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Pacific Gas and Electric Company®

Work Procedure: WP 347-15
Effective Date: 11/28/2018 Rev. 11

Applied Technology Services (ATS)

Operating, Safety, and Emergency Manual for ATS Industrial X-ray Machines

☐ Yes ☒ No Approved for Nuclear Quality-Related Work ■■■ ☒Periodic Use ☐ Reference Use

1. Scope

1.1 This procedure defines the Radiation Safety Program and Operating, Safety and Emergency (OS&E) Procedures for Pacific Gas and Electric Company (PG&E) Applied Technology Services. The elements and methods, described herein, are based on the State of California Code of Regulations, Title 17, pertaining to radiography employing radiation machines (X-ray equipment).

2. Target Audience

2.1 Only individuals who are trained and have demonstrated an understanding of the operating procedures for the unit, personnel dosimetry, survey instruments, and techniques which will be employed in their assignments, may operate an X-ray machine.

3. Safety

3.1 Safety is covered throughout this document.

Table of Contents for Section 7 - Instructions

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4. Discussion

4.1 This procedure is the guide to safely operating radiation machines. Have the Operating, Safety and Emergency Procedures (OS&E) available whenever you are performing radiography using radiation machines.

4.2 The OS&E manual includes detailed instruction on performing your job in a safe manner, the rules you must follow in your work and useful reference information.

4.3 When the state regulations and specific site procedures (e.g., Diablo Canyon Power Plant [DCPP Procedures]) conflict, the most restrictive requirement applies. If you are not sure which one to follow, contact the radiation safety officer (RSO).

5. Definitions

5.1 As Low As Reasonably Achievable (ALARA)

A radiation safety principle for minimizing radiation doses and releases of radioactive materials by employing all reasonable methods. ALARA is a regulatory requirement for all radiation safety programs.

5.2 Assistant Radiographer

See Radiation Machine Radiographer Assistant

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5.3 Cabinet Radiography

Radiography conducted in an enclosed, interlocked cabinet, such that the radiation machine will not operate unless all openings are securely closed, and the interior of which is so shielded that every location on the exterior meets conditions for an uncontrolled area.

5.4 Controlled Area

Control area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

5.5 Deep-Dose Equivalent

Deep-dose equivalent (Hd), which applies to external whole-body exposure is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm2)

5.6 Dosimeter

A device for measuring the amount of exposure to ionizing radiation received by an individual.

5.7 Effective Dose Equivalent

Effective dose equivalent (HE) is the sum of the products of the dose equivalent to the organ or tissue (HT) and the weighting factors (wT) applicable to each of the body organs or tissues that are irradiated (HE = ΣwTHT).

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5.8 Exposure Room Radiography

Radiography conducted in an enclosed exposure room, the interior of which is not occupied during radiographic operations, which is so shielded that every location on the exterior meets conditions for an uncontrolled area, and the only access to which is through openings which are interlocked so that the radiation machine will not operate unless all openings are securely closed.

5.9 Field Radiography

All radiography other than cabinet and shielded room radiography.

5.10 Gray (Gy)

The SI unit of absorbed dose. One Gray is equal to an absorbed dose of 1 joule/kilogram [1 Gray (Gy) = 100 Rad].

5.11 High Radiation Area

High radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 Rem (100mRem) (1mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

5.12 Radiation Area

Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 Rem (0.05mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

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5.13 Radiation Signs

Signs which warn of the presence of ionizing radiation or material that emits radiation. They display the conventional three-bladed radiation symbol in magenta on a yellow background.

5.14 Radiographer

An experienced radiographer holding an agreement State or IRRSP card that carries the Combination endorsement, who performs radiographic testing with another radiographer, and who is responsible to the licensee for assuring compliance with State Regulations and this OS&E manual. Individual shall have a minimum of 320 hours of radioactive material experience (RAM) and 160 hours of (X-ray) experience using radiation machines, performing radiographic operations, radiation surveys and radiation safety related activities for a total of 480 hours.

An experienced radiographer holding an agreement State or IRRSP card that carries the X-Ray only endorsement, who performs X-ray only testing with another radiographer, and who is responsible to the licensee for assuring compliance with State Regulations and this OS&E manual. Individual shall have a minimum of 160 hours of (X-ray) experience using radiation machines, performing radiographic operations, radiation surveys and radiation safety related activities for a total of 160 hours.

5.15 Radiation Machine Radiographer Assistant

A qualified and certified individual who, under the DIRECT personal supervision of a radiographer trainer, uses exposure devices or survey instruments in radiography and assists the radiographer trainer by manipulating X-ray equipment, survey instruments, and related equipment under the trainer's supervision.

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5.16 Radiographer Trainer (Radiation Machines Radiographer Trainer)

An experienced individual holding an agreement state or IRRSP Combination or X-ray endorsed Industrial radiographer identification card, whose experience is having in excess of 2000 hours of using radiation machines, performing radiographic operations, radiation surveys and radiation safety related activities and so designated in this manual and designated by the Company as radiographer trainer.

5.17 Radiography

The nondestructive testing of materials by the production of an image on a radiation-sensitive surface, such as a radiographic film, by a beam of X-rays.

5.18 Restricted Area

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive material.

5.19 Roentgen

A Roentgen is a measure of ionization in air produced by x-radiation or gamma radiation.

5.20 Roentgen Equivalent Man (Rem)

Rem is a measure of dose of any ionizing radiation to body tissue relative to the estimated biological effects of exposure of 1 R of X-ray. For the purpose of this procedure, 1 "Rem" and 1 "R" are identical for the reason that the sealed sources utilized in industrial radiography do not emit Alpha or Beta radiation outside of the stainless steel capsule. 1 Rem = 1000 milliRem (mR).

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5.21 Shielding Material

Any material used to absorb radiation, and thereby reduce its intensity.

5.22 Shallow-Dose Equivalent

Shallow-dose equivalent (Hs), which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm2) averaged over an area of 1 square centimeter.

5.23 Sievert (Sv), milliSievert (mSv)

The SI unit of any of the quantities expressed as dose equivalent. (1 Sv = 1000 mSv), (1 Sv = 100 Rem, 1 Rem = 0.01 Sv = 10 mSv.)

5.24 Survey

The measurement and recording of radiation intensities at various locations in an area where ionizing radiation exists.

5.25 Total Effective Dose Equivalent (TEDE)

Total effective dose equivalent means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

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6. Responsibilities

NOTE:

California Code of Regulations, Title 17, specifies the tasks a person is allowed to perform when working with X-ray equipment. The complexity of tasks allowed, are based on the radiation safety training and experience of the employee. The levels of training, experience and/or authority, as used by PG&E, are identified by certification as Assistant Radiographer, Radiographer Trainer, Alternate Radiation Safety Officer (ARSO) and Radiation Safety Officer (RSO). However, this procedure recognizes that there is a need for the position of Radiographer, which has the same overall requirements as Radiographer Trainer, but is limited to the role of Radiographer's Assistant due to the State or IRRSP carried by the individual, being limited to Gamma only and does not have the X-ray or Combination endorsement.

6.1 Table 1 lists ATS personnel responsibilities.

Table 1

PERSONNEL	ROLES AND RESPONSIBILITIES
Radiation Safety Officer (RSO)	• RSO has appropriate radiation safety experience and training with full authority and responsibility to administer and enforce the Radiation Safety Program. • Authority to stop radiographic activity until safety requirements have been satisfied and to discharge or suspend any individual who violates the rules and regulations in situations relative to radiation safety. • Provides meaningful interpretation of procedures based on the state andfederal regulations. • Designates ARSO's, and certifies radiographers and assistant radiographers. • Maintaining pre-job planning and tailboard/training records (may also be done bythe Alternate Radiation Safety Officer [ARSO]).

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PERSONNEL	ROLES AND RESPONSIBILITIES
Alternate Radiation Safety Officer (ARSO)	• Responsible for all phases of the program in the absence of the RSO and will report directly to the RSO. • Assists the RSO in the training, qualification and certification for all levels of radiation safety. • Implements the radiation safety program for radiography operations, as directed by the RSO. • Maintaining pre-job planning and tailboard/training records (may also be done by the RSO).
Radiographer Trainer	• Assures the job is performed in accordance with the requirements of this OS&E manual. • Shall not delegate responsibility to an assistant radiographer, but may delegate certain responsibilities to the radiographer. • Clears the restricted area of unauthorized personnel at the time when preliminary control is being established. • Establishes the controlled **RADIATION** and **HIGH RADIATION** areas and assures unauthorized personnel are not allowed to enter the restricted area. • Assumes the role of job site radiation safety lead. • Signs out and signs back into the key safe, any X-ray set keys required to complete radiography. • In the event that the X-ray set has to be taken to the radiographer trainer, the key should be signed out (in this instance only) by a radiographer • Ensures that pre-job planning is conducted (may also be done by the radiographer).

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PERSONNEL	ROLES AND RESPONSIBILITIES
Radiographer	• Carries out the instructions as identified by the radiographer trainer, but not under the direct supervision of the radiographer trainer. • Signs out operational keys (under the specific circumstances detailed in the radiographer trainer section) and transports X-ray equipment to and from jobsites, establishes radiation boundaries, completes radiation boundary surveys, completes associated documentation required by this procedure, and returns equipment to storage upon completing the work. • Ensures that pre-job planning is conducted (may also be done by the radiographer trainer). • Safety of all personnel entering the restricted area. • Any emergency action involving assigned equipment. • Maintaining pre-job planning and tailboard/training records (may also be done bythe radiographer trainer).
Assistant Radiographer	• Carries out instructions and directions given by the radiographer trainer. • Solely an assistant to the radiographer trainer and is under constant supervision of the radiographer trainer at all times and while performing radiation safety related activities such as the establishment of boundaries, site radiation surveys or movement of the x- ray tube and other related equipment. • Shall NOT operate the X-ray set controls unless under the direct supervision of the radiographer trainer. • Only under the direct supervision of a radiographer trainer: Establish the controlled **RADIATION** and **HIGH RADIATION** areas and assure unauthorized personnel are not allowed to enter the restricted area.

7. Instructions

7.1 Personnel Certification, Qualification, and Training

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7.1.1 Authority

- The radiation safety portion of personnel qualification and certification is vested with the RSO or ARSO.

- As a minimum, an annual 8-hour safety refresher training shall be provided for employees on radiation safety aspects of industrial radiography.

7.1.2 Tables 2-4 list the levels of qualification and training for ATS personnel.

Table 2

ASSISTANT RADIOGRAPHER	
QUALIFICATIONS	**TRAINING/CERTIFICATION**
Minimum age - 18 years. No known history of previous radiation exposures which would prohibit or restrict activity. Physically capable of performing assigned duties without endangering themselves or others. Completion of radiation safety training requirements for an Assistant Radiographer. Satisfactory completion of the Assistant Radiographer training and examinations detailed under "Training/Certification."	Carries out instructions and directions given by the Radiographer Trainer and documents these training hours. The radiation safety training hours shall not reflect radiographer training class or field hours as a Level I, II or III, film development, film interpretation, travel, safety meetings, or work that does not relate to actual performance of radiography). Review of state regulations. To have demonstrated understanding in the operating, safety and emergency procedures followed by a written examination of no less than 50 questions in length achieving a grade of at least 80% in which training for this material shall be at least 8 hours long. To have demonstrated competence in the use of radiation machines and survey equipment employed by PG&E ATS, followed by a practical examination containing a minimum of 25 questions and achieving a grade of at least 80%. Instruction in this material shall be at least 4 hours long. The RSO certifies assistant radiographers. Certification includes "I certify that (name of individual) has met the requirements to be a radiation machine radiographer's assistant" (See Attachment 4, 347-15-F04, "Assistant Radiographer Radiation Safety Training".)

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Table 3

RADIOGRAPHER	
QUALIFICATIONS	**TRAINING /CERTIFICATION**
Must meet all assistant radiographer qualifications. Satisfactory completion of the Radiographer training and examinations detailed under "Training/Certification."	Attended a formal 40-hour radiation safety class that is approved by the NRC, the State of California, a state approved program which meets Reciprocal Recognition (title 17, California Code of Regulations section 30335.3), or the ASNT IRRSP program and hold a radiographer identification card issued by any one of the reciprocal recognition states or organizations (e.g. ASNT IRRSP). An experienced radiographer holding an agreement State or IRRSP card that carries the Combination endorsement, who performs radiographic testing with another radiographer, and who is responsible to the licensee for assuring compliance with State Regulations and this OS&E manual. Individual shall have a minimum of 320 hours of radioactive material experience (RAM) and 160 hours of (X-ray) experience using radiation machines. Individual shall have a minimum of 160 hours of (X-ray) experience using radiation machines performing radiographic operations, radiation surveys and radiation safety related activities for a total of 480 hours. An experienced radiographer holding an agreement State or IRRSP card that carries the X-ray only endorsement, who performs X-ray only testing with State Regulations and this OS&E manual. Individual shall have a minimum of 160 hours of (X-ray) experience using radiation machines, performing radiographic operations, radiation surveys and radiation safety related activities for a total of 160 hours. Note:(RAM) and (X-ray) Radiation Safety hours above shall not reflect radiographer training class hours as a Level I, II or III, Film development, film interpretation, travel, safety meetings or work that does not relate to actual performance of radiography. To have demonstrated understanding in the operating, safety and emergency procedures followed by a written examination of no less than 50 questions in length achieving a grade of at least 80% in which training for this material shall be at least 8 hours long. To have demonstrated competence in the use of radiation machines and survey equipment

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RADIOGRAPHER	
QUALIFICATIONS	**TRAINING /CERTIFICATION**
	employed by PG&E ATS, followed by a practical examination containing a minimum of 25 questions and achieving a grade of at least 80%. Instruction in this material shall be at least 4 hours long. Radiographers meeting the above requirements shall be certified by the RSO. Certification shall include “I certify that (name of individual) has met the requirements to be a radiation machine radiographer”. ID cards shall contain name, unique personnel identifier, name and signature of the issuing officer (RSO). (See Attachment 5, 347-15-F05, “Radiographer Radiation Safety Training”.)

Table 4

RADIOGRAPHER TRAINER	
QUALIFICATIONS	**TRAINING/CERTIFICATION**
Previous qualification and certification as a radiographer.	Accumulated a minimum of 2000 hours experience. Satisfactory completion of the ATS radiographer examinations. Completion of periodic radiation safety training requirements for Radiographers as defined in the California Code of Regulations, Title 17, Section 30336.6. Upon successful completion of the required formal training, demonstration and examinations, a radiographer is eligible for certification by the RSO as a radiographer trainer.

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Table 5

PREVIOUSLY EXPERIENCED RADIOGRAPHIC PERSONNEL
REQUIREMENTS
Verification by previous employer(s) of the following: • Confirmation of employment • Length of time employed • Position and/or title held while employed • Verification and record of formal radiation safety training, experience and rating held relative to position or placement. • Prior occupational radiation exposure information. After completing prior employment information and training verification by the RSO or designated individual, the experienced personnel will be given a copy of the OS&E manual to study and review. Radiographic personnel with previous experience are given a minimum of eight (8) hours of informative instruction on PG&E's OS&E along with four (4) hours of training on instruments and equipment used to perform their duties in radiographic inspection. Radiographic personnel with previous experience shall be required to pass examinations that are applicable to the position being filled. Upon completion of these requirements, radiographic personnel with previous experience will be eligible for certification to the level for which they are qualified. (See Attachment 7, 347-15-F07, "Training Record for Previously Trained Radiographers".)

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7.2 Pre-Job Planning

7.2.1 Review Appendix A, “Exposure Room Layout,” and Appendix B, “Warning Signs for Alarms,” to familiarize yourself with the on-site work area.

7.2.2 See Attachment 12, 347-15-F12, “Industrial Radiography Safety Tailboard,” and Attachment 13, 347-15-F13, “Job Safety Analysis (JSA).”

7.2.3 Topics for such pre-job planning include, but are not limited to, the following items:

- California Code of Regulations, Title 17
- X-ray equipment and detection instrumentation (survey meters, dosimeters, TLD, etc.) to be used
- Survey meter techniques, operations, and limitations
- Operating and emergency procedure
- Fundamentals of radiation safety
- Prevention of overexposures to personnel
- Applicable NRC case histories

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7.2.4 The RSO or ARSO maintains pre-job planning and tailboard/training records including:

- Name(s) of instructor(s).
- Names and initials of individuals attending.
- Dates and duration of training.
- Topic(s) discussed.

7.2.5 Training Categories for X-ray Equipment

a. Cabinet Radiography

- No radiographer or assistant radiographer shall operate a cabinet radiography unit until they have received a copy of, instruction in, and demonstrated an understanding of operating procedures for the unit and have demonstrated competence in its use. All cabinet radiographers shall be trained and certified in accordance with section 7of this procedure.

b. Exposure Room Radiography

1. Exposure room radiography is:

- Conducted in an enclosed exposure room, the interior of which is not occupied during radiographic operations.
- So shielded that every location on the exterior meets conditions for an uncontrolled area.

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7.2.5.b (continued)

- Protected by restricted access which is through interlocked openings so the radiation machine will not operate unless all openings are securely closed (except as required by step 7.6.8).

2. No radiographer or assistant radiographer shall operate a shielded room radiography unit until they have received a copy of, instruction in, and demonstrated an understanding of, operating procedures for the unit and has demonstrated competence in its use. All Exposure room radiographers shall be trained and certified in accordance with section 7 of this procedure.

3. Radiographic personnel and every individual who operates, who makes "set-ups", or who performs maintenance on a shielded room radiography unit shall wear appropriate personnel monitoring equipment.

c. Field Radiography

1. Field radiography is all radiography other than cabinet radiography, shielded room radiography, diffraction x-ray and electron microscope. All field radiographers shall be trained and certified in accordance with section 7 of this procedure which also includes the following special training:

- Characteristics of x-radiation
- Units of radiation dose
- Radiation hazards
- Radiation levels from radiation machines

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7.2.5.c (continued)

- Methods of controlling radiation exposure: time, distance, shielding
- Use of radiation survey instruments: operation, calibration, limitations
- Radiation survey techniques
- Characteristics and use of personnel monitoring equipment
- Use of radiation machines in radiography
- Posting of boundaries
- Control of access

d. Diffraction Machine Operation

Diffraction machine operation is used for determining the atomic and molecular structure of a sample. Diffraction machine operators shall be qualified and certified per the instructions in the ATS procedure “WP 357 MT-12 (XRF Operator)”.

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7.2.5.e (continued)

e. Electron Microscope Machine Operation

Scanning Electron Microscope Machine Operation is used to obtain surface information and composition of a sample by focusing an electron beam over the surface of a sample and by using the signals produced by the interaction. Scanning Electron Microscope operators shall be qualified and certified per ATS Form AP QPR.5F2 (Task Name: Scanning Electron Microscope (SEM) Operator) task specific qualification.

7.3 Radiation Safety and Monitoring

7.3.1 Equipment Security

a. Equipment operation keys:

- Secure at all times.
- Do not leave them unattended.
- When not in use, lock them in the secure key safe in the Met Building.

b. The radiographer trainer shall be ultimately responsible for key sign out, use and return signature using form Attachment 9, 347-15-F09, “X-ray Equipment Utilization Log”.

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7.3.2 Before working with X-ray equipment, confirm the following are available at the site:

- Operating and emergency procedures
- California Code of Regulations, Title 17
- Calibrated dosimeter on person (and charger available) or EPD
- LD on person
- Calibrated alarming rate-meter on person
- Minimum one survey meter (operable on all ranges and in current calibration)
- Current Radiation Safety Certification (IRRSP or State Card)

7.3.3 Occupational Dose Limits (As Low As Reasonably Achievable [ALARA])

a. The RSO:

- Should have the cumulative occupational dose to the whole body.
- Shall control (not to exceed) the occupational dose to individuals 18 years of age or over to the limits listed in Table 6.
- The individual's current year history on file

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Table 6

TYPE OF LIMIT	DETAILS
Annual (general)	The more limiting of: • The total effective dose equivalent being equal to 5 Rems (0.05 Sv). OR • The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 Rems (0.5 Sv).
Annual limits to the lens of the eye, to the skin, and to the extremities	An eye dose equivalent of 15 Rems (0.15 Sv). AND A shallow-dose equivalent of 50 Rems (0.50 Sv) to the skin or to any extremity.
An occupational dose of 0.5 Rem (5 mSv)	Applies to an embryo/fetus of a declared pregnant woman during the entire pregnancy.
NOTE: The ATS administrative dose limits are 80% of the previously listed state limits (e.g., 80% of 5 Rem/yr TEDE would be 4.0 Rem/yr).	

b. IF you are approaching any limit, report it to the RSO immediately.

c. An additional trigger level for internal investigation shall be set at 1.5 Rem, after which, a review of the reasons behind the increasing dose shall be assessed.

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7.3.3 (continued)

d. Radiographic personnel shall make every reasonable effort to maintain ALARA radiation exposure, including:

1. The RSO/ARSO reviewing the TLD reports quarterly.

2. Remedial action with individual(s) receiving radiation exposure in excess of reasonable limits will be conducted by the RSO/ARSO, to include, but not be limited to:

- Counseling of the individual(s).

- Investigation by the RSO/ARSO or other qualified individual.

3. The RSO/ARSO will make every reasonable effort to distribute high exposure assignments among different radiographic personnel so as to comply with the ALARA commitment. Additional precautions will be taken with “Declared Pregnant Employees” as necessary.

4. Using, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that comply with the ALARA commitment.

7.3.4 Use of Monitoring Equipment

a. TLDs, pocket dosimeters (or personal electronic dosimeters), and alarming rate meters shall be used by all persons carrying out radiography and who are likely to receive, from sources external to the body, a dose in excess of 500 mRem (5 mSv) in a calendar year,

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
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7.3.4 (continued)

OR

b. Other personnel monitoring devices shall be worn by radiographic personnel as prescribed by the RSO.

c. A currently calibrated survey meter shall be used every time a person enters a radiation area or is required to work with or around storage containers or exposure devices.

7.3.5 Specific Monitoring Equipment

a. Self-Reading Dosimeter (Pocket Ion Chamber)

1. NEVER WORK WITHOUT YOUR DOSIMETER.

2. The dosimeter measures total accumulated dose from zero to at least 200 mR (2 mSv). It shows if the accumulated dose is abnormally high.

3. Wear dosimeters within 6" from the TLD.

4. Prior to each work shift, zero [0 to ±+5 mR (0.05 mSv)] using the dosimeter charger, and record the actual reading of the dosimeter.

5. Record this reading on the Radiation Survey Report (X-ray Producing Machines-"Dosimeter-IN").

6. To confirm safe operation, check your dosimeter frequently.

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(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.3.5.a (continued)

7. A saturated (off-scale) reading could mean danger.

   - Stop work immediately.
   - Contact the RSO (immediate film badge processing is required if an accidental overexposure cannot be ruled out).

8. IF your dosimeter is lost,

   THEN immediately stop work and contact your RSO for a replacement.

9. Record your final dosimeter reading on the Radiation Survey Report ("OUT") at the end of your work shift.

10. Calibrate dosimeters at least yearly.

11. Do not wear assigned dosimeters at DCPP when DCPP's dosimetry has been issued.

12. Electronic personal dosimeters (EPDs) may be used in lieu of self-reading dosimeters (see Step 7.3.5).

b. TLD (Thermo Luminescent Dosimeter)

   1. NEVER WORK WITHOUT YOUR TLD.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

Applied Technology Services (ATS)

Operating, Safety, and Emergency Manual for ATS Industrial X-ray Machines

☐ Yes ☒ No Approved for Nuclear Quality-Related Work ■■■ ☒Periodic Use ☐ Reference Use

7.3.5.b (continued)

2. Your TLD:

   - Is the most accurate record of your total radiation exposure.
   - Should be worn on the belt (waist area) or on the trunk of the body.
   - Is assigned to each individual person and may not be worn by anyone else.
   - Shall be processed quarterly by a qualified TLD service (NVLAP accreditation) or bi-annually by DCPP when using DCPP issued dosimetry).
   - Shall have its exposure data reviewed by the RSO.

3. The exposure data includes:

   - Starting date of TLD use and processing date.
   - Reporting date.
   - Employee name, employee number and date of birth.
   - Current dose [mRem (mSv)].
   - Cumulative dose [mRem (mSv)].

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.3.5.b (continued)

4. Store the TLD during non-working hours in a secure location free from extreme temperature changes (especially heat) and free from moisture.

5. Do not store your badge in an area where accidental exposure could occur.

6. IF your badge is lost,

   THEN stop work immediately and contact the RSO for replacement.

7. IF a TLD is lost or not returned within fourteen days of the end of the month, THEN the RSO/ARSO:

   - Investigates.

   - Writes a report as to the reason the badge was not returned, including the individual's corrective action for the prevention of its recurrence.

8. Total individual dosimeter readings for the period of use and use for the exposure received during that period.

9. The RSO/ARSO reviews dosimetry (TLD) reports and radiation safety (utilization) reports' dosimeter readings for proper use and reporting of monitoring devices.

10. Do not wear assigned TLDs at DCPP when DCPP's dosimetry has been issued.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

c. Alarming Ratemeter

1. Check each alarming rate meter to ensure that the alarm functions properly (sounds) prior to use at the start of each shift and record on the Radiation Survey Report.

2. Alarming ratemeters must be set to give an alarm signal at a preset dose rate of ≤500 mR/hr (5 mSv/hr).

3. Calibrate alarming ratemeters at periods not to exceed one year for correct response to radiation

d. Survey Meter

1. The survey meter measures the radiation field strength and shall have a range such that 2 mRem/hr (0.02 mSv/hr) through 1 R/hr (10 mSv/hr) can be measured.

2. Use the meter to:

- Establish safe boundary lines (perimeters).

- Predict the accumulated dose for several exposures.

3. Check the survey meter each shift for normal functioning on all ranges, current calibration date, and acceptable battery strength.

4. Calibrate at intervals not to exceed 6 months.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.3.5.d (continued)

5. IF functioning is abnormal or the calibration date has expired,

   THEN replace with a calibrated/properly functioning meter.

6. Physically check survey meters and record results using Attachment 8, 347-15-F08, “Radiation Survey Meter Checks”.

e. Electronic Personal Dosimeters (EPD [e.g., RadEye from QSA])

1. The EPD may be worn **in place of** the self-reading dosimeter (pocket ion chamber, Step 7.4.5.a).

2. Record:

   - Initial readings at the start of the shift.
   - End of shift reading.
   - Dose received during the shift recorded.

3. IF the work requires more than one jobsite establishment,

   THEN record at the:

   - Commencement of the jobsite.
   - Completion of the jobsite.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.3.5.e (continued)

4. Subsequent readings recorded at the start of the second or consecutive jobsite, and the end reading at the jobsite.

5. Record all readings on the radiographic survey report for the shift or jobsite.

7.4 Inspection and Maintenance

7.4.1 Daily inspection and maintenance by a radiographer or radiographer trainer help assure equipment is in good working order.

7.4.2 Maintain equipment in good condition by periodic inspection, testing, calibration, and maintenance.

7.4.3 Record daily inspections using Attachment 1, 347-15-F01, ”Radiation Survey Report.”

7.4.4 Complete and document formal inspections on the respective forms:

- Attachment 2, 347-15-F02, “X-ray Equipment Inspection”
- Attachment 8, 347-15-F08, “Radiation Survey Meter Checks”

7.4.5 Place a maintenance/calibration label, when applicable, on equipment to identify the date for the next servicing/calibration.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.4.6 Survey Instruments

a. Inspect the survey instrument at the beginning of each shift for normal function on all ranges, current calibration date, and acceptable battery strength.

b. Calibration is required at intervals not to exceed 6 months.

c. NEVER use survey instruments with expired calibration dates.

7.4.7 Defective Equipment

- Remove and tag any equipment found to be inoperable and/or out of calibration from service.

- Notify the RSO/ARSO.

7.5 Field Radiography Instructions

7.5.1 Controlling the Area

a. Preliminary Control

1. The radiographer trainer clears the restricted area of unauthorized personnel at the time the preliminary control is established.

2. Prior to setting up the X-ray equipment, the radiographer or radiographer trainer establishes preliminary controls by conspicuously posting an area to prevent anyone from entering and receiving, at the perimeter of these areas, a dose in excess of 2 mR (0.02 mSv) in any 1 hour. (See note

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
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7.5.1 (continued)

3. 7.5.1.a.8 [below] for dose limits to the general public)

4. Refer to step 7.5.2.c for instructions on calculating dose rates per hour when exposure time(s) in any 1 hour is under 60 minutes.

5. Establish the approximate perimeter of the radiographic area and post with CAUTION--RADIATION AREA signs.

6. Calculate and post the approximate perimeter of the high radiation area [100 mR/hr (1mSv/hr) or more].

7. CAUTION--HIGH RADIATION AREA signs shall be the conventional magenta and yellow colors used to indicate radiation areas. Perimeters shall be established using radiation area signs.

8. The radiation (restricted) area may be further controlled by radiation barrier tape or rope as required (magenta or yellow colors recommended).

9. Dose limits to the individual member of the public shall not exceed 0.1 rem (1mSv) in a year.

10. Take extreme care and consideration when radiation related work is required in residential areas.

11. The radiographer ensures adequate shielding is employed and that the direction of the radiation beam is directed to the safest orientation, with additional collimation being used as required.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.5.2 Final Control

a. After the X-ray equipment is readied for operation:

1. Energize the equipment (make an exposure).

2. Perform a survey to establish the restricted area.

3. Survey the perimeter of the area which was posted during the preliminary control.

4. Correct the positioning of the signs, as necessary, to reflect the 2 mR (0.02 mSv) in any 1 hour field and record on the Radiation Survey Report.

b. A survey is required for each shift or when the source-target configuration is substantially different from that of the preceding exposure and shall be recorded using Attachment 1, 347-15-F01,"Radiation Survey Report".

c. Survey meter readings in excess of 2 mR/hr (0.02 mSv/hr) are permissible at perimeters of the restricted area when the total exposure time during any 1 hour is less than 60 minutes by using the following formula and example shown in Figure 1.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

FORMULA

$$\frac{\text{Any One Hour (60 Minutes)}}{\text{Exposure Minutes}} \text{x } 2 \text{ mR /hr} = \text{Maximum Allowable mR/ hr (mSv/hr)}$$

EXAMPLE

The maximum allowable mR/hr (mSv/hr) at the perimeter of the restricted area for a job requiring 5 exposures of 4 minutes each would be figured as follows:

$$\frac{60}{5XX4} \text{X } 2\text{mR/hr} = 6\text{mR / hr (0.06 mSv/hr)}$$

Figure 1

d. All signs shall be magenta or black on a yellow background and display the conventional three-bladed radiation safety symbol.

7.5.3 Use of X-ray Equipment – Field Exposures

a. No one may enter the area without the consent of the radiographer for each specific entry.

b. IF any non-radiography person enters the posted area,

THEN:

- Secure the X-ray equipment until the person leaves.
- Report the problem to the RSO/ARSO.

7.5.4 Use survey meters to determine the X-ray machine is OFF except in cases where the main power source is disconnected.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.5.5 Never leave an X-ray machine unattended whereby unauthorized personnel could energize the unit.

7.5.6 Store or lock the control panel or power cables if the unit is left unattended.

7.5.7 During an exposure, all non-radiography personnel shall stay outside the restricted area while the radiographer and assistant radiographer (if used) shall act as guards.

7.5.8 They must be:

- Alert at all times to prevent anyone from entering the area.
- Ensure that ALARA process is maintained at all times, by, wherever possible, remaining in low dose areas while radiography is in process.
- Mindful to only state the facts about radiation dangers and not exaggerate.

7.5.9 Maintain personnel training records.

7.5.10 Prior to entering the controlled area, verify the meter is turned on the desired scale and is functional.

7.5.11 X-ray machines require a label with the statement "Caution X-rays - This Equipment Produces X-rays When Energized."

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.5.12 At the conclusion of each exposure:

a. Proceed toward the tube head with a survey meter in hand and carefully examining the meter readings to verify that the unit is in the OFF position.

b. Prior to approaching the X-ray tube, turn the operating key to the SAFE position and remove from the key switch

7.6 Permanent Radiography Installation-Instructions

7.6.1 Safety procedures of this step apply to radiographic operations using permanent installations (shielded exposure rooms and X-ray cabinets). Additionally:

- Exposure rooms and cabinets shall be used only with those X-ray machines authorized by the RSO.

- Exposure rooms and cabinets, having special requirements (other than listed in this step) as required by the RSO, shall be complied with. Post those requirements at the radiographic installation.

7.6.2 Ensure each exposure room is equipped with a visible or audible alarm signal.

- The alarm should sufficiently warn an individual attempting to enter the area to be aware of the hazard during an exposure.

- Repair or replace faulty or inoperable equipment immediately.

- Exposure rooms may be used until equipment is repaired or replaced by complying with field radiography requirements of this procedure.

7.6.3 Check prior to each exposure to assure the area is clear of personnel.

7.6.4 Exposure rooms shall:

- Have a functioning and currently calibrated survey meter available.
- Have a functioning emergency cut-off switch so that power to the X-ray machine can be secured from within the exposure room.

7.6.5 When completing the scheduled radiographic operations, control the X-ray machine as described in steps 7.5.5 and 7.5.6.

7.6.6 Exposure rooms and cabinets utilizing X-ray equipment shall be interlocked such that the unit will not operate unless all openings are securely closed.

7.6.7 X-ray equipment used in exposure rooms on a temporary basis (not interlocked) may be used by complying with the field requirements of this procedure.

7.6.8 In the case where an interlock is not possible, or inoperable, radiography shall be conducted only with the approval of the RSO or ARSO.

7.6.9 Complete a Radiation Survey Report.

7.7 Handling an Emergency

7.7.1 An emergency is a condition, or potential condition, which may cause one of the following:

- Overexposure, or potential overexposure, of any person in excess of the regulations.
- Malfunctioning, damaged, stolen, or missing survey meter.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.7.1 (continued)

- Malfunctioning, damaged, stolen, or missing X-ray machine.
- Vehicle accidents, fires, or other relative situations.

7.7.2 IF there is an emergency,

- Follow the four key steps in Table 7.
- The RSO will provide step-by-step instructions on how to safely handle the emergency.

Table 7

THE FOUR KEY STEPS	
Step 1	If you should encounter an emergency, immediately stop X-ray production by either: - Pressing the emergency shut-off button on the control panel - Turning off the main power key on the control panel - Disconnecting power supply cable to X-ray unit - Turning generator off if plugged in to an alternate power source
Step 2	Assure all personnel are cleared from any other potential danger.
Step 3	Notify emergency services if necessary and notify the RSO immediately.
Step 4	Document incident along with time, dates and personnel involved.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

Applied Technology Services (ATS)

Operating, Safety, and Emergency Manual for ATS Industrial X-ray Machines

☐ Yes ☒ No **Approved for Nuclear Quality-Related Work** ■■■ ☒**Periodic Use** ☐ **Reference Use**

THE FOUR KEY STEPS			
In the event of an emergency, attempt to notify the following persons in the order listed:			
	Days	**Evenings**	**Other**
RSO [redacted] *	[redacted]	[redacted]	Mob: [redacted]
ARSO [redacted] **	[redacted]	[redacted]	Mob: [redacted]
* Or current RSO if personnel have changed			
** Or current ARSO if personnel have changed			

7.7.3 Personnel involved in the emergency are barred from further work with or around all radiography operations until released by the RSO.

7.7.4 Do not use equipment which may have been damaged as a result of the emergency until released by the RSO.

7.7.5 Any individual, who believes that a violation of Company, federal and/or state regulations has occurred or could possibly occur, should notify the RSO of the alleged violation.

7.8 Records

7.8.1 The radiographer trainer is responsible to complete Attachment 1, 347-15-F01, ”Radiation Survey Report”

7.8.2 Complete the forms per the instructions. Make sure your signature and the date are legible.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

7.8.3 The RSO maintains following copies of records, which are necessary for inspections and verification of compliance with California Code of Regulations, Title 17, and Company Procedures.

- TLD Reports.
- Radiation Survey Reports (X-ray Producing Machines)
- Radiation Safety Program OS&E Manual
- X-ray Machine State Registration
- Records of radiation safety refresher training
- Inventory and Inspection (see Attachment 3, 347-15-F03, “X-ray Equipment Inventory”)
- Survey Meter, Dosimeter, and Alarming Ratemeter Calibration Certifications
- Individual's Radiation Safety Qualifications and Certifications (see Attachment 6, 347-15-F06, “Radiation Safety Audit for Radiographic Operations and Personnel”)
- Safety Audits (Personnel)
- All required survey records
- Annual Audit and Annual Management Review

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

8. Governing Documents

N/A

9. Records

9.1 See Subsection 7.8.

10. Compliance Requirement/Regulatory Commitment

N/A

11. References

11.1 10 CFR 20 - Standards for the protection against radiation

11.2 10 CFR 34 - Licenses for Industrial Radiography and Radiation Safety requirements for Industrial Radiographic operations

11.3 17 CA ADC - California Code of Regulations

11.4 US NRC Regulatory guide 8.4 - June 2011

11.5 10 CFR Part 19 – Notices, Instructions, and Reports to Workers: Inspections and Investigations.

11.6 Diffraction Machine User's Guide (XL3 Analyzer Version 7.0.1 Revision C Nov 2010) Located with user and also available with RSO.

11.7 Electron Microscope Machine User's Manual (P/N 52E-9201-11 HH-R (R-AMS) Jan 2012 12th Edition). Located with the Scanning Electron Microscope.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

12. Appendices

12.1 Appendix A, “Exposure Room Layout”

12.2 Appendix B, “Warning Signs for Alarms”

13. Attachments

13.1 Attachment 1, 347-15.F01,”Radiation Survey Report”

13.2 Attachment 2, 347-15.F02, “X-ray Equipment Inspection”

13.3 Attachment 3, 347-15.F03, “X-ray Equipment Inventory”

13.4 Attachment 4, 347-15.F04, “Assistant Radiographer Radiation Safety Training”

13.5 Attachment 5, 347-15.F05, “Radiographer Radiation Safety Training”

13.6 Attachment 6, 347-15.F06, “Radiation Safety Audit for Radiographic Operations and Personnel”

13.7 Attachment 7, 347-15.F07, “Training Record for Previously Trained Radiographers”

13.8 Attachment 8, 347-15.F08, “Radiation Survey Meter Checks”

13.9 Attachment 9, 347-15.F09, “X-ray Equipment Utilization Log”

13.10 Attachment 10, 347-15.F10 “Radiation Safety Formula and Half Value Thicknesses”

13.11 Attachment 11, 347-15.F11, “Radiography Experience Validation”

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

13.12 Attachment 12, 347-15.F12, “Industrial Radiography Safety Tailboard”

13.13 Attachment 13, 347-15.F13, “Job Safety Analysis (JSA)”

13.14 Attachment 14, 347-15.F14, “OS&E Manual Annual Review Sheet”

13.15 Attachment 15, 347-15.F15, “Cabinet X-ray Machine Survey Form”

13.16 Attachment 16, 347-15.F16, “X-ray Vault and Cabinet X-ray Interlock System Evaluation Form”

14. Document Recession

14.1 ATS OS&E Manual, Rev. 10, Operating, Safety, and Emergency Manual for Industrial X-ray Machines

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

Pacific Gas and Electric Company®

Work Procedure: WP 347-15
Effective Date: 11/28/2018 Rev. 11

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Approved By [redacted], Manager, ATS Technology Application

Document Owner [redacted], NDE Supervisor, ATS Technology Application

Document Contact [redacted], ATS Radiation Safety Officer

Revision Notes

Revision Number	What Changed?
11	Added User's Manual reference for Diffraction Machines. Added User's Manual reference for Electron Microscope Machines. Added training and certification references for Diffraction and Electron Microscope Machines. Made changes to attachment 01. Added attachment 14. Added attachment 15. Added attachment 16.

_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
(Print Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date) (Initials) / (Date)

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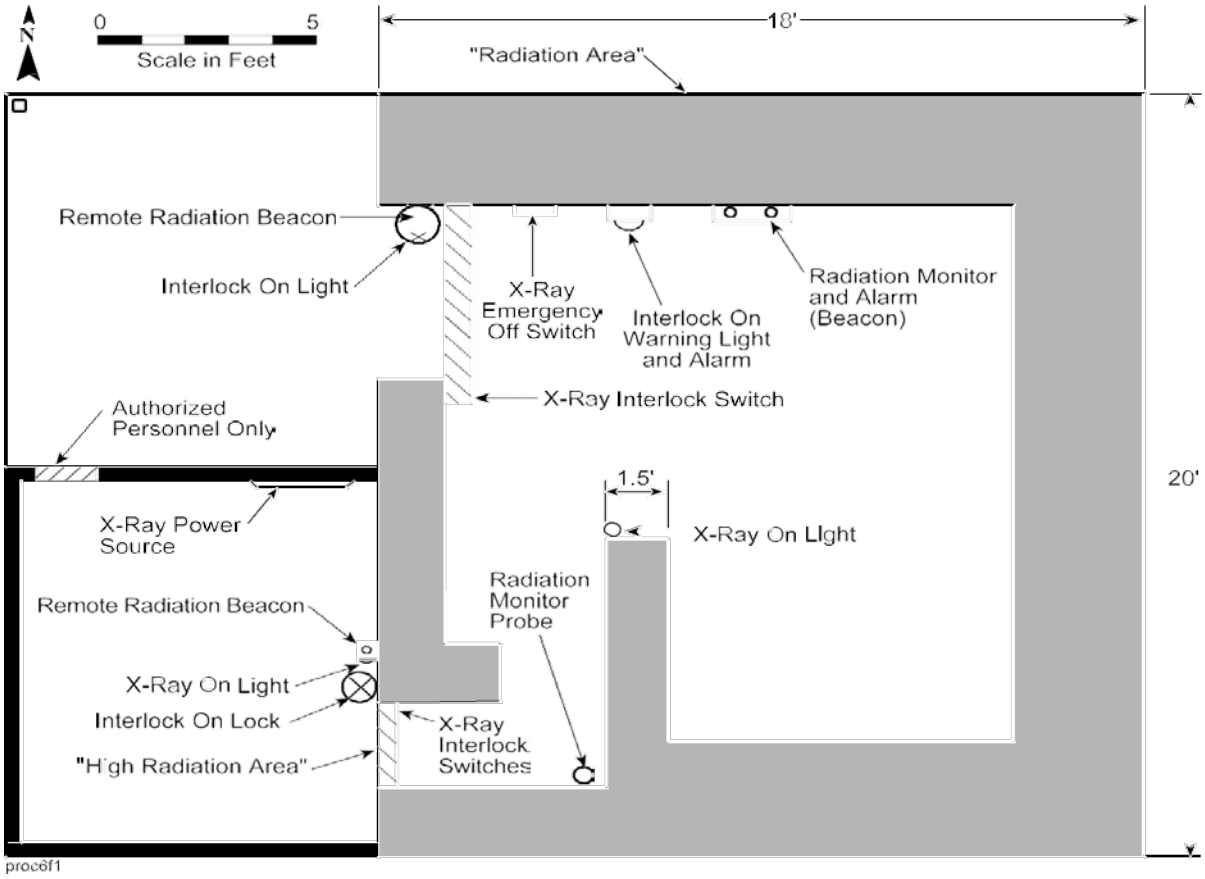
Appendix A – Exposure Room Layout



_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____ _____/_____
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Appendix B – Warning Signs of Alarms

Yellow with Black Letters | Red with White letters | Yellow with Magenta letters

Note: The above signs require caution when in the area but an emergency does not exist.

Yellow with Black Letters | Red with White letters | Yellow with Magenta letters

Note: If you are inside the vault and the above mentioned alarms are activated, immediately flip the “X-ray emergency shut-off switch on North wall of the vault”.

24 Hour Emergency Telephone
RSO 1-925-817-7426 / ARSO 1-925-719-2679

Radiation Survey Report

Location_____ Date_____

Personnel and Equipment

Survey Meter Serial No.	Calibration Due	Battery Check	**Note:** **Radiography shall not be performed unless:** **Each technician is wearing an operable and calibrated Alarming Rate Meter** **Each technician is wearing a zeroed and calibrated Dosimeter or EPD** **(2) Two operable and calibrated Survey Meters are available** **(One must be operable throughout the shift)**

Technicians	Name	Dosimeter					Alarming Rate Meter			Film Badge
		Serial No.	Calibration Due Date	Initial Reading	End Reading	Total Dose	Serial No.	Calibration Due Date	Operational Check	No.
(1)										
(2)										
(3)										

Exposure Device Model_____ Serial No._____ Daily Equipment Inspection SAT_____UNSAT_____

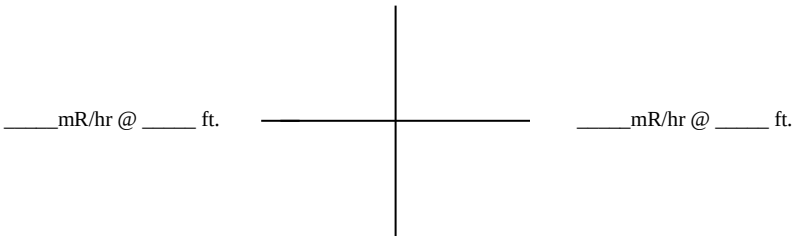
Environmental TLDs Used? Yes_____ No _____ Numbers: _____ _____ _____

The Above Has Been Reviewed and Found Acceptable:_____
(Radiographer's Signature)

---

kVp____ mA____ Time____ **Restricted Area Survey** Curies____ Time____

kVp____ mA____ Time____



Level above surveyed and restricted: _____Yes _____No _____N/A Level below surveyed and restricted: _____Yes _____No _____N/A

Initial survey before first exposure: _____ AM PM (circle one) _____mR/hr at boundary

Collimation of beam: ____ Yes ____ No (explain)_____

Additional Shielding: _____Yes _____ No (explain)_____

Final survey after last exposure:_____ AM PM (circle one)

Total number of exposures _____ Total exposure time _____

Physical survey performed prior to moving tube head: _____Yes _____No

Exposure device (check one): _____ Moved to another location

_____ Returned to storage area

Radiographer's signature: _____ **Date:** _____

Radiation Safety Officer Review: _____ **Date:** _____

**** A New Report Is Needed Whenever Any of the Above Conditions Change ***

Applied Technology Services

WP 347-15.F02
Attachment 2

X-Ray Equipment Inspection

Inspected by:		**Date:**
Tube Head # :	**Model:**	**S/N:**
Control Panel:	**Model:**	**S/N:**

X-Ray Tube			
	ACCEPT	REPAIR	REPLACED
1. Check power chord.			
2. Check tube general condition			
3. Check condition of label ("Caution—X-Rays. This equipment produces X-rays when energized."			
4. Serial number tags legible.			
Control Panel			
	ACCEPT	REPAIR	REPLACED
5. Check general condition of case.			
6. Check meter or display condition.			
7. Check timer.			
8. Check all connectors.			
9. Check warning lights functioning.			
10. Check key and switch lock.			
Control Cables			
	ACCEPT	REPAIR	REPLACED
11. Check all connectors.			
12. Check cables for damage to insulation.			

X-Ray Equipment Inspection

Power Cable			
	ACCEPT	REPAIR	REPLACED
13. Check connectors and electrical plug.			
14. Check insulation for damage.			
Remarks:			
Signature:			
Date:			

X-Ray Equipment Inventory

Inventoried by:	Date:
Location:	

	Manufacturer	Model	Control Number	Tube Head Serial Number	Maximum	
					kV	mA
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						

Remarks:

Signature	Date

Assistant Radiographer Radiation Safety Training

I.

Assistant Radiographer:		**Date of hire:**
Date of birth:	**LAN ID:**	**Jobsite:**

II. The above named individual has satisfactorily completed PG&E – ATS qualification and certification testing for Assistant Radiographer as specified below:

1. Attended informative instruction of the topics outlined in the ATS Radiation Safety Procedure.
    a. Basic Radiation Safety Class (minimum 40 hours state or NRC approved)
    b. Needs and requirements for personnel training
    c. Instructions in the O&EP
    d. Radiographic Equipment
    e. Review State/Federal Regulations

    Minimum 8 hours b. through e. Number of hours: _____ Date____

III. The above named individual has satisfactorily completed PG&E's Assistant Radiographer Training, Qualification, and Certification Testing as specified below:

1. Attended instruction on the topics outlined in the operating and emergency procedures.
    a. Operating and Emergency Procedure Date _____
    b. Radiographic Equipment Date _____

2. Successfully completed the written examination and oral review associated with the position of Assistant Radiographer.

    Date_____ Score_____/_____/_____

IV. I hereby certify the above information is correct to the best of my knowledge.

_____ _____
Signature of Assistant Radiographer Individual Administering Training/Exam

Date_____ Date _____

Approved by ATS RSO:_____Date_____

Radiographer Radiation Safety Training

I.

Assistant Radiographer:		**Date of hire:**
Date of birth:	**LAN ID:**	**Jobsite:**

II. The above named individual has satisfactorily completed PG&E - ATS Qualification And Certification Program and has received radiation safety training and testing as specified below:

a. Attended instruction (40 hours) on topics outlined in the Qualification/Training Procedure (NRC 10 CFR Part 34, Appendix A), covering required subjects (1-5 below).

1. Fundamentals of Radiation Safety	No. of hours:	Date:
2. Radiation Instrumentation	No. of hours:	Date:
3. Radiographic Equipment	No. of hours:	Date:
4. Inspection and Maintenance	No. of hours:	Date:
5. Case Histories of Radiography Accidents	No. of hours:	Date:

b. Received instruction in additional Company requirements as follows:

1. Transfer, packaging, and transport of X-ray machines	No. of hours:	Date:
2. Requirements of State/Federal Regulations	No. of hours:	Date:
3. Terms and conditions of the Registration of X-ray machines	No. of hours:	Date:
4. Instructions in the Radiation Safety Program with emphasis on the Operating, Safety, and Emergency Procedures	No. of hours:	Date:

c. Completed on-the-job training (1 month minimum) as an Assistant Radiographer, directly supervised by a qualified Radiographer from: Date:_____To_____

Name of the principle Radiographer trainer: _____

d. Passed a written examination to determine knowledge of topic outlined above.
Date:_____Exam Score_____/_____/_____

e. Satisfactorily demonstrated competence to perform Industrial Radiography using an X-ray machine and to use the necessary tools and equipment associated with such operations. (Practical Examination)
Date:_____Exam Score_____/_____/_____

III. I hereby certify the above information is correct to the best of my knowledge.

_____ _____
Signature of Radiographer Individual Administering Training/Exam

Date_____Date_____

Approved by the ATS RSO_____Date_____

Applied Technology Services

WP 347-15.F06
Attachment 6

Radiation Safety Audit for Radiographic Operations & Personnel

Location _____ Date_____

Technician 1) _____
2) _____
3) _____

1.0	TECHNICIANS	SAT	UNSAT	NOTES
1.1	Technician are qualified (State or ID Cards)	☐	☐	
1.2	Dosimeters zeroed prior to start of shift	☐	☐	
Name	Dosimeter S/N			Calibration Due Date
1.3	Rate alarm meters checked for operability	☐	☐	
Name	Rate Alarm Meter S/N			Calibration Due Date
1.4	Survey Meters are operable and calibrated	☐	☐	
Serial No.	Battery Condition			Calibration Due Date
1.5	Technicians know RSO and how to contact	☐	☐	

2.0	EQUIPMENT	SAT	UNSAT	N/A	NOTES
2.1	Daily Inspection Documented	☐	☐	☐	
2.2	Exposure Device, S/N _____				
	a. Required labels in good condition	☐	☐	☐	
	b. Leak test sticker	☐	☐	☐	
2.3	Drive Assembly				
	a. Crank assembly condition (label)	☐	☐	☐	
	b. Source tube/extension condition (label)	☐	☐	☐	
3.0	**RADIATION AREA**	**SAT**	**UNSAT**	**N/A**	**NOTES**
3.1	Boundary roped off adequately	☐	☐	☐	
3.2	Radiation area signs posted sufficiently and conspicuously	☐	☐	☐	
3.3	High radiation area signs posted	☐	☐	☐	
4.0	**OPERATION**	**SAT**	**UNSAT**	**N/A**	**NOTES**
4.1	Area checked for personnel prior to each exposure	☐	☐	☐	
4.2	Radiation readings at the perimeter noted and recorded	☐	☐	☐	
4.3	Area monitored during the exposure	☐	☐	☐	
4.4	Radiation survey includes the full circumference of the exposure device and the full length of the guide tube	☐	☐	☐	
4.5	Collimator in use, when practical	☐	☐	☐	
5.0	**RECORDS**	**SAT**	**UNSAT**	**N/A**	**NOTES**
5.1	Exposure Device utilization logged	☐	☐	☐	
5.2	Shipping Report completed	☐	☐	☐	

Notes:

_____

_____

Audit Performed By: _____ Date: _____

Applied Technology Services

Training Record for Previously Trained Radiographers

Assistant Radiographer:		**Date of hire:**
Date of birth:	**LAN ID:**	**Jobsite:**

I. The above named Radiographer has been licensed previously to use X-ray machines as a fully qualified radiographer prior to employment at PG&E. To ensure that the individual has received adequate training prior to being designated as a qualified Radiographer, the following training and examination were given:

1. Informative instruction on PG&E's Operating, Safety, and Emergency Procedures (OS&EP), instruments, X-ray machines, devices, and equipment used in the course of Radiography operations. (Shall include NRC Case Histories)
   No. of hrs._____Date_____
2. Passed a written examination to determine individual's knowledge of topics outlined in Section 7.1.2 table 3 of the OS&EP.
   Date_____Exam Score_____/_____/_____
3. Satisfactorily demonstrated the competence to perform Industrial Radiography using the X-ray machines and use of the necessary related tools and equipment associated with such operations. Date_____Exam Score_____/_____/_____
4. Received instructions in the X-ray machine registration, OS&EP, and State and Federal Regulations for Control of Radiation.
   Date_____

II. Previous training and experience as a Radiographer as follows:

1. Received formal instruction on topics outlined in PG&E's OS&EP, NRC 10 CFR Part 34, Appendix A.
   Previous Company_____Date_____
2. Was first qualified as a Radiographer at:
   Previous Company_____Date_____
3. Worked as a Radiographer for the following company on the dates shown (report additional experience on the back of this form).

III. I hereby certify the above information is correct to the best of my knowledge.

_____ _____
Signature of Assistant Radiographer Individual Administering Training/Exam

Date_____ Date _____

Approved by ATS RSO:_____Date_____

Applied Technology Services

WP 347-15.F08
Attachment 8

Radiation Survey Meter Checks

SURVEY METER NO.		
DATE OF CHECK		
CHECKED BY		
SIGNATURE		
CALIBRATION DATE		
DETAIL	SATISFACTORY	UNSATISFACTORY*
BATTERY FUNCTION TEST		
RANGE SWITCH FUNCTION		
SCALE & NEEDLE CONDITION		
CASE CONDITION		
CARRYING HANDLE		
Note* If unsatisfactory, remove from service until repairs, adjustments and calibrations have been completed.		

Applied Technology Services

X-Ray Equipment Utilization Log

X-RAY MACHINES

UTILIZATION LOG **X-RAY TUBE ID** _____

Radiographer	Location	Date Out	Time Out	Initial Out	Date Back	Time Back	Unit Used Y/N	Signature In

Radiation Related Formula And Half Value Thicknesses

Inverse Square Law

$I_1/I_2 = D_2^2 / D_1^2$

Example 1:

The intensity of radiation is 530 R/h at 5 feet away from a source. What is the intensity of the radiation at 10 feet?

Rework the equation to solve for the intensity at distance 2

$I_2 = I_1 \times D_1^2 / D_2^2$

Plug in the known values

$I_2 = 530\text{R/h} \times (5\text{ft})^2 / (10\text{ft})^2$

Solve for I_2

$I_2 = 132.5$ R/h

In this instance the distance has been doubled and the intensity at that point has decreased by a factor of four.

Example 2:

A source is producing an intensity of 456 R/h at one foot from the source. What would be the distance in feet to the 100, 5, and 2 mR/h boundaries.

Convert R/hour to mR/hour

456R/h x 1000 = 456,000 mR/h

Rework the equation to solve for D2

$$D_2 = \sqrt{\frac{I_1 \times D_1^2}{I_2}}$$

Plug in the known values and solve

Radiation Related Formula And Half Value Thicknesses

$$D_2 = \sqrt{\frac{456{,}000\, mR/h \times (1ft)^2}{100\, mR/h}}$$

Using this equation the 100mR/h boundary would be at 68 feet, the 5mR/h boundary would be at 301.99 feet, and the 2mR/h boundary would be at 477.5 feet.

Example 3:

Doserate = 590mR/hr, what will the doserate be at 25ft?

New Doserate = Old Doserate x D_1^2 / D_2^2

New Doserate = 590 x $10^2 / 25^2$

New Doserate = 94.4mR/hr

Half Value Thicknesses

Approximate HVL for various materials from Gamma sources:

	Half Value Layer in inches				
Source	**Concrete**	**Steel**	**Lead**	**Tungsten**	**Uranium**
Ir192	1.75	0.5	0.19	0.13	0.11
Co60	2.38	0.85	0.49	0.31	0.27
Se75	1.2	0.32	0.04	0.03	0.02

Approximate HVL for X-Rays

	Half Value Layers in Inches	
Peak Voltage (kVp)	**Lead**	**Concrete**
50	0.06	4.3
100	0.27	15.1
150	0.30	22.3
200	0.52	25.0
250	0.88	28.0
300	1.47	31.2
400	2.5	33.0

Applied Technology Services

WP 347-15.F11
Attachment 11

Radiography Experience Validation

Adaptation of California Title 17 Requirements for Radiography

California Title 17 has followed the State of Texas requirements in requiring there to be specific personnel available for machine radiography.

The object is to ensure that only experienced personnel perform and are responsible for radiation safety. To this end, there are some specific requirements that need to be considered.

These are:

Radiographer Trainer has to have at least two thousand hours of operational experience using X-Ray machines, which will include documentation of said experience and shall include:

- X-ray machine operation
- Radiation Safety Surveys
- Radiation Safety related activities

Please use the table below to document said experience; this document will be reviewed to assess your experience in hours to ensure we are compliant with Title 17.

Name of Radiographer:_____

State or IRRSP card first held from:_____

First date of radiation safety audits or experience:_____

COMPANY NAME	COMMENCEMENT DATE	EXPERIENCE HOURS	X, GAMMA, OR COMBINATION	INITIALS	DATE

Signature of radiographer: _____ Date:_____

Approved by ATS RSO _____ Date_____

Applied Technology Services

WP 347-15.F12
Attachment 12

INDUSTRIAL RADIOGRAPHY SAFETY TAILBOARD

This tailboard should be delivered to all personnel associated with work in the immediate vicinity of the radiography process, irrespective of their employer(s). It is the responsibility of the site supervisor to brief **ALL** of site-supervised personnel on the process to be undertaken, and address any questions or concerns PRIOR to commencement of radiographic activities. The lead radiographer shall give the brief.

PG&E performs radiography in order to assess certain conditions of either the parent material or welds associated with the gas transmission system.

To achieve this, PG&E may employ direct PG&E staff or contract companies to undertake the work.

Companies other than PG&E have had their operating, safety, and emergency manual documents reviewed. They are licensed by the State of California to carry appropriate radioactive materials to undertake the tasks requested. PG&E ATS is also registered with the State of California to undertake the same processes, but using x-ray generators as opposed to radioactive materials.

The plan of work will generally follow a process whereas the radiographers:

1. Erect legally designated boundaries using yellow and magenta colored ropes or cones with radiation warning signs.
2. Enter the work area and commence to establish the radiographic "shot or shots" of the component to be tested.
3. Exit the high radiation area and commence the exposure.
4. Upon completion of the work, survey the work equipment to ensure the equipment is in a safe condition.
5. Remove all boundaries or demarcations and associated warning signs.

The site is now safe to allow non-radiographic staff to return to work in the area.

There are legal obligations placed on those using such equipment, namely, no other persons other than the radiographers may enter the area once the boundaries are erected AT ANY TIME without expressed consent from the lead radiographer. As a non-radiographer, you may not reach under, over, or enter through the set boundaries.

This will be made clear by the radiographer in charge. Any willful disregard to this instruction is a violation and will be treated with appropriate disciplinary action.

That does not remove any rights you as an individual have in requesting a "stop work" where there is a perception of a safety issue. If this is the case, make the request at the very first opportunity to the lead radiographer without violating the above mentioned instructions.

Applied Technology Services

WP 347-15.F12
Attachment 12

DO NOT ENTER THE BOUNDARIES TO MAKE YOUR CASE.

Confined space attendants shall also remain outside of these boundaries when maintaining confined space entry requirements. This means the confined space attendant should be positioned to clearly see all personnel in the hole.

If rescue of radiographic staff is required inside the confined space due to their inability to self-extract from the confined space, then the nominated rescue staff under the rescue plan may enter the boundary.

In this instance as well as initiating the rescue, calls should be placed to the Radiation Safety Officer for the respective Company (this will be found in the contractor company vehicle) and **ALSO** to the PG&E ATS Radiation Safety Officer (RSO) – (Federico Necochea 925-817-7426) for help and assistance in processing the site and ensuring the site is safe. In absence of the RSO, the Alternate Radiation Safety Officer (ARSO) should be called (Kevin Rawlins 925-719-2679).

[redacted]

PG&E APPLIED TECHNOLOGY SERVICES
Radiation Safety Officer

[redacted]

Sr. Engineering Technician

ATS Job Safety Analysis / Tailboard

Brief Job Description:						
Date:		Time:		Location:		
Attendee Name		Lan ID	Initials	Attendee Name	Lan ID	Initials

Topics Discussed:

☐ Electrical Hazards/Arc Flash	☐ Safety At Heights	☐ Repetitive Movements
☐ Confined Space Hazard	☐ Cut Hazards/Sharp Edges	☐ Radiological Hazard
☐ Hazardous Chemical Exposure/Fumes	☐ Line of Fire / Pinch Points	☐ Flying particles
☐ Cold Stress/Heat Stress	☐ Fall Hazard	☐ Slip/Trip/Fall Hazards
☐ Working Near Bodies of Water	☐ Rotating Machinery	☐ Stored Energy/Pressure
☐ Heavy Lifting/Body Positioning	☐ Communication	☐ Weather Hazard
☐ Overhead Hazard	☐ Fire Hazards/Flammable Chemicals	☐ Hot Work/Welding/Grinding
☐ Public Safety	☐ Parking	☐ Driving
☐ Noise above 80 dB	☐ Environmental Hazard	☐ Traffic Hazards

Other:

Hazard Controls

Engineering Controls:

Administrative Controls:

☐ Signage/Barriers	☐ Complete Permits	☐ Lock Out Tag Out

Other Administrative Controls:

PPE and Safety Equipment Required:

☐ Safety Glasses	☐ Face Shield	☐ Rain Gear
☐ Hard Hat	☐ Ear Plugs	☐ Radios
☐ Gloves	☐ Fall Harness	☐ Fire Extinguisher
☐ FR Clothing	☐ Dust Mask	☐ Air Monitor
☐ Steel-Toe Boots	☐ Long Sleeve Shirt	☐ Reflective Vest

ATS Job Safety Analysis / Tailboard

Other PPE:

Procedure Information ☐ **N/A**

Procedure #		Procedure Description:	

Emergency Information

Task	Name	Task	Name
Perform CPR:		Contact Emergency Services:	
Retrieve AED:		Escort Emergency Services:	
Evacuation Area:			

Evaluation of Task Steps, Hazards and Controls

Task Steps	Hazards	Controls

Additional Notes:

WP 347-15 Operating Safety and Emergency Manual			
Annual Review Sheet			
Current Revision	**Review Date**	**Reviewed By:**	**Comments**

Pacific Gas and Electric
Cabinet X-ray Machine Survey Form

Equipment Serial Number:_____

Title 17 states that cabinet systems shall be maintained to ensure radiation emitted from the system shall not, under any condition of use, exceed an exposrure of 0.5 milliroentgens in one hour at any point five centimeters (cm) outside the external surface, or any door or port. The system shall be checked and results logged prior to each use.

Date:	Operator:	Results:

If the test results exceed the established exposure limit of 0.5 milliroentgens in any one hour, turn the machine off **immediately** and contact the RSO. Do not use this piece of equipment until it has been cleared by the RSO.

Pacific Gas and Electric

X-ray Vault and Cabinet X-ray Machine Interlock System Evaluation Form

Equipment Serial Number:_____

Date:	Operator:	Results:	Reviewed By: