Global Trade in Applications of Radiation Processing: IAEA role in advising developing countries and fostering adaptation

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• The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.

IAEA Organisation
3 Pillars: Technology; Safety & Security; Safeguards & Verification
6 Departments: MT, NA, NE, NS, SG, TC
Radiation Processing aspects addressed by the IAEA units

- Fostering radiation processing technology development and their applications and facilitating adaptation: NA - NAPC
- Radiation treatment aspects of food and agricultural products: NA - NAFA
- Safety and security of radiation sources: NS - NSRW & NSNS
- Management of spent sources: NE – NEFW
- Technology transfer in the above areas: TC
Outline of Coverage

- Introductory Remarks
- Support to adaptation and development of technology and applications through (i) TC projects, (ii) CRPs and their outputs, and (iii) Technical Publications
- Addressing food irradiation aspects for market access to producers in developing countries
- Support to (i) Safety and transport of radioactive material; (ii) Security of radiation sources
- Sum-up and Acknowledgements
Radiation processing is being successfully applied in both developed and developing countries.

Regional distribution of irradiation units:
- E. Asia & Pacific: 36%
- Europe: 25%
- North America: 24%
- Latin America: 7%
- Africa: 4%
- West Asia: 4%
Context of IAEA-NA activities in support of Radiation Processing Technology

Programme 2.5: Radioisotope Production and Radiation Technology

Project 2.5.2.2: Radiation Technology for Advanced Materials Development

Project 2.5.2.3: Remediation of Pollutants using Radiation Technology

Objectives: To enhance MS capabilities in applying radiation technology for,

- Advanced materials development and processing natural polymers into value-added products; \textit{i.e.} synthesis, \textit{modification}, \textit{analysis}; \textit{natural and man-made polymers}

- Managing agricultural and industrial waste and effluents and decontamination of biological agents
Context of IAEA-NA activities in support of Radiation Processing Technology

Programme 2.1: Food and Agriculture
Subprogramme 2.1.3: Improving Food and Environmental Safety

Objective: To enhance MS capabilities in the use of irradiation for sanitary and phytosanitary purposes and to improve food safety and quality, ........

Project 2.1.3.1: Irradiation and agricultural countermeasures for food safety and trade
IAEA functions to meet its mandate

• **Fostering Relevant Developments and Dissemination of Information**
  - Coordinated Research Projects (CRP)
  - Thematic Topical Meetings (Technical & Consultancy)
  - Publication of Technical Reports and Documents

• **Technology Transfer & Capacity Building**
  - Technical Cooperation Projects – Regional & National

• **Synergies thro’ Partnerships with other international efforts & Networking**

• **Support to International Meetings**
Technical Cooperation Assistance to Projects related to Radiation Processing

**Active Projects: 38 - National: 29; Regional: 9**

*Examples of projects completed or soon to be concluded*

**Bangladesh** (completed in 2007)
- Pilot-Scale Production of Biomaterials for Medical Treatments - gamma facility 350 kCi

**Algeria** (completed in 2007)
- Radiation Synthesis and Sterilization of Medical and Pharmaceutical Aids - gamma pilot facility, present source strength 16 kCi

**Tunis** (started 2004)
- Establishment of an Electron Beam Irradiation Facility for Radiation Processing - gamma facility 100 kCi; EB 5–7.5 MeV

**Moldova** (started 2005)
- Feasibility Study for Establishing the National Radiation Processing Centre

**Saudi Arabia** (started 2005)
- Feasibility Study for Electron Beam Flue Gas Treatment - gamma facility 110 kCi; EB 10 MeV
Typical Example of a National Technical Cooperation Project

**Turkey** (project active, started 2007)

*Establishment of a Laboratory for Application of Radiation Processing Techniques in Nanostructuring of Polymers*

**Scope:** Strengthening the capacity of the existing laboratories for radiation and polymer sciences (LRPS) at Hacettepe University to use radiation processing techniques for nanostructuring of polymeric materials. **Facilities available:** gamma facility 225 kCi

**IAEA role:** support to capacity building

**Expected Results:** new functional polymers synthesized and characterized using radiation processing applied on the nanoscale

*Projects with similar scope:* **Malaysia, Poland, Saudi Arabia**
Region: **Asia and Pacific**, 13 RCA countries, 2005-2008

**Title:** Radiation Technology for Development of Advanced Materials and for Protection of Health and the Environment

**IAEA role:** support to facilitate the regional network building; organization of regional events, training courses, expert missions, scientific visits

**Achievements:** processes, technologies, and advanced materials, e.g. production of hydrogel commercialized (Malaysia, India, Korea, China); composites developed (India, Malaysia); biofoam, biofilm and palm oil acrylates in pilot scale production (Malaysia); natural polymer plant elicitor commercialized (Thailand, Vietnam)
TECHNOLOGY TRANSFER
Example of Regional Technical Cooperation
Projects in Radiation Processing Applications

Region: **Africa, 16 countries** (active, started 2001)
Radiation Processing for Materials and Environmental Applications
IAEA role: support training courses & workshops, expert missions, harmonizing protocols and standards; help with the integration of potential niche markets in the business plan of irradiation facilities

Region: **Europe, 14 countries** (active, started 2005)
QC Methods and Procedures for Radiation Technology
IAEA role: coordination of expert services; technical support to workshops & training courses → uniform QC procedures, calibration procedures and control of accurate dosimetry measurements through inter-comparison exercises
Radiation treatment of flue gases

• **Background:** Fossil fuel $\rightarrow$ energy and ‘emissions’ $\rightarrow$ ‘acid rain’

• **Methods and Issues:** Separate physical and chemical processes for different pollutants (e.g. for S, flue gas desulphurisation, selective catalytic reduction) $\rightarrow$ waste water and solids (gypsum and used catalyst)

• **EB method:** Acidic oxides of S and N treated and converted to useful fertiliser; Single efficient step for removal of both S and N – interest/demonstration by Japan and China
Radiation treatment of flue gases


  Preparation of an IAEA-TECDOC containing
  - new trends in EBFGT process
  - VOCs treatment
  - high power accelerators for EBFGT

- **TC Projects: Poland, Bulgaria, Saudi Arabia**
- **Regional-Europe: Feasibility Study for EB Flue Gas Treatment Technology, 10 countries**

  - **Challenges:** High power EB machines; Rugged for continuous operations in harsh ambience
  - **Cost – Benefit Analysis (UNIDO role)**
Remediation of polluted waters and wastewater by radiation processing (2002-2006)

Objective

- to assess potential applications of radiation processing treatment in MS in the area of water, wastewater and ground water treatment.

Scope

- radiation-induced disinfection and decontamination of wastewater for agricultural and industrial re-use
- treatment of contaminated groundwater for remediation and eventual use of the water resource

Participants: Austria, Brazil, Ecuador, Hungary, Jordan, Poland, Portugal, Rep of Korea, Turkey, USA
Radiation treatment of wastewater from dye chemical industry in ROK

- Installation of *EB industrial facility* in Rep of Korea:
  - Maximum flow rate of 10,000m3/day with 1MeV, 400kW EB accelerator
  - Combined with existing Biological Treatment Facility
- Decrease the amount of chemical reagent up to 50%
- Improve the efficiency of Biological Treatment by 30%
- Decrease the retention time in Biological Treatment Facility

Economic evaluation; TC Project
Examples of projects proposed (2009-11); awaiting approval

- **Bangladesh:** Promoting Radiation Processed Biodegradable Materials for Healthcare and Environmental Protection
- **Egypt:** Producing Curable Polymeric Materials for Controlled Release of Agrochemicals by using EB Accelerators
- **Ghana:** Establishment of the PG School of Nuclear and Allied Sciences
- **Madagascar:** Establishing National QC Standard for Foodstuffs and Fishery Products
- **Malaysia:** Establishing a Laboratory for the Application of Radiation in Nanotechnology
- **Latin America** (ARCAL, 21 countries): Establishing QC for Industrial Irradiation Process
- **Europe** (30 countries): Supporting Radiation Synthesis and the Characterization of Nanomaterials for Healthcare, Environmental Protection and Clean Energy Applications
Coordinated Research Projects (CRP) on Radiation Technologies: Fostering international cooperation


- Development of Novel Adsorbents and Membranes by Radiation-Induced Grafting for Selective Separation Purposes (2007-2011)

- Development of Radiation-processed Products of Natural Polymers for Application in Agriculture, Healthcare, Industry and Environment (2007-2011)

MNA is IAEA Collaborating Centre

- **Scope:** R&D on Natural Polymers
  - Radiation processing of polymer blends and composites
  - Radiation modification of polysaccharide
  - Radiation curing and synthesis of palm oil acrylates

- **Outputs**
  - New products or processes, reports, publications and transfer of knowledge through training courses, expert missions, acceptance of fellows
  - Hosting regional training courses and workshops
New CRP on Radiation Technologies to be launched

- Radiation Processing of Composites
- Radiation Resistant Polymers for Value-Added Products and Packaging Applications (to facilitate the replacement of ETO method)
- Treatment of Biohazardous Contaminants by Radiation Processing
- Radiation Processing for Remediation of Organic Pollutants in Solids and Aqueous Environment
Technical Publications related to the above topics

http://www-naweb.iaea.org/napc/iachem/publications.html

**Radiation Processing: Environmental Applications** (2007)
IAEA – non-serial publications

**Trends in Radiation Sterilization of Health Care Products** (2008)

**Directory of Gamma Processing Facilities in Member States**

**Directory of Electron Beam Processing Facilities in Member States**


**Industrial Electron Beam Processing** (draft document ready) – in cooperation with iiA

**Guidelines for QA/QC in Radiation Processing of Materials**
(in preparation)
Radiation Treatment for Food Safety

APPLICATION OF IRRADIATION TECHNOLOGY WITH EMPHASIS ON POST-HARVEST PHYTOSANITARY TREATMENTS

Inputs from D. Byron and G.J. Luckman
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Radiation Treatment for Food Safety

- Food irradiation: used in over 60 countries; about 500,000 metric tons per year; over 180 gamma plants worldwide
- NAFA: since 1964 Joint Division of IAEA and FAO – collaboration with WHO → food safety
- For sanitary applications of food irradiation: In 2003 the Joint FAO/WHO Codex Alimentarius Commission established:
  - Codex General Standard for Irradiated Foods
  - Codex Recommended International Code of Practice for Radiation Processing of Food
Radiation Treatment for Food Safety

Existing approvals for various products and countries with significant volumes of food irradiated for sanitary purposes

- China (spices, seafood, vegetables)
- France (spices)
- Germany (spices)
- Japan (potato)
- Korea (spices, vegetables, special astronaut meals)
- Indonesia (spices, grains, seafood)
- India (spices, seafood)
- Malaysia (spices)
- Thailand (grains, spices, meats)
- United Kingdom (spices, specially prepared meals)
- USA (herbs and spices, grains, poultry, ground beef, seafood); (from Aug 2008, lettuce and spinach)
- Vietnam (spices, seafoods)
Volumes of Irradiated Produce Treated for Sanitary Purposes
(Source IAEA, 2006)

- **China**: 140,000 tons (spices, garlic, grains, dry vegetables)
- **USA**: 100,000 tons (spices, meats (beef and poultry), vegetables)
- **Japan**: 20,000 tons (potato)
- **Vietnam**: 15,000 tons (spices, seafood, frog legs, seasoning)
- **Indonesia**: 6,000 tons (cocoa powder, frozen foods, spices, dry vegetables, honey powder)
- **Rep of Korea**: 3,500 tons (spices and dry vegetables)
- **Thailand**: 3,000 tons (spices, herbs, pork sausages, seafood, frog legs)
- **India**: 2,000 tons (spices, dry vegetables, cereals and pulses)
Radiation Treatment for Phytosanitary Purposes (1)

- NAFA is collaborating with the International Plant Protection Convention (IPPC) on updates to the 2006 ISPM 18 - Guidelines for the Use of Irradiation as a Phytosanitary Measure, to help meet increasingly rigorous international quarantine standards

- Phytosanitary applications of irradiation target insect pests (e.g. fruit flies), which facilitates trade, increases foreign exchange and enables greater international market access

- Rising international concerns on insecticide use for crops and fruit, which are impacting health, safety and the environment (methyl bromide) → increased interest in irradiation treatment
Radiation Treatment for Phytosanitary Purposes (2)

- since 1970’s: Its utility for fruit known, especially as a quarantine measure.

- 1989: The US Animal and Plant Health Inspection Service published first rule for use of irradiation as a phytosanitary treatment. Many varieties of tropical fruits are now irradiated in Hawaii and then shipped to US mainland markets.

- 2005: Australia established trade in irradiated mangoes to New Zealand, followed by papaya.

- 2007: India started shipping irradiated mangoes to the USA.

- Several other countries including Mexico and Thailand are developing Framework Equivalence Work Plans for export of several irradiated fruit varieties to USA.
Technical Cooperation Projects related to Food Irradiation

Projects running since 2005, soon to be concluded

- **Brazil**: Applying Ionizing Radiation for Food Security and Health Care
- **Bangladesh**: Phytosanitary Treatment for Insect Pests Infesting Fresh Fruits
- **China**: Strengthening the Quality Assurance System for Food Irradiation
- **Guatemala**: Establishing a Food Irradiation Plant
- **Morocco**: Industrial Application of Irradiation
- **Philippines**: Upgrading the Gamma Irradiation Facility
Technical Cooperation Projects related to Food Irradiation

Projects being implemented, running since 2007

- **Argentina**: The Use of Ionizing Radiation for the Phytosanitary Treatment of Fresh Fruit
- **Colombia**: Cost Benefit Assessment for the Modernization of an Irradiator
- **Morocco**: Conserving and Improving the Quality of Aromatic and Medicinal Plants
- **Nigeria**: Feasibility Study on the Optimal use of an Industrial Gamma Irradiation Facility
- **Sri Lanka**: Establishment and Operation of a Multi-Purpose Gamma Irradiation Facility
- **Asia/Pacific**: Novel Applications of Food Irradiation Technology for Improving Social Economic Development
Technical Cooperation Projects related to Food Irradiation

Projects proposed to start in 2009, awaiting approval

- **Israel**: Supporting a Feasibility Study for using Irradiation as a Quarantine Treatment
- **Jamaica**: Supporting the Food Irradiation of Selected Economically Important Crops
- **Uruguay**: Preparing for the Introduction of Irradiation Techniques
- **Asia/Pacific**: Enhancing Sanitary and Phytosanitary Treatment of Regional Products for Export
IAEA Databases related to Radiation Treatment

Resource for researchers, government officials and the general public

- **Food irradiation clearances database:** Information on country, class of food, specific food product, objective of irradiation, date of approval, recommended dose limit
- **Food irradiation facilities database:** Information on country, facility contact details, type of irradiator and energy source

http://www-naweb.iaea.org/nafa/databases-nafa.html
Contributions of Dept of Nuclear Safety

Inputs provided by NS – NSRW & NSNS

K. Mrabit on Transport Safety
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NSRW Functions and Support to the Application of the Standards

- **Functions**: to establish safety standards; to provide for the application of international standards
- **Support to Application of the Standards**
  - Providing Technical Support: e.g. (i) RAIS; (ii) Publications; (iii) Education & Training;
  - Information Exchange and Networking
  - Conferences
  - International Action Plans
Recent activities in support of safe transport of radioactive material

- Continue to implement the action plan of the Intnl Steering Committee (ISC) on Denials of Shipment of Radioactive Material
- Regional workshops held in Uruguay (07/07), Italy (05/08), Tanzania (06/08), Madagascar (06/08), China (06/08)
- 3rd Meeting of ISC in Jan 2008 → Special Session planned in IRPA-12 in Oct 2008
- Agency database on national focal points and list of competent authorities for transport safety. Also, test database on denials of shipments in place
- Instructional video: Overview of shipping and regulatory needs
- Training material on transport regulations available in all six official languages of the UN
NSRW: Providing technical support in Transport Safety - Denials of Shipments of Radioactive Material

Denial of Shipments of Radioactive Material can effect the delivery of

- Critical medical supplies,
- Medical sterilizing equipment,
- Facilities for food irradiation,
- Fuel for power generation.

Approach
All parties to work together to solve the problem of denials of shipments and minimize the number of denials to the greatest extent practicable.

- Focus thro’ GC-2007 Side Event coverage done
- RT Discussion on 1 Oct 2008: GC-2008 Side Event

Security of Radioactive Material during Transport

**Goals**

- Internationally accepted guidelines and recommendations
- Common methodology for categorization of nuclear and radioactive materials based on attractiveness and potential radiological consequences of sabotage or unauthorized removal
- Focusing on sabotage and unauthorized removal of material
NS Office of Nuclear Security (NSNS) Security of Radioactive Material during Transport

**NSNS Actions**
- Guidance for the security in transport of nuclear and other radioactive material
- **Transport security guide to be published in Oct 2008**
- Training on security in transport of radioactive material
- Assessment procedure on security of transport of radioactive material

**Purpose and Scope**
- A uniform and consistent approach
- Guidelines apply to all radioactive material
- Should provide states with guidance in implementing or enhancing a state security system to protect radioactive material
IAEA Guide “Security of Radioactive Material during Transport” has been circulated to Member states for comments

- Specific comments helped improve the draft and minimize operational impacts
- The Security of Radioactive Material during Transport Guide will be published and available in October 2008
NS: Facilitating & Servicing International Undertakings

Code of Conduct on the Safety and Security of Radioactive Sources: 92 States have provided written political support

Guidance on the Import and Export of Radioactive Sources: 46 States have made the additional political commitment for its harmonised implementation

Political support: July 2008

States should have effective national legislation, regulations and regulatory body, and effective import/export controls
IAEA cooperation support for Intnl. Meetings on Radiation Processing held during 2006 - 2008

- IMRP 2006 - 14th International Meeting on Radiation Processing (KL, Malaysia)
- 11th Tihany Symposium on Radiation Chemistry (Hungary, 2006)
- IRaP-2006 - 7th International Symposium on Ionizing Radiation and Polymers (Turkey)
- RadTech Asia 2007 - 11th International Conference on Radiation Curing (Malaysia)
- IRaP-2008 - 8th International Symposium on Ionizing Radiation and Polymers (Brazil)
- IMRP 2008 – 15th International Meeting on Radiation Processing (London, UK)
Thank you for your attention!