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of Radiation Science and Technology

Gamma Irradiator Technology: Challenges & Future Prospects

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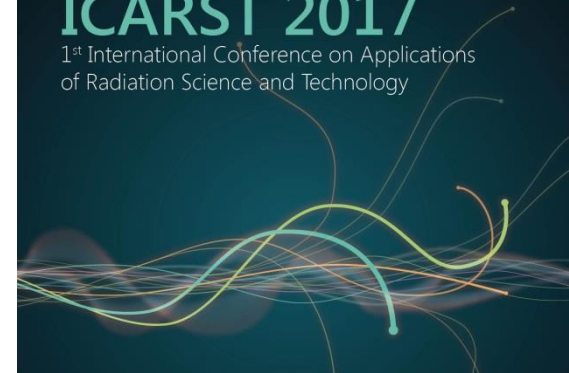
Gamma Irradiators

- Gamma Cells, Gamma Chambers
- Blood Irradiators
- Pilot Scale R & D Irradiators
- Industrial Irradiators
 - Bulk irradiation-
Sterilization of medical products,
Hygienization of spices, food irradiation for
preservation or safety

*Simple, rugged, convenient, easy
to maintain, reliable*

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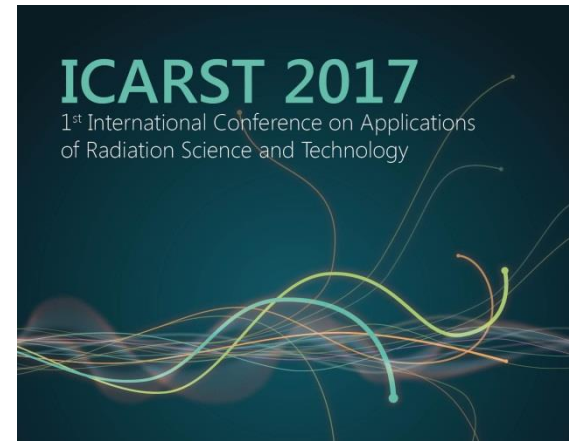
World's First Gamma Irradiator

Stuttgart, Germany : 1958

Irradiation of Spices

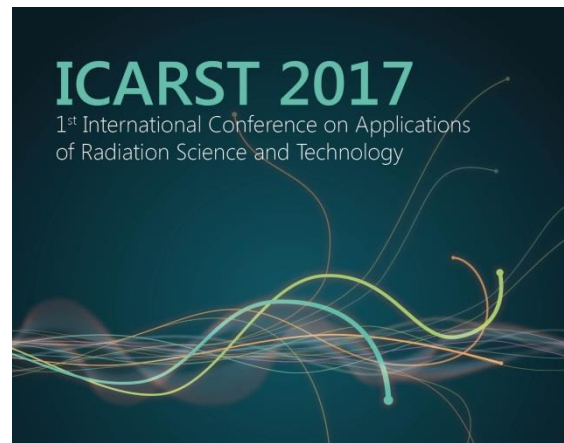
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Gamma Irradiators in the World

- No. steadily growing in last 6 decades
- Currently > 340 industrial irradiators
- Highest addition in the beginning of 21st Century
- China leading country
- Decommissioning rate now picking up

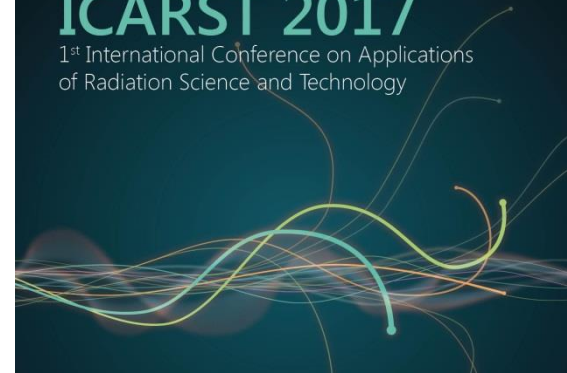


Safety & Economy →

+ Security & Convenience

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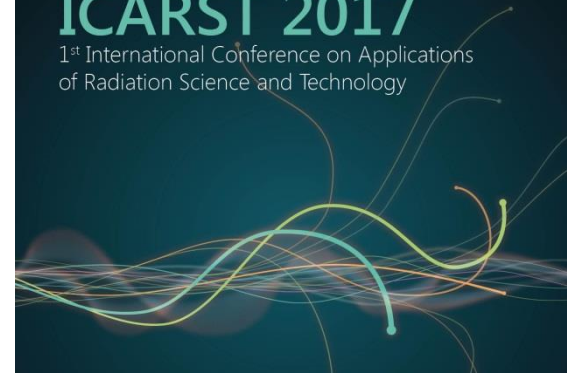
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Challenges

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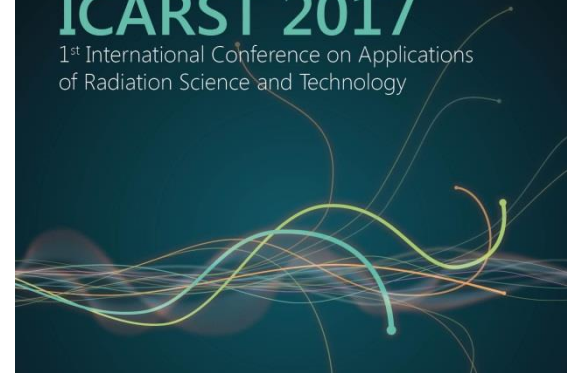
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Safety Related Issues

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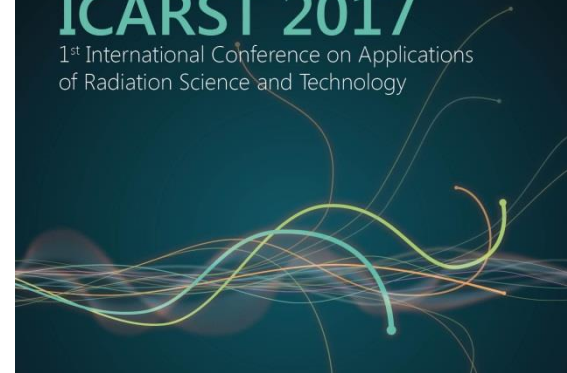
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Contamination due to Leakage of Radioactive Sources

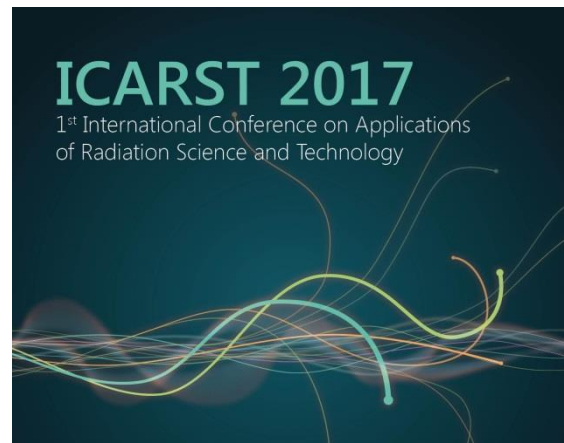
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Contamination

- 1982: Dover
 - Damaged Co-60 Source
 - Contamination of pool water
 - Water released to the facility floor and surrounding soil
 - No ground water contamination or public exposures



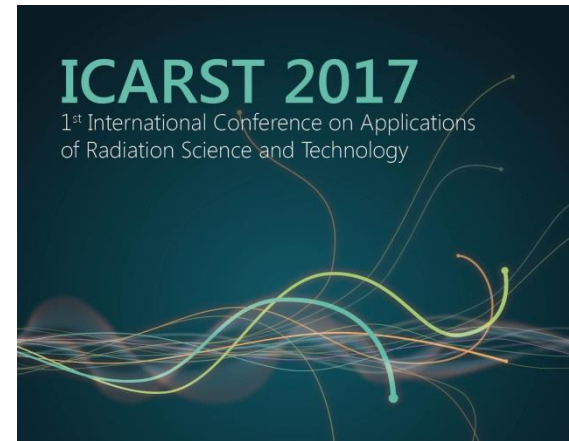
^{137}Cs Irradiators

All sources from DOE of same design

- Westerville, Ohio 1985- Cat IV
- Northglenn, Colorado 1985- Cat I
- Decatur, Georgia 1986- Cat IV
- Lynchburg, Virginia 1986-Cat III

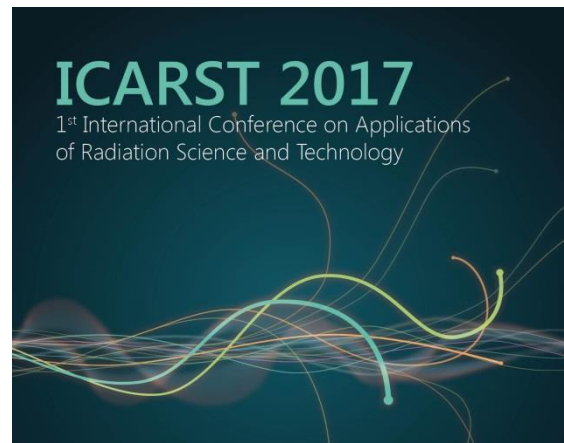
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Decatur:1988

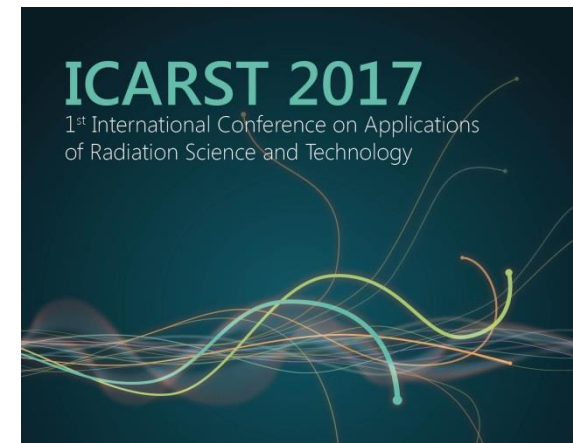
- Cs in CsCl form
- Highly soluble & corrosive
- Insertion in and out of pool causing thermal shock
- Contamination was discovered in employee's vehicles, their residences and several of products which were shipped from the irradiator.
- Surrounding the building of the irradiator, soil contamination was also found.
- 8 ci of Cs-137 had leaked
(out of 50,000 ci present in the pencil)



Implications

- USNRC suspended all operations at wet storage irradiators using Cs-137 source
- Denied source certificate to GrayStar which planned to use 3.3 Mci of Cs-137 in “caked powder” form for a dry storage food irradiator

In Vitrified form very low Sp. Activity
Unsuitable for Industrial Irradiators

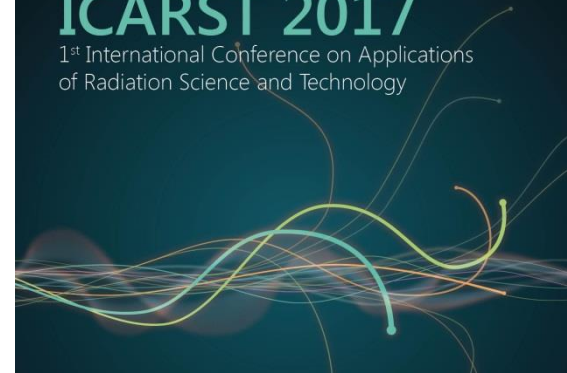


Standard Adopted

Doubly Weld Encapsulated Austenitic
Stainless Steel Ni Coated Co-60 Sealed
Sources

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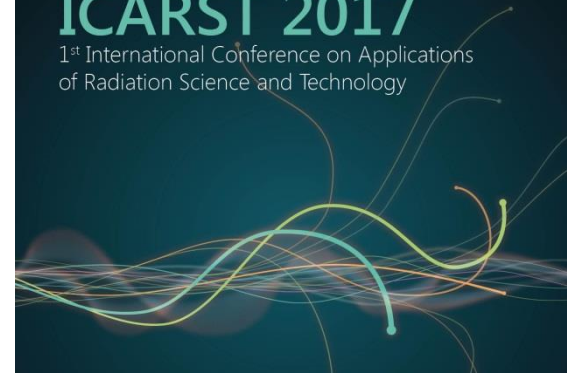
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Operation & Maintenance Related Issues

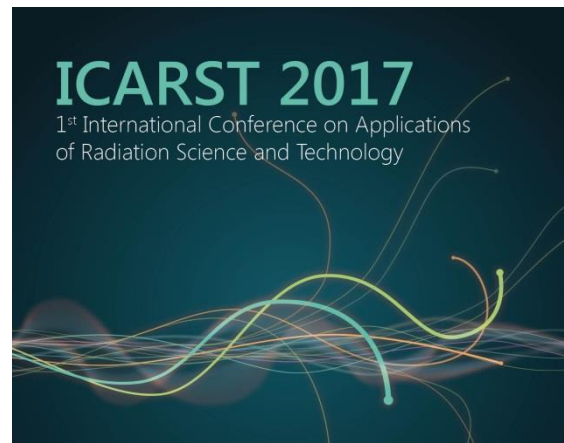
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Operation & Maintenance Related Issues

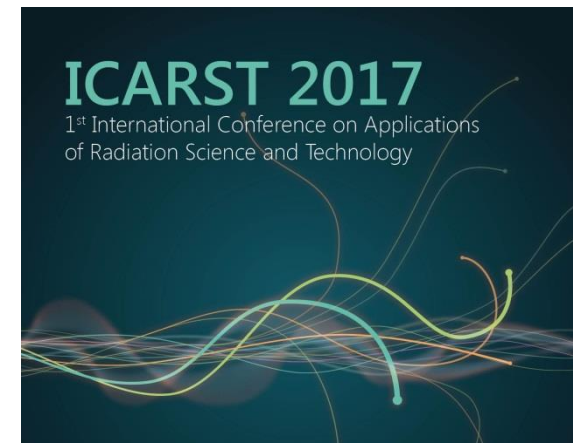
- Material Handling Related
 - Fatalities, morbidities
- Overexposures due to entry of personnel with Source Exposed in the irradiation area
 - Inadequacy or bypassing of Safety Interlocks
 - Ignoring or misinterpretation of alarms
 - No. of fatalities, morbidities



Safety Features Added during its Journey

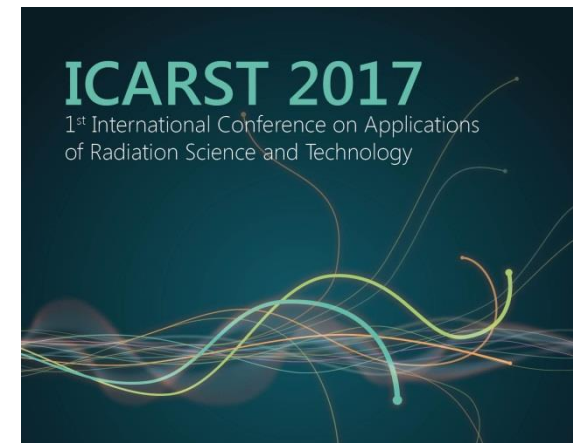
- Source Shroud
- Multiple Electrical Safety Interlocks
- Mechanical Safety interlock on the Cell Door
- Pressure Plate
- Wire cable Pull
- Positive Indication of Source in Water Pool
- Shielded View Window on Cell Door
- Nickel Coated non-leachable Capsules in Doubly Encapsulated in SS Welded Pencils

***Current Designs Fail Safe &
Fool Proof***



Co-60 Shortages & Economics

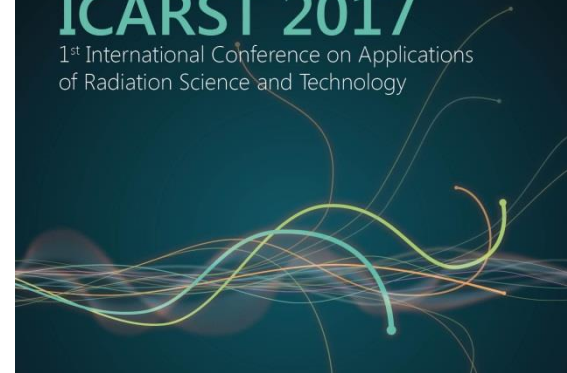
- Rapid growth of gamma irradiators in the early 21st century
- China >44, India 9 in 1st decade
- No addition of ⁶⁰Co production facilities
- Price of ⁶⁰Co started going up rapidly
- EB/X-ray based system technology had matured with reduction in their investment cost
- Places where large volumes were available, EB/X-ray based technology became attractive



Radioactive Source Security

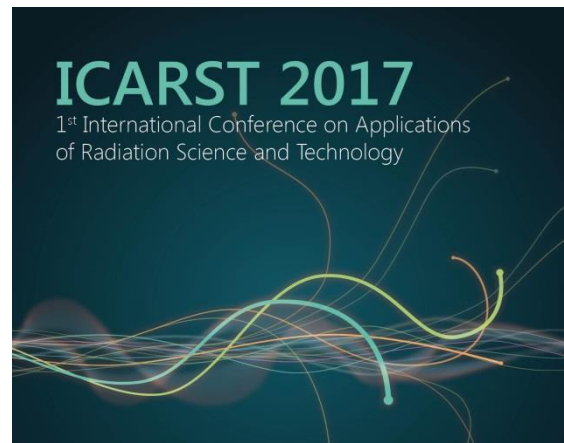
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Security during Operation & Maintenance

- Inherent Security
 - Lethal to go near the source
 - Thick concrete labyrinth cell
- Large inventory, highly penetrating long half-life
- Threat of getting stolen for making RDDs
- Dismemberment due to explosion (carton itself carrying explosive material)
- Physical Protection Measures
- Emergency Preparedness against fire, flooding, earthquake, rioting
 - Procedures for management before issue of license for operation
 - Co-ordination with police, disaster management authorities

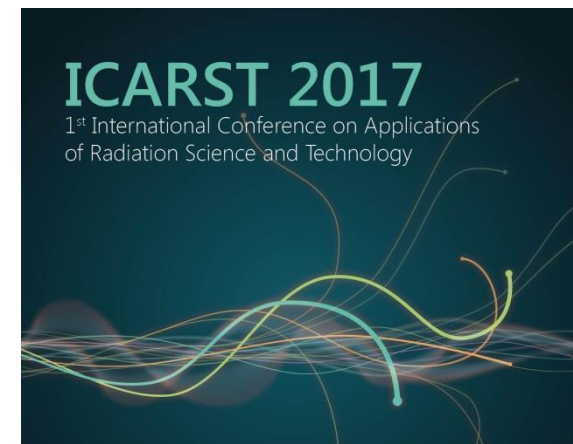


Security during Transportation

- Restriction in maximum quantity which can be transported by air to 30kci
- Long distances involved.

Multi country, multi modal transportation-
Transshipments

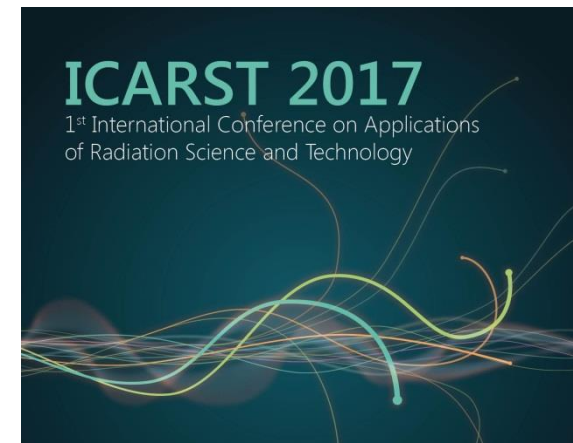
- Transport through disturbed or sensitive areas
- Uncertainty in feasibility and costs involved in transportation of decayed sources
- Denial of shipments



Decommissioning

- Long time between purchase of new and return of decayed sources
- Willingness of supplier to accept back the decayed sources
- Requirement of large no, of shipping flasks
- Long distances involved, multi-country involving transshipment and multi-modal=

Denial of Shipments

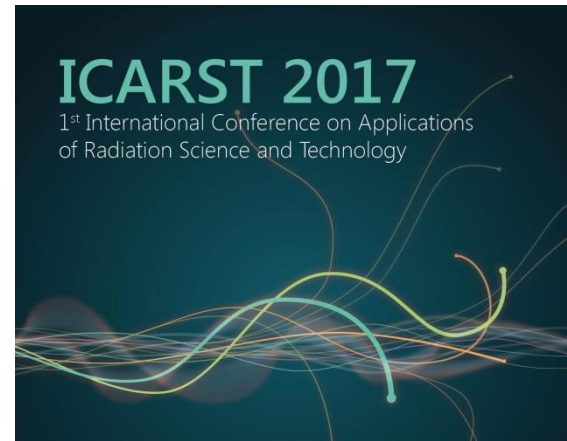


Concurrent Parameters

- Economics
 - Capital & Running Expenditures
 - Indigenous Manufacturers (Equipment & Co-60) & Management of Disused Sources
- Irradiation Volumes Expected
 - Medical
 - Food with similar dosage and handling requirements
- Security Implications
 - Environment Prevailing
 - Stringency of Regulations
- Public Acceptance

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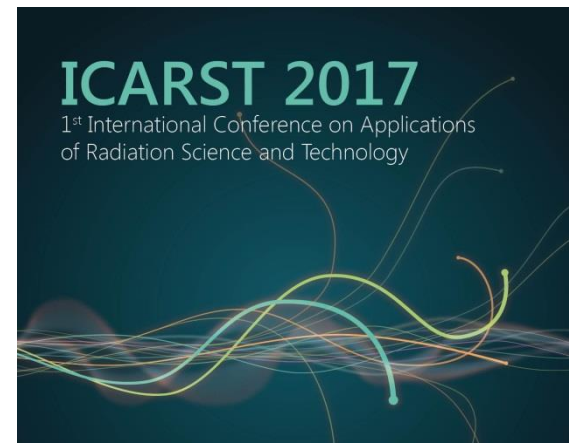


Future

- Gamma irradiators-rugged, safe, economical?
- Accelerators becoming cost competitive
- Choice for Quality Products going up, Volumes going up
- Security Issues gaining importance needing higher expenditure & attention
- Public acceptance for radioactive materials?
- Decommissioning- Return of sources, large no. of sources, shipping flasks, transportation

Country & Location Specific

Unless economics is overwhelmingly in favour of Gamma Irradiators, Accelerator based systems are bound to prevail



Thank you for your attention

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