RADIATION SAFETY MANUAL

(Adopted from ***Radioactive Materials-Wisconsin Regulatory Guides (WISREGs) and UCLA Radiation Safety Manual)***

Chemistry Department, UWEC, 2016

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Incident Notifications to DHS

Telephone notifications shall be made to DHS at **(608) 267-4797** (7:45 a.m. until 4:30 p.m., weekdays) and at all other times to **(608) 258-0099**.

Important links:

https://www.dhs.wisconsin.gov/radiation/index.htm
https://www.dhs.wisconsin.gov/radiation/radioactivematerials/wisregs.htm

TABLE OF CONTENTS

I. PURPOSE OF THE PLAN

The intent of this radiation safety plan is:
1. To protect laboratory employees and students from health hazards associated with the use of radioactive materials in our laboratories.

2. To assist the university's regulatory compliance with the appropriate OSHA Standards related to ionizing radiation.

3. To assist the university's regulatory compliance in handling of radioactive materials.

4. To assure that laboratory employees and students are not exposed to radioactive substances in excess of the permissible exposure limits.

This plan will be available for review to all employees and students using or planning to use radioactive materials for review. This plan will be reviewed annually and updated as necessary by the Radiation Safety Officer and the authorized users (Faculty Members only).

II. RESPONSIBLE INDIVIDUALS UNDER THE RADIATION SAFETY PLAN ARE:

1. Radiation Safety Officer

2. Authorized Faculty Members

3. Authorized Student Assistants

4. Environment Health & Safety Manager (Diane Hunter)

While the Radiation Safety Officer (RSO) is responsible for ensuring that operations in various research/teaching labs comply with regulatory requirements, direct supervising responsibility of requirements specified in this manual rests with the Principal Investigator (PI) who has the Radioactive Materials Permit. Ultimately, it is the responsibility of each individual user to maintain safe work practices and a safe working environment.

PRINCIPAL INVESTIGATOR (AUTHORIZED USER)
The Principal Investigator of a Radioactive Materials Permit is responsible for the safety of individual users working with radiation under their permit. The PI is responsible for ensuring that all radiation safety-related duties are adequately performed. These duties include, but are not limited to:
1. Knowing and complying with applicable regulations and policies for the type of radiation work conducted under the permit.
2. Providing all student assistants (authorized individuals) with documented training, including proper operating procedures, use and location of safety equipment, and applicable regulations and policies as appropriate for the scope of the work.
3. Immediately notifying the **Wisconsin Department of Health and Family Services** by calling the **Radiation Emergencies Hotline at 608-258-0099** in the event of a serious injury, significant spill, or other emergency.

4. Ensuring that all radioactive materials and radiation-producing machines are kept secured from access by unauthorized individuals.

AUTHORIZED USERS

Each individual who works with radiation is responsible for following established safety and operating guidelines (***Chapter DHS 157- Radiation Protection Regulatory Guide; https://www.dhs.wisconsin.gov/publications/p4/p45047.pdf***) to support a safe work environment for themselves and other workers. Responsibilities include, but are not limited to:

1. Reviewing and following the requirements of the Radiation Safety Training Manual, laboratory standard operating procedures, and the Radioactive Materials Permit.
2. Reporting unsafe conditions and accidents to the Principal Investigator or Radiation Safety Officer in a timely manner.
3. Reviewing and understanding associated safety hazards before beginning work.

III. RADIOACTIVE MATERIALS PERMITS

The UWEC has the permission to use only the short half-life isotopes like ^{32}P and ^{35}S. Radioactive isotopes must be managed safely and legally. The record of the receipt, handling, and disposal of radioactive material on campus should be maintained.

PLANNING FOR THE USE OF RADIOACTIVE MATERIAL

Each project involving the use of radioactive material must be planned by the PI to ensure that research activities are conducted safely and are compliant with all pertinent laws, regulations, policies, and procedures. Planning ensures the safety of those handling radioactive material directly as well as other lab members by maintaining radiation exposures at levels as low as reasonably achievable. Inadequate planning may result in unwarranted radiation exposure, contamination issues, or other serious safety problems. When planning for the use of radioactive material in an experiment or project, it is important to consider many factors, including:

- Personnel training
- Radioactive material quantities and chemical forms
- Safety controls
- Laboratory layout

RADIOACTIVE MATERIAL QUANTITIES AND CHEMICAL FORMS

Radioisotopes are approved for use by activity and chemical form by the RSO. The radioisotope quantities requested by a PI for a project should be limited to only the quantities needed. Requesting approval for the minimum quantity of radioisotope required for a project will reduce exposure to personnel and minimize radioactive waste.

LABORATORY LAYOUT

The PI and RSO should plan the layout of the main radioactive material work area within a radioactive material laboratory to minimize exposure to laboratory personnel and to control potential contamination. Items to consider are: the location of the radioactive material work area and its proximity to peripheral laboratory workers, and the location of essential equipment such as fume hoods, centrifuges, emergency showers, eyewash fountain, spill kits, radioactive stock vial and waste storage locations.

IV. PERSONNEL TRAINING

Adequate training of individuals who are directly and indirectly involved with radiation and radioactive material handling is foundational to a strong radiation safety program. At UWEC, radiation safety training is accomplished through RSO and PI. Effective radiation safety training has two primary elements: initial training and continuing training. Additionally, periodic performance-based review of how radioactive material is used by the research group is critical. Any change to existing standard operating procedures (SOP) requires retraining of applicable personnel. Hazard awareness and personal protective equipment training is also essential for all laboratory staff, whether individuals are directly handling radioactive material or if they are working peripherally in a commissioned laboratory.

OCCUPATIONAL RADIATION WORKERS

Individuals who directly handle radioactive material are referred to as occupational radiation workers and are required to complete radiation safety training; this training must be documented by the PI who provides initial radiation safety training about basic radiation safety principles, techniques, and requirements along with supplemental documents containing relevant safety and compliance information. The PI is responsible for ensuring that ongoing training is also conducted when protocols or laboratory conditions have changed. Laboratory specific training should cover, but is not limited to, the following:

- Where radioactive material and/or radiation-producing machines are used and stored in the laboratory
- The location of standard operating protocols and emergency procedures
- The location of safety equipment, personal protective equipment, and spill kits
- Laboratory security

ANNUAL RADIATION SAFETY REFRESHER TRAINING

Annual radiation safety refresher training, also referred to as continuing training, is required for all radioactive material users and radiation-producing machine operators, including PIs.

V. PROTECTION AGAINST RADIATION EXPOSURE

Radiation is defined as the emission and propagation of energy through space or matter by high-speed particles or electromagnetic radiation. At high enough energies, radiation has the ability to ionize matter and can cause adverse health effects. Therefore, it is important to understand the nature of ionizing radiation and when individual users conduct their work, they do so in a safe and efficient manner such that radiation dose is kept as low as reasonably achievable (ALARA). Radiation exposure can be minimized by:

- Safe handling procedures
- Personnel training
- Proper labeling, signage and postings
- Frequent safety audits
- Fume hoods
- Shielding

Radioactive material may enter the body through one of four pathways: inhalation, ingestion, absorption, and injection. Therefore, it is important to maintain a safe work environment. Each laboratory member must be suitably trained on all pertinent standard operating procedures for the scope of work performed.

VI. LABORATORY GUIDELINES

Individuals working in, or visiting, a laboratory using unsealed radioactive material must always follow the following rules:

- Closed-toe shoes and long pants (or equivalent) are required when entering or working in radioactive material use laboratories that use unsealed material.
- Gloves, lab coats, and eye protection must be worn during any and all operations in which unsealed radioactive material is used and there exists a potential for contamination.
- Personnel should frequently monitor their hands, clothing, and shoes for contamination during and after each experiment with radioactive material.
- There will be no food or drink consumption or storage in any unsealed radioactive material use labs at any time. This also applies to personal items such as make-up, lip balm, etc.
- Do not dispose of food, empty food wrappers, or beverage containers anywhere in the lab.
- Hands should be washed thoroughly with soap and water prior to leaving the laboratory.
- All work with volatile materials will be performed in a certified radioactive material use fume hood.
- Appropriate shielding will be used to keep external radiation exposure ALARA (As Low As Reasonably Achievable), as appropriate.
- Radioactive material use areas and equipment will be monitored with an appropriate calibrated survey meter to ensure that contamination is not present and that radiation fields are kept ALARA.
- All contaminated waste must be disposed of in appropriate waste receptacles that indicate the radioisotope and are labeled with standard radiation warnings.
- All sharps must be disposed of in proper sharps containers and must not be overfilled. All syringes must be capped while not in use.
- Visitors require the permission of the RSO to enter any lab using unsealed radioactive material.

VII. GUIDELINES FOR THE USE OF RADIATION DETECTORS

Things to Remember:

- Geiger-Mueller detectors will not detect tritium (H-3) or other very low-energy beta emitting radioisotopes. This class of radioisotopes must be evaluated using a liquid scintillation counter or other windowless detector.
- Geiger-Mueller detectors are highly inefficient at detecting low-energy gamma ray sources (I-125).

OPERATING PROCEDURE:

- Before use, look over the instrument carefully and check for any signs of damage to the detector, probe, or cable.
- Check the calibration certificate label affixed to the detector. Confirm the calibration date has not been exceeded by one year.
- Check the batteries. Before each use, use the battery check switch to ensure there is enough battery to operate the detector. Replace weak batteries if needed. Turn off the instrument when not in use. (Note: When storing the instrument for extended periods, remove the batteries to prevent damage from battery acid leakage.)
- If a check source is present on the detector, check for a response and compare the results to those indicated on the calibration sticker.
- The audible indicator will help the operator notice an increase in the count rate without looking at the meter.
- Begin all measurements on the lowest scale first (usually x0.1 or x1), then increase the scale as appropriate.
- Survey slowly. The detection sensitivity of the instrument decreases with increased survey speed. Use a slow sweeping motion that is no more than two inches per second.
- Survey at the proper geometry. The detector should be held as close to the surface as possible without touching it. Typically, a detector-to-surface height of 1 cm or ½ inch is used. This will ensure maximum sensitivity while not contaminating the detector.
- Do not use a Geiger-Mueller detector probe for contamination surveying while it is covered with a plastic cap. Additionally, do not cover the probes with plastic film, as the plastic.

VIII. HANDLING OF RADIOACTIVE WASTE

Radioactive waste generated through research or classroom teaching involving radioactive material is subject to strict Federal and State regulations, and must be handled and disposed of according to DHS guidelines. Prior to receiving approval to order and use radioactive material, Principal Investigators (PIs) must ensure that a method for the segregation, temporary storage, and transfer of radioactive waste is established. Three main types of radioactive waste are generated at UWEC; they include: Dry solid, Aqueous liquid, and Liquid Scintillation Vial (LSV)

DRY SOLID RADIOACTIVE WASTE

Dry solid waste includes the most common laboratory items such as gloves, paper products, pipette tips and glass tubes. Free-standing liquid must never be placed in dry solid waste. When segregating dry waste, shielding should be considered. Beta box storage for beta-emitting radioisotope or lead-lined containers for gamma-emitting radioactive waste are recommended. Dry solid waste must be double-bagged in thick (3 mil or greater), transparent bags and should be taped closed using a "J" seal to secure contents. Sharps should be placed in a sturdy plastic or cardboard container that is labeled with the word "SHARPS". The container should be taped closed and placed into a thick (3 mil or greater), transparent bag. Red sharps containers must not be used unless the sharps are biohazardous.

AQUEOUS LIQUID RADIOACTIVE WASTE

Aqueous liquid radioactive waste consists of free standing liquid stored in a plastic container such as a carboy. The aqueous liquid waste must not exceed 90% of the container capacity and containers must always be closed when not in active use. Liquid waste must always be stored and transported in secondary containment. When completing the radioactive waste tag, the chemical constituents and their volume percentages must be noted (e.g., 75% water, 20% saline buffer solution, and 5% ethanol) in addition to the other required information. It is best to use the generic term for the chemical constituent rather than the brand or specific chemical names.

LIQUID SCINTILLATION VIAL (LSV) RADIOACTIVE WASTE

It is recommended that the Liquid scintillation waste vials must always be tightly capped when in storage or during transfer to prevent spillage of the contents. When transferring liquid scintillation vial waste, the vials should be double-bagged in thick (3 mil or greater), transparent bags and "J"-sealed using tape. When completing the radioactive waste tag, the brand and type of liquid scintillation cocktail must be noted, along with the total volume. The brand and type of scintillation cocktail determine whether the vial waste is biodegradable or hazardous.

GENERAL GUIDELINES

- All radioactivity labels must be defaced or removed from containers and packages prior to disposal in ordinary (non-radioactive) waste. If waste is compacted, all labels that are visible in the compacted mass must be defaced or removed.
- All non-radioactive waste such as leftover reagents, boxes, and packaging material should not be mixed with radioactive waste.
- Occasionally monitor all procedures to ensure that radioactive waste is not created unnecessarily.
- Review all new procedures to ensure that waste is handled in a manner consistent with established procedures.
- In all cases, consider the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and costs.
- Waste management program should include waste handling procedures for the users within their laboratories or assigned areas, and for waste handlers who may collect waste from areas of use to bring to the storage area for eventual disposal.
- Housekeeping staffs should be informed about the laboratories using unsealed radioactive material to avoid the possibility of exposure of those individuals to radioactive materials or to radiation.

PROCEDURE FOR DISPOSAL BY DECAY-IN-STORAGE (DIS)

- Only short-lived waste (physical half-life of less than or equal to 120 days) may be disposed of by DIS.
- Short-lived waste should be segregated from long-lived waste (half-life greater than 120 days) at the source.
- Waste should be stored in suitable well-marked containers, and the containers should provide adequate shielding.
- Liquid and solid wastes must be stored separately.

- When the container is full, it should be sealed. The sealed container should be identified with a label affixed or attached to it.
- The identification label should include the date when the container was sealed, the longest-lived radioisotope in the container, date when ten half-lives of the longest-lived radioisotope will have transpired, and the initials of the individual who sealed the container. The container may be transferred to the DIS area.
- The contents of the container should be allowed to decay for at least 10 half-lives of the longest-lived radioisotope in the container.
- Prior to disposal as ordinary trash, each container should be monitored as follows:
    - Check the radiation detection survey meter for proper operation;
    - Survey the contents of each container in a low background area;
    - Remove any shielding from around the container;
    - Monitor all surfaces of the container;
    - Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e., surface readings are indistinguishable from background; and
    - If the surveys indicate residual radioactivity, return the container to DIS area and contact the RSO for further instructions.
- If the surveys indicate no residual radioactivity, record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

PROCEDURE FOR DISPOSAL OF LIQUIDS INTO SANITARY SEWERAGE

- Confirm that sewerage system is a public system, not a private sewerage system, septic system, or leach field.
- Confirm that the liquid waste being discharged is soluble or biological material that is readily dispersible in water.
- Calculate the amount of each radioisotope that can be discharged by using the information from prior, similar discharges and the information in **Chapter DHS 157 'Radiation Protection', Appendix E**.
- Make sure that the amount of each radioisotope does not exceed the monthly and annual discharge limits specified in ***DHS 157.30(3)*** and **Chapter DHS 157 'Radiation Protection', Appendix E**.
- Record the date, radioisotope(s), estimated activity of each radioisotope, location where the material is discharged, and the initials of the individual discharging the waste.
- Liquid waste should be discharged only via designated sinks, toilets or release points.
- Discharge liquid waste slowly to with water running from the faucet to dilute it.
- Survey the sink and surrounding work surfaces to confirm that no residual material or contamination remained in the sink or on work surfaces.
- Prior to leaving the area, decontaminate all areas or surfaces, if found to be contaminated.
- Maintain records of each radioisotope and its quantity and concentration that is released into the sanitary sewer system

IX. PERSONNEL RADIATION MONITORING

Personnel monitoring, or dosimetry, involves the measurement and interpretation of worker exposure to radiation sources. Evaluate the licensee's determination that unmonitored personnel are not likely to receive more than 10 percent of the allowable limits. If personnel dosimetry is provided or required, verify that it complies with ***DHS 157.25(1)*** and licensee commitments. Review personnel monitoring records; compare exposures of individuals doing similar work; determine reasons for significant differences in exposures. If any worker declared her pregnancy in writing, evaluate the licensee's compliance with ***DHS 157.22(8)***. Check whether records are maintained as required by ***DHS***. In order to provide an accurate exposure record and prevent invalid dosimeter readings, the following guidelines should be followed:

- The dosimeter or badge must be worn only during periods of occupational exposure.
- Exchange your dosimeter at the predetermined time.
- Wear your whole-body badge on the front of your body, between the neck and waist, preferably at the collar. The badge must be facing outwards, toward the source of exposure.
- Wear only your assigned dosimeter.

X. STANDARD GUIDANCE FOR WORKING WITH RADIOACTIVE MATERIALS

- **Training:** Only personnel who have completed radiation safety training may use radioactive materials.
- **Personal Protective Equipment (PPE):** Wear appropriate PPE, including full length pants, closed toe shoes, gloves, lab coat, protective eyewear, and dosimeter in the lab.
- **Survey Equipment:** Use an appropriate survey meter and probe when working with radionuclides (other than H-3).Tritium can only be detected with a wipe test using a liquid scintillation counter (LSC).
- **ALARA:** Radiation exposures should be reduced to as low as reasonably achievable (ALARA) by employing the principles of time, distance and shielding.
- **Work in designated radioactive materials area:** Use designated benches covered with an absorbent liner. A certified fume hood should be utilized if working with volatile radioactive materials.
- **Labels and Shielding:** Clearly label each item in storage and properly indicate all storage and work areas. Ensure all materials in storage have adequate shielding.
- **No Food or Drink:** Do not store food in areas (including refrigerators) where radioactive material is stored or used. Do not eat, drink, smoke or apply cosmetics in areas where radionuclides are being used.
- **Secondary Containment:** Provide appropriate secondary containment for all liquid radioactive materials, including waste. A tray with a lip should be used to catch spills.
- **Spills of liquids and solids.**
  - **Major**: If life threatening injuries, dial **911** immediately. Evacuate all personnel from immediate area. Do not permit those directly involved with the spill from leaving the vicinity. Shield spill if necessary and isolate area. Survey personnel involved with spill using appropriate survey instrument. Remove any contaminated articles of clothing and place in plastic bags. Immediately call DHS at (608) 267-4797 (7:45 a.m. until 4:30 p.m.,w eekdays) and at all other times to (608) 258-0099.
  - **Minor** (<100 uCi of non-alpha emitters; and contained in labs; and with no personnel contamination): Cover spill with absorbent material and isolate area. Notify others in immediate vicinity. Begin decontamination efforts, if experienced. Wear PPE and clean

using absorbent materials and cleanser, starting at lowest concentration of contamination working towards highest. Check gloves frequently and change when contaminated. Place all contaminated materials in radioactive waste bag. Monitor involved personnel with appropriate survey instrument and conduct final survey of area. If levels persist above acceptable limits **(see Chapter DHS 157, pp146-149)**, call DHS at (608) 267-4797 (7:45 a.m. until 4:30 p.m., weekdays) and at all other times to (608) 258-0099 for any further instructions.

- **Personal Contamination:** Immediately remove contaminated gloves and/or clothing. Rinse area, especially between fingers and around fingernails if hand contamination, with lukewarm water first then wash with mild detergent. Call DHS at (608) 267-4797 (7:45 a.m. until 4:30 p.m., weekdays) and at all other times to (608) 258-0099.
- **Radiation Safety Journal:** Log all receipts, uses, and disposal of radioactive material in the Radiation Safety Journal.
- **Transferred Materials:** Recipients of transferred materials must be authorized to receive the isotope intended for transfer. Both parties should have a copy of the transfer form and a copy must be sent to the RSO.
- **Weekly Surveys:** Contamination surveys using a wipe test must be performed on at least once a week when radioactive materials were used.
- **Purchasing Radioactive Materials**
- **Review your Radioactive Materials Permit**: Ensure you are authorized to receive the radionuclide and chemical form before ordering from the vendor. Contact RSO for questions regarding your permit.
- **Order Placement:** Always include PI's name and get approval from the RSO when placing your order.
- **Order Delivery:** All radioactive materials packages must be sent to the Chemistry Stock Room. You must notify DHS if your lab accidentally receives any radioactive materials directly.
- **Spill Kits** should include the following:
  - Disposable gloves;
  - Housekeeping gloves;
  - Disposable lab coats;
  - Disposable head coverings;
  - Disposable shoe covers;
  - Roll of absorbent paper with plastic backing;
  - Masking tape;
  - Plastic trash bags with twist ties;
  - "Radioactive Material" labeling tape;
  - Marking pen;
  - Pre-strung "Radioactive Material" labeling tags;
  - Box of Wipes;
  - Instructions for "Emergency Procedures";
  - Clipboard with a copy of the Radioactive Spill Report Form for the facility;
  - Pencil and appropriate survey instruments including batteries (for survey meters).

XI. RADIATION SAFETY TRAINING

February 18, 2011 (Radiation Safety Officer: Sanchita Hati)

1) If you are pregnant, you are advised to inform the radiation safety department. They will give you special training.

2) No eating, drinking, or even empty food containers are allowed in the labs. Food wrappers or bags should not be disposed of in lab trashcans.

3) All food containers that are used for experimental purposes should be marked: NOT FOR FOOD.

4) Lock the lab when it will be empty for more than twenty minutes.

5) If you want to "borrow" radioactive material from another lab, there are multiple steps involved, so check with the RSO.

6) When a stock vial comes in, record the PO#, **ORDER** date, type of radioactivity, and amount in mCi from the Radioisotope Receipt on the Use Record form. On the stock vial, write the PO# and ORDER date. The receipt can then be given to the RSO.

7) Before you begin your experiment, please record the amount and type of radioactivity being used. This is the only way the RSO knows that the material has been used. For ^{32}P, let the RSO know what type of assay is being performed (the key to usage is at the top of the form).

8) Proper clothing for radioactive use: Goggles, double gloves, LAB COAT, closed-toe shoes. Remember if your clothing is contaminated, you may lose it, so don't wear anything you are not willing to throw away.

9) Things to minimize exposure: *time, distance, shielding.*

   Use β-shields when necessary, bench paper, secondary containers, lab coat, safety glasses, gloves, caution tape.

   When dealing with ^{32}P, always use a shield. This is not only for your own protection, but it is also for protecting other lab members from exposure to your ^{32}P samples. **So please be considerate**.

10) To use the GM-counter:

    a) Check the battery

    b) Turn the setting to x10. Hold the window against the standard. The meter should register at 3 mr/hr (read the scale in the middle). If the meter is not functioning properly, let the RSO know.

    c) Leave the counter on during the experiment.

    d) Remember to turn counter off when done.

    For ^{32}P Place saran wrap or parafilm over probe so it will not be contaminated.

11) Always survey the area and equipment **<u>before</u> and after** an experiment. For ^{32}P use the GM-counter.

12) Survey yourself (shoes) and change your gloves every time you leave the room. Minimize walking around while using radioactivity. Do not walk in the lab offices without making sure you are not hot and remember to remove your lab coat.

13) Dispose of radioactive waste properly.

14) Solid wastes: No liquid in solid wastes. A good way to remove liquid sample from eppies is to absorb the liquid by a Q-tip or spot it onto a Kimwipe.

No sharps in solid waste. Dispose of sharps in a sharps container (red in color, labeled: radioactive materials").

Liquid wastes: Use proper pouring procedures to avoid spillage. Aqueous liquid waste must be neutralized before pick-up, therefore: **Do not fill containers to the top.**

15) Radiation spill: In case of a radiation spill, the "rule" is, if you feel comfortable in cleaning it up, go ahead and do so.

MAKE SURE THAT YOU DO NOT SPREAD THE RADIOACTIVE SPILL TO OTHER AREAS, especially THE HALLWAY.

Proper ways to decontaminate include:

a) Inform people in the lab that there is a spill so people will not walk around in the area.
b) Use absorbing paper towels to absorb the material and dispose of it properly.
c) Use Liftaway to decontaminate the area thoroughly. You should use the GM-counter and wipes to monitor the progress of decontamination.
d) Do a final wipe on the area. PLEASE stay and make sure that the wipes are okay before you leave. If the area is still hot, repeat.

Do the following calculation to determine dpm:

(wipe reading in cpm – background reading in cpm) x 4

Anything > 250 dpm needs to be decontaminated.

STUDENTS TRAINING RECORD

Training Date	Topics covered	Signature of the Instructor	Signature of the Student