NILES STEEL TANK COMPANY

Radiography Operation Manual

8503110530 850213 REG3 LIC30 21-04741-01 PDR

LIST OF CONTENTS

ORGANIZATIONAL STRUCTURE

- 1. Radiographic Facility
- 2. Radiation Detection Instruments
- 3. Training Program
- 4. Radiographic Operating Procedure T/O 402 Projector
- 5. Radiographic Operating Procedure T/O 660 Projector
- 6. Internal Inspection and Management Control System
- 7. Emergency Procedures
- 8. Use of Survey Meter, Dosimeter and Film Badge
- 9. Inspection and Maintenance Procedures
- 10. Source Changer Procedure, Inspection and Maintenance Form

ORGANIZATIONAL STRUCTURE RADIOGRAPHIC DEPARTMENT



1.0 RADIOGRAPHIC FACILITY

1.1 Material of Radiation Cell

1.1.1 The floor of the radiation cell is constructed of a concrete slab. The area above the cell is covered by mason board type material and corrugated metal. The roof area immediately above the cell, is a "High Radiation" area with a "Radiation Area" at its perimeters. This radiation area is surrounded by an anti-personnel fence with a locked gate and appropriate warning signs. The key to the gate will be controlled by the R.S.O. The radiation levels outside this "Radiation" area shall not exceed two millirems in any one hour, nor 100 millirems in seven consecutive days. The walls of the radiation cell are as called out on drawing (Appendix 1) and shows the respective radiation levels.

1.2 Security Safeguards

1.2.1 A Tech/Ops Model 492D "Gamma Alarm" is installed in the radiation cell. The "Gamma Alarm" emits a flashing high intensity red light when 1 mR/hr. is present. If the door is opened or left open, a loud audible alarm will sound. Audible alarm will discontinue when door is closed. Personnel are warned to keep out of area when red light is present. (When no radiation is present, a green light is on.) The "Gamma Alarm" is checked for proper operation when quarterly inventory of source is taken.

2.0 RADIATION DETECTION INSTRUMENTS

- 2.1 The Niles Steel Tank Company uses two survey meters, two pocket dosimeters and one dosimeter charger for radiographic functions performed; they are as follows:
 - A. Gamma Industries Model 250 B
 - 1. Radiation detected: Gamma
 - 2. Detection range: 1 mR/hr. to 1 R.
 - Intended use: This instrument shall be the instrument used mainly for the radiographic operations performed at Niles Steel Tank Company.
 - 4. Calibration method: The survey meter shall be sent every three (3) months to Tech/Ops, Inc., 40 North Avenue, Burlington, Massachusetts, 01803 for calibrations. The type of source they use is a Cs 137. The procedures provided for the operation of this unit are followed by Tech/Ops, Inc. Tech/Ops, Inc., are licensed under NRC license #20-00277-03, to perform calibrations on survey meters.

- The survey meter calibration due date shall be offset of the other to avoid having both meters sent out of the plant at the same time.
- B. Victoreen Model 492 B
 - 1. Radiation detected: Gamma
 - 2. Detection range: 1 mR/hr. to 1 R.
 - 3. Intended use: The instrument shall be used as a back-up instrument in the event that the Gamma Industries Meter would fail. It would also be used when the Gamma Industries Meter is out at its required calibration. This instrument would also be used with the other survey meter in open air exposures.
 - 4. Calibration method: The survey meter shall be sent every (3) months to Tech/Ops, Inc., 40 North Avenue, Burlington, Massachusetts, 01803, for calibration. The type of source they use is a Cs 137. This source is contained in the Tech/Ops Model 571 Gamma Survey Meter Calibration Unit. The procedures provided for the operation of this unit are followed by Tech/Ops, Inc. Tech/Ops, Inc., are licensed under NRC license #20-00277-03, to perform calibration on survey meters.
 - The survey meter calibration due date shall be offset of the other to avoid having both meters sent out of the plant at the same time.
- 3.0 TRAINING PROGRAM
 - 3.1 Radiographer's Assistant

3.1.1 Initial Training

- (A) A trainee will work with a radiographer for a period of three months minimum to familiarize himself with our radiographic operations. At this time the trainee is not using the equipment, but is only observing.
- (B) During this three month period, the radiographer is teaching the trainee the handling and use of radiographic equipment and our operating and emergency procedures.
- 3.1.2 On the Job Training
- (A) At the end of the three month period, the trainee is given a written examination. After successfully passing this examination and demonstrating his competence in the handling and use of the radiographic equipment, he is classified as a radiographers' assistant. This individual is allowed to perform radiographic duties under the personal supervision of a radiographer.

- (B) Personnel who are to be classified as radiographers' assistant shall only perform radiographic operations under the supervision of a radiographer and meet the following requirements:
 - Pass an examination taken out of context of the training course manual provided by the Technical Operations, Inc. This examination shall be reviewed by the Radiation Safety Officer.
 - Show competency in the use of radiographic equipment, which will be employed in his assignment.
 - Have a clear understanding of the operating and emergency procedures of the radiographic operation at the Niles Steel Tank Company.

3.2 Radiographer

- 3.2.1 Initial Training
 - (A) Personnel who are to be classified as radiographers shall complete all required training of a radiographers' assistant plus attend schools or commercial companies, which provide training courses for radiographers. (i.e., Technical Operations, Burlington, Massachusetts)

3.2.2 On the Job Training

- (A) A minimum of three months on the job training is required.
- 3.3 Periodic Training
 - 3.3.1 Periodic training will be provided annually to keep personnel abreast of any new developements in the radiography program.
 - 3.3.2 Quarterly examinations shall be given by the Radiological Safety Officer to ensure that all personnel have a working knowledge of the Commissions regulations.
 - 3.3.3 Personnel who are hired with experience as a radiographer or radiographers' assistant, shall pass the prescribed test accompanied this section. The radiographer shall demonstrate to the R.S.O. he has competency in the practical application of operating and conducting surveys with this company's radiography equipment.
- 3.4 A record shall be kept for certification of individuals classified either as radiographers or radiographers' assistant. This record will be maintained for inspection by the Commission.

3.5 When an individual classified as radiographer, either has left our company or been advanced to a position where his duties as radiographer cannot be performed in completeness, the radiographer's assistant shall be sent to school so we can always have a radiographer employed who meets all required qualifications.

3.6 Instructors

- 3.6.1 All personnel who have successfully completed the Industrial Radiography Safety Course given by the Technical Operations, Inc. and designated as radiographers, shall also be employed as instructors for personnel who are to be trained as radiographers' assistant.
- 3.6.2 The following personnel presently employed shall serve in a supervisory capacity over radiographers' assistants:
 - A. NAME: J. C. Wood TITLE: Radiological Safety Officer
 - B. EDUCATIONAL BACKGROUND: B. S. Degree. Successfully completed the course "Isotopes for Industrial Radiography" given by the Picker Corporation of Cleveland, Ohio.
 - C. EXPERIENCE: 21 years experience using the Tech/Ops 402 Gamma Ray Projector. 21 years experience using the Depleted U. Source Changer, Tech/Ops Model 414 and Tech/Ops Model 650.

RADIOGRAPHIC OPERATING PROCEDURES

- 4.0 TO PERFORM RADIOGRAPHY WITH THE T/O 402 PROJECTOR: THE FOLLOW-ING STEPS WILL BE FOLLOWED:
 - 4.1 In Radiation Cell
 - 4.1.1 Carry an operable and calibrated survey meter and always be sure the meter is on. (See procedure #8)
 - 4.1.2 Wear your film badge on clothing that you won't be removing during the course of radiographic functions.
 - 4.1.3 Wear a charged pocket dosimeter on clothing that won't be removed during the course of radiographic functions.
 - 4.1.4 Get keys for Radiation Cell door and Projector from R.S.O.
 - 4.1.5 Approach Cell door with survey meter on. If reading is zero mR/hr., open door and approach Projector. Do not enter Cell if "Gamma Alarm" is activated and red light is flashing. Make sure the Projector is LOCKED.
 - 4.1.6 Survey all sides of Projector and record "Base Reading." NO BASE READING SHALL EXCEED 200 mR/hr.
 - 4.1.7 Unlock Projector and carefully remove source guide tube then the control cable and crank assembly. Make sure source stop is connected to source guide tube.
 - 4.1.8 Set-up exposure, securely clamp source stop, remove all kinks and bends (as possible) and make sure nothing can fall and/or cause damage to the source guide tube during exposures.
 - 4.1.9 Retreat with control crank (and survey meter) outside of the Cell. Make sure there are no kinks or sharp bends in the control cable. Radiographer should place control crank in the place where he feels that he will receive the least exposure.
 - 4.1.10 Lock Cell door and activate source by turning the control crank handle counter-clockwise (rapidly) until source reaches source stop, counting the amount of turns. Radiographer will remain in constant surveillance of Cell area during exposures.
 - 4.1.10A If undue resistance is encountered at any point, reverse direction of crank until source is in its shielded position. (The amount of cranks <u>out</u> should be equal with the amount of cranks <u>in</u>.)

- 4.1.10B With survey meter in hand, approach Cell and unlock. (If "Gamma Alarm" is activated with red light flashing, Do Not open door, Do Not enter. Return to crank and completely retract source to it's full shielded position). Enter Cell noting survey reading. Survey all sides of Projector and re-establish Base Reading. Survey source guide tube and collimator (if used).
- 4.1.10C Check for kinks or sharp bends in source guide tube. Check for kinks or sharp bends in control cable. Return to step 4.1.10.
 - 4.1.11 Survey outside wall of radiation cell. Reading should be 2 mR/hr. or less at 18 inches from any surface.
 - 4.1.12 If any readings exceed 2 mR/hr., post a "Restricted Area" and secure from unauthorized personnel.
 - 4.1.13 When the exposure is complete, retract the source by the control crank rapidly clockwise to the source's fully shielded position, counting the amount of cranks. (The amount of cranks in should equal the amount of cranks <u>out</u>.)
 - 4.1.14 With survey meter in hand, approach Cell door, survey and unlock. (Do not enter Cell if the "Gamma Alarm" is activated with the red light flashing. Make sure source is in it's fully shielded position.) Approach Projector, survey all sides and re-establish Base Reading.
 - 4.1.15 When making another exposure, proceed from step 4.1.8.
 - 4.1.16 When all series of exposure are complete, return control cable and control crank assembly back to the Projector cabinet. Return source guide tube and source guide stop back to the Projector cabinet. Survey all sides of Projector. No survey shall exceed 200 mR/hr. at any surface.
 - 4.1.17 Read and log pocket dosimeter readings and return film badges to their proper places.

- 4.2 In Plant Open Exposures (with T/O 402 Projector)
 - 4.2.1 After determining the area in the plant where the exposures are to be taken, also in taking into consideration available auxiliary shielding. Walls and neighboring tanks are good examples. Calculate the perimeters of your "High Radiation Area" and your "Restricted Area" using the "Inverse Square Law."
 - 4.2.2 Post your "High Radiation" signs in their respective places. Post and rope off "Restricted Area" perimeters. Notify all personnel in area, of the perimeters of the "Restricted Area."
 - 4.2.3 Proceed from step 4.1.1 through 4.1.6.
 - 4.2.4 Roll Projector out into the shop to where the exposures are to be taken.
 - 4.2.5 Proceed with steps same as 4.1.7 and 4.1.8. Remember there is no "Gamma Alarm" in the shop for this type of exposure.
 - 4.2.6 Retreat with control crank to the full length of the control cable away from the Projector and the exposure to be taken.
 - 4.2.7 With survey meter at side, expose source as prescribed in step 4.1.10. Again, if undue resistance is encountered with the source traveling down the source guide tube, the source is to be retracted to it's fully shielded position and the following step shall be taken:
 - 4.2.7A Approach Projector with survey meter in hand. Survey all sides of Projector, re-establish Base Reading and survey source guide tube and collimater (if used). To assure proper location of the source in it's shield.
 - 4.2.7B Remove any kinks or tight bends from control cable and source guide tube. Return to step 4.2.7.
 - 4.2.8 After each exposure, retract source as prescribed in 4.1.13. Approach Projector with survey meter, survey all sides and re-establish tise Reading. Survey source guide tube and collimator (if used). NO PROJECTOR SURVEY SHALL EXCEED 200 mR/hr. AT ANY SURFACE.
 - 4.2.9 When series of exposures are complete, repeat step 4.2.8, then put control cable assembly in Projector cabinet. Put source guide tube in Projector cabinet. Lock Projector cabinet. Survey all sides of Projector.

- 4.2.10 Roll Projector into Radiation Cell. Survey, close and lock Cell door, remove "Restricted Area" boundry, etc.
- 4.2.11 In the event a sealed source becomes disconnected or jammed during radiographic functions and cannot be returned to its fully shielded (stored) position by use of the control crank, the following steps shall be immediately taken by the Radiographer:
 - All surrounding personnel shall be evacuated Α. immediately.
 - Β. Survey the area.
 - Establish a restricted area of 2 mR/hr. or lower C. and secure.
 - Notify the Radiological Safety Officer: D. J. C. Wood ----- 683-0340 1505 Valley View Dr. Niles, Michigan 49120
 - Maintaining direct surveillance and control over the Ε. area until the situation is corrected.
 - F. At NO time shall the radiographer try to retrieve or attempt to place the sealed source in its shielded position without qualified personnel conducting this situation.
 - G. Technical Operations will be called in for source retrieval.
- 4.3 Inspection and Maintenance
 - 4.3.1 Inspection and maintenance shall be in accordance with procedure number 9.0.
- 4.4 Source Changing
 - 4.4.1 The source should be changed every six months in accordance with procedure number 10.0 or must be leak tested in accordance with procedure number 6.1.8.
- 4.5 Documentation
 - 4.5.1 As outlined in Section 6.0, all documentation shall be kept for inspection by the Commission. This shall include: Personnel monitoring records, utilization log, quarterly inventory, instrument calibration and daily inspection log.

- 5.0 TO PERFORM RADIOGRAPHY WITH THE T/O 660 PROJECTOR: THE FOLLOW-ING STEPS WILL BE FOLLOWED:
 - 5.1 In Radiation Cell
 - 5.1.1 Carry an operable and calibrated survey meter and be sure the meter is on. (see procedure #7)
 - 5.1.2 Wear your film badge on clothing that you won't be removing during the course of radiographic functions.
 - 5.1.3 Wear a charged pocket dosimeter on clothing that you won't be removing during the course of radiographic functions.
 - 5.1.4 Get keys for Radiation Cell door, Projector cabinet and Projector from R.S.O.
 - 5.1.5 Approach Cell door with survey meter on. If reading is zero mR/hr. and "Gamma Alarm" green light is on, open Cell door and approach Projector storage cabinet. Do not enter Cell if "Gamma Alarm" is activated and red light is flashing.
 - 5.1.6 Make sure Projector cabinet is locked, Survey all sides. Unlock cabinet, remove Projector, survey all sides at surface and record Base Reading. NO READING SHALL EXCEED 200 mR/hr. AT ANY SURFACE.
 - 5.1.7 After disconnecting source shipping plug, remove source guide tube from Projector cabinet. Connect to Projector and make sure source stop is connected to source guide tube. Remove control cable and crank assembly from Projector cabinet and connect to Projector. DO NOT unlock source selector ring at this time.
 - 5.1.8 Set-up exposure, securely clamp source stop, remove all kinks and sharp bends (as possible) and make sure nothing can fall and/or cause damage to the source guide tube during exposures.
 - 5.1.9 Retreat with control crank (and survey meter) outside of the Cell. Make sure there is no kinks or sharp bends in the control cable. The Radiographer should place control crank in the place where he feels that he will receive the least exposure.
 - 5.1.10 Unlock source selector ring on Projector and turn selector ring to the "operate" position. Retreat outside the Cell, lock Cell door, then activate the source by turning the control crank handle rapidly counter-clockwise until source reaches the source stop. Notice distance recorded on the odometer. (The odometer should read seven feet for each section of source tube used. Max. of three or 21 feet.) Radiographer will remain in constant surveillance of Cell during all exposures.

- 5.1.10A If undue resistance is encountered at any time while source is traveling down source guide tube or odometer does not show that the source is not in it's fully <u>exposed</u> position in the source stop. Retract source by turning rapidly the control crank clock-wise until it stops in the shielded position. The odometer should read 000. DO NOT FORCE CRANK.
- 5.1.10B With survey meter in hand, approach Cell and unlock. (If "Gamma Alarm" is activated with red light flashing, Do Not enter. Return to crank and completely retract source to it's fully shielded position.) Enter Cell noting survey reading. Survey all sides of Projector and re-establish Base Reading. Survey source guide tube and collimator (if used).
- 5.1.10C Check for kinks or sharp bends in source guide tube. Check for kinks or sharp bends in control cable. Correct situation and return to step 5.1.10.
 - 5.1.11 Survey outside walls of the Radiation Cell. Readings should be 2 mR/hr. or less 18 inches from any surface.
 - 5.1.12 If any reading exceeds 2 mR/hr., post a "Restricted Area" and secure from unauthorized personnel.
 - 5.1.13 When exposure is complete, retract source by turning the control crank handle rapidly clockwise to the source's fully shielded position. The odometer should read 000.
 - 5.1.14 With survey meter in hand, approach Cell door, survey and unlock door. Again, check the "Gamma Alarm" for a green light. Approach Projector, survey all sides and re-establish Base Reading. Move selector ring to locked position.
 - 5.1.15 When making another exposure, proceed from step 5.1.8.
 - 5.1.16 When all series of exposures are complete, lock Projector selector ring with key. (If selector ring will not lock, this means that the source is not in it's fully stored position.) Remove cable and source guide tube from Projector and store in Projector cabinet. Return Projector shipping plug back into the Projector. Re-survey all sides of the Projector and check Base Reading. No readings shall exceed 200 mR/hr.
 - 5.1.17 Put Projector and gear back into the Projector cabinet. Lock cabinet and survey. NO READING SHALL EXCEED 200 mR/hr. Retreat from Cell and lock Cell door.

- 5.1.18 Read and log pocket dosimeter readings and return dosimeter and film badge to their proper places.
- 5.2 In Plant Open Exposures (with T/O 660 Projector)
 - 5.2.1 After determining the area in the plant where the exposures are to be taken, also in taking into consideration available auxiliary shielding. Walls and neighboring tanks are good examples. Calculate the perimeters of your "High Radiation Area" and your "Restricted Area" using the "Inverse Square Law."
 - 5.2.2 Post your "High Radiation" signs in their respective places. Post and rope off "Restricted Area" perimeters. Notify all personnel in area, of the perimeters of the "Restricted Area."
 - 5.2.3 Proceed from steps 5.1.1 through 5.1.6.
 - 5.2.4 Put Projector on "two wheel dolly" along with the control cable assembly and the source guide tube. With survey meter in hand, roll Projector and gear out to where the exposures are to be taken.
 - NOTE: The T/O 660 Projector should not be carried by personnel, or as little as possible. Projector <u>surface</u> to <u>skin</u> contact should be kept to a very minimum.
 - 5.2.5 Disconnect source shipping plug, connect source guide tube, then connect control cable assembly to Projector. DO NOT unlock source selector ring at this time.
 - 5.2.6 Set-up exposure, securely clamp source stop, remove all kinks and sharp bends (as possible) and make sure nothing can fall and/or cause damage to the source guide tube during exposures.
 - 5.2.7 Retreat with control crank to the full length of the control cable away from the Projector and the exposure to be taken.
 - 5.2.8 Unlock source selector ring on Projector and turn selector ring to the "operate" position. Retreat to crank, then activate the source by turning the control crank handle rapidly counter-clockwise until source reaches the source stop. Notice distance recorded on the odometer. (The odometer should read seven feet for each section of source tube used. Max. of three or 21 feet.) Radiographer will remain in constant surveillance of exposure area during all exposures.

- 5.2.8A If undue resistance is encountered at any time while source is traveling down source guide tube or odometer does not show that the source is not in it's fully <u>exposed</u> position in the source stop. Retract source by turning rapidly the control crank clock-wise until it stops in the shielded position. The odometer should read 000. DO NOT FORCE CRANK.
- 5.2.88 With survey meter in hand, approach Projector. Survey <u>all</u> sides of Projector and re-establish Base Reading. Survey source guide tube and collimator (if used). Check for kinks or sharp bends in source guide tube. Check for kinks or sharp bends in control cable. Correct situation and return to step 5.2.7.
- 5.2.9 After each exposure, retract source as prescribed in 5.1.13. Approach Projector with survey meter, survey all sides and re-establish Base Reading. Survey source guide tube and collimator (if used). NO PROJECTOR SURVEY SHALL EXCEED 200 mR/hr. AT ANY SURFACE. Turn selector ring to "LOCKED" after each exposure.
- 5.2.10 When series of exposures are complete, repeat step 5.2.9, then key lock Projector selector ring. Disconnect control cable assembly (roll up properly). Disconnect source guide tube and replace source shipping plug in the Projector.
- 5.2.11 Survey all sides of Projector. Check Base Reading. Return Projector and gear to Radiation Cell using a "dolly" if possible. NOTE: The T/O 660 Projector should not be carried by personnel, or as little as possible. Projector surface to skin contact should be kept to a
- 5.2.12 Put Projector and gear back into the Projector cabinet. Lock cabinet and survey. NO READING SHALL EXCEED 200 mR/hr. Retreat from Cell and lock Cell door.
- 5.2.13 Read and log pocket dosimeter readings and return dosimeter and film badge to their proper places.
- 5.2.14 In the event a sealed source becomes disconnected or jammed during radiographic functions and cannot be returned to it's fully shielded (stored) position by use of the control crank, the following steps shall be immediately taken by the Radiographer:

- All surrounding personnel shall be evacuated Α. immediately.
- Β.
- Survey the area. Establish a restricted area of 2 mR/hr. or lower C. and secure.
- Notify the Radiological Safety Officer: D. J. C. Wood ----- 683-0340 1505 Valley View Dr. Niles, Michigan 49120
- Maintaining direct surveillance and control over Ε. the area until the situation is corrected.
- F. At NO time shall the radiographer try to retrieve or attempt to place the sealed source in its shielded position without qualified personnel conducting this situation.
- Technical Operations will be called in for source G. retrieval.
- 5.3 Inspection and Maintenance
 - 5.3.1 Inspection and maintenance shall be in accordance with procedure number 9.0.
- 5.4 Source Changing
 - 5.4.1 The Source should be changed every six months in accordance with procedure number 10.0 or must be leak tested in accordance with procedure number 6.1.8.

5.5 Documentation

As outlined in Section 6.0, all documentation shall be 5.5.1 kept for inspection by the Commission. This shall include: Personnel monitoring records, utilization log, quarterly inventory, instrument calibration and daily inspection log.

INTERNAL INSPECTION AND MANAGEMENT CONTROL SYSTEM

- 6.0 Internal inspection and management control shall be the responsibility of the Radiological Safety Officer (RSO).
 - 6.0.1 Radiological Safety Officer: J. C. Wood
 - 6.0.2 Qualifications: Successfully completed the course "Isotopes for Industrial Radiography" given by the Picker Corporation of Cleveland, Ohio. Twenty-one year experience using the Tech/Ops 402 Gamma Ray Projector, Depleted Uranium Source Changer, Tech/Ops Model 414 and 650.
 - 6.0.3 Duties of the RSO are as follows:
 - A) Conduct the training program.
 - B) Audits of radiographers and radiographer's assistants performances to assure they are performing their duties in the prescribed manner.
 - 1. Personnel monitoring records.
 - 2. Utilization log.
 - 3.
 - Quarterly inventory. Instrument calibration. 4.
 - 5. Review radiographic operations to determine that all persons involved are doing their jobs in the prescribed manner.
 - () On a semi-annual basis perform the following inspections and/or verify by records kept that the duties are being performed.
 - 1. Supervise receipt of new source and return of the old source and record same.
 - 2. Preventative maintenance of equipment.
 - D) On an annual basis.
 - 1. Nuclear Regulatory License.
 - E) On a periodic basis review radiographic operations to determine that all persons involved are doing their job in the prescribed manner.
 - F) At anytime: Halt the duties of a radiographer or radiographer's assistant when a report is received that a dosimeter has discharged. That person's film badge shall be sent in immediately for processing. The person involved shall not perform any radiography until the report on the film badge reading is received.

6.1 INTERNAL INSPECTION

- 6.1.1 Personnel Monitoring
 - A) The radiographer is responsible for the changing of film badges and presenting the dosimetry reports to the R.S.O. for review.
 - B) Film badges are type "G" as supplied by the R.S. Landauer Company.
 - We are on an automatic system with Landauer and receive new badges every two weeks.
 - When received, badges are given to the radiographer who's duty it is to change the old badge with the new and return the old for processing.
 - 3. Upon receipt the report received from Landauer is given to the radiographer to review and see that radiographic personnel have not exceeded the permitted radiation dose given in Section 20.101 of Part 10 of the Code of Federal Regulations.
 - After review by the Radiographer, the report is presented to the R.S.O. for his review and approval then it is filed.

6.1.2 Utilization Log

- A) A log of radiographic exposures shall be kept and logged by the radiographer.
- B) Incorporated in the utilization log form are a description of the type of exposure device and the identity of person to whom the device is assigned to and location.
- C) Radiography personnel are instructed to fill in the provided spaces as follows (Appendix 3):

Line	1:	Date exposure(s) were taken.
Line	2:	Underline whether the projector was used inside or outside of the radiation cell.
Line	3:	Number of curies at time of exposure.
Line	4:	Reading of mR/hr before entering cell and base reading.
Line	5:	Number of exposures taken - time for each exposure - sequential list of specimens radiographed.
Line	6:	Surveys performed during the exposure at different distances from source.
Line	7:	Pocket dosimeter reading before beginning the radiographic operation.
Line	8:	Pocket dosimeter reading after the comple- tion of all exposures of that day.

- Line 9: Indicate that all the equipment has been locked securely.
- Line 10: Survey reading after completion of exposure and locking of radiation door.
- Line II: Signature of assistant radiographer and radiographer.
- D) The above shall be reviewed quarterly, as a minimum, by the radiological safety officer.
- 6.1.3 Daily Inspection
 - A) Daily inspection of radiographic equipment at the beginning and end of each day that radiography is performed. The radiographer is instructed to thoroughly check equipment by using the inspection form. (See Appendix 2). This will be checked frequently by the radiological safety officer.
- 6.1.4 Quarterly Inventory
 - A) Each quarter of the year, the radiological safety officer shall list the following information, which will be kept on record for review:
 - 1. Isotope used at the Niles Steel Tank Company.
 - Quality of the source (Curies) at the time of inventory.
 - Serial number of the source as given by source supplier.
 - 4. Location of source.
 - 5. Date of inventory.
- 6.1.5 Instrument Calibration
 - A) The radiographer is responsible to send out the two survey meters to Tech/Ops, Inc. for calibration and presenting the proper documentation to the R.S.O. for review.
 - B) The R.S.O. will verify that a file of this documentation is properly completed.
- 6.1.6 Preventative Maintenance of Equipment
 - A) The enclosed procedure for inspection of equipment shall be performed under the supervision of the radiographer.
 - B) The R.S.O. will periodically check to assure that this is being done.
- 6.1.7 Training Program
 - A) It is the duty of the R.S.O. to initiate and/or conduct all training. He will designate responsibility to the radiographer as required.

6.1.8 Leak Testing

- A) Under normal conditions we do not retain a source for more than six months, so no leak test is required.
- B) If a source is retained for more than six months, a leak test shall be performed. Under such conditions the radiographer shall use a Technical Operations, Inc. leak test kit number 518 in accordance with the instructions provided with the kit.
- C) After removing the shipping plug from the Gamma Ray Projector, the nearest accessible point to the stored position of the source shall be checked with the radiation survey meter for detectable radiation.
- D) After the gamma ray projector has been wiped as instructed in Technical Operations leak test kit 518, the swab shall be checked with radiation survey instrument for detectable radiation.
- E) Any radiation readings exceeding 0.005 microcuries after the above has been performed in paragraphs (C) and (D), the radiographer shall perform the required procedures as noted in 34.25 (D) of 10 CFR energy parts 0 to 199.
- F) If radiation levels do not exceed the 0.005 microcuries, the swab shall be sent under normal mailing conditions to Technical Operations for radioassay.
- G) If a situation occurs as described in paragraphs (C) and (D), special handling shall be executed in returning the swab to Technical Operations, Inc.
- H) Records of leak test results shall be kept in units of microcuries and maintained for inspection by the commission for six months after the next required leak test is performed or until the sealed source is transferred.
- All the above operations shall be verified by the Radiation Safety Officer.

7.0 EMERGENCY PROCEDURE RADIOGRAPHY

- 7.0.1 An emergency shall be constituted as the dropping, loss or accidental misuse of a source. In the event of any emergency, however slight, the following steps are to be taken:
 - All surrounding personnel shall be evacuated A. immediately.
 - Β.
 - Survey the area. Establish a restricted area of 2 mR/hr. or lower C. and secure.
 - Notify the Radiological Safety Officer: D. J. C. Wood ----- 683-0340 1505 Valley View Dr. Niles, Michigan 49120
 - Maintaining direct surveillance and control over the area until the situation is corrected. E.
 - At NO time shall the radiographer try to retrieve or attempt to place the sealed source in its F. shielded position without qualified personnel conducting this situation.
 - Technical Operations will be called in for source G. retrieval.

8.0 USE OF SURVEY METERS, DOSIMETERS AND FILM BADGE

- 8.1 Survey Meter
 - 8.1.1 Survey meter shall be operable and calibrated before it may be used.
 - If survey meter is not operating properly, no radio-8.1.2 graphic operations may be performed. Report this problem to the Radiological Safety Officer.
 - Survey meters are to be sent out every three months 8.1.3 for calibration as described in Niles Steel Tank Company Document, "Radiation Facilities and Instruments."
 - 8.1.4 Gamma Industries Model 250 B
 - (A) (B) Turn switch to the battery check position.
 - Meter should move on scale to area marked battery check.
 - If battery strength is adequate, as indicated by (C)
 - the meter, move the switch to the desired range.
 - (D) If battery strength is inadequate:
 - Turn meter off. 1.
 - 2. Remove back cover.
 - Remove two old batteries. 3.
 - 4. Replace with two new batteries.
 - Reassemble unit.
 - 5. Return to step 8.1.4 (A)
 - 8.1.5 Victoreen Model 492 B

Same as procedure above.

- 8.1.6 Dosimeter
 - (A) Place dosimeter on charger and reset at zero at the beginning of each shift and log.
 - (B) If unable to zero dosimeter, log reading shown.
 - (C) (D)
 - Check dosimeter frequently during work day. If a dosimeter has gone off scale, secure equipment and suspend operations. Report immediately to the Radiological Safety Officer. Film badge will immediately be sent in to Landauer for processing and determination of actual exposure.
 - Wear dosimeter on clothing that will not be removed, (E) such as pants loop.
 - Log reading of dosimeter at end of shift and log (F) readings.

8.1.7 Film Badge

- (A) Film badge shall be worn on clothing that will not be removed, such as pants loop.
 (B) Always return film badge to x-ray cabinet at the end of shift and do not take home.

INSPECTION AND MAINTENANCE PROCEDURES

9.0 EQUIPMENT: Tech/Ops Model 402 & 660 Gamma Ray Projector

- A) To insure safety in use and to avoid malfunctions that could impair the productivity of this equipment, the following inspections are to be made. Missing or defective components must be replaced or repaired if the equipment is to function as designed.
- 9.1 Daily Inspection
 - A) The daily checklist is shown on form NST/R1.
 - B) Each item on this checklist is to be performed daily and be recorded by the radiographer. (But only if projector is being used.)
- 9.2 Periodic Inspection and Maintenance
 - A) This inspection shall be conducted on a quarterly basis as outlined in the following paragraphs.
 - 9.2.1 Equipment and Material
 - A) Source changer wrenches screwdriver and allen keys - basin approximately 12" diameter - two (2) quarts solvent (perchlorethylene) - syringe lubricant (2 oz. Texaco "Unitemp" grease) - dummy source assembly.
 - 9.2.2 Procedure
 - A) Remove the source from the unit and store it in the source changer. Follow the instructions for the use of the source change.

9.2.3 Control

A) After the source has been removed from the projector, eject and coil the source drive cable by cranking the control in EXPOSE direction. Examine cable for kinks, fraying, broken wires, or rust. Minor bends in the cable may be straightened by hand. DO NOT USE PLIERS. A cable with frayed or broken wires must be replaced. Light rust may be removed by HAND wire brushing. Do not use a powered brush or abrasives. Heavy rust that has penetrated into the cable will cause unsatisfactory operation or failures. Replace cable.

- B) Clean the cable by immersing the coil in solvent. A heavy accumulation of dirt-ladden lubricant may require more than one washing.
- C) Examine the connector. Use the Tech/Ops Model 550 connector gage to check for wear. Replace if connector fails at any gaged dimension. Examine cable attachment to connector for straightness and evidence of looseness. A loose attachement or bend at this point must be repaired. Do not attempt to fabricate a replacement connector or to fasten one to the cable. The connector is a special heat treated steel made to exacting tolerances and under strict metallurgical control. The attachment is swaged with special tools and proof tested. Order a replacement from Technical Operations, Inc.
- D) Lubricate the cable with Texaco "Unitemp" grease. This is the most satisfactory lubricant for this purpose. Common greases can cause gumming and unsatisfactory operation. Take care in handling the cable to avoid picking up dirt or grit.
- 9.2.4 Control Crank
 - A) Remove control cable housings by undoing fitting nuts. Remove crank unit from reel, remove crank and disassemble. Wash parts in solvent. Check inside of housing for evidence of galling and wear. A deeply scored (more than .020 deep) line where the cable contracts the inner wall of the housing indicates the need for replacement.
 - B) Check clearance between the hubs of the wheel and the bushings. More than .005 clearance indicates need for replacement.
 - C) Examine teeth of wheel for damage. A bent tooth may be filed off. Two or more bent teeth adjacent will require replacement of the wheel.
 - D) Lubricate bushings with "Unitemp" grease and reassemble.

9.2.5 Control Cable Housings

- A) Examine carefully for internal damage by flexing the housings by hand. Internal damage to the reinforcing braid or flexible metallic tube will be evidenced by a crunch feeling when the cable housing is flexed. Cut, flattened, or burnt cable housings should be replaced. Superficial cuts or burns may be sealed and reinforced with tape. Clean housings by syringing a few ounces of solvent into bore, and blow out with low pressure air (not more than 20 PSI.) Do not allow solvent to remain in housings. Do not soak in solvent. Check end fittings for secure attachment.
- 9.2.6 Source Guide Tubes
 - A) Check for cuts, burns or crushed tubes. Check fittings for secure attachment. Examine and test screw threads for function. Clean bore of tube with water or solvent and drain out promptly. Do not soak in solvent. Check for free passage of source by holding tube vertical and dropping dummy source assembly through tube. The dummy source assembly should fall through freely.
- 9.2.7 Shield Assembly
 - A) Check exterior for loose or missing hardware. Replace or tighten as required. Examine source exit fitting. Nut should rotate freely without excessive shake. Look into exit port and check concentricity of source tube with nut. Misalignment indicates a damaged housing or shifting of the shield within the housing. This is best repaired by Technical Operations. We do not recommend disassembly of the shield assembly.
 - B) Examine the shield assembly for complete labels and warning symbol. Replace obliterated or illegible markings. Replacements are available from Technical Operations, Inc.
- 9.2.8 T/O 660 Locking Assembly
 - A) Maintenance of locking mechanism of T/0 660 procedures are found in Appendix 3 of this manual, titled "Tech/Ops Service Bulletin Model 660 Gamma Ray Projectors (Feb. 1970)."

9.2.9 Final Inspection

- A) Reassemble system, connect control cables and source guide tubes to shield, and install DUMMY source. Operate machine several times to be sure of proper function. Check operation of the source position indicator system.
- B) Return to safe position in exposure device and survey. Radiation levels must not exceed the following:
 - 1. At one meter, not more than 10 mR/hr.
 - At the surface of the device, not more than 200 mR/hr.
- C) For further maintenance and repair specifications, consult respective "operations manuals" supplied to Niles Steel Tank Company by projector manufacturer, which are on file with R.S.O.

SOURCE CHANGER PROCEDURES

10.0 RECEIPT, CHANGING AND SHIPMENT OF SOURCES (T/0 414 & T/0 650 Source Changers)

- 10.0.0 Receipt of Shipping Package (Source Changer)
 - 10.0.1A Upon shipment of the Shipping Package, before removal from the final delivering carrier, a survey reading is to be taken of all external sides to assure that the source is properly stored in it's shield. Readings should be below 200 mR/hr. at any given surface. If readings are above 200 mR/hr. on any surface, the Shipping Package shall be immediately removed from the carrier by the (monitored) R.S.O. or the radiographer only. Quickly and safely put the Shipping Package in the radiation cell, post and rope off a "Restricted Area" (if necessary), and secure. The appropriate regional office of the N.R.C. is to be immediately contacted by telephone, along with the final delivering carrier and Tech/Ops, (source vendor).
 - 10.0.1B After assuring that the source is stored properly, a wipe test is to be performed on the external surfaces of the Shipping Package to measure the amount of "removable radioactive contamination." If the removable contamination exceeds .01 microcuries, the final delivering carrier, appropriate regional office of the N.R.C. and Tech/Ops (source vendor), shall be notified immediately by telephone.
 - 10.0.10 At any time, there is a discrepancy in the Shipping Package, such as <u>damage</u>, <u>radioactive contamination</u>, <u>abnormally high survey readings</u>, <u>violation of</u> <u>shipping seals or mismarking</u>, the R.S.O. shall be notified immediately. And after which, the package is only to be moved by the (monitored) radiographer, radiographer's assistant or the R.S.O. The package is to be secured in the Radiation Cell, monitored and a "Restricted Area" is to be posted (if necessary) until discrepancies are resolved by the R.S.O. or his nominee.
- 10.1.0 Removal of Old Source from Projector
 - 10.1.1 Changing of sources shall always be performed in Radiation Cell. Operable survey meters should always be at radiographers side.

- 10.1.2 Locate the source changer so that one section of source guide tube reaches between the fittings on the changer and projector. Remove the source changer cover. Fasten the source guide tube of the projector to the EMPTY channel of the source changer. Note radiation level at source changer. It should not be higher than 2 mR/hr per curie contained.
- 10.1.3 Crank the source from the projector into the source changer. Monitor this operation with your survey meter and be sure the source is propelled into the source changer as far as it will go. The radiation levels at the source changer should not be higher than 2 mR/hr per curie contained.
- 10.1.4 Open the source guides and disconnect the source assembly from the drive cable. The locking sleeve must be retracted by moving the actuated pin from left to right. The thumbnail, a coin or key may be used. This permits the drive cable terminal to be moved sideways out of the hole, freeing it from the connector.
- 10.1.5 Remove source tube from the source changer. Close source guides and replace cap and hold down rod.
- 10.2.0 Installing of New Source
 - 10.2.1 Remove cap and hold down rod from channel containing the new source. Open source guides. Fasten the source guide tube to this channel and engage drive cable terminal to connector of new source by retracting the locking sleeve and inserting the terminal. Release the locking sleeve and allow it to come forward.
 - 10.2.2 Close the source guides. Crank the control to retract the new source into the projector. Monitor this operation and be sure the source is fully retracted.
 - 10.2.3 Remove the old source identification plate from the projector and affix it with seal wire to the source channel containing the old source.
 - 10.2.4 Affix the new source identification plate to the projector.

- 10.2.5 Replace the source changer cover. Tighten bolts and seal with tamper-proof seal provided.
- 10.2.6 Survey all sides of source changer. Readings shall not exceed 200 mR/hr on any surface or 10 mR/hr at 3 feet from any surface.
- 10.3.0 Shipment of Old Source
 - 10.3.1 The container shall be returned to Tech/Ops within thirty (30) days or Niles Steel Tank Company is subject to rental fees. Upon receipt of the container, Tech/Ops will mail an acknowledgement of receipt.
 - 10.3.2 D.O.T. shipping labels for radioactive material provided by Tech/Ops shall be completed by radiography personnel as follows:
 - 1. Name of radioactive element (Iridium 192).
 - 2. Strength of source in curies.
 - mR/hr output at three (3) feet from source changer.

This label then shall be applied to the source changer.

- 10.3.3 The transportation of the source changer will be scheduled with a qualified commercial trucking company. The bill of lading shall show the contents of the source changer, the element contained in the source changer, color of D.O.T. label and state "radioactive material." This information shall be checked by radiographic personnel.
- 10.3.4 Loading of the source changer shall be supervised by radiographic personnel.
- 10.3.5 All receiving and shipments shall be in strict accordance with 10 CFR part 71 (1983) for type B (U) containers.



	ENANCE	REPORT: Sht of Date	
T/O Model Gamma Ray Proje	ctor us	ing IR ¹⁹² Assigned to: Mr. J.C. Wood	
Projector Used Inside/Outside Ra	adiation	n Cell .	
Number of Curies Reading	ng of _	MR/HR Before Entering Cell	
BASE READING @ START M	R/HR	BASE READING @ FINISH MR/HR	
Exposure(s): Number	Time	Serial No.	
	-		
	_		
	1		
	-		
Survey Readings During Exp.	Pocket	Dosimeter Reading Before Exp. MR/HR	
AT FT MR/HR	Pocket I	Dosimeter Reading After Exp MR/HR	
AT FT MR/HR	All Equ	ipment Locked	
Comments:	Survey I	Reading After all Exps MR/HR	
Changes in Operating Characteri	stics	Rust, Dirt, or Sludge Build-Up in the Source Tube	
Proper Operation of Source Position Indicator Mechanism	Proper Positioning of Source Inside the Shield		
Proper Operation of the Crank Mechanism	Shifting of the Shield Inside the Projecting Housing		
Proper Operation of Locking Mechanism	Proper Connection of all Mating Components		
Source and Drive - Cable Wear or Damage	Damage to the Device, Which May Impair its Operation		
Damaged or Worn Source and Drive Tube and Connector Wear and Dam	e Cable age	Cable Drive Gear-Box Damage and Wear	
		Proper Labeling	

Radiographer

à

NUMBER OF

NST/R1

UTILIZATION, INSPECTION & MAINTENANCE REPORT: Sht _____ of ____ Date _____ T/O Model Gamma Ray Projector using IR¹⁹² Assigned to: Mr. J.C. Wood Projector Used Inside/Outs: de Radiation Cell

SOURCE CHANGE

(Model)	Serial No.		
IR/HR			
1R/HR	Projector Projector Projector	Base Reading Old Source In Base Reading Old Source Out Base Reading New Source In	MR/HR MR/HR MR/HR
AR/HR AR/HR	<u>cc</u>	OMMENTS	
Pocket	Dosimeter	Reading Before Exp.	MR/HR
Pocket	Dosimeter	Reading After Exp.	MR/HR
All Equ	uipment Locked		
Survey	Reading At	fter all Exps.	MR/HR
istics	Rust, Di the Source	rt, or Sludge Build- ce Tube	Up in
ition	Proper Positioning of Source Inside the Shield		
	Shifting of the Shield Inside the Projecting Housing		
1	Proper Connection of all Mating Components		
	Damage to the Device, Which May Impair its Operation		
ve Cable mage	Cable Drive Gear-Box Damage and Wear		
	Proper Labeling		
	Pocket Pocket All Equisition	Projector IR/HR CC Pocket Dosimeter Pocket Dosimeter All Equipment Loc Survey Reading And istics Rust, Dia the Source ition Proper Po- the Shie Shifting Projection Damage t Impair i ve Cable Cable Dr mage Proper L	Projector Base Reading New Source In

Radiographer

Radiographer's Assist.

NST/R2

APPENDIX 3 page 1 of 2 SERVICE BULLETIN

Model 660 Gamma Ray Projectors



TECHNICAL OPERATIONS, INC. RADIATION PRODUCTS DIVISION (617) 272-2000 BURLINGTON, MASSACHUSETTS

WARNING

NEVER DISASSEMBLE A GAMMA RAY PROJECTOR WITHOUT PROPER RADIA-TION MONITORING AND MEASURING EQUIPMENT. FOR MAXIMUM SAFETY ALWAYS ASSUME THE PROJECTOR CON-TAINS A RADIOACTIVE SOURCE WHEN RECEIVED FOR SERVICING.

EQUIPMENT

8 1970

The following is a list of equipment required to service the Gamma Ray Projector. The list does not include standard tools, such as allen wrenches, screwdrivers, TRU-ARC pliers, etc.

Master Key (P/N A66001-11) Dummy Source (P/N B66001-20) Drive Cable, Short Length (P/N BSK1760) U-Tool (P/N BSK 1764) Survey Meter Source Changer (P/N TO-414 or TO-650) Cleaning Solvent (clorothene or carbon tetrachloride) Rivet Gun Texaco "Uni-Tenap" Grease

DISASSEMBLY PROCEDURE

The procedure given here has been prepared for the Model 660 Gamma Ray Projector but is applicable for other Technical Operations, Inc. Gamma Ray Projectors. Perform the following:

1. Using a source changer, remove the radioactive source from the projector and insert a dummy source.

2. Remove the protective plate (secured with rivets) located at the bottom of the projector's rear plate.

Remove the screws securing the rear plate to the projector. Remove the end plate from the projector.

4. Using the master key unlock the connector lock. Remove the lock assembly (P/N B66001-12) from the end plate by removing the two attaching socket head screws (# $10-32 \times 1/2$).

 Disassemble the connector. Refer to figure 1, the index numbers given are used to identify all components and also provide the recommended disassembly order.

Note that there are several spring-loaded components in the connector. Care should be exercised during disassembly so that these components are not lost or dropped on the floor.

6. If lock servicing is required refer to the applicable section in this bulletin.

Remove the front plate (14) and retaining ring (12).
 Clean and examine connector (13).



APPENDIX 3 Page 2 06 2

CLEANING AND INSPECTION

All connector components should be thoroughly cleaned with a degreasing solvent. After cleaning, inspect all components for signs of damage or wear. Replace damaged or heavily worn components with identical components (Figure 1 gives correct part numbers for all items).

CONNECTOR LOCK REPLACEMENT

If the lock requires servicing, perform the following disassembly procedure trefer to the exploded view of the lock given in figure 2):

 Remove the two socket head screws(1) holding the lock retainer(3) to the rear plate(2).

2. Remove screw(4) from the lock(5).

3. Remove the lock(5) from the lock retainer(3) by turning key approximately 90° . If a key has broken off in the lock use a pliura ion-the external plunger to turn the lock approximately 90° .



To reassemble the lock, perform the following:

1. If the lock(5) is damaged, replace it with an identical unit.

2. Depress the internal plunger so it clears the hole in the lock retainer(5) and insert the lock into the lock retainer.

3. Align the screw hole in the lock with the slot in the lock retainer and secure the lock with the screw(4).

 Secure the lock assembly to the rear plate(2) using the two socket head screws(1).

CONNECTOR REASSEMBLY

Perform the following:

1. Lightly coat the connector components with Texaco "Uni-Temp" grease (Note: Other greases may form tars or corrosive compounds when exposed to radiation)



2. Refer to step 1 illustration and place the selector ring retainer (9) on a flat surface. (Note the index numbers given in the figure correspond to those in figure 1 to assist in component identification).

3. Place the compression spring (10) on the hub of the selector ring retainer. The spring

should be firmly seated over the hub.

 Place the sleeve (11) on top of the compression spring (10) as shown.

5. Place the selector body (6) on a flat surface so that it is resting on its 5/8" hub. Note the orientation of the stop pin in step 2 illustration.

6. Insert the two short compression springs (8) into the holes in the selector body circumference.

7. Insert the two locking pins (7) into the compression springs (8). With the pins facing up, engage the pins into their respective slots. Restrain the pins in their slots with the thumb and index finger of your left hand. Place the selector ring (5), with lettering (OPERATE-LOCK-CONNECT) facing up, over the selector body (6) as shown in step 2. Note the proper orientation. The stop pin must be located in the cam on the reverse side of the ring (shown dotted in step 2).



8. Holding the selector ring (5) and selector body (6) together, pick them up and place them over the step 1 subassembly [sleeve (11), compression spring (10), and selector ring retainer (9)]. The resulting assembly is shown in step 3 illustration. Check that the following conditions exist:

a. The stop pin is in the cam slot of the ring.

b. The two large holes in the selector ring retainer (9) are aligned with the two large holes in the selector body (6). Note: The internal locking cam will have these holes partially blocked at this time.

9. Insert the anti-rotation lugs (4) and the long compression springs (3) into the two large holes in the selector body (r) as shown in figure 1.

10. Using the four socket head screws (1), attach the connector assembly to the rear plate (2) checking that the word OPERATE on the selector ring (5) is facing out and is in the 12 o'clock position (aligned with the top edge of the rear plate).

11. Connect the dummy source to the short length drive cable and insert the cable through the rear plate and connector.

12. Check spring action in connector by pulling on the cable. Spring action should provide approximately 1/4" travel in the spring. Check the connector action by rotating the selector ring from the OPERATI position, to the LOCK position, and to the CONNECT position.

13. Insert the U-Tool into connector and check reverse connector action by rotating the selector ring from the CON-NECT position, to the LOCK position, and to the OPERATE position. Repeat steps 12 and 13 several times to assure smooth operation. If smooth operation is not obtained, disassemble the connector and thoroughly inspect components for rough edges, burrs, bent pins, etc. which could cause jamming or irregular connector action. Re-lubricate the components and reassemble the connector.

14. When smooth connector operation is obtained, place the dummy source in the connector (selector ring should be in the CONNECT position).

15. Install lock assembly (P/N B66001-12) on the rear plate using two $\# 10^{-3.2} \times 1/2$ socket head screws.

16. Replace the rear plate on the projector and secure with the six attaching screws.

 Replace the protective plate over the bottom two rear plate screws using pop rivets (1/8" diameter x .294" long).