

The Role of Inspection & Maintenance Programmes for NDT Gamma Radiography Exposure Systems in Reducing the Occurrence of Source Retrievals & Source Retrieval Training

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Gamma Radiography Exposure System

- Components of Gamma Radiography Exposure System
 - *Exposure Device*
 - *Remote Control Unit*
 - *Source Guide Tube*
 - *Collimators*

Sentinel 880 Delta Exposure Device

Manufacturer – QSA Global, USA

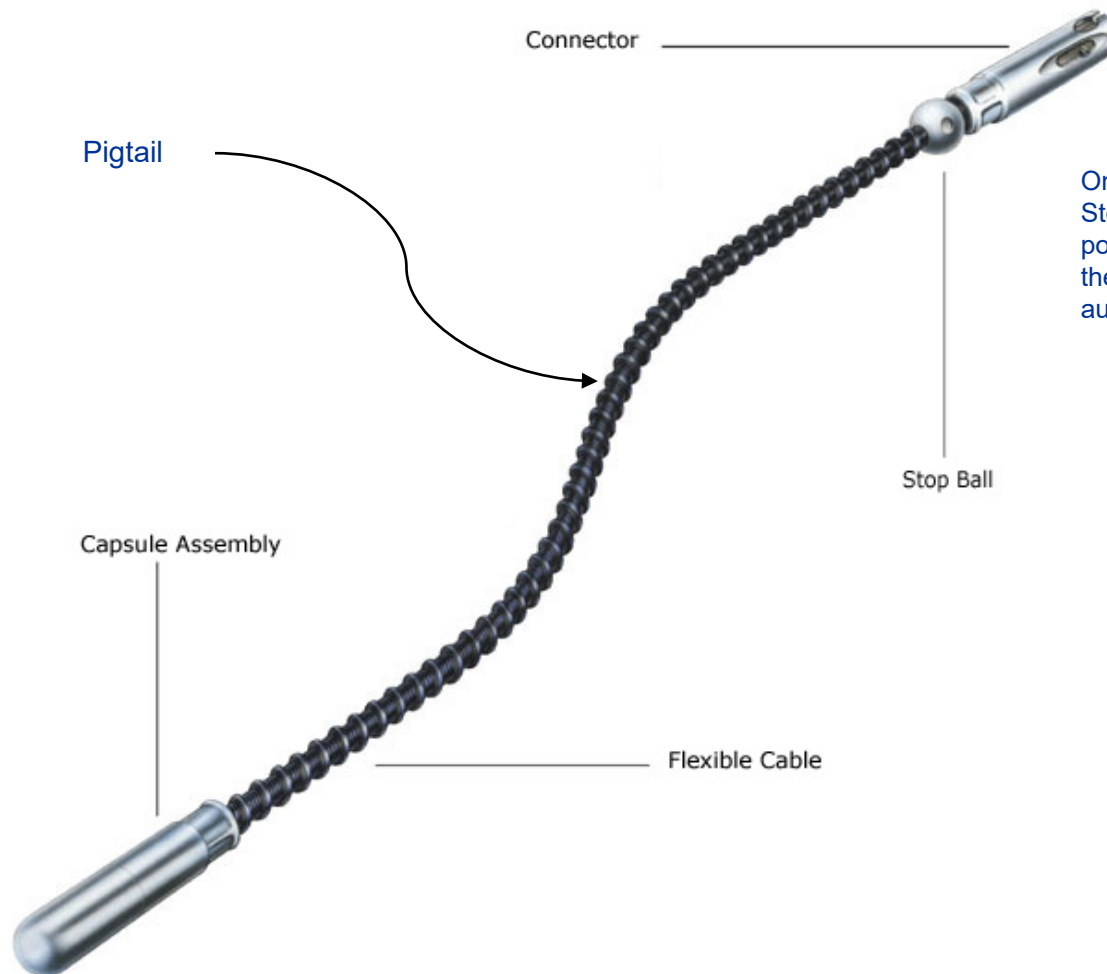
- **Components:**
 - *Stainless Steel Shell*
 - *Internal DU Shield*
 - *Internal Titanium 'S' Tube*
 - *Outer Yellow Plastic Jacket*
- **Serves Two Functions**
 - *Projects & Retracts Source Assemblies*
 - *Type A Approved & Type B (U) Certified Transport Container*



LHS – Remove Stainless Steel - see DU Shield
RHS – Section through DU Shield - see Titanium 'S' Tube



Special Form Source Assembly



On QSA Source Assemblies, the Stop Ball is the unit that correctly positions the source capsule within the shield and activates the automatic locking system

Remote Control Unit

Crank Handle



Drive Cable Connector End
With **Protective Cap**



Drive Cable Connector End

Source Guide Tube with Protective Cap



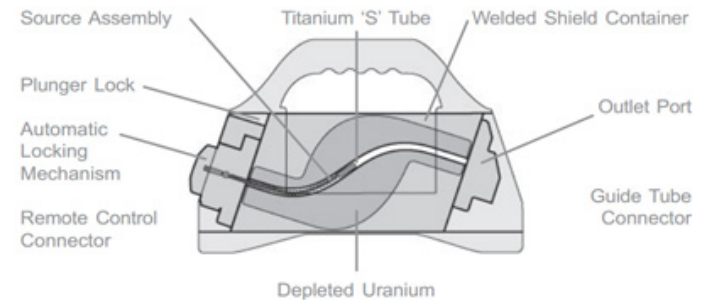
Collimators which attach to Source Stop



Complete Gamma Radiography Exposure System

Source Drive Cable

Source Guide Tube



Source Guide Tube Removed
 Dummy Source Assembly



Factors Giving Rise to Source Retrievals (USNRC Survey over 5 year Period in 1990s)

- 50% of Reported Events  Source Disconnects
- 20% of Reported Events  Source Hang-Ups
(Dents/Kinks in Source Guide Tubes)
- 12% of Reported Events  Lock/Autolock Failures

Summary: *70% of Reported Events give rise to Source Retrievals with Source Assembly out of the Exposure Device*

12% of Reported Events give rise to Source Retrievals with Source Assembly most likely still inside the Exposure Device

Source Disconnects

- Drive Cable disconnects from the Connector end of source Assembly
 - *Worn or Damaged End Connectors on one or both Units leading to mechanical failure or misconnect*
 - *Swaged Connector End breaks off from the Pigtail ie the Source Assembly [Poor Inspection & Maintenance]*

End Result is a Loss of Control of the Source Assembly and the unattached Source Assembly is now free somewhere within the Exposure Device or the Guide Tube

Source Hang Ups

- Damage to Source Guide Tube
 - *Bends, Kinks, Dents caused by transportation, objects falling, Poor Set-Up, [Poor Inspection & Maintenance]*

Most serious case is when the Source Assembly projects out but will not retract back into the Exposure Device.

End Result is that the attached Source Assembly is hung up somewhere in the Unshielded Guide Tube and the dose rates can therefore be significantly high.

If you touch a Guide Tube for 2 secs with a typical 1TBq Ir-192 source in it, then Dose to Hand is c. 1.6 Sv.

Manufacturer's Recommendations

Daily Inspection

- Daily Inspection of the complete Gamma Radiography System is essential to ensure the equipment is in a safe and proper operating condition ie Exposure Device, Remote Controls – Crank, Drive Cable, Drive Cable Conduit, Source Guide Tubes – Ends, Source Stop, Source Guide Tube Conduit
- Most Important is a final check on the Drive Cable Connector and Source Assembly Connector using the No-Go Gauge. Any failures using the No-Go Gauge indicates significant wear that could allow safety features of the design of the 880 to be defeated

Daily Inspection Contd.

- Daily means prior to the first radiographic exposure of the shift regardless of any previous inspections that may have been performed that day
- Results should be recorded and include the date, the name of the inspector and the equipment inspected
- If defective or damaged components are found, they should be tagged and immediately removed from service and sent for repair

Manufacturer's Recommendations Quarterly Maintenance Requirements

- Routine Quarterly Maintenance must be carried out to ensure Consistent and Safe Operation of the Radiographic System and to ensure the integrity of the Type A Approval and Type B (U) Certification
- Routine Quarterly Maintenance requires partial disassembly, cleaning, inspection, re-lubrication and operational checks of the System ie Exposure Device, Remote Controls, Source Guide Tubes

Manufacturer's Recommendations Quarterly Maintenance Requirements

- Most Important Test – Misconnect Test
- This Test Identifies long-term wear or damage on the Safety Connector Assembly, the Drive Cable Connector, the Automatic Securing Mechanism and the Source Assembly Connectors simultaneously
- During this particular Misconnect Test, there is a risk of losing control of the Source Assembly
- Must be trained to conduct it.

Manufacturer's Recommendations Annual Maintenance Requirements

- Complete disassembly, cleaning, inspection, re-lubrication and operational checks of the System ie Exposure Device, Remote Controls, Source Guide Tubes
- Source Assembly must be transferred to Source Changer before disassembling the Exposure Device
- Leak Testing for both the Sealed Source and DU
- Must be performed by personnel specifically trained. Can be staff of the NDT Companies

Interesting Facts

- If a source does not project out of or retract into a Sentinel 880 Exposure Device or the Autolocking System or the Manual Locking Mechanism fails then under USNRC Regulations you are dealing with a Source Retrieval Situation
- Source Retrieval comes under the area of “Planned Special Exposures” in the USA or in our parlance “Specially Authorised Exposures”
- Must be approved in advance by Regulatory Body and can only be performed by Category A Radiation Workers

Source Retrieval Course in USA

- US Regulations for NDT
- Radiation Exposure/Dose Calculations – Review
- Accidents/Incidents – Source Recovery
 - *Causes and Prevention*
 - *US NRC Documentation and Reporting Requirements*
 - *Being Prepared*
 - *Retrieval Equipment*
 - *Public Relations*
 - *Dosimetry Considerations*
- *Retrieval Sequence*
- *Assessment*
- *Planning*
- *Exposure Determination*
- *Locating the Source*
- *Shielding*
- *Retrieval-Operational Guidelines*
- **Workshop - Exercise**
Recovery Operation with a Live Source
13 Ci Ir-192
- *Practical skills Review and Written Awareness Quiz*

Next Steps

- As the Regulatory Body, EPA will engage with the NDT Sector to:
- Emphasise the significance and importance of a detailed Inspection & Maintenance Programme of daily checks, quarterly checks and annual maintenance of Complete Exposure System
- Emphasise the importance of the Misconnect Test and simple things like keeping the Rubber Caps on ends of source Guide Tubes and Wind-Out Drive Cables when not in use

Next Steps

- Hopefully, in time this will lead to a change in Safety Culture within the NDT Sector and will also be of benefit to NDT Licensees in the training of Radiographers in work practices which will ultimately lead to the prevention of having to do Source Retrievals
- Determine how “Source Retrieval” will be handled under our “New” Regulations