



X-Ray Radiation Safety Manual

Registration: R00109; R40380



X-ray Radiation Safety Program

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1 GENERAL

1.1 Purpose

The purpose of the X-ray Radiation Safety Program is to provide standard guidance and training standards for the permitting and use of all X-ray containing machines on the Texas Christian University (TCU) campus. These X-ray units may be found in research settings as technical and analytical units, as diffraction machines; in sports medicine or sports rehabilitation; in the arts for both art restoration and art creation, and in its more well-known use in the medical arts. All of these uses are potentially located on, or affiliated with the TCU campus.

1.2 Annual Review Acknowledgement

This program has been reviewed and edited by the Radiation Safety Officer and the Office of Risk Management as of **March 1, 2025**.

The contact information for the Radiation Safety Officer is as follows:

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Hazardous Material Safety Manager

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1.3 Regulatory references

This plan has been developed to comply with the following regulatory requirements:

1.3.1 OSHA

[29 CFR 1910 Subpart I Personal Protective Equipment Standards](#)

[CFR 1904 Recordkeeping Standards](#)

1.3.2 Texas Regulations

[Title 25 Texas Administrative Code §289.203,](#)

[Title 25 Texas Administrative Code §289.204,](#)

[Title 25 Texas Administrative Code §289.205,](#)

[Title 25 Texas Administrative Code §289.226,](#)

[Title 25 Texas Administrative Code §289.227,](#)

[Title 25 Texas Administrative Code §289.228,](#) and

[Title 25 Texas Administrative Code §289.231.](#)

1.4 Regulatory Road Map

Topic or Issue	Regulatory Requirement	Addressed in Section:
Purpose	Institutional Requirements	Section 1.1
Annual review and Acknowledgement	TCU License	Section 1.2
Regulatory references	Institutional Requirements	Section 1.3
Exclusions	Title 25 Texas Administrative Code §289.228(e)(1)(A)	Section 1.5
Implementation on campus	Institutional Requirements	Section 1.6
Responsibilities	Institutional Requirements	Section 2.0
Radiation Safety Officer	Title 25 Texas Administrative Code §289.226 , (e)(3), §289.226(n)(1) and those specific to the TCU license.	Section 2.4
Definitions	Title 25 Texas Administrative Code §289.231 .	Section 3.0
Radiation Facilities and Equipment	Title 25 Texas Administrative Code §289.226	Section 4.0
Radiation Machines	Title 25 Texas Administrative Code §289.226 , §289.203 , §289.204 , §289.205 , §289.227 , §289.228 , and §289.231	Section 4.2
Mobile Service of X-ray Machines	Title 25 Texas Administrative Code §289.226(g) .	Section 5.1
Industrial/Analytical X-ray Machines	Title 25 Texas Administrative Code §289.228 ,	Section 5.2
X-ray Diffraction Units	Title 25 Texas Administrative Code §289.228 ,	Section 5.2.1
Portable/Handheld Fluorescence X-ray Devices	Title 25 Texas Administrative Code §289.227 §289.228 , §289.228(e)(1)(A)	Section 5.2.2
Radiation Machines in the Healing Arts	Title 25 Texas Administrative Code §289.227 , §289.227(i) .	Section 5.3
Digital Image Acquisition QC requirements	TCU License	Section 5.4
Radiation Accountability	TCU License	Section 6.0
Acquisition, transfer and Discard of Radiation Machines	TCU License	Section 6.1

New Authorized Users	TCU License	Section 6.2
Shipping	TCU License	Section 6.3
Security and Control	TCU License	Section 6.4
Posting and Labeling Requirements	Title 25 Texas Administrative Code §289.202(bb) and §289.231(y) .	Section 6.5
Radiation Monitoring	Title 25 Texas Administrative Code §289.231(m) and (o)	Section 7
Instrument Calibration	Title 25 Texas Administrative Code §289.231(m) and (o)	Section 7.2
Occupational Dose Limits	Title 25 Texas Administrative Code §289.231(m)(1)(C) and (D) , §289.202(n) and §289.231(p)	Section 7.3
Personnel Monitoring	Title 25 Texas Administrative Code §289.231(m)(1)(C) and (D) , §289.202(q) and §289.231(n)	Section 7.4
Required Test and Records	25 Texas Administrative Code §289.227 , §289.231	Section 9
Surveys	Title 25 Texas Administrative Code §289.231(m) and (o)	Section 9.2
Inventories	TCU License	Section 9.4
Usage Records	Title 25 Texas Administrative Code §289.203(d)	Section 9.5
Individual Monitoring	TCU License, Title 25 Texas Administrative Code §289.231(m)(1)(C) and (D) , §289.202(q) and §289.231(n)	Section 9.6
Other Records	Title 25 Texas Administrative Code §289.203 .	Section 9.7
Inspections	Title 25 Texas Administrative Code §289.203 .	Section 9.8
Training	Title 25 Texas Administrative Code §140.521, §289.252(jj)(1) .	Section 8.0
Emergency Procedures	Title 25 Texas Administrative Code §289.231(hh) .	Section 10
X-ray Machine Accident/Incident	Title 25 Texas Administrative Code §289.231(hh) .	Section 10.2
Emergency Notification Contacts	Title 25 Texas Administrative Code §289.231(hh) .	Section 10.2

PPE Assessments	29 CFR 1910.132 (f), 29 CFR 1910.132 (d)	Appendix A
TCU Monitoring Equipment List	Institutional Requirements	Appendix B
Radiation Caution Sign	Title 25 Texas Administrative Code §289.202(bb) and §289.231(y) .	Appendix C
Forms and Records	RSO guidelines	Appendix D
Facility Diagrams	RSO guidelines	Appendix E

1.5 Exclusions

There will be no exclusions or exemptions of any X-ray producing equipment or machinery on the TCU campus, or used by TCU personnel on an exclusively leased property.

1.6 Implementation on Campus

Implementation of this program will be directed by the RSO and conducted by the individual registered users. No person may possess, or use a piece of X-ray-producing equipment on the TCU campus (or under the control of the TCU campus) without falling under the auspices of this program and the oversight of the RSO.

Additional oversight will be conducted by the Office of Risk Management (ORM) and the Office of Research (Research Compliance).

2 RESPONSIBILITIES

2.1.1 The Office of Risk Management (ORM)

2.1.1 Director of Risk Management

The Director, or Associate Director of Risk Management will act as the initial contact for reporting exposure incidents and ensuring that the appropriate corrective action response is carried out.

2.1.2.1 ORM

The ORM will be responsible for ensuring that:

- Maintaining PPE Hazard Assessments for the duration of the assessed activity plus three years. Amendments to original PPE Hazard Assessments shall be maintained with the original.
- Ensuring Exposure determinations are conducted as required,
- Ensuring all medical actions required by the regulations are performed,
- Ensuring appropriate employee health and OSHA records are maintained, and that
- Documents are furnished upon request.

2.3 Office of Research – Research Compliance (ORC)

The Office of Research - Research Compliance (ORC) is responsible for ensuring that all research parameters are maintained and that research integrity is ensured through proper working equipment, testing, and written policies. The ORC is responsible for working with the RSO and the ORM to ensure research continuity within each laboratory.

2.4 The Radiation Safety Officer (RSO)

The Radiation Safety Officer (RSO) for the university is Richard Adickes. The RSO duties as assigned below:

- The RSO monitors, updates, and determines compliance with established regulations, policies, and practices for the licensing, purchasing, shipment, use, monitoring, disposal, and transfer of radioisotopes or sources of ionizing radiation at Texas Christian University.
- The responsibilities of the RSO include those specified in TAC §289.226(n)(1) and those specific to the TCU license. The RSO responsibilities are to:
 - Establish and oversee operating, safety, emergency, and as low as reasonably achievable (ALARA) procedures and to review them at least annually to ensure that the procedures are current and conform with the latest rules;
 - Ensure that individual monitoring devices are used properly by occupationally-exposed personnel, that records are kept of the monitoring results, and that timely notifications are made in accordance with §289.203;
 - Investigate and report to the agency each known or suspected case of radiation exposure to an individual or radiation level detected in excess of limits established by TAC (Chapter 289);
 - Have thorough knowledge of TCU policies and administrative procedures;
 - Assume control and have the authority to institute corrective actions, including shut-down of operations when warranted in emergency situations or unsafe conditions;
 - Ensure that records are maintained as required by regulation;
 - Ensure that personnel are complying with institutional procedures and state and federal regulations, the conditions of the license, and the operating, safety, and emergency procedures of the licensee;
 - Serve as the primary contact with DSHS;
 - Maintain and update TCU's license and radiation-producing equipment registration with the DSHS;
- Ensuring that training is conducted and managed through universities learning management system and via one-on-one in-person training for applicable users.
 - Ensuring that X-ray laboratories have been inspected and all units have been properly licensed per the regulations.

2.5 Deans, Directors and Department Heads

Deans, Directors, and Department Heads are responsible for compliance with the X-ray Radiation Safety Plan within their departments and for ensuring that implementation of this program is addressed.

Additionally, these individuals are responsible for ensuring that:

- employees are provided with training at, or near, the time of hire and at appropriate intervals thereafter.
- applicable students are provided with training, commensurate to their actions and duties, each semester.
- environmental health and safety practices are implemented within the department/unit.

Departments are responsible for ensuring that the X-ray machinery is maintained and repaired by the Department where they are housed. Any cost associated with repair or maintenance will be billed to the appropriate Department.

2.6 Laboratory Managers, Coordinators & Principal Investigators

Duties and responsibilities of laboratory managers and principal investigators (PIs) include:

- Ensuring emergency equipment and X-ray machines are operating properly and have been properly registered with TCU RSO, as required, within the last year.
- Working with the administration to address employee health and safety concerns, engineered controls, and improved processes.
- Ensuring that users know the safety rules; that protective equipment is available and in working order, and that appropriate training is provided.

2.7 TCU Employees

Duties and responsibilities of TCU employees are defined as:

- Routinely wear required safety equipment (such as safety glasses, gloves, and ear plugs) and appropriate clothing (such as long pants and closed-toed shoes);
- Developing and maintaining good safety habits (i.e., chemical safety practices and procedures); and,
- Attending required training on an annual basis.

2.8 Applicable TCU Students

Students who use any type of X-ray machinery, as defined in this plan, must comply with the requirements of this plan as soon as work on this machinery commences. This applicability extends to pre-professional students, clinicians, and graduate students who work with potential radiation hazards.

All students who work with potential X-ray-producing machines must contact Environmental Health and Safety for appropriate safety training.

Email safety@tcu.edu for further questions and or concerns.

3 Definitions

As low as reasonably achievable (ALARA)

Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of ionizing radiation and licensed sources of radiation in the public interest.

Dose

A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent.

Dose equivalent

The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the Sievert (Sv) and rem.

External dose

That portion of the dose equivalent received from any source of radiation outside the body.

High radiation area

Any area, accessible to individuals, in which radiation levels from sources of radiation external to the body could result in an individual receiving a dose equivalent in excess of 100 mrem/hr. at 30 cm from any source of radiation or from any surface that the radiation penetrates.

Lens dose equivalent (LDE) The external dose equivalent to the lens of the eye at a tissue depth of 0.3 cm (300 mg/cm²)

Radiation area

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

Radiation Safety Officer (RSO)

An individual who has a knowledge of and the authority and responsibility to apply appropriate radiation protection rules, standards, and practices, who must be specifically authorized on a radioactive material license, and who is the primary contact with the DSHS.

Rem

The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert (Sv)).

Restricted area

An area for which access is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to sources

of radiation. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Shallow dose equivalent (SDE)

Applies to the external exposure of the skin of the whole body or the skin of an extremity. It is the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm²).

TAC

Texas Administrative Code

DSHS

Texas Department of State Health Services, Bureau of Radiation Control.

Total effective dose equivalent (TEDE)

The sum of the effective dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

Very high radiation area

An area, accessible to individuals, in which radiation levels from sources of radiation external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter (m) from a source of radiation or from any surface that the radiation penetrates. At very high doses received at high dose rates, units of absorbed dose, gray, and rad, are appropriate, rather than units of dose equivalent, Sv and rem.

4 Radiation Facilities and Equipment

- 1) The use of all radiation machines is authorized by the Department of State Health Services Radiation Control Program under registration numbers R00109 and R40380 issued to Texas Christian University. A copy of this registration is available for inspection from the RSO.
- 2) Texas Christian University owns all facilities in which radiation machines authorized under registration numbers R00109 and R40380 are housed.
- 3) All X-ray machines and other radiation-producing equipment are required to be registered in accordance with TAC §289.226.
- 4) University personnel procuring radiation-producing equipment must contact the RSO and EHS prior to procurement. Email safety@tcu.edu or call 817-257-5395 for further questions and or concerns.

4.1 General

Each person authorized to use sources of radiation is responsible for the safe use of such devices. The user must carry out the required administrative and safety procedures; select those laboratory practices that are applicable to the work and consistent with ALARA procedures; train and supervise those assisting and acquaint all with proper radiation safety practices; maintain the required records on surveys, training, operating and safety procedures, safety equipment/devices and ensure that the laboratory is posted with the proper warning signs.

4.2 General Safety Guidelines

- 1) Only the appropriate research directors and authorized users will be allowed to operate X-ray units. A list of authorized users will be maintained by the research director of each laboratory and by the RSO.
- 2) A personal monitoring device will be worn by the operator of an X-ray unit in accordance with Section 7 of this document, and a suitable survey meter will be used to monitor the general area of the X-ray unit to ensure that excessive radiation levels are not present to endanger the operator or other personnel.
- 3) As a safety feature in the use of uncollimated X-ray beams, micro-switches will be located on the doors to the exposure cell that will deactivate the X-ray generator should the door be opened while the generator is in operation. For well-collimated, narrow beam geometries, physical restriction of access to the X-ray beam is required.
- 4) Any variance in these requirements must be approved by the DSHS.
- 5) The specific manufacturer's instructions shall be followed when operating X-ray devices. Records should be kept of each operation of the X-ray machine. The records should indicate the date of operation, time, voltage, filter, shield or shutter arrangement, and the record should be initialed by the operator using the instrument.
- 6) The RSO will be notified whenever the shielding or the location of X-ray devices is changed.
- 7) No person shall bypass a safety device unless that person has obtained the approval of the RSO. When a safety device has been bypassed, a visible sign bearing the words "SAFETY DEVICE NOT WORKING," shall be placed on the radiation source housing.

- 8) Documented safety and operating procedures must be present for each radiation-producing machine.

4.3 Radiation Machines

Every user of an X-ray machine shall review and understand the appropriate regulations of this manual and of the DSHS. Copies of all state regulations [25 TAC (Texas Administrative Code)] are available for download from the [DSHS website \(https://www.dshs.state.tx.us/texas-radiation-control\)](https://www.dshs.state.tx.us/texas-radiation-control). Relevant to the X-ray safety program at TCU are the following regulations: [§289.203](#), [§289.204](#), [§289.205](#), [§289.226](#), [§289.227](#), [§289.228](#), and [§289.231](#).

5 Special Management Procedures

5.1 Mobile Service of X-ray Machines

Mobile Service of X-ray Machines

- 1) A radiation-producing Ortho Scan fluoroscopic machine may only be used for mobile service if explicit permission is granted by DSHS and is indicated on TCU's Certificate of X-ray Registration R00109. This permission is granted to Texas Christian University by condition six (6) on Registration R00109.

The following conditions must be met to utilize mobile capabilities of the ortho-scan fluoroscope:

- a. Application for mobile service must first be requested through the RSO for approval before the unit is temporally relocated to the new site.
- b. The fluoroscopes mobile capabilities must be utilized only to provide care for intercollegiate athletic programs affiliated with Texas Christian University or other game participants at contest sites within Texas that do not have adequate medical facilities.
- c. Only a licensed practitioner shall initiate operation of the Orthoscan fluoroscope for human use.
- d. The fluoroscope may only be operated by the authorized physicians on the TCU Athletics Department staff. The physicians on staff in the TCU Athletics Department are Dr. K. Michele Kirk, Texas Medical Board License L9289, and Dr. Jason Mogonye, Texas Medical Board License M8189. No other medical assistant or athletic trainer may operate the Orthoscan unit.
- e. Individuals who do not meet the established credentialing requirements shall not operate a radiation machine for human use.
- f. Radiation machines in the healing arts are subject to [§289.227](#) and all operators of such machines shall be familiar with this section of the TAC. General operating requirements can be found in §289.227(i).
- g. The RSO shall maintain records of equipment performance evaluations. These records will be housed in the Athletics Department with the OrthoScan equipment
- h. During operation, the practitioner must maintain a distance of six feet (6') from the patient and ensure that the practitioner and the patient are shielded with lead aprons, ensuring that ALARA safety precautions are followed.
- i. Each directing practitioner shall review and understand the written operating and safety procedures for the use of the Fluoroscan as a mobile device. These procedures shall include but are not limited to the items in §289.227(i)(2). The procedures shall be made available to each medical practitioner operating a radiation machine, including any restrictions of the operating technique required for the safe operation of the particular X-ray system. The practitioner shall

document they have reviewed and understand the Operating Safety and Emergency Procedure Manual for radiation machine use for Texas Christian University. This documentation must be maintained for inspection by the DSHS. The documentation shall include the following:

- Name and signature of individual
- Date individual read the operating and safety procedures
- Initials of the RSO

The normal daily operation of the fluoroscope will be within the confines of the Athletics Department at Texas Christian University. The address is as follows:

TCU Sports Medicine
3500 Bellaire Drive North
Fort Worth, Texas 76129

All records for the OrthoScan Fluoroscope will be kept at this location.

The unit may only be operated by Dr. K. Michele Kirk, Texas Medical Board License L9289, and Dr. Jason Mogonye, Texas Medical Board License M8189. No other medical assistant or athletic trainer may operate the Orthoscan unit.

Any further questions or concerns please contact askrisk@tcu.edu or by phone at 817-257-5395.

5.2 Industrial/Analytical X-ray Machines

5.2.1 X-ray Diffraction Units

- a) This section provides special requirements for analytical X-ray diffraction equipment. These requirements are in addition to, and not in lieu of, requirements in other sections of this manual.
- b) A safety device that prevents the entry of any portion of an individual's body into a primary X-ray beam path or that causes the beam path to be shut off upon entry into its path will be provided on all open-beam configurations. A user may apply to the RSO for an exemption from the requirement of a safety device. This exemption must be approved by the DSHS. Such application will include:
 - (i) A description of the various safety devices that have been evaluated;
 - (ii) The reason that each of these devices cannot be used; and
 - (iii) A description of the alternative methods that will be used to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.
 - (iv) The RSO will forward this application to the DSHS for its approval.
- c) Open-beam configurations will be provided with a readily discernible warning device that will reveal the X-ray tube status (on-off) and shutter status (open-closed). Warning devices shall be labeled so that their purpose is easily identified and shall have fail-safe characteristics. Unused ports will be secured in the closed position in a manner that will prevent casual opening.

- d) Each port of any radiation device with open-beam configuration will be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.
- e) Areas or rooms housing an X-ray diffractometer shall have postings in accordance with Section 6.5 of this manual.
- f) An easily visible warning light labeled with the words, "X-RAY ON," will be located near any switch that energizes the X-ray tube and will be illuminated only when the tube is energized. Warning lights will have fail-safe characteristics on new equipment installations.
- g) Sufficient radiation surveys will be conducted on all analytical X-ray equipment to show compliance with this manual and the DSHS regulations. A radiation survey will be made after any change in operating configurations.
- h) No person will bypass a safety device without obtaining the approval of the RSO. When a safety device has been negated, an appropriate warning sign will be placed on the radiation source housing.
- i) Finger dosimetry devices will be worn by users of X-ray equipment as appropriate and in accordance with Section 7.4 of this manual.

5.2.2 Portable/Handheld Fluorescence X-ray Devices

- a) Portable/handheld fluorescence X-ray devices (open beam) manufactured without safety devices are exempt from the requirements of §289.228(e)(1)(A). All other regulations applicable to industrial X-ray equipment apply.
- b) An easily visible warning light must be present and illuminated when the X-ray tube is energized and the X-ray is in use.
- c) An appropriate shielding cover must be available and in place when measurements are taken. If a sample is too large for use of the cover, ensure that the analyzer is in contact with the sample material and that the entire aperture is covered by the material.
- d) Do not point the analyzer at an individual when the analyzer is activated.

5.3 Radiation Machines in the Healing Arts

- 1) Radiation machines in the healing arts are subject to §289.227 and all operators of such machines shall be familiar with this section of the TAC. General operating requirements can be found in §289.227(i).
- 2) Individuals who supervise the use of radiation machines for human use shall meet the appropriate credentialing requirements of rules issued in accordance with the Medical Radiologic Technologist Certification Act, Texas Occupations Code, Chapter 601. Copies of the credentialing document shall be maintained at the location(s) where the individual is working.
 - a) A licensed practitioner shall supervise the operation of radiation machines for human use.
 - b) A person who operates a bone densitometry unit(s), which utilizes X-ray radiation, must have documented training consistent with 25 TAC §140.521.

- c) Individuals who do not meet the established credentialing requirements shall not operate a radiation machine for human use unless there is oversight by a licensed practitioner.
- 3) Equipment performance evaluations shall be performed by a licensed medical physicist according to the time intervals outlined in §289.227(o).
 - a) Fluoroscopic machines shall be evaluated annually, not to exceed 14 months from the date of prior equipment performance evaluation (EPE).
 - b) All other radiographic machines shall be evaluated once every other year (2 years from the date of the prior EPE).
 - c) Bone densitometers are exempt from performance evaluations; however, an initial performance evaluation shall be performed on all new densitometers upon start-up, transfer to a new location, and after repairs.
- 4) The licensed practitioner directing the operation shall maintain records of equipment performance evaluations. A copy should also be provided to the RSO.
- 5) Each directing practitioner shall have and implement written operating and safety procedures. These procedures shall include, but are not limited to the items in §289.227(i)(2). The procedures shall be made available to each individual operating a radiation machine, including any restrictions of the operating technique required for the safe operation of the particular X-ray system. The directing practitioner shall document that each individual operating a radiation machine has read the operating and safety procedures and shall maintain this documentation for inspection by the DSHS. The documentation shall include the following:
 - a) Name and signature of the individual
 - b) Date the individual read the operating and safety procedures
 - c) Initials of the RSO
- 6) Protective devices, including aprons, gloves, and shields shall be checked by the directing practitioner annually for defects such as holes, cracks, and tears. If a defect is found, protective devices shall be replaced or removed from service until repaired. A record of this test shall be made and maintained for inspection by the DSHS.

5.4 Digital Image Acquisition QC Requirements

Our facility uses a direct digital imaging acquisition system for image processing. Processing and routine quality control will be completed according to an established program, maintained in the Radiographic room work area. The program will consist of imaging a phantom at a frequency not to exceed quarterly, with results compared to a baseline value. Service will be conducted if a failure is noted. [See §289.227(r)].

6 Radiation Accountability

6.1 Acquisition, Transfer, and Discard of Radiation Machines

- 1) No TCU employee or student is authorized to purchase, receive, or transfer radiation-producing equipment except as authorized by the RSO.
- 2) All purchase and transfer requests will be routed to the RSO for approval prior to acquisition, transfer, or discard. The forms found in Appendix C shall be used as appropriate to report the desire for radiation machine acquisition, transfer, or discard:
 - a) Notice of Radiation Machine Acquisition
 - b) Notice of Radiation Machine Discard/Transfer
- 3) All survey meters and radiation-producing equipment must be reported to the RSO, regardless of how it is procured.

For any further questions or concerns please email askrisk@tcu.edu or call 817-257-5395.

6.2 New Authorized Users

- 1) Before authorization for any research director to use radiation-producing equipment is issued, the research director will notify the RSO to schedule a safety training and test. Upon completion, they will be added to the list of approved users. If required, the new user will complete the Request for Radiation Dosimeter form found in Appendix C. Appropriate personnel monitoring will then be ordered by the RSO.
- 2) Before authorization for students or research associates to use any radiation-producing equipment is issued, the research director will notify the RSO to have the student or research associate added to the list of approved users. The prospective user will contact the RSO to schedule a safety training and test. If personal monitoring is required, the prospective user will complete the Request for Radiation Dosimeter form found in Appendix C. Appropriate personnel monitoring will then be ordered by the RSO.

For any further questions or concerns please email askrisk@tcu.edu or call 817-257-5395.

6.3 Shipping

All shipments of radiation machines from or by the University to outside agencies shall comply with the requirements of the appropriate regulating agencies. For any further questions or concerns please email askrisk@tcu.edu or call 817-257-5395.

6.4 Security and Control

- 1) Users shall secure radiation machines from unauthorized removal or access.
- 2) Users shall maintain constant surveillance, using devices and/or administrative procedures to prevent unauthorized use of radiation machines.

For any further questions or concerns please email askrisk@tcu.edu or call 817-257-5395.

6.5 Posting and Labeling Requirements

- 1) Facility Postings

- a) Signs shall identify each area as a restricted area in which a dose rate above 2.0 mrem/hr. exists.
 - b) Each radiation area shall have a conspicuous sign or signs bearing the radiation symbol (Appendix B) and the words "CAUTION, RADIATION AREA." This sign will be posted on the outside door(s).
 - c) Each high radiation area shall have a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA." This sign will be posted on the outside door(s).
 - d) Each very high radiation area shall have a conspicuous sign(s) bearing the radiation symbol and the words "GRAVE DANGER, VERY HIGH RADIATION AREA." This sign shall be posted on an outside door(s).
 - e) Each room where radiation equipment is used shall post a RC 203-1 "Notice to Employees" form or sign with the same wording on the inside door(s).
 - f) Each room where radiation or equipment is used shall post a list of emergency phone numbers on the inside door(s).
 - g) Exemptions to posting requirements can be found in §289.202(bb) and §289.231(y).
- 2) Radiation Machine Labeling
- a) All analytical X-ray equipment will be labeled with a readily discernible sign bearing the radiation symbol and the words, "CAUTION – HIGH INTENSITY X-RAY BEAM," or words having a similar intent, placed on the source housing.
 - b) All analytical X-ray equipment will be labeled with a readily discernible sign bearing the radiation symbol and the words, "CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED," or words having similar intent, placed near any switch that energizes the X-ray tube.

7 Radiation Monitoring

7.1 General

- 1) Various survey instruments available to users and the RSO are listed in Appendix A.
- 2) The RSO shall be notified about any other survey meter that is or will be actively used. Such meters must be calibrated as indicated in Section 7.2.

7.2 Instrument Calibration

All radiation survey instruments will be calibrated to read within +/- 20% of full scale on linear meters and at the point of the reading for long readout meters. A DSHS-approved company will perform this calibration every 12 months. The RSO will arrange for calibration of this equipment and will review and maintain calibration records. Calibration is currently carried out by MPM Products, Inc.; Texas License # L-00967.

7.3 Occupational Dose Limits

- 1) The following limits correspond to the amount of radiation dose received by adult users in one year:
 - a) Total Effective Dose Equivalent: 5 rems (0.05 Sv)
 - b) Lens Dose Equivalent: 15 rems (0.15 Sv)
 - c) Shallow Dose Equivalent: 50 rems (0.5 Sv) to the skin of the entire body or to the skin of any extremity.
- 2) The annual dose limits for minors and pregnant women are as stated in §289.231(m)(1)(C) and (D).
- 3) Dose limits for members of the public are as follows:
 - a) The total effective dose equivalent from exposure to radiation from radiation sources does not exceed 500 mrem in a year, exclusive of the dose contribution from background radiation, exposure of patients to radiation for the purpose of medical diagnosis or therapy, or to voluntary participation in medical research programs.
 - b) The dose in any unrestricted area from registered external sources cannot exceed 2 mrem/hr.
 - c) Compliance with dose limits for individual members of the public shall be according to §289.202(n) and §289.231(p).

7.4 Personnel Monitoring

- 1) Personnel monitoring by film badge is required in accordance with §289.202(q) and §289.231(n). Users shall monitor exposures from radiation sources at levels sufficient to demonstrate compliance with the occupational dose limits of this section. Individual monitoring devices are required for:
 - a) Adults likely to receive, in one year from sources external to the body, a dose over 10% of the limits established in this section.
 - b) Minors likely to receive, in one year from sources of radiation external to the body, a deep dose equivalent in excess of 0.1 rem (mSv), a lens dose equivalent in excess of

0.15 rem (1.5 mSv), or a shallow dose equivalent to the skin or to the extremities in excess of 0.5 rem (5 mSv).

- c) Declared pregnant women likely to receive during the entire pregnancy, from sources of radiation external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv).
 - d) Individuals entering a high or very high radiation area.
 - e) Either a whole-body film badge or ring badges are available as appropriate. The current monitoring time between exchanges of badges is two (2) months. This time interval has been determined to be appropriate for the typical level of exposure that all users can be expected to receive during the monitoring period.
- 2) Landauer, Inc., provides the film badge service. They provide bimonthly exposure records and annual cumulative records of exposure on each monitored user. These records are maintained by the RSO.
 - 3) Requests for film badges can be made by submitting the appropriate form found in Appendix C to the RSO.

8 Training

Safety training is provided in accordance with University policy, OSHA, and TDSHS regulatory requirements. Any department needing assistance with job-specific training and/or medical surveillance should contact the RSO. Individuals should email askrisk@tcu.edu or call 817-257-5395 for further guidance.

8.1 Contents of Training

To help ensure that X-ray equipment is used safely, all student users must have adequate training. Students are not authorized to use X-ray equipment until the following has been accomplished:

- 1) Student users must successfully complete courses in general laboratory and radiation safety. Topics will include those mentioned in §289.252(jj) (1).
- 2) Student users must receive lab-specific training offered by their research director. Lab-specific training should cover the safe handling of radiation machines specific to the lab where they will work.
- 3) Documentation of all training shall be available upon request.

8.2 Training Method

All training is to be conducted through the SafetySkills/HSI learning management system, through documented hands-on lab-specific training, and through continuing education as deemed necessary to keep users up-to-date and current.

9 Required Tests and Records

9.1 General

The DSHS requires that certain tests and records be maintained. The requirements for tests, surveys, personnel monitoring, record keeping, and reports of incidents are covered under 25 TAC §289.227 and §289.231. Specific rules relevant to these areas discussed in this section are the following:

- §289.227(s) – Record/document requirements for mobile services and authorized use locations
- §289.231(bb) – General provisions for records
- §289.231(cc) – Records of surveys
- §289.231(dd) – Records of individual monitoring results
- §289.231(ee) – Records of dose to individual members of the public
- §289.231(ff) – Form of records
- §289.231(gg) – Reports of stolen, lost, or missing radiation machines
- §289.231(hh) – Notification of incidents
- §289.231(ii) – Reports of exposures and radiation levels exceeding the limits
- §289.231(jj) – Notifications and reports to individuals

Every research director will become familiar with these requirements and shall ensure that personnel under their supervision adhere to these requirements. Copies of all state regulations [25 TAC (Texas Administrative Code)] are available for download on the [DSHS website \(https://www.dshs.state.tx.us/texas-radiation-control\)](https://www.dshs.state.tx.us/texas-radiation-control).

9.2 Surveys

All laboratories and facilities where radiation machines are used will be surveyed periodically in effort to detect any changes in radiation levels and ensure compliance with acceptable dose limits established by §289.231 (m) and (o). Results from these surveys should be documented on a current facility map indicating where measurements were taken and the radiation levels at each point. These surveys shall be conducted, at a minimum, annually for areas utilizing radiation-producing machines. Survey results shall be maintained by the research director and the RSO in a survey log.

9.3 Areas with radiation machines shall be surveyed:

- 1) Upon installation of the equipment.
- 2) Following any change in the initial arrangement, number, or type of local components in the system.
- 3) Following any maintenance requiring the disassembly or removal of a local component in the system.

- 4) During the performance of maintenance and alignment procedures if the procedures require the presence of a primary X-ray beam when any local component in the system is disassembled or removed.
- 5) Any time a visual inspection of the local components in the system reveals an abnormal condition.
- 6) Whenever individual monitoring devices show a significant increase from the previous monitoring period or the readings are approaching the radiation dose limits.

9.4 Inventories

- 1) An annual inventory of all X-ray units is required and will be maintained by the RSO. Records of inventory must be available for inspection by DSHS.
- 2) Each annual inventory will include the following information regarding each X-ray unit:
 - a) Manufacturer's name.
 - b) Model number.
 - c) Serial number.
 - d) Room number.

9.5 Usage Records

- 1) Usage records shall be kept for all X-ray machines. This includes a log indicating the name of the user, the date of usage, time of usage, and operating conditions.
- 2) If mobile service is authorized for a particular machine, the location of usage shall also be indicated on the usage log.

9.6 Individual Monitoring Records

- 1) Records of the radiation exposure of personnel using radiation machines at the university will be maintained by the RSO. A personal report of exposure history is maintained annually by the RSO and will be provided to users in accordance with §289.203(d).
- 2) Users can request a record of their exposure history in writing to the RSO, which will be provided within 30 days of the written request.
- 3) The RSO will provide the exposure history of an individual to the RSO at another institution when requested and authorized by the person in question.

9.7 Other Records

- 1) The RSO and each research director or licensed user will maintain a list of authorized users for their facility.
- 2) Documentation of lab-specific training for each user shall be available from each research director.

9.8 Inspections

The RSO will make periodic inspections of required records that are to be maintained by each licensed user. Inspections will occur annually, at a minimum.

10 Emergency Procedures

General

- 1) In case of suspected or known overexposure to an individual, the RSO shall be contacted immediately. The individual and research director overseeing the project will make a written report in each case of overexposure. Additional investigation by the RSO and ORC may be necessary prior to turning this information over to the Office of Risk Management. If it is determined or suspected that an overexposure has occurred, the RSO will submit a report to the DSHS in accordance with §289.231(hh).
- 2) A current notification list shall be posted in each area where radioactive-producing equipment is used.

X-ray Machine Accident/Incident

If an individual is suspected of being exposed to radiation involving X-ray machines or electron microscopes, the following steps should be taken:

- 1) Turn off the machine immediately.
- 2) **Do not alter** the voltage or current controls or the position of the tube head so that the conditions of irradiation may be duplicated to determine the extent of the radiation exposure.
- 3) Notify the RSO immediately of the incident.
- 4) Record the conditions under which the exposure occurred so that the RSO can determine the extent of the exposure.

Emergency Notification Contacts

Emergency and other important phone numbers are as follows:

Office of Risk Management

Phone: 817-257-4088

E-mail: Askrisk@tcu.edu

Rich Adickes, Hazardous Materials Safety Manager / RSO

Office: 817-257-5395

Cell: 518-569-5369

Email: R.Adickes@tcu.edu

Other important numbers:

Campus Police: 817-257-7777

Fort Worth Fire Dept.: 911

Ambulance: 911

Work Order Desk, Physical Plant: 817-257-7956

Appendices

11 Appendix A - PPE Assessments

11.3.1 Glove Charts appropriate for the Chemicals used in the Laboratory

Gloves, chemicals, and testing criteria can change over time. Glove compatibility charts from the manufacturer are the most reliable resource as they reflect the latest updates in materials, testing protocols, and chemical resistance. The latest known information can be found at:

Ansell Healthcare:

http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf

Best gloves: <http://www.showabestglove.com/site/chemrest/default.aspx>

All safety products: <http://www.allsafetyproducts.com/asp-glove-selection-chart-chemical-break-through-times.html>

Grainger: <http://www.grainger.com/content/qt-166-chemical-resistance-gloves>

11.3.2 Laboratory Hazard Assessment Survey for PPE

OSHA Standards 29 CFR 1910.132-138, Personal Protective Equipment*

Department: _____

Lab Room(s): _____

Principal Investigator: _____

Person completing survey: _____

Signature (P.I./Lab Manager only): _____

Date: _____

Please complete the Hazard Assessment as soon as possible. File the original and send a copy to the Hazardous Materials Safety Manager (safety@tcu.edu or r.adickes@tcu.edu).

Check If Applicable	Hazardous Material or Process Used in the Laboratory	PPE Required

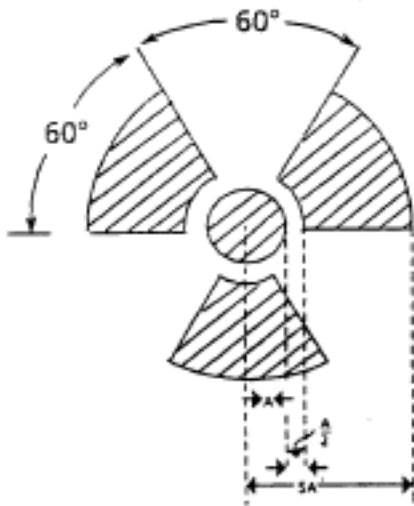
* The personal protective equipment that appears on the survey has been assigned to provide protection for eyes, face, feet, and hands. For additional information on PPE consult with the Environmental Health and Safety (EHS) Coordinator. Use the "Glove Type Selection Guide" presented in Section 11.3.1 for general guidelines on glove selection. Use the glove manufacturer's

guidelines for final selection if the chemical(s) being used (or close homologues) is listed. If the specific chemical or homologues are not listed, you will have to test gloves individually to find a suitable material and manufacturer.

12 APPENDIX B - TCU Monitoring Equipment

1. Ludlum 9DP Meter, Serial Number 25010927; **RSO's Office**
2. Ludlum M-3 Meter, Serial Number 194713; **RSO's Office**
 - a. Model 44-38 ser.# PR202473 Handprobe (GM)
3. Eberline Model ASP-1 Meter, Serial Number 3214; **RSO's Office**
 - a. HP-270 Handprobe, (GM).
 - b. HP-260 "Pancake" Probe, (GM).
 - c. LEG-1 Low Energy Gamma Probe, (SCIN).
4. Capintec, Inc., Caprac-t, NaI Scintillation Well Counter, Serial Number 010265; **RSO's Office**
5. Film badges for neutron, beta-gamma, and X-ray exposure are provided by Landauer Inc., 2 Science Rd., Glenwood, Illinois 60425-1586.

13 **APPENDIX C - Radiation Caution Sign**



1. The cross-hatched area of the symbol is to be magenta, or purple, or black.
2. The background of the symbol is to be yellow.

14 APPENDIX D - Forms and Records

1. Notice of Radiation Machine Acquisition

- a. This form is to be completed and submitted to the RSO prior to the acquisition of a radiation machine.
- b. This allows time for evaluation of the current X-ray registration and submission of amendments if required. This also serves as documentation of machine acquisition.
- c. Ensures the research director is familiar with the applicable regulations for the machine to be acquired.

2. Notice of Radiation Machine Discard/Transfer

- a. This form is to be completed upon discard or transfer of a radiation machine.
- b. This serves as documentation of radiation machine discard or transfer.

3. Request for Radiation Dosimeter

- a. This form should be filled out to obtain a dosimetry badge and grants authorization for TCU to obtain monitoring records from previous employers.
- b. Form should be submitted to RSO prior to beginning radiation work if monitoring is required

Notice of Radiation Machine Acquisition

This form shall be completed and returned to the Radiation Safety Officer (RSO) prior to the purchase of a radiation machine.

Richard Adickes, RSO, TCU Box 298860, SWR 438, Fort Worth, Texas. Ph: (817) 257-5395 or email to askrisk@tcu.edu

Research Director:

Name:		Department:	TCU ID#:
TCU Box #:	Office Location:	Phone #:	Email:

Address of laboratory or place of use and storage:

Street Address:	City, State	Zip:
	Fort Worth, TX	
Building:	Room #:	

Machine Information:

Type of Machine:	Manufacturer:	Model:
Maximum Operating Conditions:	Serial Number (completed upon receipt):	Acquisition Date (completed upon receipt):

Describe in detail how the machine will be used. What will be studied?

--

Proposed personnel monitoring devices:

--

Describe procedures which will ensure radiation doses to faculty, staff, and students are As Low as Reasonably Achievable (ALARA):

--

I acknowledge that I am familiar with the Texas Administrative Code and the specific regulations pertaining to X-ray Registration R00109; R40380 that apply to this radiation machine. I am aware of all postings, surveys, training, and safety operations and procedures required to manage this machine in a safe and regulatory compliant manner.

Research Director Signature:	Date:

Notice of Radiation Machine Discard/Transfer

This form shall be completed and returned to the Radiation Safety Officer (RSO) upon discard/transfer of a previously acquired radiation machine.

Richard Adickes, RSO, TCU Box 298860, SWR 438, Fort Worth, Texas Ph: (817) 257-5395 or email to askrisk@tcu.edu

Current Owner:

Name:		Department:	TCU ID#:
TCU Box #:	Office Location:	Phone #:	Email:

Current address of laboratory or place of use and storage:

Street Address:		City, State	Zip:
		Fort Worth, TX	
Building:		Room #:	

Machine Information:

Type of Machine:	Manufacturer:	Model:	
Maximum Operating Conditions:	Serial Number:	Acquisition Date:	Transfer Date:

If discarding:

Describe in detail how the machine will be discarded

If transferring, please complete the following regarding the future owner and place of use/storage:

Name:		Phone #:	Email:
Institution:		Department:	
Street Address of Use/Storage:		City, State	Zip:
Building:		Room #:	

Current Owner's Signature:	Date:

Radiation Safety Officer's Signature:	Date:

Request for Radiation Dosimeter

The following information is necessary for initiation of Radiation Dosimeter Service. Complete all blanks; use N/A where not applicable.

Last Name:		First Name:		Middle Name:
TCU ID#:	Date of Birth:	Sex:	Position:	
		☐ Male ☐ Female	☐ Faculty ☐ Staff ☐ Student ☐ Visitor	
Employment Start Date:	Home Phone:	Other Phone (cell, beeper, etc.):	Email:	
Campus Office Extension:	Campus Lab Extension:	Department:	Supervisor:	

Local Address:

Street	State	Zip

Permanent Address (if different than above):

Street	State	Zip

I will be working with the following radioactive materials and/or radiation producing machines:

Isotopes	Maximum Activity	Building	Room Number

Type of Radiation Producing Machine	Building	Room Number

Within the past year, I have worked at the following institution(s) where my radiation exposure was monitored: ☐ None

Name of Institution:		Name of Institution:	
Department:		Department:	
Street Address:		Street Address:	
City, State, Zip		City, State, Zip	
Employment Dates:	From To	Employment Dates:	From To

I authorize the release of all my radiation exposure data from the institutions listed above.

Signature _____

Date_____

RETURN THIS REQUEST TO:

Radiation Safety Officer

Attention: **Rich Adickes**

TCU Box 298860

Fort Worth, Texas 76129

Email: askrisk@tcu.edu

15 APPENDIX E - Facility Diagrams

The following diagrams illustrate the usage and storage locations of X-ray-producing machines on the TCU campus.

Registration Number:		R00109						Page 1 of 2	
Instrument	Manufacturer	Model #	Serial #	Building	Room	Site	Use Category	Comments	
Bone Density	General Electric	Lunar IDXA	200057GR	Rickel	256	000	576 - Medical Radiographic	Found (Rickel Academic Wing)	
Medical Radiographic	Del Medical	Anthem 50-650	01841-1015	Schollmaier Arena	E006	000	576 - Medical Radiographic	Found (Sports Medicine Athletics)	
Fluoroscope	Orthoscan	Mobile DI	560338	Walsh Complex	101B	000	J01 - Fluoroscopy	Found (Training Room Athletics)	
X-Ray Diffractometer (Powder)	Bruker Analytical	A25-X1-1 Standard	4562	Sid Richardson	338	000	573 - Other Industrial	Found (Dr. Kayala Green). Out of Service from burned tube Feb - May 2018. Jan 2019 to May 2019 out of Service generator issues.	
Cabinet X-Ray Apparatus	LD Didactic	554 800	1543/1402	Sid Richardson	138	000	572 - Minimal Threat	Found. Dr Hana Dobrovolny space. Power Plug cord has been removed and stored in SWR 437. Unit not in use (Update 2023)	
X-Ray Diffractometer (Powder)	Rigaku Corporation	Smart Lab SE	BD6900134-01	Sid Richardson	473	000	573 - Other Industrial	Installed October 23, 2019. Replaced Dr. Jeff Coffey's Phillips X-Ray Diffractor Model 12003300 (XRG 3100).	
Date of Inventory	1/20/2017 - 1/15/2018 - 8/17/2018 - 1/4/2-19 - 10/25/2019 - 4/27/2020 - 9/29/2020 - 9/27/2021 - 9/23/2022 - 9/20/2023								
Instruments Highlighted in Yellow are No Longer on Campus or are Non Functional and Cannot be Energized.									
Instrument	Manufacturer	Model #	Serial #	Building	Room	Site	Use Category	Comments	
Fluoroscope	General Electric	OE HP mini C-arm 451P	1828	Daniel Meyer Coliseum	3	000	J01-Floroscope	No Longer on Campus. Disposed.	
X-ray Diffractometer (Powder)	Phillips	PW1720	2096	Sid Richardson	127	000	573 - Other Industrial	Found. United is No longer functional disabled by Gerald Katchinska TCU CSE Engineer. (Dr. Zygmunt Gryczvnski)	
X-ray Fluorescence (Handheld)	Bruker	Tracer III-SD	T3S1097	Sid Richardson	243A	000	573 - Other Industrial	Out of Service. No longer Functional (Dr. Rhianna Mayne) RM M216. No longer part of inventory. Disabled by Jerry Katchinska TCU CSE Engineer.	
X-ray Diffractometer (Powder)	Phillips	12003300 (XRG 3100)	1178	Sid Richardson	480	000	573 - Other Industrial	Found. (Dr. Jeffery Coffey) DOS operating system failed in March 2018. System will not properly boot software and is No longer being used as of 2019. Removed October 2019 No longer in inventory. Taken by Rigaku Corp as trade-in for new unit.	
Page 2 of 2									
X-Ray Diffractometer/XRF (Portable)	Olympus	Terra	Terra 211	Sid Richardson	215/216	000	572 - Minimal Threat	Out of service. No longer Fuctional 4/12/2020. Returned to Manufacture in 2023.	
Registration Number:			R40380						
Instrument	Manufacturer	Model #	Serial #	Building	Room	Site	Use Category	Comments	
X-ray Fluorescence (Handheld)	Bruker	Tracer 5G	900G10999	Core Lab	163/A	000	573 - Other Industrial	United replaced three previous units on December 13, 2022. Traded Tracer IV-SD for this unit (T4S2704, T4S2302, T4S2648).	
Date of Inventory	1/20/2017 - 1/15/2018 - 8/17/2018 - 1/4/2-19 - 10/25/2019 - 4/27/2020 - 9/29/2020 - 9/27/2021 - 9/23/2022 - 9/20/2023								
Instruments Highlighted in Yellow are No Longer on Campus or are Non Functional and Cannot be Energized.									
Instrument	Manufacturer	Model #	Serial #	Building	Room	Site	Use Category	Comments	
X-ray Fluorescence (Handheld)	Bruker	Tracer IV-SD	T4S2704	Core Lab	163/A	000	573 - Other Industrial	Found. Units sent for disposal with US analytical Solution final letter Feb 7, 2023	
X-ray Fluorescence (Handheld)	Bruker	Tracer IV-SD	T4S2302	Core Lab	163/A	000	573-Other Industrial	Donation delivered 9/29/2020. Units sent for disposal with US analytical Solution final letter Feb 7, 2023	
X-ray Fluorescence (Handheld)	Bruker	Tracer IV-SD	T4S2648	Core Lab	163/A	000	573-Other Industrial	Donation delivered 9/29/2020. Units sent for disposal with US analytical Solution final letter Feb 7, 2023	