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360 SERIES.

RADIOGRAPHY SOURCE CHANGER

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DANGER – IMPORTANT WARNINGS

This transport container must only be used for radiography source assemblies that are approved for use with this container. Please refer to Table 3 for a listing of source assemblies that are authorized for use. The container must be operated only by trained and qualified radiographers who have read and understand this Operating Manual or by trained assistants working under their direct supervision.

WARNING

The use of this radiographic source changer by unqualified personnel or when safety procedures are not fully met, could result in life-threatening dangers.

Do not use this container for unauthorized, damaged or cropped source assemblies.

The radioactive source assemblies utilized in this container emit high levels of highly penetrating radiation during use. An unshielded radiation source at close range can cause **injury, sickness or death** to anyone who is exposed to it even for a short period of time.

A radiation source **must not** be touched by the hands under any circumstances.



DANGER – IMPORTANT WARNINGS

Since gamma radiation cannot be detected by the human senses, strict operating and emergency procedures must be followed. The proper use of calibrated and operable survey meters must be employed to avoid potentially dangerous levels of radiation exposure.

Proper dosimetry including film badges or thermoluminescent dosimeters, optically stimulated luminescence badges (OSL); direct reading pocket dosimeters and audible alarm ratemeters must be worn during all radiographic operations.

It is imperative that the users of this container perform adequate radiation surveys of the exposure device. Surveys must be performed using a calibrated survey instrument before, during and after source exchanges, source exposures, and before transport to determine if the source assembly is properly shielded within the container. The failure to perform an adequate radiation survey can cause unnecessary exposure to personnel resulting in a reportable incident.

It is very important, and required by national regulations, to prevent access by unauthorized persons to radiographic equipment and to the area where radiography is performed.

Take advantage of the three basic radiation protection methods to minimize radiation exposure:



DANGER – IMPORTANT WARNINGS

Time: Spend less time near the radiation source.

Distance: Increase your distance in a direction away from the radiation source.

Shielding: Use effective shielding between you and the radiation source.

Do not perform any unauthorized modifications to the radiographic source changer or components of the radiography system.

It is important that trained and qualified radiographers perform or supervise a daily safety inspection of the radiography system for obvious defects prior to operation of the system.

Do not use any components that are not approved for use with the radiography system, or after-market components that may compromise the safety designed into the system.

It is important that trained and qualified radiographers perform or supervise a daily safety inspection of the radiography system for obvious defects prior to operation of the system.

Do not use any components that are not approved for use with the radiography system, or after-market components that may compromise the safety designed into the system.

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1. TECHNICAL SPECIFICATIONS.

1.1 Radiography Source Changer General Requirements

The Model 360 Series are used as source changers and also a Type B(U) (or Type A) transport package for authorized special form radiography source assemblies. A list of authorized source assemblies is shown in Table 3.

In order to use this equipment to perform a source transfer within the United States, the user must be specifically licensed to do so. Application for a license should be filed with the appropriate Regional Office of the U.S. Nuclear Regulatory Commission or appropriate Agreement State Office.

Prior to the initial use of this source changer in the United States, the user must:

- a. As applicable, amend the Materials License to use the Model 360 Series source changers. An NRC QA program is no longer required under 10 CFR 71.101(g) so long as you have a program for transport container inspection and maintenance that complies with 10 CFR 34.31(b) or equivalent Agreement State requirements.

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b. For Type B transport,

- 1 Register as a user of the Type B package with the Transportation Branch of the U.S. Nuclear Regulatory Commission.

Attn: Director
Document Control Desk
Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20590

- 2 Maintain on file a copy of the Certificate of Compliance Number USA/9371/B(U)-96 issued by the Nuclear Regulatory Commission, including copies of all applicable drawings referenced on this certificate and the operating instructions for the package.

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- 3 Prior to the first shipment of this source changer from the United States, the user must also register with:

Office of Hazardous Materials Technology
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
400 Seventh Street SW
Washington, D.C. 20590

- 4 The user must have in his possession a copy of IAEA Certificate of Competent Authority Number USA/9371/B(U)-96 issued for this source changer. Users of this equipment outside of the United States must comply with the regulatory, licensing and transportation rules and regulations of their respective countries.
- c. For Type A transport, maintain on file, for the time period specified, documentation that meets the requirements of 49 CFR 173.415(a).

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- d. When transporting a special form source, maintain on file a copy of the U.S. Department of Transportation Certificate of Competent Authority for the special form source transported in the source changer.
- e. Prepare this package for transport per the applicable Type A or Type B approval requirements including as shown in the applicable drawings referenced under the USNRC Type B certificate (or as specified under the Type A approval requirements) and as described in these Operating Instructions.

1.2 Radiography Source Changer General Description

The source transfer system consists of the Model 360 Series source changer with new source assemblies, special source jumpers (applicable only for Models 360-10 and 360-10W), transfer guide tubes, a control assembly, and the old (decayed) source assemblies contained within the radiographic exposure device. Field source transfers can be performed with the Model 360 without exposing the operator to unsafe radiation levels when proper procedures are followed and radiation surveys are used.

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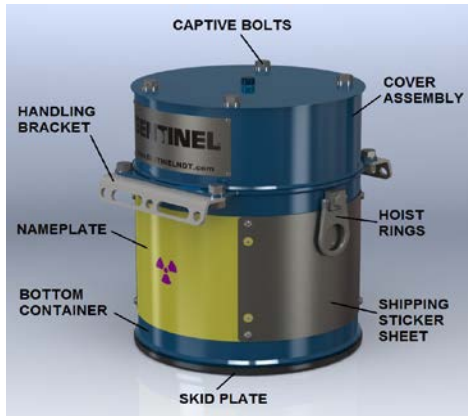


Figure 1 – External Components

The source changer is designed, manufactured and serviced under an ISO 9001 QA Program and a USNRC 10 CFR 71, Subpart H QA Program. The QA program also includes the reporting requirements of USNRC 10 CFR 21 for suppliers of source and byproduct materials. The source changer is compliant to all industry standards referenced in this manual and meets the requirements of 105 CMR 120.300 and 10 CFR 34 for source changers and storage containers.

The Model 360 Series transport package can ship any of the compatible source assemblies shown in Table 3. The transport package is approved as a Type B(U) transport package.

Each source assembly is secured by their own independent source securing mechanism and all sources are shielded by the centrally located shield assembly within the container. Every source securing mechanism is numbered for easy identification of the source.

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The Model 360 source changer is available in five different configurations, each providing multiple source transport capability in a standard outer package. Table 2 identifies each of the five Model 360 configurations. Two of the five configurations do not use depleted uranium (DU) in the package and allows for more flexibility when shipping to certain areas of the world. The three DU shielded changers are rated significantly higher than the non-DU counterparts.

All five Model 360 configurations use a common protective structure made of painted stainless steel. The structure consists of a welded cover assembly and bottom drum style container with plastic “skid” plate.

Four long captive bolts secure the cover to the bottom container. Lock wire and tamper indicating seals can be laced through the hole in the head of the captive bolts when preparing for transport.

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Figure 2 – Lifting Configuration

1.3 Lifting & Tie-down Provisions

Manually lifting the Model 360 package is not recommended. A powered lifting device with flexible lifting slings rated to lift the weights shown in Table 2 is recommended for lifting the package.

The lifting slings should be attached to either the two (not one) hoist rings or the two (not one) handling brackets located on the side of the container. **Before lifting, always inspect the hoist rings and handling brackets to ensure they are undamaged and securely attached to the container.**

Model 360 lifting provisions can also be used as tie-down provisions. The tie-down arrangement must be symmetrical and balanced. Blocking and bracing is recommended to supplement the tie-down provisions. The Model 360 center of gravity is located approximately at its axial center and just over 8 inches up from its base.

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1.4 Radiography Source Changer Specifications

Table 1 – General Radiography Source Changer Specifications	
Manufacturer	QSA Global, Inc., Burlington, Massachusetts, USA.
Container Model	360-2, 360-4, 360-4W, 360-10 & 360-10W
Primary Application	Industrial gamma radiography
Container Application	Radiography Source Changer and Transport Package
Container Overall Dimensions	15.9 inches (404 mm) tall and 13½ inches (343 mm) in diameter
Operating Temperature	-40°F to 300°F (-40°C to 149°C)
USA Device Approval	MA-1059-D-376-S
Transport Approvals	USA/9371/B(U)-96 Type B (USNRC, USDOT and ADR) CDN/E243/-96 Type B (Canada) Type A Package Certified to 49 CFR173, IAEA TS-R-1 (2009) and IAEA SSR-6 (2012)

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Table 1 Continued – General Radiography Source Changer Specifications	
Compatible Sources	Refer to Table 2.
Inspection Requirements	Daily pre-operational inspection for obvious damage to the system.
Shipment Data	An envelope accompanies each shipment and contains: <ul style="list-style-type: none">• Source decay chart and leak test certification. Keep for user's records.• Source identification plate for attachment to user's exposure device.• Return shipping labels.• Tamper indicator seals.• Operating Instructions.

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Table 2 - Model 360 Configuration Specifications						
Model 360 Configuration	Nuclide	Form	Maximum Capacity per Package	Maximum Capacity per Channel (Hole)	Maximum Package Weight	Maximum DU Weight
360-2	Ir-192	Special Form Sources	300	150	110 lbs (50 kg)	40 lbs (18 kg) 6.4 mCi (237 MBq)
	Se-75		400	200		
	Yb-169		60	30		
360-4	Ir-192	Special Form Sources	600	150	130 lbs (59 kg)	55 lbs (25 kg) 8.8 mCi (326 MBq)
	Se-75		800	200		
	Yb-169		120	30		
360-4W	Ir-192	Special Form Sources	260	65	155 lbs (70 kg)	NA
	Se-75		324	81		
	Yb-169		120	30		

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Table 2 Continued - Model 360 Configuration Specifications						
Model 360 Configuration	Nuclide	Form	Maximum Capacity per Package	Maximum Capacity per Channel (Hole)	Maximum Package Weight	Maximum DU Weight
360-10	Ir-192	Special Form Sources	1500	150	170 lbs (77 kg)	80 lbs (36 kg) 12.8 mCi (474 MBq)
	Se-75		2000	200		
	Yb-169		300	30		
360-10W	Ir-192	Special Form Sources	170	17	180 lbs (82 kg)	NA
	Se-75		810	81		
	Yb-169		300	30		

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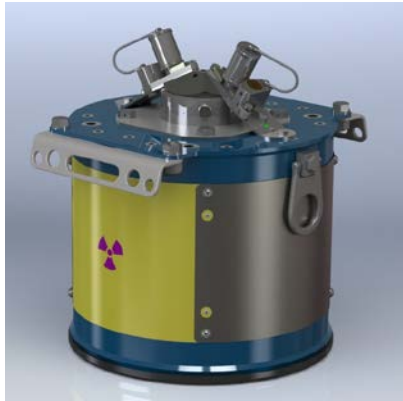


FIGURE 3 - MODEL 360-2

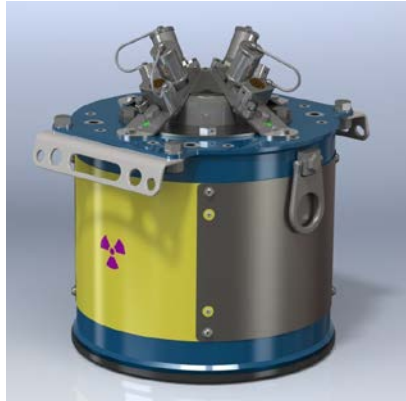


FIGURE 4 - MODEL 360-4 & 4W

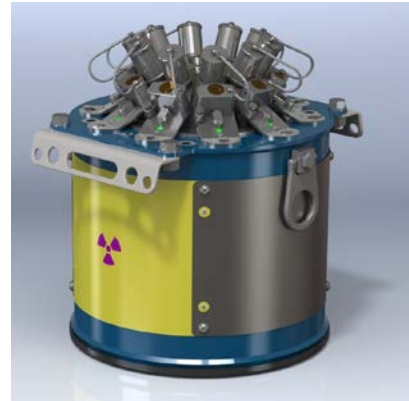


FIGURE 5 - MODEL 360-10 & 10W

Figures 3 through 5 show the three basic configurations with the top cover removed.

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Safety Considerations

- All operations must be monitored with an operable, currently calibrated survey meter capable of reading 2 mR/hr (20 μ Sv/hr) to 1,000 mR/hr (10 mSv/hr).
- Personnel monitoring devices must be worn during all source changing operations. This should include a direct reading pocket dosimeter, alarming ratemeter if applicable, and either a film badge or thermoluminescent dosimeter. These must be worn by any individual that enters a restricted area or is involved in a source changing operation.
- Pocket dosimeters should be initially charged (zeroed) at the start of the day and checked periodically during the operation for accumulated exposure. In the event that an individual's pocket dosimeter goes off scale, or if the alarm ratemeter alarms unexpectedly, stop work immediately, restrict and secure the area against unauthorized personnel and alert the Radiation Safety Officer. The individual's film badge or thermoluminescent dosimeter must be sent in for immediate processing. The individual must refrain from all work with radioactive material until the individual's exposure is determined to be below regulatory limits.



WARNING



All of the radiological precautions used during radiographic exposures must be followed during a source changing operation.

1.5 Source Assembly Specifications

a. General Details

The standard source assembly consists of ^{192}Ir Iridium, ^{75}Se Selenium, ^{169}Yb Ytterbium or ^{137}Cs Cesium encapsulated within a welded capsule crimped onto a wire with connector or contained within a chain assembly. Each source contained in the Model 360 is independently locked and secured by its own source securing mechanism.

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Unless specifically authorized by a regulatory agency, sealed sources for radiography, where the source is projected outside the exposure device, are designed and tested to achieve a minimum ISO/ANSI classification equivalent to 97C43515 and most source capsules comply with the IAEA and USDOT requirements for 'Special Form' radioactive material. The ISO/ANSI classification and the special form status for QSA Global sources are referred to as the source capsule which is part of the completed source assembly.

Table 3 - Model 360 Authorized Source Assembly Information

Source Assembly Manufacturer	Source Assembly Model	Nuclide	Special Form Certificate	Maximum Source Activity	Authorized for Use		
					Can.	USA	R.O.W.
QSA Global, Inc.	969	Ir-192	USA/0335/S-96	150 Ci (5.55 TBq)	X	X	X
QSA Global, Inc.	87703	Ir-192	USA/0335/S-96	120 Ci (4.4 TBq)	X	X	X
QSA Global, Inc.	89911, 89912	Ir-192	USA/0335/S-96	225 Ci (8.33 TBq)		X	X
QSA Global, Inc.	89913, 89916	Ir-192	USA/0335/S-96	240 Ci (8.88 TBq)		X	X
QSA Global, Inc.	91807	Yb-169	USA/0790/S-96	108 Ci (4 TBq)			X
QSA Global, Inc.	91810	Yb-169	NA	108 Ci (4 TBq)			X

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Table 3 - Model 360 Authorized Source Assembly Information

Source Assembly Manufacturer	Source Assembly Model	Nuclide	Special Form Certificate	Maximum Source Activity	Authorized for Use		
					Can.	USA	R.O.W.
QSA Global, Inc.	A424-23	Ir-192	USA/0335/S-96	150 Ci (5.55 TBq)			X
QSA Global, Inc.	A424-25	Se-75	USA/0502/S-96	150 Ci (5.55 TBq)			X
QSA Global, Inc.	A424-25W	Se-75	USA/0502/S-96	150 Ci (5.55 TBq)	X	X	X
QSA Global, Inc.	A424-26	Yb-169	NA	108 Ci (4 TBq)			X
QSA Global, Inc.	A424-30	Cs-137	USA/0335/S-96	380 mCi (14.1 GBq)	X	X	X
QSA Global, Inc.	A424-9	Ir-192	USA/0335/S-96	150 Ci (5.55 TBq)	X	X	X
CIS-US	702	Ir-192	Contact Manuf.	140 Ci (5.18 TBq)	X	X	X
INC	7	Ir-192	Contact Manuf.	140 Ci (5.18 TBq)		X	X
Nordion	TIF*, TSI*	Ir-192	Contact Manuf.	140 Ci (5.18 TBq)	X		X
SPEC	G-60	Ir-192	Contact Manuf.	150 Ci (5.55 TBq)	X	X	X
SPEC	T-5F	Ir-192	Contact Manuf.	140 Ci (5.18 TBq)	X	X	X
SPEC	T-5	Ir-192	Contact Manuf.	140 Ci (5.18 TBq)	X	X	X

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***NOTE:** Nordion TIF and TSI chain style sources require the use of a special jumper (extension) when transporting the chain style source assemblies in the Model 360-10 & 360-10W. See figures 6 through 11 below.

Table 4 - Model 360 authorized contents.				
Isotope	Gamma Energy Range	Half Life	Output at 1 meter per Curie (37 GBq)	Output at 1 foot per Curie (37 GBq)
Iridium-192	206 - 612 keV	74 days	0.48 R/hr	5.2 R/hr
Selenium-75	66 – 401 keV	120 days	0.203 R/hr	2.2 R/hr
Ytterbium-169	8 - 308 keV	32 days	0.125 R/hr	1.3 R/hr
Cesium-137	662 keV	30 years	0.32 R/hr	3.4 R/hr

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b. Jumper Assembly

The jumper or extension assembly is only required when transporting the TSI or TIF chain style sources in either the Model 360-10 or the Model 360-10W containers.

The jumper is not required to ship the chain style sources in either the Model 360-2, 360-4, or the 360-4W.

The purpose of the jumper is to extend the locking length of the chain when the chain drops further into the storage position in the container shield.

The two-piece jumper transforms from a short length jumper for the TIF chain to a longer length jumper for the shorter TSI chain sources.

In the longer length configuration, one end of the jumper can be used to retrieve any chain source that has accidentally dropped down into the storage channel without the jumper attached. The figures below show the jumper assembled and used in its multiple configurations.

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FIGURE 6 - TWO-PIECE JUMPER UNASSEMBLED



FIGURE 7 – JUMPER ASSEMBLED TO SHORT LENGTH CONFIGURATION

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FIGURE 8 – SHORT LENGTH JUMPER CONNECTED TO TIF SOURCE CHAIN



FIGURE 9 – JUMPER ASSEMBLED TO LONG LENGTH CONFIGURATION

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FIGURE 10 – LONG LENGTH JUMPER CONNECTED TO TSI SOURCE CHAIN



**FIGURE 11 – JUMPER IN RETRIEVAL MODE INSERTING INTO TIF CONNECTOR.
ROTATE JUMPER 90° AND SLOWLY PULL TO RETRIEVE**

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1.6 Accessory Equipment Specifications

Table 5 - Complete Remote Control Assemblies

Item number	Model Number	Control Cable Length	Unit Weight
TAN66425	664/25	25 ft (7.6 m)	21 lb (10 kg)
TAN66435	664/35	35 ft (10.7 m)	24 lb (11 kg)
TAN66450	664/50	50 ft (15.2 m)	27 lb (12 kg)
TAN69325	693/25	25 ft (7.6 m)	21 lb (10 kg)
TAN69335	693/35	35 ft (10.7 m)	24 lb (11 kg)
TAN69350	693/50	50 ft (15.2 m)	27 lb (27 kg)
TAN69225	692/25	25 ft (7.6 m)	21 lb (10 kg)
TAN69235	692/35	35 ft (10.7 m)	24 lb (11 kg)
TAN69250	692/50	50 ft (15.2 m)	27 lb (12 kg)
SAN88225	882/25	25 ft (7.6 m)	14 lb (6 kg)
SAN88235	882/35	35 ft (10.7 m)	17 lb (8 kg)
SAN88250	882/50	50 ft (15.2 m)	22 lb (10 kg)
SAN88225R	882/25R	25 ft (7.6 m)	14 lb (6 kg)

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Table 5 Continued - Complete Remote Control Assemblies

Item number	Model Number	Control Cable Length	Unit Weight
SAN88235R	882/35R	35 ft (10.7 m)	17 lb (8 kg)
SAN88250R	882/50R	50 ft (15.2 m)	22 lb (10 kg)
SAN88525	SAN885/25	25 ft (7.6 m)	18 lb (8 kg)
SAN88535	SAN885/35	35 ft (10.7 m)	21 lb (9 kg)
SAN88550	SAN885/50	50 ft (15.2 m)	26 lb (12 kg)
SAN88625	886/25	25 ft (7.6 m)	15 lb (7 kg)
SAN88635	886/35	35 ft (10.7 m)	18 lb (8 kg)
SAN88650	886/50	50 ft (15.2 m)	23 lb (10 kg)
SAN88625R	886/25R	25 ft (7.6 m)	15 lb (7 kg)
SAN88635R	886/35R	35 ft (10.7 m)	18 lb (8 kg)
SAN88650R	886/50R	50 ft (15.2 m)	23 lb (10 kg)
SAN88725	SAN887/25	25 ft (7.6 m)	19 lb (9 kg)
SAN88735	SAN887/35	35 ft (10.7 m)	22 lb (10 kg)
SAN88750	SAN887/50	50 ft (15.2 m)	27 lb (12 kg)

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Table 6 - Model 664 and 885 Control Storage Reel Unit Size

Length	Width	Height
21 in (533 mm)	12 in (305 mm)	6.6 in (168 mm)

The Model 664 reel and Model 693 pistol grip controls are equipped with odometers. The Model 692 pistol grip, Model 882 series and Model 885 reel-type remote controls are not equipped with an odometer.

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Table 7 - Source Guide Tube Extension

Item Number	Model Number	Length
TAN48907	48907	7 ft (2.1 m) male 1-18 threaded fitting
48930-7	48930-7	7 ft (2.1 m) bayonet fitting/female 1-18
48930-X	48930-X	Customer specified length bayonet fitting/female 1-18
95021	95021	7 ft (2.1 m) male/female 1-18 threaded fittings*
95021-X	95021-X	Customer specified length*

NOTE: X indicates customer can order lengths other than the standard length.

* Indicates source guide tube material for extreme condition use.

Operating Distance

The distance between the remote control and the source changer or exposure device is determined by summing the length of the remote control conduits plus the total length of source guide tube used to perform the source transfers.

Typically source transfers between the exposure device and the source changer use a single 7ft (2.1 m) guide tube extension and a set of 25 ft. controls.

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1.7 Notice

This device is used as a radiography source changer and a Type A or Type B(U) shipping package for QSA Global Inc. source assemblies. The purpose of this manual is to provide information, which will assist qualified radiographers in using the Model 650L source changer. The user must be thoroughly familiar with this instruction manual before attempting operation and use of this equipment.

In order to use this equipment, users within the USA must be specifically licensed to do so. Applications for a license should be filed with the Materials Licensing Section of the appropriate U.S. Nuclear Regulatory Commission regional office or Agreement State.

It is the responsibility of users of this equipment outside of the United States to comply with all local, national and international regulatory, licensing and transportation rules and regulations as they apply in their respective countries.

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1.8 Warranty and Limitation of Liability

QSA Global, Inc. (herein referred to as the manufacturer) warrants its product, which it manufactures and sells, to be free from defects in material and workmanship for a period of one year from the date of shipment. This warranty shall not apply to any product or parts which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, abnormal conditions of operation, or use in any manner contrary to instructions.

The manufacturer's liability under such warranty shall be limited to replacing or repairing, at its option, any parts found to be defective in such respects, which are returned to the manufacturer, transportation prepaid; or at its option, to returning the purchase price thereof.

The warranty on other manufacturer's components shall be that of the original manufacturer whose warranty shall be binding.

In no event shall the manufacturer be liable for any incidental or consequential damages, whether or not such damages are alleged to have resulted from the use of such product in accordance with instructions given by or referred to by the manufacturer.

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QSA Global, Inc. assumes no liability or responsibility for the usage of any radioactive material or device generating penetrating radiation used in connection with this product. The use of such material or generators in any manner other than prescribed in the U.S. Nuclear Regulatory Commission, equivalent Agreement State, International Licensing Authority, or permitted by any regulation of the U.S. Nuclear Regulatory Commission, Agreement State, or International Regulatory regulations may constitute a violation of such license terms.

All other warranties, except those warranties expressly stated herein, including without limitation warranties of, merchantability and implied warranties of fitness, are expressly excluded.

The warranty on this device is specifically limited to its use only with sealed sources and connectors, parts, and accessories manufactured by QSA Global, Inc.

QSA Global, Inc. has received equipment approvals for the Model 650L from the Commonwealth of Massachusetts. For additional information on compliance with Type A approvals or USNRC 10CFR34, please contact QSA Global, Inc.

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QSA Global, Inc. shall not be liable for any errors or omissions contained herein and the provision by QSA Global, Inc. of the information set out in this manual does not in itself constitute acceptance of any liability on the part of QSA Global, Inc.

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2. OPERATING INSTRUCTIONS.

2.1 Job Site Safety Precautions

Instruments

The radiographer and radiography assistants must at all times wear a film badge or TLD and pocket dosimeter with a range of 0- mSv (0-200mRem). Regulatory requirements in the USA also require that an audible alarm ratemeter be worn at temporary jobsites. Specifically, those locations that are not permanent radiographic installations equipped with functional door interlocks and audible/visual alarms.

Radiographers in the USA must also have a survey meter capable of measuring in the range 20 μ Sv/hr (2mR/hr) up to 10mSv/hr (1,000mR/hr). Canadian regulations require that survey meters used for industrial radiography be capable of measuring from 2 μ Sv/hr (0.2mR/hr) and up to 100mSv/hr (10R/hr). In any regulatory jurisdiction, always verify survey meter requirements affecting the range and calibration requirements prior to engaging in industrial radiography operations.

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An audible 'chirper' pocket alarm may be required in some countries.

Restricted Area

Radiography must be performed only in a restricted area that is marked with the appropriate radiation warning signs and secured against unauthorized entrance.

Distance

Since the source emits high levels of radiation it is good practice to operate the system from as great a distance as possible.

Shielding

Whenever possible, situate the radiographic source transfer area in a room with suitably thick walls, floor, ceiling and doors to minimize occupational exposure to radiation.

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Surveillance

Only trained and qualified radiographers or assistants working under their direct supervision may operate radiography systems. The radiographer must be physically present at the site and able to control and limit access to the restricted area.

Locking

Keep the source changer and any associated exposure devices locked while assembling the system and when not being used to perform a source transfer. Locked is defined as the device's lock is fully engaged with the key removed. Store the key in a secured location.

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2.2 General Requirements Before Use

- a. Upon receipt of a source changer, survey the source changer on all sides to assure that the source is in its proper storage position. Radiation levels should be less than 200 mR/hr (2 mSv/hr) at the surface of the container and less than 10 mR/hr (100 μ Sv/hr) at one meter from the surface of the container.

If either of these radiation levels are exceeded, place the source changer in a restricted area and notify the Radiation Safety Officer. The Radiation Safety Officer must notify the U.S. Nuclear Regulatory Commission or appropriate regulatory agency, the final delivering carrier and QSA Global Inc. immediately.

Visually inspect the source changer for signs of damage and assure that the seal wire (tamper-indicator seal) has not been compromised or broken. Record any deficiencies of the visual inspection on the receiving report.

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- b. Ensure the gamma-ray source projector, remote controls and transfer tube/guide tube to be used for the source transfers have received a daily inspection as described in the gamma-ray source projector's operation and maintenance manual (e.g., MAN-027 for the SENTRY Series, etc.)
- c. Place the source changer and radiographic exposure device in a restricted area. Arrange them so that the source changer is resting on its base (DO NOT place the changer on its side during source transfers), and so that one length of guide tube (projection sheath) will fit between the two devices without any sharp bends or kinks in the tube. The bend radius of the source guide tube (projection sheath) during source exchanging operations should be greater than 20 in (0.5 m) to avoid restricting the movement of the source assembly.



WARNING



The source changer **MUST** remain upright at all times. **DO NOT** lay the source changer on its side.

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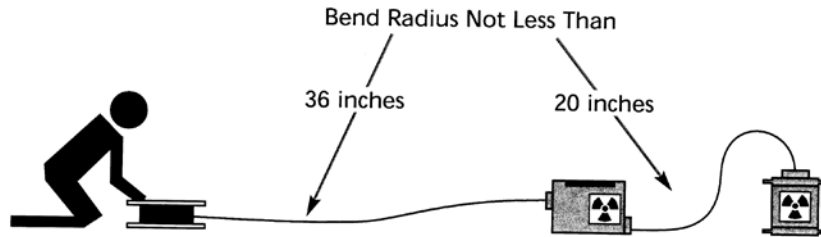


FIGURE 12 – SOURCE EXCHANGE LAYOUT

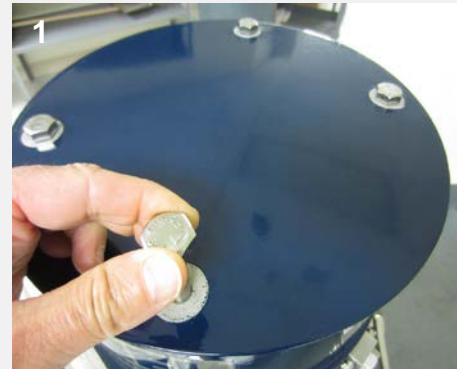
- d. Check for falling objects, vehicles or doorways to avoid the risk of crushing the source guide tube during set-up and during source transfer operations.

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2.3 Spent Source Assembly Transfer into the 360 Series Source Changer

STEP 1 – Removing the Cover

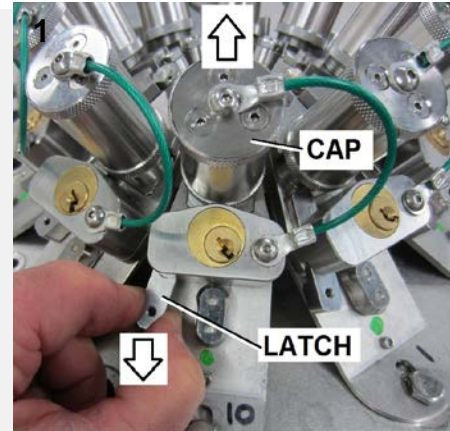
1. At the changer, cut and remove the tamper indicating wire(s) strung between the cover bolts if present.
2. Use a $\frac{3}{4}$ inch socket wrench to loosen all four cover bolts. Lightly pull up each bolt but do not remove them from the cover. The bolts should remain captive in the cover.
3. Remove cover and place it nearby.



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STEP 2 – Connecting the Source Guide Tube

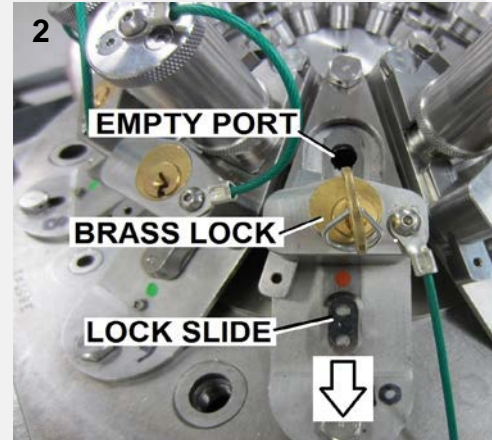
1. The source guide tube must always be attached to the outlet port of the device before connecting the remote controls in the set-up for a radiographic exposure. Connect the source guide tube to the gamma-ray source projector outlet port following the instructions in the gamma-ray source projector's operating manual.
2. Choose an empty changer port to transfer the source into.
3. At the port, pull the latch and lift up on the cap to remove the cap. Release the latch once the cap is removed. The cap should remain tethered to the lock body by the cable.



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STEP 2 Continued – Connecting the Source Guide Tube

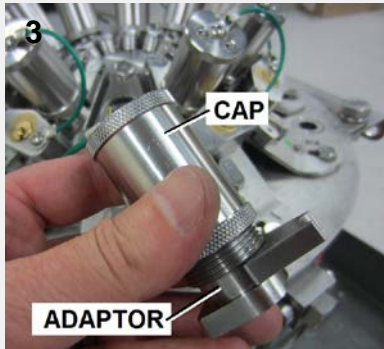
4. With the cap removed, visually check to ensure the port is empty.
5. Insert a key into the brass plunger lock and twist. The brass lock should pop up and the lock slide should drop down to unlock.
6. If the lock slide did not drop down on its own, then pull the slide down to reveal the **RED** dot (see picture 2).
7. At this point the empty port is unlocked and open.



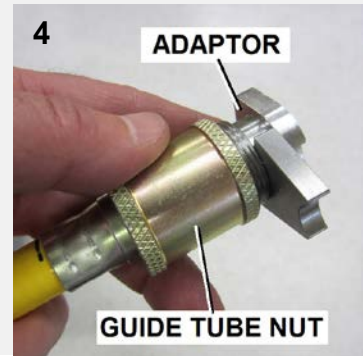
QSA GLOBAL.

STEP 2 Continued – Connecting the Source Guide Tube

8. Remove the adaptor from the cap.



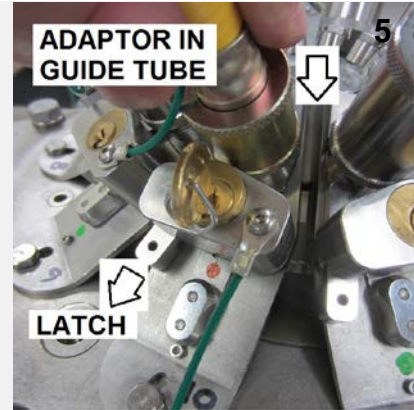
9. Thread the adaptor onto the nut of a guide tube extension.



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STEP 2 Continued – Connecting the Source Guide Tube

10. Pull the latch and push the adaptor with guide tube attached back into the port.
11. Release the latch once the adaptor is back in the port.
12. Give a light tug on the guide tube to ensure the adaptor is securely in the port.
13. Place the exposure device close enough to the source changer for guide tube connection.
14. At the front of the exposure device, attach the free end of the guide tube to the front outlet port. Follow the exposure device manual to ensure proper guide tube attachment.



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STEP 3 – Connecting the Remote Control Cable

Check the control cable and source assembly connector using the NO GO gauge. Without using excessive force, check the following four positions (see Figure 13):

- 1 Ball at the end of the control cable connector must NOT GO into the hole of the gauge.
- 2 The shank or stem of the control cable connector must NOT GO into the smaller of the two notches located on the side of the gauge.
- 3 The width of the gauge must NOT GO into the female slot of the source assembly connector.
- 4 After a positive connection between the control cable and source assembly connectors has been accomplished, verify that the larger notch located on the side of the gauge will NOT GO in the gap between the joined connectors.

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STEP 3 Continued – Connecting the Remote Control Cable

Replace any components that fail any of the NO GO gauge tests, because a failure indicates significant wear that could allow safety features of the design to be defeated.

IMPORTANT WARNINGS!

The control cable connector is made from hardened steel and should never be left unprotected or forced into connection with the source assembly connector as this could damage the connector over time, leading to possible breakage during use.

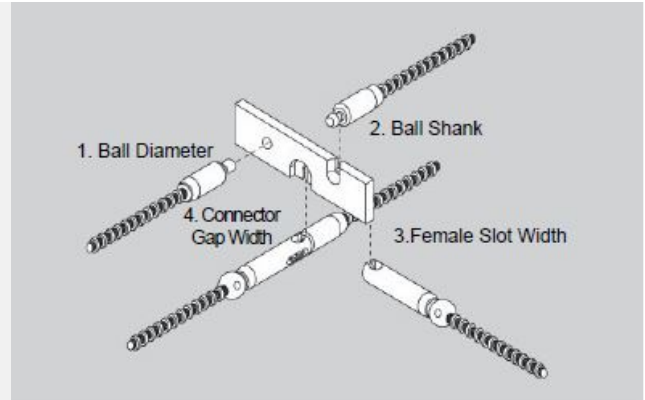


FIGURE 13 – NO GO GAUGE TESTS

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STEP 3 Continued – Connecting the Remote Control Cable

NOTE: When engaging or disengaging the drive cable from the source assembly, do the following to prevent damage to the drive cable or source assembly.

- Press back the spring-loaded pin of the source assembly connector with a fingernail and engage the male and female portions of the connectors.
- Release the locking pin of the source assembly connector and check that the connection is secure.

Connect the control cable to the source projector following the instructions in the gamma-ray source projector's operating manual.

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STEP 4 – Transferring the Source

1. Set the exposure device as for an exposure according to the procedure in the exposure device operating manual.
2. Assure no unauthorized personnel are in the restricted area.
3. At the exposure device controls, crank the source rapidly from the exposure device to the source changer. Observe the survey meter readings during this procedure. The radiation intensity should greatly increase as the source is first exposed, decrease slightly as the source is being cranked towards the source changer and then drop to background when the source is in the source changer.
4. Approach the exposure device with a survey meter. Survey the exposure device, survey the entire length of source guide tube (projection sheath), and survey all sides of the source changer to assure that source assembly has been properly transferred and is in the fully shielded position. The maximum radiation level should be less than 200 mR/hr (2 mSv/hr) at the surface of the container and less than 10 mR/hr (100 μ Sv/hr) at one meter from the surface of the container.

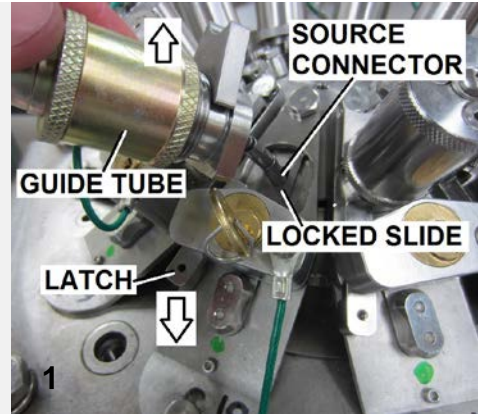
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STEP 4 Continued – Transferring the Source

In Canada, if the surface dose rate of 200 mR/hr (2 mSv/hr) is exceeded after the source has moved to the shielded position, or if the source does not project normally, you must immediately make a preliminary report of the incident to the Canadian Nuclear Safety Commission. This preliminary report must include the location and circumstances of the situation and any actions taken or proposed to be taken with respect to the incident.

If either of these radiation levels are exceeded, control access to the “restricted” area and notify the Radiation Safety Officer and QSA Global Inc. immediately.

5. At the source changer port, remove the key from the brass plunger lock and put it aside.



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STEP 4 Continued – Transferring the Source

6. Push and hold the lock slide up to reveal the **GREEN** dot while pushing down on the brass plunger lock until the lock slide is secured. The key is not needed for this step.
7. At the source changer port, remove the key from the brass plunger lock and put it aside.
8. Push and hold the lock slide up to reveal the **GREEN** dot while pushing down on the brass plunger lock until the lock slide is secured. The key is not needed for this step.
9. Ensure the source is locked by the slide before removing the guide tube with adaptor.
10. Pull the latch and then **slowly and carefully** lift up on the guide tube while checking to ensure the source connector is locked by the locked slide. If this is not the case, then place the guide tube back into the port and contact QSA Global, Inc.
11. If a chain style source was just transferred into a 10-port source changer (e.g., 360-10 or 360-10W), then proceed to Step 4.12, otherwise disconnect the drive cable and proceed to Step 4.22.

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STEP 4 Continued – Transferring the Source

- Chain style sources shipped in a 10-port source changer use a special jumper which must be prepared before use.
- Change the jumper length by threading the two parts together into one of the two configurations shown in Figures 14 and 15 depending on the source just transferred, either TIF or TSI.
- After setting the configuration, place the jumper nearby within easy reach.



FIGURE 14 - TIF CONFIGURER JUMPER

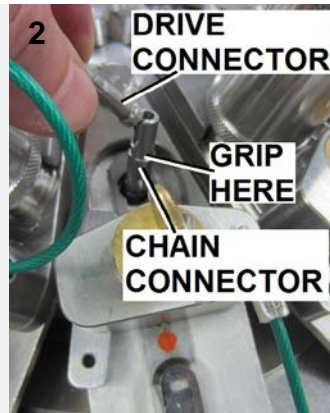


FIGURE 15 - TSI CONFIGURED JUMPER

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STEP 4 Continued – Transferring the Source

15. **The next 4 steps will require two hands and must be performed with extreme caution.**
16. The lock slide may need to be unlocked temporarily to disconnect the drive cable. **Keep the source down in the shield at all times.**
17. Grip the source chain connector and **DO NOT RELEASE** it after disconnecting the drive cable.
18. Disconnect the drive cable and continue to grip the source chain connector.
19. Attach the jumper to the source chain connector and allow the source with jumper attached to drop back into the port.
20. If the chain falls into the port without the jumper attached, then use the retrieval end of the TSI jumper configuration to carefully pull it up enough to grip the connector and then attach the jumper.

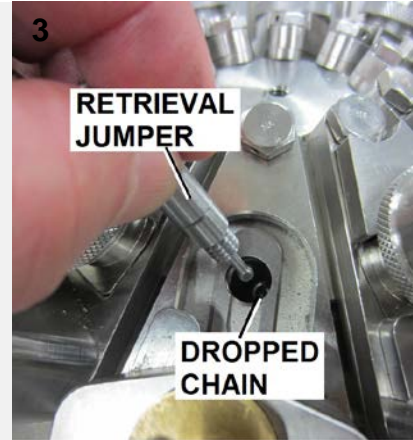


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STEP 4 Continued – Transferring the Source

21. If retrieval is unsuccessful, then lock the source using Step 4.22, and contact QSA Global, Inc. before proceeding.

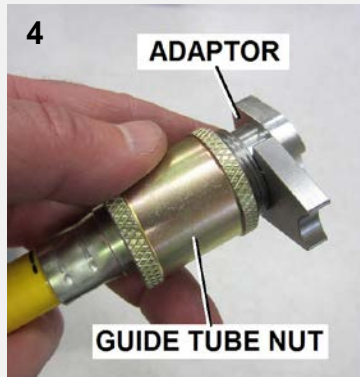
22. If the lock slide is unlocked, then lock it by pushing the lock slide to reveal the **GREEN** dot while pushing down the brass plunger lock until the slide is locked in place. (Remove the plunger lock key if not already removed).



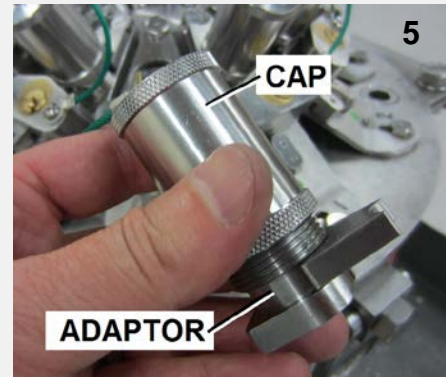
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STEP 4 Continued – Transferring the Source

23. Remove the adaptor from the guide tube.



24. Attach the adaptor back onto the port cap.



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STEP 4 Continued – Transferring the Source

25. Check to ensure the lock slide is locked (See **GREEN** dot) and the brass plunger lock is down.
26. Pull on the latch and replace the cap back into the port.
27. Remove the spent source ID tag from the exposure device.
28. Mark the changer port number on the back of the ID tag with black marker.
29. Use a tie-wrap to attach the ID tag to the port cap cable for the port containing the stored source.



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2.4 Transfer from the 360 Series Source Changer into a Gamma-Ray Source Projector

STEP 1 – Setting up for the Transfer

1. The source guide tube must always be attached to the outlet port of the device before connecting the remote controls in the set-up for a radiographic exposure. Connect the source guide tube to the gamma-ray source projector outlet port following the instructions in the gamma-ray source projector's operating manual.
2. Attach the remote controls to the **empty** exposure device (including attaching the drive cable to the dummy/jumper connector if present in the device). Set the exposure device as for an exposure according to the procedure for the particular exposure device in accordance with the exposure device operating manual. Crank the drive cable through the **empty** device and guide tube until approximately 6 in (15 cm) of cable is exposed past the end of the guide tube fitting. Remove the dummy/jumper connector if it was present.
3. Remove the dust cover plate from the loaded side of the source changer by releasing the plunger lock and rotating the selector ring to the "Connect" position. For added safety, rotate the selector ring to the "Lock" position.

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STEP 1 Continued – Setting up for the Transfer

4. Check the control cable and source assembly connector using the NO GO gauge. Without using excessive force, check the following four positions (see Figure 13) and Section 2.3 Step 3 of this manual.

If any components fail any of the NO GO gauge tests, this indicates significant wear that could allow safety features of the design to be defeated. Replace the controls with another suitable set of controls and repeat the NO GO gauge inspections.

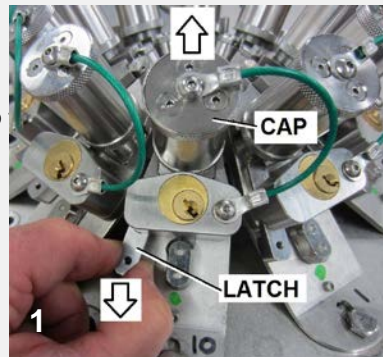
If no control/source combination can be found that will pass all of the NO GO gauge tests, contact QSA Global, Inc. and do not transfer the source.

5. Attach the drive cable to the source assembly connector and then attach the other end of the guide tube extension to the source changer where the source was just connected to the drive cable.

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STEP 2 – Transferring the Source

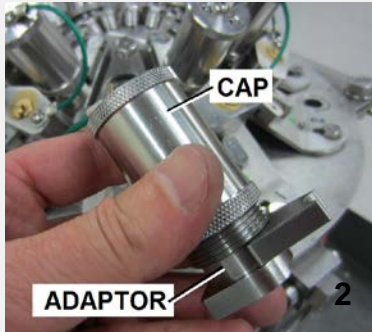
1. At the changer, choose the port containing the desired source for transfer into
2. At the port, remove the cap by pulling the latch while lifting up on the cap.



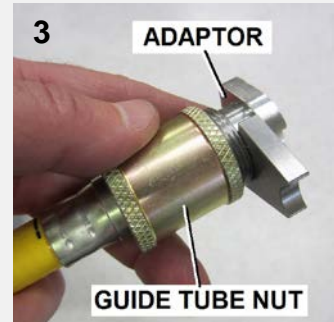
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STEP 2 Continued – Transferring the Source

3. Remove the cap from the adaptor.



4. Attach the adaptor to the guide tube nut with the drive cable connector protruding.



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STEP 2 Continued – Transferring the Source

5. If the port contains a chain style source in a 10-port changer, then proceed to step 2.4.7.
6. If the port does not contain a chain style source in a 10-port changer, then ensure the source is secured by the lock slide and **attach the drive cable connector to the source connector**, then proceed to step 2.4.20.



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STEP 2 Continued – Transferring the Source

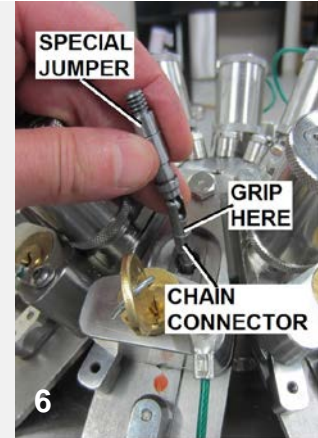
7. Chain style sources shipped in a 10-port source changer require the special jumper to be removed before attaching the drive cable to the source.
8. Removing the special jumper is a two handed operation and will require extreme caution.
9. Extreme caution is required because the lock slide may need to be unlocked temporarily to remove the jumper and attach the drive cable.



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STEP 2 Continued – Transferring the Source

10. Remove the special jumper by temporarily unlocking the lock slide. **Use extreme caution because at this point the source is not secure.**
11. **Keep the source chain in shield at all times.**
12. Slowly lift up the special jumper with source attached until the chain connector can be gripped.
13. Remove the special jumper while gripping the chain connector. **DO NOT RELEASE** the chain connector.
14. Attach the drive cable connector to the chain connector.



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STEP 2 Continued – Transferring the Source

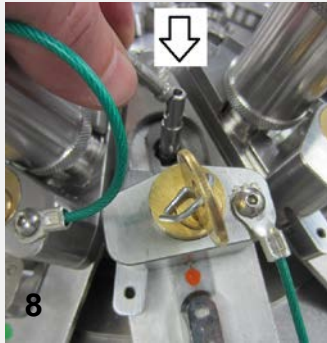
15. If the chain falls back into the shield without the drive cable attached, then use the retrieval end of the jumper TSI configuration to carefully pull it up only enough to grip the connector and attach the drive cable.
16. If retrieval is unsuccessful, then lock the source and contact QSA Global before proceeding.
17. Place the special jumper in a bag and attach the bag to the cap cable.



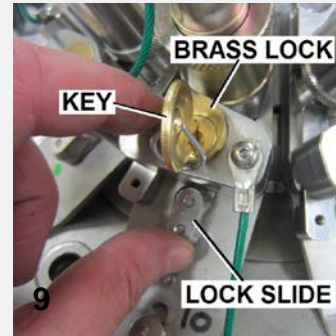
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STEP 2 Continued – Transferring the Source

18. With the drive cable now attached, the source chain can be released back down into the shield.



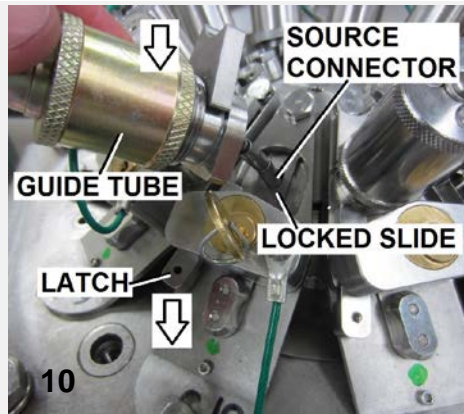
19. Push the lock slide up until the **GREEN** dot is visible and push down on the brass plunger lock to secure.



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STEP 2 Continued – Transferring the Source

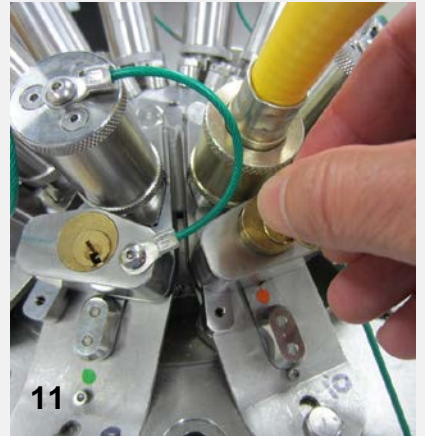
20. Pull the latch and push the adaptor with guide tube back down into the port. This may require a partial crank rotation of the control unit to remove the slack in the drive cable.



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STEP 2 Continued – Transferring the Source

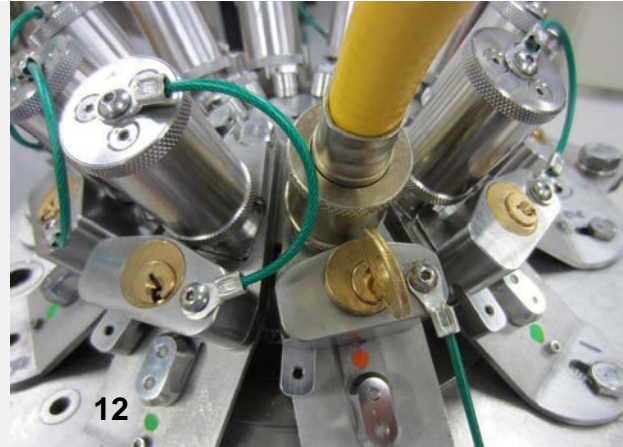
21. Turn the plunger lock key to unlock the slide. The **RED** dot on the lock slide should be visible.



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STEP 2 Continued – Transferring the Source

22. The source is now ready to be retracted into the exposure device.



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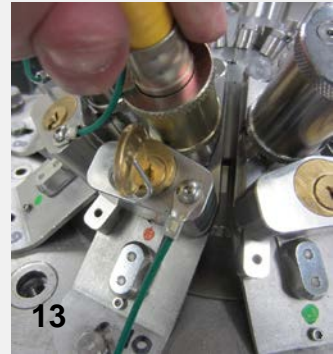
STEP 2 Continued – Transferring the Source

23. Before and during source retraction, assure everyone is at a safe distance from the source changer and exposure device and no unauthorized personnel are in the restricted area.
24. With the controls at a safe distance from the change and exposure device, retract the source rapidly from the changer to the exposure device. Observe the survey meter readings during this procedure. The radiation intensity should greatly increase as the source is first exposed, decrease slightly as the source is being cranked towards the source changer and then drop to background when the source is in the source changer.
25. Observe the survey meter while approaching the exposure device and source changer. Survey the exposure device on all sides, survey the guide tube and survey the source changer on all sides to assure the source has been properly transferred and stored in the shield.
26. Secure the source in the exposure device as specified in the device manual – locking the source in the shielded position within the device.

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STEP 2 Continued – Transferring the Source

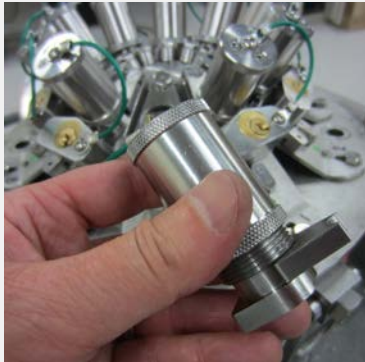
27. Disconnect the drive cable from the source connector and install the protective cover over the source connector as required by the exposure device manual.
28. Install the storage plug, or rotate the outlet port cap bac on the front outlet port of the exposure device.
29. Disconnect the guide tube from the exposure device and source changer.



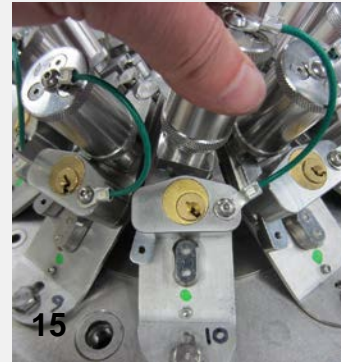
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STEP 2 Continued – Transferring the Source

30. Attach the adaptor back onto the cap.



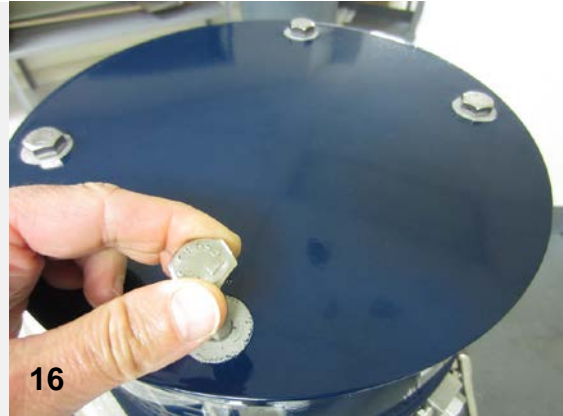
31. Replace the cap with adaptor back into the empty port



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STEP 2 Continued – Transferring the Source

32. Remove the source ID tag from the source change and attach it to the exposure device.
33. If no other source transfers are required, attach the cover to the changer and tighten down all four bolts to secure the cover.
34. Seal wire at least two bolts together before shipment.



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STEP 3 Surveys and Storage

Surveying

After installing the locking mechanism's protective cover and the outlet port cover, survey the entire circumference of the exposure device and/or source changer with the survey meter to ensure the source is fully shielded and properly secured. The survey should not measure more than 2 mSv/hr (200 mR/hr) on any surface of the exposure device or source changer and should indicate the same measurement as the initial survey.

Storage

Lock the exposure device and/or source changer containing a radioactive source and secure them in a clean dry storage area where they cannot be tampered with or removed by unauthorized personnel. Perform a storage survey on the surface of the exposure device and/or source changer to verify the dose rate is less than 2 mSv/hr (200 mR/hr) and record.

A radioactive material warning notice must be posted on the door or entrance of the storage area. The door or entrance must be locked to prevent access by unauthorized personnel.

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2.5 Leak Testing of Radioactive Sealed Sources

Periodic leak tests of radioactive sealed sources used in the Model 867 source changer are required by most national and international regulations. The leak test provides a confirmation of the integrity of the hermetically welded sealed source by determining the amount of removable contamination. In most regulatory jurisdictions, a leak test of a sealed source must be performed every 6 months or prior to its first use after removal from storage. Acceptable results of a radio-assay must indicate removable contamination is less than $<185 \text{ Bq}$ ($0.005 \mu\text{Ci}$).

Evaluation of depleted sources for return to QSA Global, Inc. should be leak tested while still contained in their exposure device in accordance with the applicable device procedures. This test must be performed in a properly secured Controlled Area. The individual performing this test should wear a direct reading pocket dosimeter and either a film badge or thermoluminescent dosimeter. The individual should also use a properly calibrated and operable radiation survey instrument.

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2.6 Safety Class A Components

a. Safety Class A Designation Items

Items that comprise the Model 880SC source changer that are critical for safe radiological operation are classified as Class A items or components. Class A items can be structures, components and systems whose failure or function could directly result in a condition adversely affecting public health and safety. This would include extreme conditions such as the loss of primary containment with a subsequent release of radioactive material and or a loss of shielding creating a substantial safety hazard. Replacement parts that are sent to you with a safety Class A designation are clearly marked with lot numbers and contain instructions to maintain traceability.

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b. Considerations of Safety Class A Items

Typically service of the Model 880SC source changer is performed by QSA Global, Inc. Should a user of the package need to replace a component on the Model 880SC source changer, they must contact QSA Global, Inc. prior to replacement to ensure the replacement component meets all required specifications including Class A requirements when applicable.

Users of the Model 880SC source changer must recognize their responsibilities of maintaining the integrity of the Type B(U) package and the control of Safety Class A items and components by:

- maintaining traceability of Class A replacement items or components to a specific source changer or an associated component.
- use of manufacturer specified items to maintain the integrity of the source changer/transport package according to the certifications. Do not use generic grade items or components that do not meet original design specifications.

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- performance of periodic inspections to verify the Class A items are not excessively worn from long term use or have been damaged from accidents.
- use and handling of the system consistent with its design and intended application.
- promptly notifying the manufacturer in the event a Safety Class A item or component which contains a defect or deviates from the original design specifications. This action will initiate a formal evaluation of the defect or deviation

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3. SAMPLE TRANSPORTATION INSTRUCTIONS.

The following instructions are samples for the transport of this radiographic source changer/transport container and source assembly within the United States and are based on current transport regulations. Shippers of radioactive materials in regulatory jurisdictions outside the USA must ensure full compliance with all current and applicable transport regulations. Listed are some of the regulations that should be referenced for the legal transport of radioactive materials:

- International Atomic Energy Agency requirements No. TS-R-1 (2009 Edition) AND SSR-6 (2018), 'Regulations for the Safe Transport of Radioactive Materials' and the IAEA 'Code of Conduct on the Safety and Security of Radioactive Sources' – IAEACODEOC/2004.
- International Air Transport Association, 'Dangerous Goods Regulations'.
- International Civil Aviation Organization, 'Technical Instructions for the Safe Transport of Dangerous Goods by Air'.
- International Maritime Organization, 'International Maritime Dangerous Goods Code'.

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- U.S. Department of Transportation, Title 49 Code of Federal Regulations Parts 171 through 178.
- U.S. Nuclear Regulatory Commission, Title 10 Code of Federal Regulations Parts 20, 34 & 71.
- Canadian Nuclear Safety Commission, Nuclear Safety and Control Act, 'Packaging and Transport of Nuclear Substances Regulations'; 'Nuclear Substances and Radiation Devices Regulations'.
- Transport Canada, 'Transport of Dangerous Goods Regulations'.
- Transport in the United Kingdom: Refer to the regulations as listed on the ADR approval Certificate.

3.1 Transport Package Requirements

As a shipper of radioactive material, you must perform a pre-shipment inspection to verify conformance to the Type B(U)-96 certification (or Type A approval as applicable) for each individual shipment of radioactive material. This verification assures the package's integrity is not compromised, which may cause a reduction of safety while in the transport system.

Visually inspect the transport package:

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- Ensure all markings are legible and labels are securely fastened to the container.
- Inspect the container for signs of significant degradation. Ensure that the housing integrity is secure and does not have any significant dents, cracks or any significant rust on the cover (lid).
- Visually assure all welded areas are not cracked. If there is any evidence of cracked weld, contact QSA Global, Inc. prior to shipment.
- Examine the 360 source changer to ensure that the weldment is intact, oriented properly and has no severe deformation.
- Assure all hardware is present and secured. Assure safety wires are present and intact as noted on the drawings referenced in the Type A approval or Type B(U) certificate as applicable.
- Assure the locking assemblies allow free movement of the lock slide when performing an operational test and that the plunger lock engages and is functional. Assure the shipping caps install and secure over the source tubes on the lock assemblies.
- Assure threaded holes used to secure the protective lid to the container body do not have damaged threads and engage the shipping cover bolts.
- Wipe test the transport package over an area of 300 cm² and assure the level of removable contamination is less than 0.00001 $\mu\text{Ci}/\text{cm}^2$.

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- Examine hardware for signs of fatigue cracking. If identified, do not ship. Contact QSA Global, Inc. for guidance.
- Assure the source assembly (when loaded in a source tube) is properly secured in the locked position. The lock slide must be in the LOCK (Green) position, the protective cover in place, the key plunger lock engaged and the key removed.
- Assure the seal wire is properly installed as specified in the referenced drawings/specifications prior to transport.
- Assure all the conditions of the Certificate of Compliance are met and the transport package has all the required markings.
- If the container fails any of these inspections, contact QSA Global, Inc. before making a Type B(U) or Type A radioactive material shipment.

If the package fails any of the inspections described, remove the container from use until it can be brought into compliance with the Type B (U) certificate or the Type A approval as appropriate.

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3.2 Receipt of Radioactive Material

- a. A radioactive material package must be accepted from the carrier at the time it is delivered. [10CFR20.1906(a)(1)]
- b. If a radioactive material package is to be held at the carrier's terminal for pickup, arrangements must be made to receive notification from the carrier of the arrival of the package at the time of arrival. The package must be picked up expeditiously upon receipt of notification (within three hours if practicable). [10CFR20.1906(c)]
- c. Monitoring as described below must be performed as soon as practicable but at least within three hours if received during normal working hours or within three hours of the next work day if received after normal working hours. [10CFR20.1906]
 - Upon receipt of a package of radioactive material, the package shall be placed in a restricted area. Assure appropriate personnel are notified.

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- Survey the entire exterior surface of the package at the time of receipt and assure that the maximum radiation level does not exceed 2 mSv/hr (200 mRem/hr). Survey all sides of the device at 1 m from the exterior surfaces of the packages and assure that the maximum radiation level does not exceed 0.1 mSv/hr (10 mRem/hr). If either of these limits are exceeded, notify the Radiation Safety Officer immediately. Record the maximum radiation levels measured at the package surface and at 1 m from the package surface on the Receiving Report. [10CFR20.1906(d), 10CFR71.47]

Note: If any of these limits are exceeded, the Radiation Safety Officer must immediately notify the USNRC (or applicable governing agency) and the final delivering carrier.

- d. Inspect the package for any evidence of physical damage. Record the results of this inspection on the Receiving Report. Also record on the Receiving Report the date, source model number, source serial number, radionuclide, activity, the individuals name making the record, transport package model number, mass or activity of the depleted uranium and the package serial number. [10CFR34.63]

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- e. Assure that the package is locked or place the package into an outer locked container and secure the package in accordance with your license requirements. [10CFR34.35, 10CFR34.23]
- f. Keep a copy of the Operating Manual for the package on file to assure you have the proper opening and handling instructions. Assure that the instructions are followed and any noted special precautions are performed. [10CFR20.1906(e)]

Note: For licensees transporting special form sources in licensee owned or operated vehicles to and from a work site are exempt from the contamination monitoring requirements. The radiation survey required upon receipt must still be performed. [10CFR20.1906(f)]

- g. If you are receiving a nationally tracked source (Category 1 or 2 quantities) from another licensee, complete the report: USNRC form 748 and submit the report by the close of the next business day after the transaction. [10 CFR 20.2207 and Appendix E]. Some regulatory jurisdictions require reporting of depleted Uranium shielding of the transport container in addition to the radioactive materials. Verify current national regulatory and security requirements to ensure compliance.

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3.3 Shipment of Radioactive Material

- a. Prior to shipment of a Type B package within the USA, assure that you are a registered user of the radioactive material package you wish to ship. Also, assure that you have appropriate quality assurance procedures for Type B packages. [10CFR71.12, 10CFR34.31(b)]

- b. Pre-shipment training requirements:

Prior to shipping hazardous materials, personnel must be trained in accordance with 49CFR172, Subpart H and be retrained every three years. Training shall include:

- General awareness/familiarization training.
- Function specific training.
- Safety training, providing:
 - Emergency response information.

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- Measures to protect employees from potential hazards associated with hazardous material to which employees may be exposed in the workplace, both radioactive and chemical hazards.
- Employer safety measures implemented to protect employees.
- Methods and procedures for accident avoidance, i.e. proper procedures for handling hazardous material packages.
- OSHA or EPA training, MSDS information.
- Transportation security training for organizations that are required to have a security plan. Haz-Mat employees must be trained in the security plan and its implementation including awareness of security risks and how to recognize and respond to security threats. [49CFR172.800, 10CFR30, IAEA CODEOC/2004]
- If shipments involve use of a Declaration of Dangerous Good form, all personnel involved with the shipment must be trained in IATA/ICOA/IAEA requirements every two years.

An appropriate test must be administered and the following documentation must be kept:

- Employee name.
- Date of most recent training.

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- Description, copy or location of the training methods.
- Name of person performing training.
- Certification that person has been trained and tested.

Documentation should be kept in one file, i.e. all radiation safety related training used as part of the Hazmat training should be included.

- c. Prior to shipment maintain copies on file of the most current Type B(U) and Special Form certifications (or Type A approval as applicable) and assure the package and its contents meet the following requirements:
- The radioactive contents and form are authorized for use in the package.
 - The package is in good physical condition for transport.
 - All locks and outlet port fittings are properly installed and seal wired where required.
 - All conditions of the Type B(U)-96 Certificate of Compliance (or Type A approval as appropriate) are met [10CFR71.87]. Maintain copies of the current Type B (U), Type A and special form certifications on file. For Type B(U) shipments, this must also include the applicable drawings.

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- d. Assure that the source is secured in the proper shielded position in the shipping package as described in this operation's manual. Perform a pre-shipment inspection as described in Section 3.1 under the Transport Package requirements and verify the package is assembled as described in the Type B(U) certification (or Type A approval as applicable).
- e. Attach a security seal as specified on the descriptive assembly drawings with an identification mark to the package closure that serves as a tamper indicator. [49CFR173.412(a)]
- f. If the shipping package is to be packaged inside a crate or other outer packaging, the outer packaging must be strong enough to withstand the normal conditions of transport and must not reduce the safety of the package. The shipping package must be placed within the outer package with sufficient blocking to prevent shifting during transportation. [49CFR173.25]
- g. Survey the entire exterior surfaces of the package and assure that the maximum radiation level does not exceed 2 mSv/hr (200 mRem/hr). Survey 1 m from all sides of the exterior surfaces of the package and

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assure that the maximum radiation level does not exceed 0.1 mSv/hr (10 mRem/hr). Determine the proper shipping labels to be applied to the package using the criteria of Table 8. [49CFR172.403]

Note: If shipping the container inside an overpack or convenience box in the back of a vehicle, survey and label both the inner 360 Series source changer and the overpack. Placarding the vehicle is dependent on the category of label applied to the overpack if used. [49CFR173.448]

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Table 8 - Shipping Label Criteria.		
Label	Maximum Radiation Level at Surface	Maximum Radiation Level at 1 Meter
Radioactive White I 	0.5 mRem/hr (0.005 mSv/hr)	None
Radioactive Yellow II 	50 mRem/hr (0.5 mSv/hr)	1.0 mRem/hr (0.01 mSv/hr)

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Table 8 Continued - Shipping Label Criteria.		
Label	Maximum Radiation Level at Surface	Maximum Radiation Level at 1 Meter
Radioactive Yellow III 	200 mRem/hr (2 mSv/hr)	10 mRem/hr (0.1 mSv/hr)

For a package, both the transport index (TI) and the surface radiation level conditions shall be taken into account in determining which is the appropriate category of radioactive material label. Where the TI satisfies the condition for one category but the surface radiation level satisfies the condition for a different category, the package shall be assigned to the higher category of the two. For this purpose, category White-I shall be regarded as the lowest category.

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The TI is the maximum radiation level measured in mRem/hr at a distance of 1m from the external surfaces of the package. When recording the TI, the dose rate units of mRem/hr are not listed, for example a reading of 20 μ Sv/hr (2mem/hr) would indicate a TI = 2.0. (Note that the TI is rounded to the nearest tenth value.)

- h. Properly complete two shipping labels indicating the contents (e.g. Ir-192, Se-75, etc.), the activity of the source (in Becquerels or multiples of Becquerels, e.g. GigaBecquerels (GBq)) and the transport index. The transport index is used only on Yellow II and Yellow III labels and is defined as the maximum radiation level in mRem/hr at 1m from the package surface (see Table 8). [49CFR172.403(g)]
- i. Assure that any old shipping labels have been removed from the package. Apply two properly completed labels to two opposite sides of the package (excluding the bottom surface). [49CFR172.403(f)]
- j. For air shipments within the USA, the package must be labeled with '**Cargo aircraft only**' labels. Ensure that these labels do not cover any other package markings or labels. [49CFR172.448 & 173.448(f)].

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- k. Mark the outside of the package with the proper shipping name and identification number (e.g., 'Radioactive Material, Type B(U) Package, UN2916' for a Type B(U) shipment or 'Radioactive Material, Type A Package, Special Form, UN3332' for a Type A shipment) if not already marked. Place the letters RQ (stands for Reportable Quantity) next to the proper shipping name when shipping more than 10 Ci (370 GBq) of Ir-192, Se-75 or of Yb-169. [49CFR172.300]

Description	Proper Shipping Name
Type B(U) package containing a special form source	Radioactive Material, Type B(U) Package UN 2916
Type A package containing a special form source	Radioactive Material, Type A Package Special Form UN 3332
Type A package containing a non-special form source	Radioactive Material, Type A Package UN 2915

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- i. If the shipping package is inside a crate or other outer packaging, mark the outside package with 'RQ' (if applicable), the 'UN Identification Number', followed by the 'proper shipping name'. The word 'OVERPACK' must be marked on the outside package. The required markings must be in letters a minimum of ½ inch (13 mm) high. [49CFR172.310; 49CFR173.471; 49CFR173.25]

Note: If shipping a Type A quantity of an isotope in a Type B (U) package that is not approved for that isotope, i.e. a sealed source assembly with Yb-169 in a Type B (U) source changer, the Type B (U) container labels must be covered with the appropriate Type A container information.

- m. Assure that the levels of removable radioactive contamination on the outside surface of the outer package do not exceed 0.37Bq (10^{-5} µCi) per cm². [49CFR173.443]
- n. Mark the outside of the package with the gross weight since the 360 Series packages weigh 110 lb (50 kg) or greater. [IATA 10.7.1.3.1]
- o. Properly complete the shipping papers indicating:

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- 1 United Nations identification number, Proper shipping name, Class Number '7', and (e.g. 'Radioactive Material, Type B(U) Package, Class 7, UN2916' for a Type B(U) shipment or 'Radioactive Material, Type A Package, Special Form, UN3332' for a Type A shipment).
- 2 The letters RQ must appear before or after the proper shipping name when shipping more than 10 Ci (370 GBq) of Ir-192, Se-75 or of Yb-169.
- 3 Name of the radionuclide (e.g., Iridium-192, Selenium-75, Yb-169).
- 4 Physical and chemical form (i.e. Special Form).
- 5 Activity of the source in Becquerels or other appropriate multiples of Becquerels on the DOT label and the shipping papers. Note: number of Curies x 37 = number of GigaBecquerels (GBq).
- 6 Category of label applied (i.e. Radioactive Yellow II).
- 7 Transport Index.
- 8 USNRC identification number (i.e. USA/9371/B(U)-96) (or DOT Type A Specification 7A for a Type A shipment).
- 9 For export shipments, the IAEA identification number (i.e. USA/9371/B(U)-96).
For Canadian export shipments only: include the Canadian Endorsement Number (CDN/E243/-96) for a source activities greater than an A1 value in a Type B(U) package or as Type A as applicable.

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- 10 Shipper's certification: **'This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.'** [49 CFR 172.204(a)(1)].

NOTE: For shipments in company vehicles to and from job sites within the USA, the shipper's certification is not required.

- 11 The shipping papers must indicate your company's emergency telephone number. The telephone number must have 24-hour coverage in case of an emergency concerning your shipment. The telephone number must be clearly visible on the shipping paper and must be answered by a person that can provide immediate emergency response information. Beepers and pagers are not acceptable. [49CFR172.604].
- p. For air shipments, the shipping papers must meet the requirements specified in IATA for a Shipper's Declaration for Dangerous Goods. In addition to the information listed in Step 3.3(o) of this part, the following information needs to be specified:

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- 1 Air waybill number: Enter the number of the air waybill to which the declaration form will be attached. (This may be amended by the carrier.)
- 2 Aircraft limitations: Specify that the shipment is within the limitations for 'Cargo aircraft only.' A notation can be added in the handling information box of the Shipper's Declaration which states 'This shipment may be carried on passenger aircraft outside U.S. jurisdiction'.
- 3 Airport of departure: Enter the full name of the airport of city of departure, which may be amended by the carrier.
- 4 Airport of destination: Enter the full name of the airport or city of destination, which may be amended by the carrier.
- 5 Shipment type: Specify the shipment type as 'Radioactive'.
- 6 Under quantity and type of dangerous goods, specify the number of packages (of same type and content), their type of package and activity in Becquerels or multiples thereof (units used must be clearly indicated) in each package, including packages in overpacks.

(If relevant) Indication of use of overpack and dimensions of the overpack (including dimensional units). When an overpack is used, the wording '**Overpack used**' must be inserted on the declaration form

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immediately after all the relevant entries relating to the packages within the overpack. In such cases, packages within overpacks must be listed first. Dimension units must be in sub-multiples of meters.

- q. The 24-hour emergency number required by Step 3.3(o)(11) of this part, must appear in the 'Additional Handling Information' section of the Declaration for Dangerous Goods.

For air shipments within the USA, the following statement must be included:

“This shipment is within the limitations prescribed for cargo aircraft only.”

- r. For shipment of special form radioactive material, the Special Form Certificate of Competent Authority for the radioactive source must be included. (e.g. USA/0335/S-96). For shipment of Type B(U) packages also include the certificate of Competent Authority (e.g. USA/9371/B(U)-96).
- s. The shipper's certification must be as follows:

'I hereby certify that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in

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proper condition for transport according to applicable International and National governmental regulations. I declare that all of the applicable air transport requirements have been met.'

The information on the Declaration for Dangerous Goods must be entered strictly in accordance with the order specified in the latest edition of the International Air Transport Association, Dangerous Goods Regulations. Questions regarding completion of a Shipper's Declaration for Dangerous Goods should be directed to the Radiation Safety Officer.

If you are shipping a nationally tracked source (Category 1 or 2 quantities) to another licensed recipient, complete the report: USNRC form 748 and submit the report by the close of the next business day after the transaction. [10CFR20.2207 and Appendix E, IAEA CODEOC/2004]. Some regulatory jurisdictions require reporting of depleted Uranium (DU) shielding of the transport container in addition to the radioactive materials. Verify current national regulatory and security requirements to ensure compliance.

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3.4 Shipment of Empty Uranium Shielded Containers

- a. Assure that the package does not contain a radioactive source. Perform the following procedure to confirm there are no unauthorized source assemblies within the container:
 - Transfer all authorized source assemblies from the source changer in accordance with Section 2.0 of this manual.
 - Remove the source guide tube and controls from the source changer and secure the lock assemblies as described in Section 2.0 of this manual.
 - Attach the cover assembly as specified in section 2.0.
 - In some regulatory jurisdictions, 'empty' labels or tags must be attached to the empty Model 360 source changer.

- b. If the shipping package is to be placed inside a crate or other outer packaging, the outer packaging must be strong enough to withstand the normal conditions of transport and must not reduce the safety of the package. The shipping package must be placed within the outer package with sufficient blocking to prevent shifting during transportation. [49CFR173.25].

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- c. Assure that the levels of removable radioactive contamination on the outside surface of the outer package does not exceed 0.4 Bq (10^{-5} μ Ci) per cm^2 based on wiping an area of at least 300 cm^2 . [49CFR173.443].
- d. Survey the package at the surface and at one meter from the surface to determine the proper shipping labels to be applied to the package.

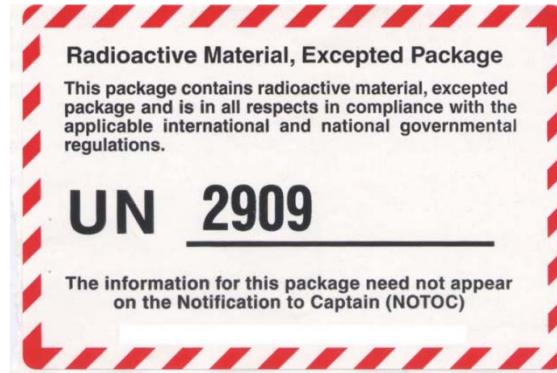
Note: If the surface radiation level does not exceed 5 μ Sv/hr (0.5 mRem/hr) and there is no measurable radiation level at 1m from the surface, continue with the instructions in Step 3.4(e) below and skip Step 3.4(f). If either of these levels are exceeded, skip Step 3.4(e) and continue with the instructions in Step 3.4(f).

- e. If the surface radiation level does not exceed 5 μ Sv/hr (0.5mRem/hr) and there is no measurable radiation level at one meter from the surface, no label is required.
 - 1 The outside of the inner packaging or, if there is no inner packaging, the outside of the packaging itself bears the marking 'Radioactive'.

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- 2 The outside of the package must be marked with UN2909.
- 3 When shipping by air, excepted packages are exempt from the requirement for use of Dangerous Goods Declaration.
 - i. For air shipments [IATA 10.8.8.3], the 'Quantity and Type of Dangerous Goods' box must read:
"Radioactive Material, excepted package, articles manufactured from depleted uranium, UN2909."
 - ii. Required after 1 January 2007, the outside of the package must include the following label [IATA 10.7.4.4.3]:

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- f. If the surface radiation level exceeds 5 $\mu\text{Sv/hr}$ (0.5 mRem/hr), or if there is a measurable radiation level at 1m from the surface, use the criteria of Table 1 to determine the proper shipping labels to be applied to the package.
- 1 Mark the outside of the outer shipping package with the proper shipping name and identification number: **Radioactive Material, Low Specific Activity (LSA-I) UN2912, Class 7**. If the container is packaged inside a crate or other outer packaging, mark the outer package with the word '**Overpack**'.
 - 2 Properly complete the shipping papers, indicating:
 - Proper shipping name, identification number and class (i.e. Radioactive Material, Low Specific Activity (LSA-I), Class 7, UN2912).
 - Name of the radionuclide (i.e. depleted Uranium-238).
 - Physical and chemical form (i.e. Solid Metal).
 - Activity of the uranium in Becquerels or other appropriate multiples of Becquerels.

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NOTE: Number of Curies x 37,000 = number of MegaBecquerels (MBq). The activity in millicuries for U-238 equals 0.16 x the shield weight in pounds. See Table 2 for U-238 activities for the Model 360 Series packages.

- Category of label applied (i.e. Radioactive Yellow II).
- Transport Index.
- USNRC identification number or USDOT specification number, i.e. Model 360 Series cert: USA/9371/B(U)-96.
- Shipper's certification:

'This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transport according to the applicable regulations of the Department of Transportation.' [49CFR172.204(a)]

Note: For shipments in company vehicles to and from job sites, the shipper's certification is not required.

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For air shipments, the following Shipper's Certification may be used:

'I hereby certify that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable International and national governmental regulations. I declare that all of the applicable air transport requirements have been met'

- For air shipments, the package must be labeled with a '**Cargo aircraft only**' label and the shipping papers must state: '**This shipment is within the limitations prescribed for cargo only aircraft**'.
- Your company's 24-hour emergency telephone number.
- The weight of the package including the unit of measurement of the hazardous material covered by the description (e.g. 110 lb. Note: For air shipments, the weight must be in multiples of kilograms.)

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- 3 For air shipments, the shipping papers must meet the requirements specified in IATA for a Shipper's Declaration for Dangerous Goods. In addition to the information listed in this Section, the following information needs to be specified:
 - Air waybill number: Enter the number of the air waybill to which the declaration form will be attached. (This may be amended by the carrier.)
 - Aircraft limitations: Specify that the shipment is within the limitations for 'Cargo aircraft only.' A notation can be added in the handling information box of the Shipper's Declaration, which states '**This shipment may be carried on passenger aircraft outside U.S. jurisdiction**'.
 - Airport of departure: Enter the full name of the airport of city of departure, which may be amended by the carrier.
 - Airport of destination: Enter the full name of the airport or city of destination, which may be amended by the carrier.
 - Specify contents (isotope) on the USDOT hazard labels as LSA-I.
 - Shipment Type: Specify the shipment type as 'Radioactive'.

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- Under Quantity and Type of Dangerous Goods, specify the number of packages (of same type and content), their type of packaging and activity in Becquerels or multiples thereof (units used must be clearly indicated) in each package, including packages in overpacks that are labeled as LSA-I.

(If relevant) Indication of use of overpack and dimensions of the overpack (including dimensional units). When an overpack is used, the wording 'Overpack' must be inserted on the declaration form immediately after all the relevant entries relating to the packages within the overpack. In such cases, packages within overpacks must be listed first. Dimension units must be in sub-multiples of meters.

- The 24-hour emergency number required in this Section, must appear in the 'Additional Handling Information' section of the Declaration for Dangerous Goods.

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The information on the Declaration for Dangerous Goods must be entered strictly in accordance with the order specified in the latest edition of the International Air Transport Association, Dangerous Goods Regulations. Questions regarding completion of a Shipper's Declaration for Dangerous Goods should be directed to the Radiation Safety Officer [49 CFR 172.402(b); 49 CFR 172.204(c)].

3.5 Carriage of Radioactive Material

- a. Assure that the vehicle used is in good condition and carries the normal complement of safety equipment including Radiation Area signs, a length of rope, spare tire, fire extinguisher, a set of vehicle tools and a set of flares. Assure that the glove compartment contains the vehicle registration certification and an operating flashlight. Additionally, assure that the operator has a calibrated and operable survey meter and assure that all individuals traveling in the vehicle are wearing both a film badge and a direct reading pocket dosimeter.

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- b. Assure that the transport package is properly packaged, marked and labeled and assure that the proper shipping papers are completed in accordance with the instructions for shipping radioactive material. The shipping papers must be accessible from the driver's seat.
- c. Place the transport package in the vehicle. Properly brace and secure the package against movement in the vehicle. [49CFR177.842(d)]
- d. Survey the driver's compartment to assure that the radiation level does not exceed 0.02 mSv/hr (2 mRem/hr). [49CFR177.842(g)] Note: This requirement is mandatory only for exclusive use shipments by a common carrier. [49CFR173.441(b)(4)]
- e. If the vehicle is transporting a package bearing a Radioactive Yellow III label, the vehicle must be placarded on all four sides with a Radioactive placard.

Note: Operation of a vehicle which is required to be placarded requires compliance with the Federal Motor Carrier Safety Regulations of 49CFR Parts 390-397 and the Driver Training requirements of 49CFR177.827; 49CFR177.804.

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- f. Complete the Radioactive Material Transport Checklist (see attached example). Forward a completed copy to the Radiation Safety Officer upon completion of the carriage.
- g. If the vehicle becomes disabled on the road, do not leave the vehicle unguarded when going for help. A message for help may be sent by a passing motorist or the police may be enlisted to guard the vehicle.
- h. Should any kind of accident occur, make an immediate radiation survey to determine if any radiation levels are unusually high. If unusual radiation levels exist, establish the boundary of the restricted area. Keep all persons out of this area and get police assistance, if possible. Notify the Radiation Safety Officer as soon as possible, but do not leave the scene without assuring that the police or some other responsible party will keep people out of the area.

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- i. Collect information pertinent to the accident, such as names of witnesses, names of people involved, and names of police, license numbers and circumstances of the accident. Call the Radiation Safety Officer promptly and give him as much information as possible.
- j. If a source should escape from the packaging, the vehicle operator should make no attempt to restore the source by himself. He should wait for assistance from the Radiation Safety Officer.
- k. If the vehicle is going to be used for storage of radioactive material at a temporary job site:
 - The vehicle's storage access entrance must be posted with 'Caution Radioactive Material' signs.
 - The vehicle must be secured/locked so that there is no unauthorized access.
 - Radiation levels must be below 20 $\mu\text{Sv/hr}$ (2 mR/hr) outside the vehicle to meet unrestricted area requirements.
 - Vehicle must meet new security requirements where applicable.

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- I. In the event of a transport emergency or accident involving this package, follow the guidance contained in “2016 Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident”, or equivalent guidance documentation.
- m. Security during transport in company vehicles:

Whenever portable and mobile radiographic exposure devices are removed from the permanent facility's approved storage area and placed into the transportation system, company trustworthy and reliable (T&R) employees that have been Haz-Mat trained will perform the following security duties during transport of radioactive materials:

- After the radioactive material package is prepared in accordance to current transport regulations, the package must be secured and locked in the designated area of the transport vehicle. The door to the storage area of the vehicle is closed locked to prevent unauthorized access to the darkroom during transport from the facility to the job-site. Shipping or receiving radioactive materials shall be accomplished in a designated area of the permanent facility.

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- While containing radioactive material packages, the vehicle is also a temporary storage area (whenever the package is not under continuous, direct surveillance by a T&R employee). The package must be locked in the vehicle as described above and the driver / passenger doors of the vehicle are to be locked. The alarm system and the transport vehicle disabling devices are activated.
- Whenever the transport vehicle is stopped for refueling, coffee stops, etc. the ignition keys are removed from the vehicle. If the T&R employee(s) leave the vehicle unattended, the vehicle must be completely locked and alarmed as described above.
- During transport to and from job-sites, T&R employees informed to:
 - Minimize the number of vehicle stops for fueling, beverages, meals, etc to minimize exposure to security risks.
 - Do not engage in any conversation with strangers concerning vehicle contents or job-site destinations.

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- Be aware of their surroundings and the people during stops, a car-jacking usually takes place at traffic lights.
- Know what action is required under the security plan by the T&R employee if a car on the highway is following them, photographing their truck, if the truck is disabled on a highway, if the truck was involved in an accident and cannot be driven away.
- Know what immediate response is required by a T&R employee if the vehicle is stolen or the radioactive material package is lost or stolen.
- Have the ability to communicate immediately with the Trustworthy and Reliable Official (TRO) should they need assistance or have a security related question.
- Know to report immediately to the TRO if an unauthorized party attempts to steal or gain access to the radioactive material being transported.
- Know what actions are required if the vehicle's alarm is triggered while parked, indicating an attempted intrusion.
- Know that all T&R employees are to safeguard all transport security documents and information regarding shipments of RAM from unauthorized disclosure.

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- Know that whenever the radioactive materials are removed from the transport vehicle at the job-site, the radioactive material must be under continuous, direct surveillance by the T&R employees until it is returned to the designated area of the transport vehicle.
- Know the purpose and reason for the increased security requirements of the USNRC, USDOT and Department of Homeland Security agencies.

T&R employees returning from job-sites will unload the radioactive material from the transport vehicle. They will secure the radioactive material in the facility's designated storage area and activate the storage area's security alarm system.

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Suggested Radioactive material transport checklist

Date _____ Operator _____

Destination _____

Transport Container Model _____ Serial Number _____

Radionuclide _____ Activity _____

Type of Label Applied _____ Transport Index _____

Survey Meter Model _____ Serial Number _____

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Calibration Date	_____	Film Badge	_____
Dosimeter Serial Number	_____	Initial Reading	_____
Final Reading	_____		
Radiation Area Signs	_____	Packing List	_____
Rope	_____	Bill of Lading	_____
Radioactive Material Sign	_____	Emergency Equipment	_____
Radiation Survey	_____	Driver's Compartment	_____ mRem/hr or μSv/hr
(Record highest reading) Vehicle (18 in from surface)	_____		mRem/hr or μSv/hr

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Packages properly marked and labeled (including transport index) _____

Packages secured in vehicle _____ Vehicle Placarded _____

Shipping papers properly completed _____

Remarks: _____

Operator's Signature _____

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4. DEFINITIONS & TERMS.

Area alarm

An area radiation level monitor that provides a highly visual warning when the radiation level exceeds a pre-set threshold. Commonly referred to as Gammalarms, use is required by most jurisdictions in permanent radiographic installations and they are often used in conjunction with door interlocks and audible alarms. Portable area alarms are required by some jurisdictions for radiography performed at temporary job-sites.

Alarm ratemeter

An alarm worn by radiography personnel that provides a continuous audible warning when the alarm ratemeter detects a radiation level in excess of a pre-set threshold of 5mSv/hr (500mR/hr). This redundant safety alarm is required by regulation for temporary job-site radiography within the USA.

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Apparatus for industrial gamma radiography

Apparatus including an exposure device, a source assembly as applicable, a remote control, a projection sheath, an exposure head and accessories designed to enable radiation emitted by a sealed radioactive source to be used for industrial gamma radiography purposes. Also known as: isotope radiography system, isotope radiography kit.

Automatic securing mechanism

An automatically activated mechanism located on the radiographic exposure device designed to restrict the source assembly in the secured position.

Beam limiter

A shielding device for confining the elements of a beam of radiation to an assigned solid angle. Beam limiters are generally manufactured from lead, tungsten and depleted Uranium and are pre-positioned over/on the radiation source's working position. Also known as: collimators.

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Control crank

A control cable cranking device that is a component of the remote controls. The control crank is used at a distance by the radiography personnel to move the radiation source to and from the device, through projection sheaths to and from the exposure position. Manual control crank mechanisms are commonly used, but automatic exposure controllers are available which can be operated from a greater distance and allows preset timing and automatic expose and retract modes. Also known as: wind-outs, crank-outs and hand-cranks.

Control cable

A cable or other mechanical means used to project and retract the source assembly out from and into the radiographic exposure device by means of remote control. The control cable includes the means of attachment to the source holder. Also known as: remote control cable, drive cable, Teleflex™ cable.

Control cable sheath

Rigid or flexible tube for guiding the control cable from the remote to the radiographic exposure device and providing physical protection to the control cable. The control cable sheath includes the necessary connections for attachment to the radiographic exposure device and to the remote control. Also known as: control cable housing, conduit.

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Exposure device (container)

Radiographic exposure devices are used to remotely project the radiation source to a predetermined exposure position when required and to securely maintain it and shield it when it is not in use. Current equipment requirements require devices be designed and tested to ISO/ANSI standards and pertinent transportation regulations for transport containers. Also known as: projector, gamma ray projector (G.R.P.), camera, pill-box, source-box, exposure container.

Exposure head

Device which locates the sealed source included in the source assembly, in the selected working position and prevents the source assembly from projecting out of the projection sheath. Also known as: source stop, end stop, snout and head-hose.

Locked position

Describes the condition when the lock on a radiographic exposure device or transport container is fully engaged to lock the source assembly in place and the key is removed from the lock. This condition prevents unauthorized personnel access to the sealed source assembly locked within the device.

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Maximum rating

The maximum activity expressed in bequerels and curies that cannot be exceeded, of a sealed source specified by radionuclide by the manufacturer when contained within a radiographic exposure device or a transport container.

Plunger lock

A mechanical device with a key used to lock or unlock the radiographic exposure device or transport container.

Projection sheath

A flexible or rigid tube for guiding the source assembly from the radiographic exposure device to the working position, having the necessary connections for attachment to the radiographic exposure device and the exposure head or including the exposure head itself. The projection sheaths also provide protection of the source assembly and attached control cable from water, dirt, sand and other foreign materials usually present at radiography environments. Also known as: source guide tubes, guide tubes, source tubes, head-hoses. Examples of rigid projection sheaths include j-tubes, probes, jet engine probes.

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Remote control

The mechanical device that enables the source assembly to and from a working position by operation from a distance away from the radiographic exposure device. The remote control includes the control crank mechanism (normally a hand-crank), and where applicable, also the control cable, the control cable sheath and the necessary connections and attachments. See additional description under 'control crank'.

Reserve sheath

Remote control sheath (conduit) containing the length of control cable, necessary for the projection of the source assembly.

Sealed source

Radioactive source sealed in a capsule or having a bonded cover, the capsule or cover being strong enough to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed. Commonly referred to as: the 'source' or the 'pill'.

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Secured position (shielded position)

The position of the sealed source when fully shielded and restricted from moving within the radiographic exposure device. Note: When in the secured position during radiographic operations, the radiographic exposure device may be unlocked.

Simulated source

A sealed source whose structure resembles a sealed radioactive source, but does not contain any radioactive material. Also known as: mock source, dummy source, phantom source, dummy pill.

Source assembly

A source holder with a sealed source attached or included. In cases where the sealed source is directly attached to the control cable without the use of a source holder, the source assembly is the control cable with the sealed source attached. In cases where the sealed source is not attached to the control cable nor included within the source holder, the sealed source is the source assembly.

In the case where a simulated source is attached to or included with a source holder or control cable, this becomes a simulated source assembly.

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Flexible type source assemblies are also known as 'pigtailed'. The source assembly is most commonly referred to as the 'source'.

Rigid or chain link type source assemblies are also known as: source rods, source pencils, source trains, source chains.

Source holder

A holder or attachment device, by means of which a sealed source or simulated source can be:

- directly included in the radiographic exposure device (category I apparatus - an exposure device in which the source assembly is not removed for exposure).
- fitted at the end of the control cable (category II apparatus - an exposure device from which the source assembly is projected out through a projection sheath to the exposure head for exposure. The exposure is remotely operated.)

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Source holders may be an integral part of the source assembly or may be capable of being dismantled for sealed source replacement.

Source changers

A lockable Type A or Type B transport container used to transport new sealed source assemblies, exchange them and return depleted sealed source assemblies to the manufacturer. Source changers are also utilized for storage of sealed source assemblies. Also known as: source exchangers and storage containers.

Working position

Condition of the exposure container and source assembly when in the position intended for the Performance of industrial gamma radiography.

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5. EMERGENCIES & PERSONNEL SAFETY.

5.1 Emergencies

During the termination of a radiographic exposure, observation of the survey meter provides an indication of source movement while cranking the remote control handle. After retracting the sealed source into the exposure device, radiographers are required to perform a confirmatory survey of the exposure device, the projection sheaths and beam limiter when used. Performing a confirmatory survey after a radiographic exposure is required by regulation and is the only method that the radiographer should rely on to determine if a source assembly is in the fully shielded position within the exposure device. If the radiographer measures any radiation level that indicates the sealed source is not fully shielded while performing the confirmatory survey, the radiographer must first recognize that problem exists and then follow his company's emergency procedures. Emergency conditions are those problems in which the source assembly cannot be returned to the shielded position by normal means, specifically the remote control crank mechanism. The majority of problems experienced by radiographers are where the source assembly becomes disconnected or when the source assembly becomes jammed in the projection sheath while in an exposed position. The important safety points for radiographers to follow are:

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- Always perform a confirmatory survey after each exposure.
- If higher than expected radiation levels are measured, recognize that an emergency exists.
- Follow emergency procedures.
- Do not attempt to retrieve the sealed source. Secure the area and notify the Radiation Safety Officer.

The radiography crew is limited to the following basic steps that must be adhered to under regulations in the USA (verify national regulations for controlled and supervised areas) :

- 1 Immediately leave the area and maintain continuous surveillance of high radiation area.
- 2 Adjust the restricted area boundary to ensure the measured dose/rate is < 2 mR/hr. Do not allow anyone into the area.
- 3 Immediately notify the Radiation Safety Officer.
- 4 Do not leave the area unattended under any circumstances. Maintain security of the area until the Radiation Safety Officer arrives at the site.

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Do not under any circumstances attempt to retrieve the source. Performing source retrieval is a licensed activity that allows only specially trained RSOs to respond to an emergency. This regulatory requirement is the result of overexposures to radiographers attempting to handle emergency retrievals by themselves.



WARNING



An unshielded source must not be picked up or handled at close range under any circumstances. An unshielded source at close range can cause serious injury or death to anyone who is exposed to it, even for a short duration of time.

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5.2 Training

Formal classroom training in radiation safety, supervised hands-on training and certification by an independent certifying organization of radiographers are essential components for radiological safety in isotope radiography and is a regulatory requirement in the United States and Canada.

QSA Global, Inc. provides radiation safety and inspection & maintenance training at the Baton Rouge, Louisiana and Burlington, Massachusetts facilities. On-site training is available by arrangement.

5.3 Access to Restricted Areas

The site where radiography is performed must be separated from other work areas by as much distance as possible. If applicable, check for occupation of the areas above and below the radiography site.

Clearly defined boundaries must be set up and warning signs displayed to provide warning and prevent access to the radiography site by unauthorized personnel before any exposure begins.

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No one should enter the boundary marking a 'Restricted Area' or 'Controlled Area' without a film badge or TLD, direct reading pocket dosimeter (or electronic pocket dosimeter) and alarm ratemeter (if required).

A pocket 'chirper' alarm is required in some countries to provide radiography personnel with an immediate audible warning of a high radiation intensity.

5.4 United States Regulations

'High Radiation Area' signs must be posted where a dose of 1 mSv (100 mRem) could be received in any one hour. The radiographers must provide continuous direct surveillance of the area or when a permanent installation is used, the entrance must be equipped with door interlocks, audible and visual warnings.

'Radiation Area' signs must be posted where dose of 5 μ Sv (5 mRem) could be received in any one hour.

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'Restricted Area' must be identified and posted where a dose of 20 μ Sv (2 mRem) could be received in any one hour or 1 mSv (100 mRem) in one year.

In practice, the 'Radiation Area' and 'Restricted Area' are combined and identified by the use of a rope barrier. The area is posted with the 'Radiation Area' signs where the maximum dose will not exceed 20 μ Sv (2 mR) in any one hour or 1 mSv (100 mRem) in a year. The practice of using the 'Radiation Area' sign at the 'Restricted Area' boundary clearly defines why the area has been restricted. Additionally, the trefoil (radiation) symbol provides a visual warning for those individuals who cannot read.

During a radiographic exposure/transfer, a calibrated and operable survey meter must be used to confirm the dose rate at the 'Restricted Area' boundary and adjusted if the dose rate exceeds the limit of 20 μ Sv (2 mRem) in one hour.

During the radiographic exposure, the radiographers must maintain continuous direct surveillance of the 'High Radiation Area' in addition to ensuring that no one enters their posted 'Restricted Area'.

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5.5 EU Regulations

A 'Controlled Area' must be marked with a barrier at a distance where the radiation intensity will not exceed 7.5 $\mu\text{Sv/hr}$ (0.75 mR/hr). The boundary dose rates must be noted and the record kept for 2 years. During radiographic operations, only classified radiation workers are allowed inside this area.

A 'Supervised Area' is defined as the area where the boundary dose rate limit must not exceed 2.5 $\mu\text{Sv/hr}$ (0.25 mR/hr). No barriers or notices are required here, but the radiographer must be vigilant to ensure that personnel in this area do not enter the 'Controlled Area'.

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5.6 Personnel Monitoring

All personnel who enter a 'Restricted' or 'Controlled' area or are present during radiographic operations are required to wear the appropriate personnel monitoring devices as required by the regulatory jurisdiction.

These devices can include; film badges; thermoluminescent dosimeters (TLD); optically stimulated luminescence badges; direct reading pocket dosimeters; electronic pocket dosimeters; alarm ratemeters; and audible alarms.

Calibrated and operable survey meters must be used to determine radiation levels when conducting radiographic operations.

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6. DISPOSAL.

By international regulations, radioactive materials that are no longer required must be transferred to a licensed recipient for final disposition. Radiography source assemblies that have depleted beyond their useful working life may be returned to authorized recipients using a source changer authorized for the specific model source assembly.

Authorized recipients will provide any specific conditions to the shipper as required by regulatory authorities. As a minimum, sources that are transferred for a final disposition must be within a current leak test and properly secured within an authorized package before shipment.

Damaged, cropped, modified or contaminated source assemblies may require special handling and special transport containers. Notify the authorized recipient for specific instructions in these circumstances.

If the Type B transport status of a damaged source changer is impaired, the source changer must be transported without radioactive source assemblies. DU shielded source changers sent for final disposition must be properly

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packaged, surveyed, marked and labeled before placement into the transportation system. **Contact QSA Global, Inc. for assistance in the transfer of a damaged source changer.**

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