ARM Training.

January 2023

General Concepts

Exposure→ energy absorption = dose

Exposure (R)- ionization of air, measured with ion chamber.

Absorbed dose (rad)- energy absorbed per unit mass of <u>any</u> material.

Equivalent dose (rem)- energy deposited per unit mass of <u>tissue</u> multiplied by a radiation weighting factor (W_R).

1 R ≈ 1 rad in tissue ≈ 1 rem (for photons)

General Concepts

Activity (Ci)- measure of the amount of radioactive material in a sample based on its rate of decay.

$1\ Ci = 3.7 \times 10^{10}\ Bq$ or $dps = 2.2 \times 10^{12}\ dpm$

Particle Type	Characteristics	Range	Shielding	Bio Hazard	W_R
Alpha (α)	2p + 2n +2 charge	~ 2" in air	Stopped by paper, dead layer of skin	Only an internal hazard	20
Beta(β)	e- or e+ 8000x less massive than α	~ 10 ' in air	Plastic, glass, Al *high Z will cause Bremsstrahlung!	-External hazard to eye/skin hazard -Internal hazard	1
Gamma/ x-ray (γ)	Electromagnetic wave (photon), no charge/mass	No specific range	Lead, concrete, steel (high Z materials)	-External hazard to WB - Internal hazard	1
Neutron (n)	No electrical charge	No specific range	Low-moderate energy shielded w/ high H content material High energy shielded w/steel, Pb	-External hazard to WB - Internal hazard	5-20

General Concepts

Cell damage:

- **Direct** break of DNA strand
- **Indirect** damage of DNA by radiation action on water → free radical formation → DNA damage

Results of damage:

1. Alterations don't really amount to "damage"- change has no effect
2. Damage is repaired- cell operates normally
3. Damage is not properly repaired- cell operates abnormally
4. Damage is severe- cell dies

General Concepts

Acute Dose:

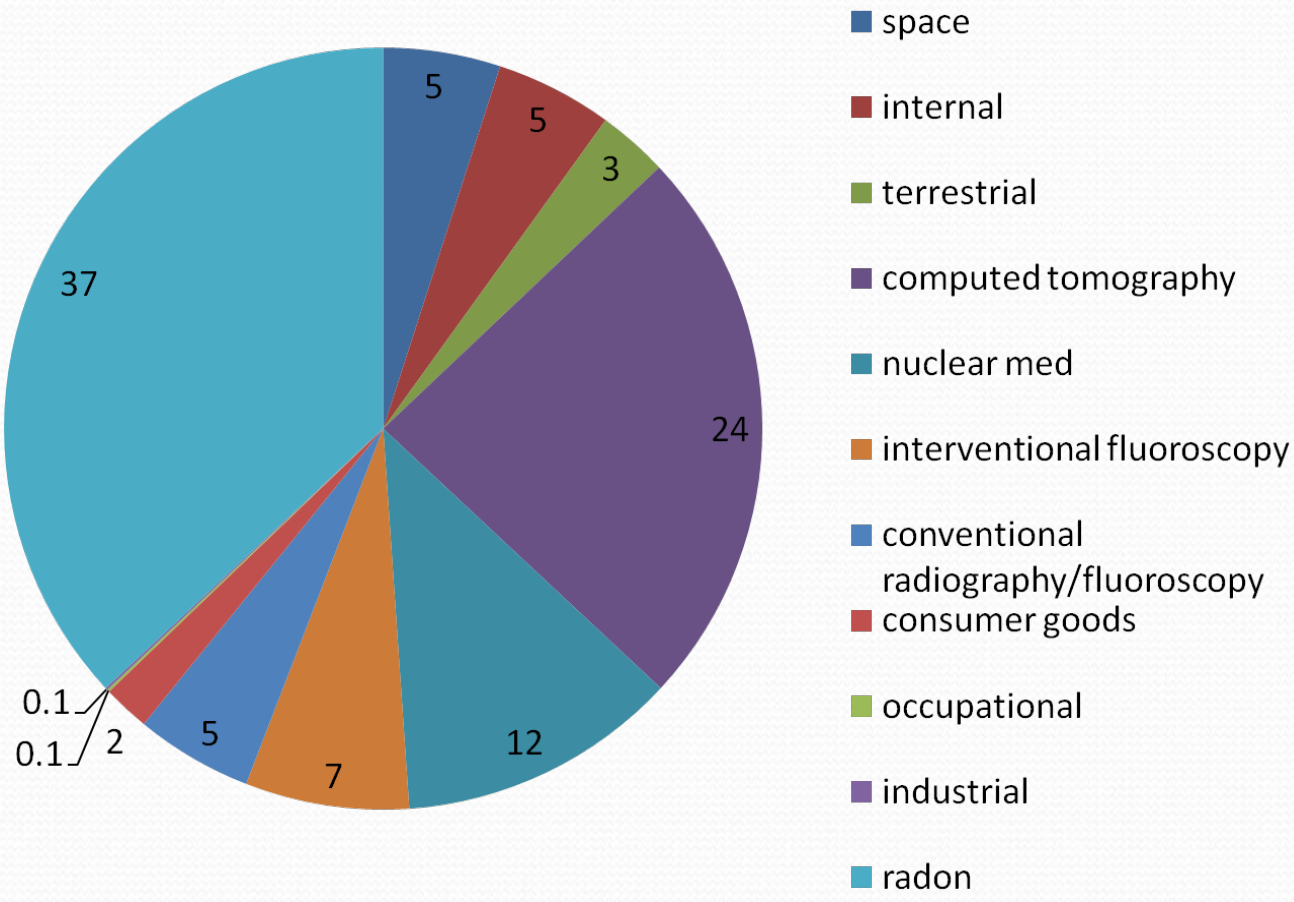
- Large dose (>10rad) in short time
- Many cells die → tissue function affected
- Acute dose to WB→ ARS
  - >200 rad = hematopoietic syndrome
  - >1000 rad = Gastro-intestinal (GI) syndrome
  - >2000 rad = Central Nervous System (CNS) syndrome
- 200-300 rad to skin = erythema
- 30 rad to testes = temporary sterility
- 200 rad to eyes = cataracts
- These effects are **deterministic**, they don't normally occur below the threshold dose, but their *severity increases with increasing dose*.

General Concepts

Chronic Dose:

- Relatively small amount received over long period of time
- Body has time to repair damage to cells
- Body has time to replace dead cells
- Occupational dose = chronic dose
- Effects are **stochastic** (random) and latent (delayed)
  - Somatic effects- occur in exposed individual (cancer)
  - Genetic (hereditary) effects- occur in future generations of exposed individual (never seen in humans!)

General Concepts



Total average bkg (natural + man-made)
620 mrem/yr

General Concept

DOE whole body limit = 5 rem/year
Jlab whole body limit = 1 rem/year

ORGAN	DOE LIMIT	JLAB LIMIT
Extremities	50 rem/year	10 rem/year
Skin and other organs	50 rem/year	10 rem/year
Lens of the eye	15 rem/year	3 rem/year

- limit for embryo/fetus = 500 mrem (during entire gestation period)
  - Efforts should be made to avoid exceeding 50 mrem/month to the pregnant worker.
- limit for visitors and public = 100 mrem/yr
- Minors are limited to 10% of adult occupational limits
  - At Jlab we do NOT allow minors to be rad workers or enter any RCAs!
- **Planned Special Exposure-** unusual instance where personnel may get >5 rem limit. Total dose to individual may not exceed 10 rem (including all other exposures received for the year).

General Concept

Keep doses ALARA

- Time
- Distance
- Shielding
- Source reduction
- Working in Contamination Areas requires RW-II training b/c concepts above are not necessarily enough.

General Concept

Prompt Radiation

- Direct beam
- Radiation produced from beam interaction with materials
- Consists of high energy γ and n
- Most activation is by high energy *photons causing neutrons*
- Elevated levels may be seen:
  - Above unshielded penetrations in service bldgs.
  - Roof of end stations
  - Accessible shielded labyrinths near beam enclosure

Residual Radiation

- γ and β radiation from activation products
- Exposure continues after beam is turned off
- Sources include:
  - Beam dumps/stops
  - Magnets
  - Beam-lines/components
  - Targets
  - Detectors
  - Other experimental equipment
  - Lubricants
  - Cooling water
  - Air

General Concept

Activation may lead to contamination if you:

- Grind/file
- Burn/weld
- Machine, cut, drill

ANY such activity requires RadCon approval!

General Concept

Engineered Controls

- Passive
  - Installed shielding
  - Walls, gates, locked doors
  - labyrinths
- Active
  - Key controls
  - Interlocked monitoring instruments
  - Warning indicators/status displays
  - Ventilation systems

Administrative Controls

- Configuration controls
  - Label/inventory
  - Inspect
  - Test
  - Procedures for changing
  - CARMs, temporary shields
- Postings
- RWPs
- Survey maps
- RCOP
- Contamination monitoring

General Concept

Personnel Safety System (PSS)

- Machine status indicators
  - Enter only in Restricted/Controlled Access
- Magenta beacons
  - Potential for high radiation levels on other side
- Run/Safe boxes
- CARMs
  - ARMs are authorized to move probes w/RadCon approval
  - If alarming secure area, get everyone to leave, call Crew Chief

Emergency Situations

- Medical emergency
  - May aid injured person even if they are in a Contamination Area or area requiring RWP
- Beam-on emergency
  - Refer to the Radiation Control Emergency Procedure kept in the MCC (see next slide)

ARM Duties/Responsibilities

Beam-On Emergency

- Note operating conditions of the machine at the suspected time of exposure
- Retain all personnel not injured or providing medical treatment
- Notify the MCC and RadCon immediately
- Perform a radiation survey on the individual(s) if possible:
  - place the detector on the abdomen and have the person bend at the waist to surround the detector. Record the reading.
  - Retain activated articles of clothing, jewelry, or coins and preserve the identity of the owner.
- Attempt to ascertain the locations and time spent in each location of the affected individuals.
- The victim would not be contaminated (unless they were in a contamination area) and therefore, would not need to be handled with any special protective measures or PPE. Handling body fluids is dealt with by standard medical procedures.

ARM Duties/Responsibilities

- You are a Radiation Worker, all you've learned applies
- While performing ARM duties you are acting on behalf of RadCon
- Under normal circumstances, ARMs will **only** perform escorted surveys (refer to ARMs RWP for specific guidance)
- Conduct/document radiation surveys as requested by RadCon
- Promptly notify RadCon upon discovery of any un-posted HRA during a survey; secure the area to prevent access
- Investigate the causes of radiation alarms
- Monitor and control potentially radioactive components- only to move to special storage areas
- Continuously monitor workplace activities for adherence to the RadCon Manual requirements

ARM Duties/Responsibilities

You may NOT:

- Free release any potentially radioactive component.
- Approve movement of radioactive material outside RCAs.
- Post or de-post radiological areas.
- Give workers permission to enter radiological areas.
- Posting, designating, or controlling access* to High or Very High Radiation Areas, Contamination Areas, or Airborne Radioactivity Areas.
- Relocate RBMs, CARMs, or CARM probes; reset CARM trip levels; remove failed CARMs or RBMs from service; or modify CARMs or RBMs in any way *without approval and specific instructions from RadCon.*
- Be a part of a work crew for any activity you are monitoring.
- Approve the release of water, other liquids or gases from potentially activated systems.

Monitoring Equipment

Proportional Detectors

- **Advantages**
  - can be used to discriminate between different types of radiation (using pulse height discrimination).
  - good sensitivity.
- **Disadvantages**
  - sensitive to voltage changes- makes instrument larger or more expensive.
- **Typical Applications of Proportional Detectors**
  - at Jlab some dose rate instruments (CARM) and field counting equipment (air monitors) utilize proportional detectors.

Monitoring Equipment

GM Detectors

- **Advantages**
  - measure pulse repetition rate not the pulse height.
  - generally more sensitive to low energy and low intensity radiations than proportional/ion chamber detectors.
- **Disadvantages**
  - cannot discriminate between different types of radiation, nor between various radiation energies; therefore, GM detectors cannot be used to directly measure true dose (or exposure).
  - limited use in extremely high radiation fields. Dead/recovery time can be reduced by reducing the physical size of the detector. However, the smaller the detector, the lower the sensitivity. For this reason, wide range GM survey instruments, such as the Teletector, commonly have two GM detectors - one for the low ranges, one for the high ranges.
- **Typical Applications of GM Detectors**
  - GM detectors are widely used in portable survey instruments due to their ruggedness and the simplicity of the associated electronics. GM detectors are also used for personnel monitoring for contamination (friskers).

Monitoring Equipment

Scintillation Detectors

- **Advantages**
  - Ability to discriminate between α/β/γ radiations and between different radiation energies with moderate resolution.
  - Organics (plastic): Durable, have energy deposition characteristics similar to tissue.
- **Disadvantages**
  - Plastics: Poor energy resolution.
  - PMTs are susceptible to high magnetic fields, RF.
  - Fragile.
- **Typical Applications of Scintillation Detectors**
  - Dose rate instruments/count rate meters (Microrem)
  - Contamination monitors
  - Laboratory instruments, spectrometers (LS Counting, gamma spec, neutron spec)
  - Process/area monitors, environmental monitors

Monitoring Equipment

Boundary Monitors (RBMs)

- Six ADM-600/606 units located at site boundary
- He-3 neutron detectors (sensitivity is fraction of µrem/h)
- Photon (GM or scintillator) channel relatively insensitive
- Readout through EDM screens (not PSS interlocked)
- New high pressure ion chambers in field use for gamma (sensitivity analogous to neutron channel)

Controlled Area Radiation Monitor (CARM)

- ~ 50 ADM-610/616 units in accessible areas near beam enclosure (units also in Test Lab)
- BF3 neutron detectors (proportional counter)
- IP-100v1 Photon channels (Ion chamber)
- Visible and audible alarms
- Readout through EDM screens
- Interlocked to PSS to trip on high alarm and power loss
  - Nominal trip point in RCA is 2 mrem/hr (may be unique to area)

Review of Monitoring Equipment

Test Lab interlocked areas use CARM.

Beam dump cooling water building access points use CARM w/ no neutron probe.

- Have feedback to EDM (not interlocked to PSS)

Rapid Access Monitors – gamma probes networked to "go-no-go" access beacon.

Monitoring Equipment

Selection and Use of Portable Survey Instruments

Many factors can affect how well the measurement reflects the actual conditions:

- Selection of the appropriate instrument
- Correct operation based on instrument characteristics/limitations
- Calibration to known radiation field similar in type/energy/intensity to the radiation field to be measured
- Other factors such as radioactive gases, mixed radiation fields, humidity, temperature, and the presence of electromagnetic fields

Monitoring Equipment

Pre-use Checks

- **Physical inspection**
- **Check calibration** (frequency is semiannual)
- All portable instruments must be **source checked** at routine intervals to ensure operability. If the response check is overdue (indicated by a dated label on the instrument), do not use the instrument.
- **Battery check**. If the instrument does not respond properly to the battery check, do not use it (changing batteries is permitted on most instruments).
- On instruments that respond at background dose rates, **select the lowest range** and **verify proper response to the background**.
- If any of the pre-use checks are not satisfactory, DO NOT USE THE INSTRUMENT- remove it from service and tag it for repair.

Monitoring Equipment

"Bicron" Microrem

- **Plastic (tissue equivalent) scintillator**
- **Radiation Detected** – Photon (LE version may see beta)
- **Readout** - Analog, microrem/hr
- **Range** - Up to 200 mrem/hr in five scales
- **Uses** - Area surveys, entry to tunnel after shutdown, item release surveys
- Specific **Limitations** - Response falls off in magnetic field

Teleprobe (FAG and other models)

- **GM (2 tubes)** with dead time correction
- **Radiation Detected** - Photon (some have beta window)
- **Readout** – Digital (some analog), some auto-ranging
- **Range** - Up to 1000 R/hr (hand held base unit goes to 1 R/hr)
- **Uses** - Area surveys, good for reaching overhead or getting distance from high dose rates (ALARA)
- Specific **Limitations** - Pulse sensitive, accuracy poor at background levels
  - ***SMART models ineffective in magnetic field***

NRC ADM-300 (base unit)

- **GM**
- **Radiation Detected** - Photon (has beta window, but not calibrated for beta)
- **Readout** - Digital auto-ranging
- **Range** - Up to 1000 R/hr
- **Uses** – "Special re-sweep" procedure (used as an alarming dose rate meter)
- Same **limitations** as other GMs

Monitoring Equipment

Ludlum-3 with "Pancake Probe"

- **GM**
- **Radiation Detected** - Beta, gamma (sees alpha, but not calibrated)
- **Readout** - Counts per minute
- **Range** - Up to 500 kcpm in four or five scales
- **Uses** - Surface contamination surveys either direct or on swipes, some activation surveys
- Specific **Limitations** - Relies on proximity to surface, gamma sensitivity low, dead time

10CFR835 Definitions

Controlled Area
access is managed <0.1 rem/y (requires GERT or escort)

Radioactive Material Area

Radiological Areas

Radiation Area
>5 mrem/h @30cm
(requires RW-I trng)

Contamination / High Contamination Area
(RW-I not allowed!)

High Radiation Area
>100 mrem/h @30cm
(requires RW-I trng)

Airborne Radioactivity Area
(RW-I may be allowed for air activation)

Very High Radiation Area
>500 rad/h @1m
(generally, no one allowed)

Other Definitions

Radiologically Controlled Area (RCA)
>0.1 rem/y possible
>.05 mrem @30cm
(requires RW-I, dosimeter, General Access RWP. No Minors)

Hot Spot
>100 mrem/h OC and at least 5x the WB reading

Posting Limits/Requirements

Radiologically Controlled Area

- Areas where personnel may receive > 100 mrem/y (> public limit).
- Must be posted when the WB dose rate > 0.05 mrem/h.
- RW-I (or Jlab escort) and dosimetry required.
- DOE does not define RCAs. The term **radiological area** is used to define a *class* of areas as previously discussed. 10CFR835 requires written work authorizations for entry into radiological areas (i.e. GARWP).
- The posting hierarchy for the RCA is as follows:
  - Hazard Level = CAUTION (Hazard level is optional on RCA)
  - Hazard Type = Radiologically Controlled Area
  - Area Modifiers = If the RCA contains radioactive material, this will be included
  - Notifications = Dosimetry required for entry

Posting Limits/Requirements

Radiation Area

- **Radiation levels could result in an individual receiving an equivalent dose to the WB >0.005 rem in 1 hour at 30 cm from the source or from any surface that the radiation penetrates.**
- The posting hierarchy is as follows:
  - Hazard Level = CAUTION
  - Hazard Type = Radiation Area
  - Area Modifiers = Any secondary area postings such as "Contamination Area"
  - Notifications = Usually, RAs require at least RadCon concurrence for work (assuming the area is within a beam enclosure). If trigger values are exceeded*, "RWP Required" is posted.
- A rope or other indication of the boundary is necessary. At a minimum, stanchions with signs attached can be used to provide this boundary, but they must be placed frequently, and be visible from any angle of approach.

Posting Limits/Requirements

High Radiation Area

- **Radiation levels could result in an individual receiving an equivalent dose to the WB >0.1 rem(100mRem) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.**
- ARMs are not normally expected to post/de-post or survey High Radiation Areas. However, suitable access controls and/or postings and barriers should be instituted pending RadCon assistance.

Hot Spot

- **A spot (usually small) where the contact dose rate is >100 mrem/h and at least 5x the WB dose rate.**
- The contact dose rate is written on the Hot Spot label.
- Hot Spots found during a survey by an ARM may not require labeling if other administrative controls are in place.

- ARMs are not expected to determine the posting requirements for :
  - Controlled Areas
  - Very High Radiation Areas
  - Contamination Areas
  - Airborne Radioactivity Areas
  - Radioactive Material Areas

Doing a Survey

Area Surveys

- When entering an area where radiation levels are unknown and potentially high, for analog meters, enter the area with the instrument on the lowest scale.
- Upon entry, if meter over-ranges, stop and move up through the scales until an on-scale reading is obtained. Then proceed on with the survey.
- Hold the instrument at approximately waist height, and slowly walk through the area.
- Periodically move the instrument vertically between the knee and head level. Unless the actual source of radiation is well known, stop and execute a full turn periodically to ensure the body is not shielding a radiation source. This is not usually necessary for beam enclosure surveys.

Doing a Survey

For beam **enclosure surveys**, pay particular attention to:

- ALL beam line passes that have had beam present in them.
- **Cryomodule zones that have experienced RF gradient.**
- Areas where there are abrupt changes in the beam path.
- Any known areas of scraping or beam loss (any area on a beam line that has been discolored by beam scraping).
- Surveys on magnets (especially strong permanent magnets, i.e. ion packs, cold cathode gauges) - the magnetic field will affect some instruments.
- Contact dose rates >120 mrem/hr.
- Potential shielding of Hot Spots by magnets and other components or shielding (i.e. beam dumplettes)
- **Possible streaming of radiation from behind shielded areas or tunnels, tubes, ducts.**

Doing a Survey

For surveys in areas **where radioactive material is stored**, pay attention to:

- Any potential movement of material which may have affected the boundary.

For **all surveys** watch for:

- The presence of radiation levels which would require a different posting or movement, modification, or addition to a boundary.
- The presence of radiation levels which require more stringent administrative controls such as a Job-specific RWP.

Doing a Survey

Initial Entry Surveys

- Identify work area radiation levels and the presence of any areas exceeding existing posting levels or that might require additional controls to those present.
- Appropriate for entries to perform routine diagnostic evaluations or equipment repair in the enclosure.
- Should not be used as the basis for controlling complex radiological work.
- Standing RWP authorizes entry to RAs (with dose rates above the normal hold points for Radiation Workers) for short durations to get survey data. In addition, it includes a task that is used to invoke physical access controls when necessary (High Rad Watch).

Doing a Survey

Escorted Surveys

- Notify accompanied personnel of locations and extent of any unposted RAs/HRAs
- Maintain surveillance of such areas until posted or the access is complete.
- Determine the intended locations and scope of work during the access and note those on the survey sheet.
- Consider follow-up radiological needs – is equipment being removed which will need release surveys; is controlled shielding being dismantled? – remind the workers of applicable requirements.
- Remind workers of limitations applicable to their work (i.e. does it appear RWP other that General access RWP might be needed).
- Identify potential need for *physical access controls* for High Radiation Areas (will need RCD support).

- A **partial survey** must be noted as such on the survey sheet. When this option is used, once the ARM and work party leave, <u>any</u> subsequent entry to the area requires <u>another</u> survey.

Doing a Survey

Material Release Surveys

- ARMs are not authorized to release potentially radioactive material from RCAs.
  - includes any trash from the beam enclosure
  - includes items present in any area which has seen RF or Beam.
  - **Exceptions:** ARMs may conduct surveys on items for purposes of relocating the item from the beam enclosure to a specifically designated and posted staging area for subsequent release survey by RadCon.
    - Any item which has potential for contamination should not be relocated to the staging area without RadCon authorization.
    - If item being relocated is measurably radioactive, RadCon should be notified.
    - If the dose rate from item is ≥.05 mrem/hr WB, RadCon should be notified immediately. These items are not candidates for transfer to the staging area.
    - Always check the radiation levels at the boundary to the storage area to ensure that the addition of an item has not changed the boundary delineation.

Doing a Survey

- When filling out survey maps/RWPs:
  - Use blue/black ink
  - Write legibly and in complete statements/words
  - Sign, do not print, where signatures are required
  - Correct errors with strike through + initials/date
- A survey must be able to provide answers to the questions: (1) what is the maximum whole body dose rate?, and therefore (2) what is the proper designation for area posting?

Doing a Survey

Information Required on the Survey Sheet

- Your name, date, time of survey, instrument used, calibration due date.
- Accelerator conditions prior to shutdown.
- Reason for the survey - Examples: Reboot computer, Check target vacuum, Open for maintenance day.
- Type of survey – initial entry, partial or complete survey, etc.
- Units - i.e. mR/hr
- Type of measurement - i.e. contact, WB, or GA. A legend that explains both units and type of reading is preferred. Each survey data point on the sheet should be identifiable as to the nature of the reading.
- Boundaries - All boundaries should be indicated on the map, and the type of posting on the boundary.
- During partial survey situations indicate areas people entered, WB and contact dose rates in the work areas, and note specifically that the work party had continuous ARM surveillance.

Doing a Survey

When to Get Contact Dose Rates

(1) Take contact readings when WB dose rates are > 2-3 mrem/hr (with the exception of HRAs).

(2) Within Radiation area - after finding the maximum WB dose rate, identify the source and the contact reading associated with it

(3) Be careful not to actually make contact with items that display dose rates approaching 120 mrem/h.

Doing a Survey

Ask the following questions:

- Are the dose rates at boundaries appropriate to the type of boundary?
- Is there any area that meets a posting trigger that is not posted?
- For the contact dose rates, consider:
  - Is a Hot Spot posting required?
  - Does the reading suggest the possibility of contamination?
- Does the reading suggest the presence of a Radiation/High Radiation Area which you have not already identified?

Rules of Thumb

RA is likely if contact dose rate > 150 mR/hr

Contamination is probable if contact dose rate > 250 mR/hr

HRA is possible if contact dose rate > 500 mR/hr

Doing a Survey

When a partial survey/escorted access is conducted radiological areas and Hot Spots do not required posting if:

- You inform all personnel in the area of the conditions and the levels found
- No one will be working in the radiological area or on the Hot Spot
- You can adequately ensure control of the area and prevent uninformed entry (i.e. through direct surveillance and access control through the SSO)

Doing a Survey

When to call RadCon

- Discovery of HRA not previously posted (includes an area that has grown in size, or grown from a RA to an HRA)
- Discovery of an area with WB dose rate > 1000 mrem/hr
- Any conditions that indicates the presence of contamination in the work area
- Any work requiring access to a Radiation Area (or higher)
- Hands-on work on a Hot Spot

Area Specific Requirements

Cryomodule zones under "RF Only" power

- C100, and re-worked C50 cryomodules under the 12 GeV era have produced radiation areas, even under "RF Only" conditions (Power Permit)
- These areas in the North and South are typically posted as "Radiation Area – Walk thru permitted" during beam operations (e.g. both C100 zones).
- "RWP required" RAs have also been identified around warm region girders (25mr/h whole body).
- When performing escorted surveys, be mindful of wb dose rates underneath cryomodules.
- All work in these RAs require RadCon approval
- Contact dose rates >120mr/h may be an indicator of potential contamination

Area Specific Requirements

Halls A and C

- Expect RAs at the target platforms and beam dumps. During high power operations (> 50 uA) these often become HRAs.
- Assume that the beam line downstream of the target chamber is contaminated for the first two or three meters. Do not allow direct handling of this portion of the beam line even if the area is not posted as a Contamination Area. Always get RadCon concurrence for work in this area.

As the WB dose rate at the target chamber increases, there is an increased probability that the pivot is contaminated. As a rule of thumb, if the dose rate at the target/exit area is high enough to trigger an RWP, assume there is a need for evaluations of surface contamination on the chamber, pivot, and immediate surrounding areas.

Area Specific Requirements

Hall B- past

- No surface contamination problems.
- Negligible air activation.
  - air handling equipment is not a concern.
- No sources of contaminated water.

Hall B- current

- Will be running with more current.
  - RCD will continue to characterize the radiological environment per experiment
  - RAS in service.
  - Survey exemption not in effect.

Area Specific Requirements

- **Hall B, D, LERF, and CEBAF injector:**
  - Rapid Access- if the dose rate is below the trip point on all detectors, Controlled Access is allowed without a performed rad survey of the area.
    - initial entrant tests the beacon at the entry point.
    - In Hall B/LERF- hands-on activities on beam line or target components not allowed without a survey.
- CEBAF injector is an RCA, and most recently as a result of field emission from R100, an RMA.
- Hall B, D, and LERF require full survey to change status to Restricted Access.

Area Specific Requirements

LERF Rapid Access

- ARMs may not de-post vault to non-RCA
- ARMs may:
  - Perform escorted surveys for incidental entries during Controlled Access with RadCon approval
- Changing to Restricted Access requires full survey by RCT.
- Do NOT enter vault without survey if Rapid Access System is alarming!!

Alarms

CARM Alarms

- Ascertain location of the CARM
- Observe the current readings
- If the condition caused an accelerator trip (High Alarm), verify that the dose rate is not sustained (alarm will reset in 30 sec). An alarm that continues longer indicates either:
  - radiation condition still exists (may need to be verified with survey meter if accessible)
  - unit has failed
- If unit resets and operations can be resumed, write an Ops-PR for the event – do not check "requires further attention". If the unit causes a second trip, investigate further to see if cause can be isolated and call RadCon with all available information.

Alarms

CARM Alarms (cont.)

- In the case of an "Alert" alarm (no trip)- check the dose rate, if necessary acknowledge the alarm.
  - If the dose rate is sustained, display the output of the unit on the datalogger. If the display indicates long term (significant portions of an hour) sustained dose rates above the alert threshold, and operational adjustments do not correct the condition, call RadCon. Write an Ops-PR, even if unit returns to normal quickly.
- Do not relocate the probes or attempt to reset the alarm levels or clear the probe dose without specific authorization from RadCon.
- Once resolved, if an alarm condition reoccurs, call RadCon.
- Note: Communications failures on CARMs do not cause the accelerator to trip.
- Rule of thumb: any time you see a magnet or RF system failure at the same time as a CARM trip, the root issue is a power failure. Probably no need to call RadCon; fix the power supply and only call RadCon if the CARM doesn't come back to normal operation.

Alarms

Beam Dump Cooling Water Building Radiation Alarms

- Monitoring of bldg. 91/95 is performed with RM-606 CARM monitors.
  - measures the dose rate at the door leading into the buildings.
  - set to alarm at 100 mR/hr.
  - activation of alarm sends a data bit to EPICS/EDM system.
- An alarm will occur on the RadCon alarm handler under the following conditions:
  - If the applicable hall is in Beam Permit, and the outer gate is open
  - If the gate is open and the monitor is registering an alarm (regardless of machine status)
  - If there is a power loss to the monitor or the interlock signal
- If an alarm occurs, contact RadCon and follow the onscreen guidance in the alarm handler.
- Note: This system is not part of the PSS, and is not interlocked to trip off the accelerator.

Non-Accelerator Systems Alarms

- The VTA and Cryo-test cave contain local interlocked PSS systems. Local procedures require notification of RadCon anytime an alarm occurs. Where temporary establishment of interlocked radiation detectors exists, RadCon must be notified when radiation alarms occur.

RWPs

- Access to RA, HRA, CA, and Airborne Rad. Areas ALWAYS require RCD approval for entry!
  - RAs posted as "walk through permitted" allow you to pass through the area but not stay there. However, NO visitors are allowed; this is still an RA!!
- Arc service bldgs and Linacs bldgs (in C100) are Radiation Areas during beam permit! Work here during beam operations is governed by a Standing RWP.

RWPs

ARMs Standing RWP

- Primarily perform escorted surveys**!**
- Do not post HRAs w/out RCD support,.
- Initial entry surveys for unescorted entries are performed by RCTs (unless there are extenuating circumstances that will be coordinated by the RCD).
- For short-duration, escorted entries, it's ok to survey only applicable work areas. But surveys are only valid for that entry!
- Contact RCD for >1 rem/h whole body dose rates!

RWPs

ARMs Standing Cont'd

- May be asked to be HRA Watch- requires briefing, visual surveillance of HRA, will be placed in area with dose rates <5mrem/h.
- May do "conditional" release surveys (i.e. you are NOT saying it's not RAM).
  - Use microrem, check battery/HV, use on lowest scale
  - Survey item on contact over entire area, and at 30cm
  - If dose rate < 0.05 mrem/h at 30cm, place note on item and remove from enclosure.
  - Ensure storage area dose rates also remain < 0.05 mrem/h
  - Notify RCD

RWPs

ARMs Standing Cont'd

May be dispatched as a Runner to check on alarms in dump cooling water bldgs.

** **FIRST NOTIFY RADCON***

- Bring teleprobe
- Will need TUN-9 and RCG-1 keys
- Beam must be OFF before accessing bldg.
- Do not enter if alarm can be resolved from outside
- Do not enter if there is a fire
- Be alert for signs of contamination (wet areas/equipment)
- For CARM alarm:
  - If >100 mrem/h no entry w/out SRPD
  - If <100 mrem/h gated walkway can be accessed and path to door surveyed

RWPs

Service Bldg. Access

- Applies during Beam Permit
  - Arc service buildings will be posted as RCA/RAs
  - Klystron gallery associated with C100 cryomodules in N and S Linac as well as interlocked klystron racks are also posted RAs.
  - Rack spaces above penetrations in the Arc service bldgs are posted as HRAs with RCD controls (i.e. RCG-1- locks and security screws).
- Access to E2-E5, and W3-W5 are governed by SRWP.
  - RCD must be notified, and "beam" off, if access is necessary for RCG-1 lock controlled areas!
- Injector, W1, W2, and BSY are posted RCAs but NOT associated with the SRWP

RWPs

Service Bldg. Access Cont'd

ARMs may de-post RA when operational status changes.

- The posting are conditional
- RA dose rates exist only from prompt radiation, not activated material
- De-posting does not depend on a survey or judgment on your part.

- All entries require Crew Chief or RCD approval
- Entering these RAs requires signing/briefing on RWP and SRPD
- Access into HRA requires termination of beam and RCD approval