national accelerator laboratory

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RADIATION SAFETY PROCEDURES AT THE 200-MeV LINAC

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I. Introduction

Radiation safety procedures at the linac shall provide adequate personnel protection commensurate with the local radiation hazards. These procedures will be sufficiently flexible to permit relatively easy access to the linac vault for tuning up and other operational needs. These considerations are especially important during the early phases of the linac operation when it will need a maximum of human attention.

Consistent with the NAL practice of starting out with as simple a system as possible and adding components and sophistication if and when needed, no interlocked gates at entrances to the linac vault will be required initially.

However, by the time the second tank is ready to accelerate protons, we will expect that the system described herein, or another equally satisfactory to the Radiation Physics Section will be fully implemented. This complete system will include locked and interlocked access doors, emergency shut-off "crash buttons", etc.

II. Linac Vault Status

There will be two linac vault access conditions: "open" and "closed".

The linac vault may be "open" only when the linac is not, and cannot, accelerate "low energy" protons (i.e. energy greater than 750 keV). The linac vault must be "closed" before and when the linac has the capability to accelerate or is in fact accelerating "low energy" protons. In particular, the vault access condition must be "closed" when

a) the 750 kV supply is on, and

b) the ion source is on, and

c) the RF is on in linac tank #1.

The following sections discuss in detail the consequences of open and closed status, and the procedures to be followed in changing the vault status.

III. Open Status

In the absence of high energy protons, the only radiation hazards at the linac are x rays from the 750 kV Cockcroft-Walton from the high gradient column, and from the linac tanks, as well as gamma rays from induced radioactivity in drift tubes, slits, etc. Radiation from these sources will be detected by a number of ionization chambers in appropriate locations. These locations, types of ionization chambers and numbers may be:

i.	Cockcroft-Walton	(2)	Thin Wall
ii.	High gradient column	(2)	" "
iii.	10 MeV tank	(2)	Standard Wall
iv.	Intermediate tanks	(1)ea.	" "
v.	200 MeV switchyard	(3)	" "

The linac vault may be subdivided into three or more "occupancy zones". The maximum daily occupation time of each zone will be

determined from the x-ray and/or gamma ray exposure rates measured by ionization chambers, by one of two methods:

a) Automatic posting of occupancy times:

The occupancy times shall be determined by the "hottest" point in the area. The occupancy time so determined (either 1/4, 1, 4 or 16 hours per day) will automatically be displayed on illuminated signs (Fig. 1) in each zone. If the exposure rate in any zone is greater than 80 mR/hr, the sign at its entrance will read "DO NOT ENTER". In addition, the signs reading, "DANGER, RADIATION AREA, LEAVE IMMEDIATELY" which are normally used only during "beam-on" conditions, will also be flashing.

b) Manual surveying:

Manual survey and interpretation of exposure rate in a particular work area will be made at the request of the concerned party.

Any person wanting to stay in a zone longer than the posted occupancy time, or wanting to enter a restricted area, must have a radiation safety officer make exposure rate measurements in the desired location and establish occupational procedures.

The "open" status of the linac vault will be indicated by illuminated linac status signs (Fig. 2). These will have segments indicating which of the 750 kV high voltage, the ion source and the RF systems are turned on. All combinations of RF system, high voltage and ion source will be allowed during the "open" condition <u>except</u> that combination of parameters which could allow 10 MeV or greater protons to be produced. That is, the high voltage, ion source and 10 MeV RF may not be on simultaneously if the linac vault is "open". Before these

conditions may occur, the vault must first be "closed" to personnel.

IV. Closed Status

This shall be a prerequisite for proton acceleration beyond 750 keV.

The procedure for closing and securing the vault is as follows:

a) Search & Secure

A team of two people shall walk from one end to the other of the vault locking all accesses as they proceed along the vault and visually ascertaining that nobody remains in the vault or its accesses.

b) Audible Alarm

Once the search is finished, the search party shall lock the last access door and a 10 second alarm horn blast shall be sounded. The sound level shall be about 90 db everywhere in the vault.

c) Time Delay Between Alarm Horn & Beam

There shall be a 60 second delay to permit possibly trapped personnel to reach and operate emergency buttons or exit through the normal exits.

Note:

All access doors shall be openable from the inside and this opening shall trip the security system into "unsafe". Locked doors shall be openable from the outside only by breaking a safety glass.

d) Signs

At the time of the horn blast, signs inside the vault reading "DANGER RADIATION AREA LEAVE IMMEDIATELY" (Fig. 2), and those at vault entrances reading "DANGER RADIATION AREA DO NOT ENTER" shall be lit.

After the linac controls are set to allow the acceleration of protons, the status sign (Fig. 3) shall darken areas 2, 3, 4 and illuminate area 5.

After beam current is sensed by the current transformers or the beam loss monitors, the following signs shall start to flash on and off:

"LINAC BEAM ON" portion (area 5) of status sign (Fig. 3)

"RADIATION AREA" portion (area 6) of status sign (Fig. 3)

"RADIATION AREA-LEAVE IMMEDIATELY" (Fig. 2)

"RADIATION AREA" and "DO NOT ENTER" portions (areas 1 & 2) of occupancy time sign (Fig. 1).

e) Entrance & Exit To and From a Closed Area

1. There shall be a person exclusively devoted to control entry and exit of personnel into and out of the vault when it is closed.

2. Entry and exit shall be made through a single access point.

3. Personnel entering the vault shall be accounted for by use of a key tree. (A key tree of 8-12 keys should suffice).

4. To unlock the key tree, one of the two master keys of the linac control shall be needed.

5. To lock and unlock the special access door, the other master key from the linac control shall be needed.

6. After all personnel leave the vault, the door and the

key tree shall be locked. The two master keys may be returned to the linac control to restart acceleration.

f) Restart of Acceleration Following an Entrance to a Closed Status Vault

The procedure listed under Closed Status shall be repeated from step (b) to step (d), inclusive.

All access doors shall be interlocked in series. All doors except the one with the key tree shall be openable using keys from the control room or through the emergency handle behind the glass door. Either mode of entry shall render the linac incapable of acceleration.

g) Reversion of Linac Vault from Closed to Open Status

Once the linac vault is closed it will remain in closed status until opened by the linac operator. If one of the components necessary for proton acceleration (H.V., ion source, RF systems) drops out, this will be reflected in the linac status signs which will reflect this malfunction by extinguishing the "BEAM-ON" portion (panel 5) and illuminating those of panels 2-4 which are relevant. Panel 6 will remain illuminated and the access door interlock system remain activated until the closed vault status is terminated by the linac operator.

V. Types of Radiation Detectors

The Radiation Physics Section will provide the linac with the following types of radiation detectors.

A. Dose-rate Measuring Instruments.

1. Thin wall gas-filled ionization chambers to use near the area where soft x rays are the sole or most important source of radiation exposure.

2. Standard wall, gas-filled ionization chambers for areas where remanent radioactivity or hardened x rays are the sole or most important sources of radiation exposure.

3. Neutron sensitive dosimeters for use outside the thick shielding walls.

B. Uncalibrated Radiation Detectors.

1. Beam loss monitors.

Initially, pulse type neutron detectors will be provided to help with the initial RF phase adjustment between tanks #1 and #2. Should these counters be useful, then they may be transferred to the Linac Section to be incorporated into the linac instrumentation.

ACKNOWLEDGMENT

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FIGURE 1

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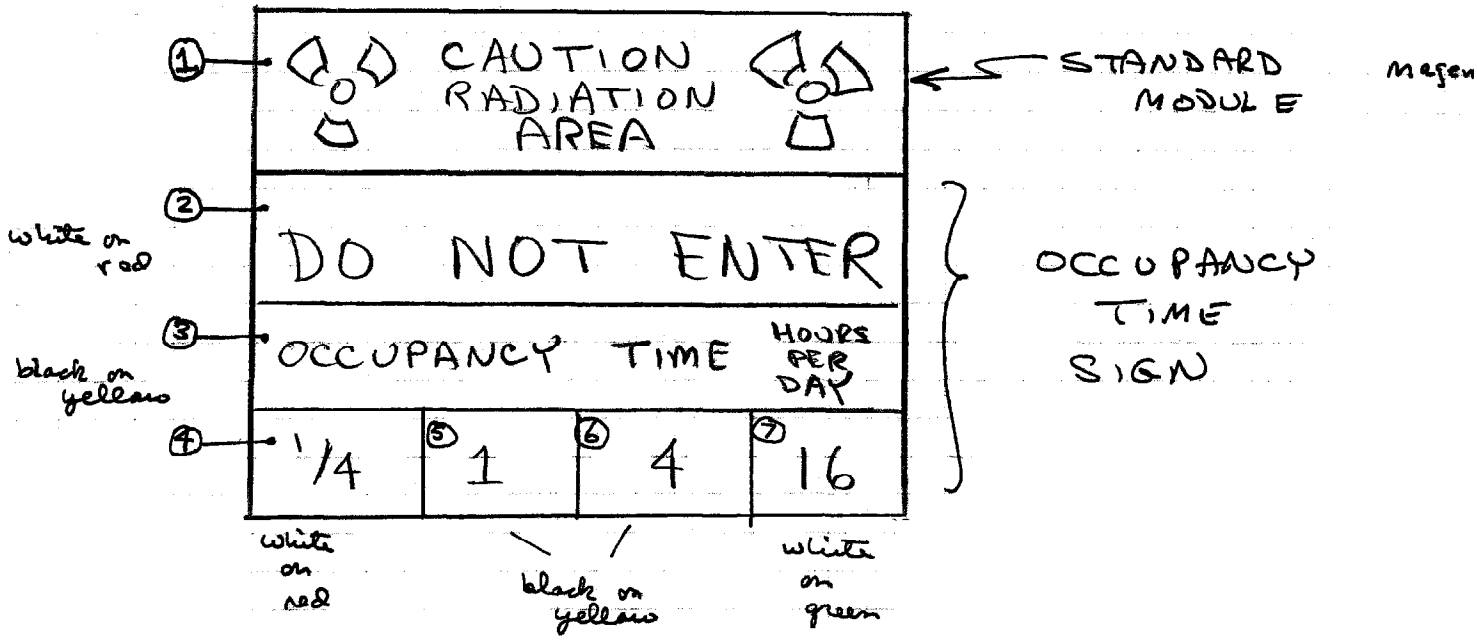

TOP PANEL (#1) OFF if occupancy time = .
STEADY if occ. time = 4, 1, 1/4
FLASHING if DO NOT ENTER condition.

PANEL ③ on steadily if any of panels 4-7 on,
Off if panel 2 on.

PANELS 2, 4-7 on according to following scheme:

DO NOT ENTER	on if D.R. > 80 mr/hr
1/4 hr	" " 80 > DR > 20
1 hr	" " 20 > DR > 5
4 hrs	" " 5 > DR > 1.25
16 hrs	" " 1.25 > DR

FIG 2.

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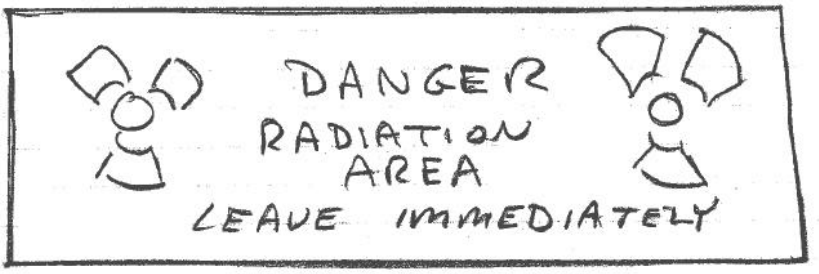
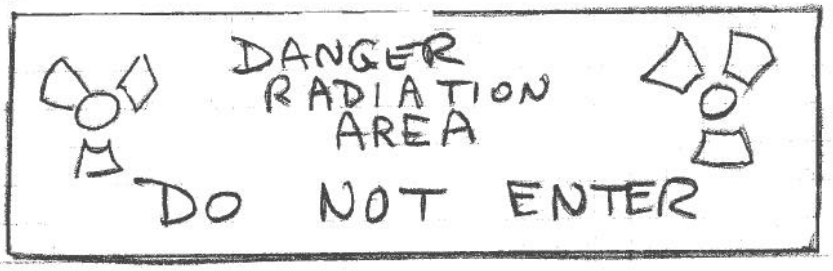


SIGN INSIDE CINAC VAULT

ON STEADILY OR FLASHING, as determined by "BEAM ON" SIGN".



SIGN at ENTRANCES TO CINAC VAULT.

FIGURE 3

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