but also make more effective use of the existing RT database, as well as the results of the previous RCA projects to improve the capacity of industrial radiography testing in their countries. The achievements of developed countries will also be shared with other IAEA members through coordinating and supporting mechanisms of the IAEA.

This proposed project will contribute to the aligned RCA MTS priority in industry (C.2.3*) and SDG target in industry, innovation and infrastructure (SDG 9**) of the Regional Programme Framework (RPF). It is in line with the RCA strategic directions in building human capacity and strategic priorities in industry through Non-Destructive Testing (NDT). Its implementation will catalyze the efforts of RCA GPs to establish regional advancement in NDT to fulfil the requirements set by global standards and industries for self-reliance and a sustainable NDT system of GPs.

Problem and objective analysis using objective and problem trees is recommended. (See pages 9 and 10 of the Quick Reference Guide on Designing IAEA TC Projects in resource documents)

The resources of each country are limited, requiring the reasonable allocation of resources to different fields for socio-economic development. Therefore, the allocation of society's resources to the NDT field cannot be unlimited. In order to improve the overall capacity of each country in the field of RMB, in addition to increasing capital and labor, it is necessary to apply advances in science and technology to increase labor productivity. This is also one of the duties of the RCA.

The lack of labor tools (in this project is AI software) and advanced NDT techniques lead to limited labor productivity, the interpretation results depend heavily on human factors, the information sharing and multimodal work are also difficult. When implementing NDT in practice, it also increases the transition time between work stages and requires additional resources to be used for quality assurance control. Consequently, the resources of capital and labor) that society devotes to NDT are not optimized, thus limiting the GPs' abilities to apply NDT techniques.

Automated decision making and predictive analytics through artificial intelligence, in combination with rapid progress in technologies such as sensor technology and robotics are likely to change the way individuals, communities, governments and private actors perceive and respond to climate and ecological change. Methods based on various forms of artificial intelligence are already being applied in a number of research fields related to climate change and environmental monitoring. Investments into applications of these technologies in agriculture, forestry and the extraction of marine resources also seem to be increasing rapidly. AI has been developed and applied by research institutions, organizations in the world to interpret industrial radiographs and other NDT techniques.

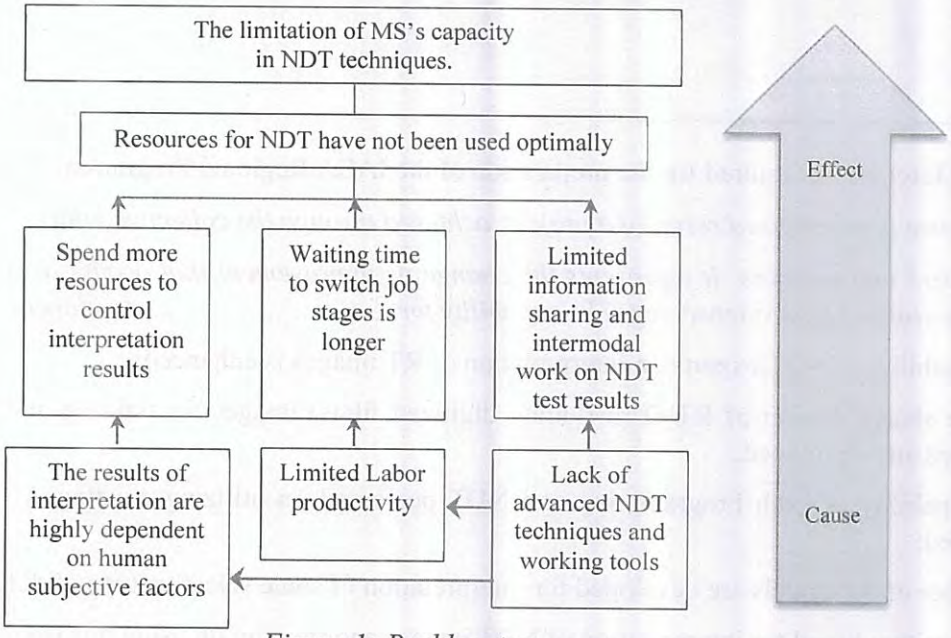


Figure 1: Problem tree

This project focuses on enhancing the capacity of NDT trainers in GPs by training in RT-D techniques, digitizing traditional RT films, and applying AI in the interpretation of inspection images. industrial radiography, introducing scalable applications for PAUT and ET techniques. These are advanced tools and techniques to improve skills and labor productivity for technicians; make the interpretation process automated, fast, stable, economical and reduce detection efforts - manual detection; and also offer opportunities of training and multimodal testing, and technological expertise improvement.

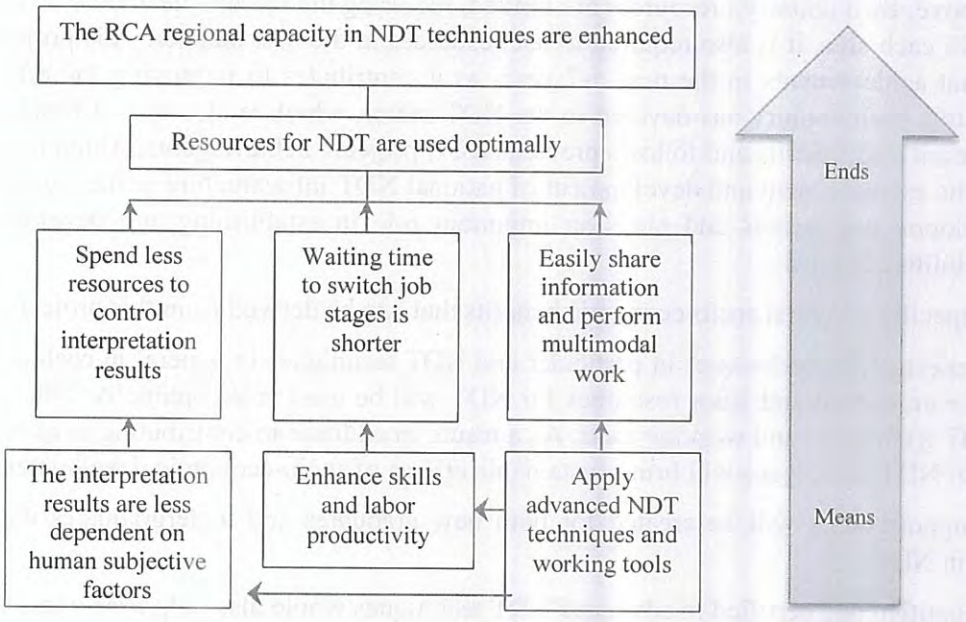


Figure 2: Objective tree

Project Outcome: (Required for the preparation of the IAEA Regional Programme Note)

The outcome is the planned result of a project, achieved through the collective effort of

stakeholders and partners. It represents the change or improvement that occurs as a result of the project. Should be worded in past tense. (eg. The capability for ……developed)

- The capability of NDT experts on interpretation of RT images is enhanced;

- A large shared dataset of RT-D (including digitized films) images for training and testing AI models is established and developed;

- The capability of both Programming and NDT personnel on utilizing existing AI algorithms for RT is established;

- A number of AI models are developed for interpretation of some selective type of defects from RT images;

- An Algorithm based for interpretation of NDT images and training on using this (tools) is provided.

RCA Projects are to be designed to have a Socioeconomic Benefit:

What is the potential socioeconomic benefit that would be realised from the project concept over a 5 to 7 year horizon?

Today, virtually all manufactured products are inspected manually from surface to internal in quality control processes, AI is a challenge and also an opportunity that can drive efficiency and productivity gains as well as the potential for innovation in manufacturing processes.

As mentioned above, each country's resources are limited, requiring the reasonable allocation of resources to different fields. In each area, it is also required to use resources in the best manner. This project is expected to give significant achievements in the next 5-7 years as it contributes to improving the efficiency of the resources using that each country has devoted to the NDT sector, which is also one of future directions of the RCA. This result also inherits and follows previous RCA projects' achievements, which have contributed significantly to the establishment and development of national NDT infrastructure in the region. It continues to support development priorities and plays an important role in establishing and developing the NDT technology capabilities of GPs.

Followings are specific potential socio-economic benefits that can be derived from this project:

- The responsiveness of RT techniques in particular and NDT techniques in general in each country will be enhanced; moreover, capital and labor resources for NDT will be used more optimally with the innovation of advanced NDT techniques and working tools. As a result, in addition to contributing to quality assurance, the application of NDT techniques will bring sustainable effects of socio-economic development;

- Employment opportunities will be created for both new graduates and undergraduates due to the self-reliance of GPs in NDT;

- Having been qualified and certified in advanced NDT techniques would also help to increase the income of NDT personnel. This will be materialized through the creation of a pool of trained NDT personnel produced directly by this project which will act as the focal resources for the GPs. They, in turn, will generate a new pool of NDT personnel through their national program and activities. As a result, the number of practitioners, the availability of technology, the scalability of new private companies, and the employment opportunities will be increased.

List the Government Parties expected to participate in the project. Indicate target and resource GPs:

1. Australia (resource GP)
2. Bangladesh
3. China (resource GP)
4. Fiji
5. India
6. Indonesia
7. Japan (resource GP)
8. Cambodia
9. Lao P.D.R.
10. Malaysia
11. Mongolia
12. Myanmar
13. Nepal
14. New Zealand
15. Pakistan
16. Philippines
17. Korea, Republic of (resource GP)
19. Sri Lanka
20. Thailand
21. Vietnam (Lead Country)

Technical Cooperation among Developing Countries (TCDC) Project Component:

Please refer to the resource documents (RPF and Recommendations on TCDC)

Will the project design feature partnering arrangements between those advanced and those less advanced in the technology to be transferred through this project?

AI will be transferred from developed countries, especially providing a database for deep machine learning of AI. Experts will carry out the training. This project will be implemented effectively if having support and data sharing from developed countries. The full project design will include detailed approaches to achieving this aspect in adaptive technologies, expertise and processes.

If so, list those expected partnerships.

1. BAM Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany (Prof. Uwe EWERT, email: uwe.ewert@bam.de)
2. Westpomeranian University of Technology Szczecin, Poland (Prof. Tomasz Chady, email: tomasz.chady@zut.edu.pl)
3. Baker Hughes - Waygate Technologies (Rhythm software) - https://www.bakerhughesds.com/
4. Sentin (Sentin explorer software) - https://sentin.ai/

The formal partnership modalities will be worked out by mutual consultation among the developed, developing and least developed GPs with respect to required technological capabilities and needs.

Requirements for participation:

Indicate the minimum requirements that the counterpart institutions in Government Parties would need to meet in order to participate in this project.

The participating GPs should have at least established infrastructure in conventional NDT and national programme/priority in related area. They should also establish committed project team (including Programming experts and NDT experts) for the implementation of the activities. Detailed requirements according to the level of participation are as follows:

1) Resource GPs:

- Availability of related equipment i.e. Computed Radiography (CR) System, Digital Detector Array (DDA) system, Film Digitization system, X-ray, gamma projector.
- Availability of training facilities i.e. exposure room, classroom, computer room.
- Competent personnel in accordance to ISO 9712 or equivalent.
- Involvement in the development of codes and standards.
- Internationally recognized publications.
- Competence on AI algorithms and experience on application of these algorithms on several NDT techniques.

2) Intermediate Level Recipient GPs:

- Trained personnel in advanced NDT technologies.
- Certified personnel in conventional NDT methods in accordance with ISO 9712 or equivalent.
- Availability of programming experts with experience in deep learning and Python programming language.

Stakeholder analysis and partnerships:

Briefly describe who are expected to be the end-users and principal beneficiaries of this project. Indicate whether the end-users contributed to development of the Concept.

Stakeholders to the proposed project are from R&D organizations, academic institutions, national institutions responsible for NDT, and main industrial organizations, which have technological background and experience to drive the project in achieving its objectives. They may represent the participating GPs as the National Project Counterpart (NPC). The main responsibility of these stakeholders is to ensure the project to be successfully implemented. Their general roles at their respective countries are as follows:

- R&D organizations: Establish and conduct research activities in NDT for the advancement and development of the technology;
- Academic institutions: Educational materials and syllabus related to NDT in academic training programs at National level i.e. diploma, BSc, MSc and PhD;

- National institutions responsible for NDT: Propagate awareness on NDT requirements and advancement to NDT community;
- Main industrial organizations: Adaptation and utilization of improved NDT technology and practices.

These stakeholders would in turn establish partnerships with related/interested stakeholders in their respective countries. This would pave ways for optimum benefits to all stakeholders through the project involvement and implementation.

The end-users (in all GPs) will contribute their RT image databases for the AI's deep learning process, which helps to improve the quality and efficiency of the project, as well as sharing benefits among members.

Have any extrabudgetary funding possibilities been identified?

RCA GPs endeavour to make a contribution to the extra-budgetary funding support for this proposed project, it is also the obligation under Article V of the Agreement. As mentioned above, R&D organizations, academic institutions, national institutions responsible for NDT, and main industrial organizations are suggested because they can find extra-budgetary funding. They can perform as an obligation when participating in the project, or because of actual needs, selectively conduct investment items that are suitable for the content of the project.

An example in Vietnam, The Center for Non-destructive Evaluation (NDE) is proposing to the government a project to support the deployment of AI applications for NDT in Vietnam. Some industry organizations such as CA NDT, Apave, Phateco have purchased RT film digitizers to send results to their customers, but they have not been able to use the results themselves because they have not been trained in AI.

Have they been involved at this concept stage?

All of these stakeholders are aware of these new requirements by ISO 9712. Most of the NPCs have direct involvement and strong link with these stakeholders and the NPCs are expected to engage the involvement of relevant stakeholders to participate in the project activities i.e. RTC, RW, EX. Strong and strategic linkage with their respective National Certification Body for NDT, NDT society, and NDT training centers can ensure the sustainability of the project and successful implementation of the activities for achieving the project objective. Also, take an example in Vietnam, industrial organizations have been invited to participate in project development. Quoc Huy Company, the distributor of Baker Hughes' Rhythm software - Waygate Technologies also participated and pledged to support the project implementation.

Role of nuclear technology:

Indicate the essential nuclear technique that would be used and outline why it is suitable for addressing the problems/needs in question.

The project using industrial radiography, industrial digital imaging like digital radiography and computed tomography will make use of conventional and high energy X-ray and radioisotope sources like Ir-192, Cs-137 and C0-60 and thus need nuclear technology in many aspects.

Is this the only available technique?

There are several other complementary NDT/NDE techniques based on other forms of non-ionising radiation. Overall, the broader objective of the new project concept does require amalgamation of their benefits with those based on ionising radiation for optimal performance.

Does it have a comparative advantage over non-nuclear techniques?

Despite of having other non-nuclear technique in performing such tasks, radiation-based method is still the most popular technique and proven to be consistent throughout the inspection processes. RT are thus fast becoming the integral part of Quality Assurance (QA) programmes in manufacturing and assembly lines worldwide due to the provision of remote evaluation, digital image processing and analysis, economy of storage and accuracy of dimensional measurement.

Duration of the project:

Indicate the number of years required to complete the project.

3 years

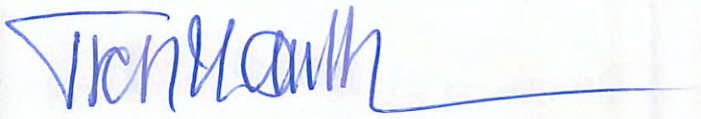
Project duration of **three years** is proposed based on the assumption that the important component of the overall objective would require certain lead time in the beginning of the forthcoming TC cycles.

Part 3: National Representative Endorsement for Project Concept

As the RCA NR of Viet Nam, I have reviewed the Project Concept thoroughly and confirm that it meets the following requirements:

1. The objective of the Project Concept is aligned with priorities set out the RCA Regional Programme Framework (RPF) for 2024/25.
2. The project addresses a regional need.
3. Nuclear technology is an essential component of the project.
4. Outcomes and achievements of previous projects in this area of technology have been taken into consideration
5. There is no overlap or duplication with current or previous RCA projects
6. Further projects in this area can be justified (if relevant)
7. The Project Concept has a strong TCDC component

Signature:



Name: Tran Chi Thanh

Date: 28 December 2021