## Basic Backup 29-15364-2

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SCNEDIX, CHILL.

EDITION NO. 1, MAALT ..

ATOMIC ENERGY OF CANADA LIN. Commercial produ-C-24

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# PART 1 DESCRIPTION

## INTRODUCTION

This manual describes the type IR68 self-contained facility, that is designed to be used as a patch irradiator.

The products to be sterilized are enclosed in boxes, loaded into the source pass mechanism, then batch irradiated.

To load the facility (Source Down position), the detachable rail of the lower tray section (adjacent to elevator P16) must be removed. This will allow the product boxes to te manually loaded into the source pass mechanism, and the product boxes must then be properly positioned in the box support beds before commencing batch operation.

The plant capacity is approximately 500,000 curies of Cobalt 60. The plant will operate with a utilization efficiency exceeding 95 per cent in any one year. (i.e., 346 days providing that the recommended preventive maintenance programme is rigidly followed).

Alest - The product sterilized will receive a minimum dosage of 2.5 megarads of ionizing radiation from a Cobalt 60 source.

Drawings quoted throughout this manual are provided under separate cover for reference purposes. GENERAL

Refer to Figure 1.

The general layout of the batch Irradiation plant is shown in AECL Drawing B106801-002.

The IR68 irradiator is a self-contained unit surrounded by a ventilated concrete biological shield.

The IR68 machine is designed to sterilize, by irradiation, medical products in fibreboard boxes of one of the following box dimensions:

1 .

Box	Unit	A	 Length	23.62	in	(60 c	m )
•			Width	15.74	in	(40 ci	m )
			Height	35.43	in	(90 c	m )
Box	Unit	в	 Length	15.74	in	(40 ci	m )
			Width	19.68	in	(50 ci	m )
			Height	35.43	in	(90 ci	m )
Box	Unit	С	 Length	•23.5	in	(59.7	cm)
			Width	19.0	In	(48.3	cm)
			Height	35.5	in	(90.1	cm)
Box	Unit	D	 Length	21.75	in	(55.2	cm)
			Width	17.0	in	(43.2	cm)
			Height	36.0	in	(91.4	cm)
Box	Unit	Ε	 Length	27.62	in	(60	cm)
			Width	19.68	in	(50	cm)
			Height	36.0	in	(91.4	cm)

The number of product box units in the irradiator at any instant is dependent on the box size chosen for this plant:

## Refer to Figure 2.

Box Units A, C, D, and E ..... a total of 21 product boxes. Box Unit B ..... a total of 29 product boxes.

The maximum product density is 0.30 gm/cc and minimum product density of 0.05 gm/cc.

In selecting product box sizes, consideration must be given to the stability of a moving unit on conveyors.

NOTE: The boxes in the irradiator must be of one size only.

#### IRRADIATOR BUILDING

The irradiator building is shown on AECL Drawing B106801-002. The building is constructed above ground of concrete having a minimum lensity of 147 lbs/cu ft (2.36 gm/cc).

The irradiator building is serviced by the main plant power, heating (and/or air conditioning), air ventilation, compressed air, water, drainage and sprinkler facilities if required.

#### BIOLOGICAL SHIELD

The biological shield is designed such that either no personnel receive more than 10 mr during any 40 hour week, or that the average dose rate does not exceed 0.25 mr/hr.

With the source in the irradiating position the shield provides shielding in all proximate areas as indicated on AECL Drawing No. B106801-002. The following areas have been taken into consideration:

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 a) Control Area - the average radiation field inside the control area does not exceed 0.25 mrh. The maximum field in any small area does not exceed 2.5 mrh.

b) Roof - This is a restricted area.

## VENTILATING REQUIREMENTS

The irradiation room requires ventilation facilities capable of providing 20 air changes per hour.

## PNEUMATIC REQUIREMENTS

The irradiator requires pneumatic facilities with a minimum capacity of 21.3 cubic feet per minute free volume of air based on free air at 7.0 atmospheres. A 7.5 HP compressor with a reservoir of 20 cubic feet capacity is recommended.

## ELECTRICAL REQUIREMENTS

The irradiator requires a 115 VAC, 1 phase, 15 AMP 60 Hz supply.

### STORAGE POOL

When the source is in the storage position radiation fields inside the irradiation room will not exceed 0.25 mrh.

## PRODUCT BOXES

Medical products are transported through the irradiator in corrugated fibreboard containers (boxes). The

strength and rigidity of the box must be comparable to that stipulated in Rule 41 of the Uniform Freight Classification code for the following minimum grade of material to ensure trouble-free operation of the product conveying system.

## PRODUCT BOX SPECIFICATIONS

1.0

Products for processing are transported through the irradiator in special containers (boxes). Box size and construction must be compatible with the specifications quoted under paragraph "GENERAL".

The tolerance of the external box dimension is ± 0.125 in (3.175 mm). <u>Under no circumstances</u> should a box be processed in the irradiator which exceeds this tolerance.

In selecting optimum box size and box material, and to ensure trouble-free operation of the product conveying systems consideration must be given to:

a) The stability of a moving unit in the source pass mechanism.

- b) The strength and rigidity of the box which must be compatible with the weight of contained product.
- c) The side loads to be expected under the specific product conditions; side loads are applied via a flat metal surface over a minimum area approximately 18.0 in (45.72 cm) long x 18.0 in (45.72 cm) wide. A single box unit has to be capable of withstanding a uniform side load, centrally located, of 400 lbs (182 kg) from a metal surface area of 18" x 18" (45.72 cm x 45.72 cm) without deflection, distortion or damage to the box unit.

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b) The product boxes in the irradiator must be of uniform size and construction.

## SOURCE PASS MECHANISM

Refer to Figure 2.

The source pass mechanism consists of two levels of box support beds, pneumatic pushers and end transfers, and two elevator mechanisms.

The product containers commence their irradiation cycle on the lower level support beds and are moved along by the pneumatic pushers. When the product reaches the end of the first pass it is transferred to the inner pass at the same level and its direction is reversed. When it reaches the end of the second pass, it is transferred to the other side of the source plaque at the same level and its direction is again reversed. When it reaches the end of the third pass it is transferred to a fourth pass at the same level and its direction is yet again reversed. When it reaches the end of the fourth pass it is raised by means of a pneumatic elevator to the upper level where it begins its fifth pass. The movement of the product continues similarly through the sixth, seventh and eighth passes finally to be discharged into the second elevator and then lowered into the lower level.

Product boxes are recirculated around the source pass mechanism until the shuffle counter counts down to zero and the source is lowered. The irradiated product boxes are then removed and the source pass mechanism reloaded with unsterile product boxes.

## CONTROL OF ROOF ACCESS OF IRRADIATION BUILDING

The roof is accessible only by a steel ladder secured to the main building wall, up to the roof of the maze. A radiation hazard sign will be displayed in this area. Use of the ladder is restricted by a fixed chain.

## COBALT 60 SOURCE

Refer to Figure 3.

Each source "pencil" is made up of 16 Cobalt 60 "slugs" each 0.63 cm diameter by 2.54 cm long, dou: encapsulated and fusion welded in type 316 ELC stainless steel tubing. Overall pencil dimensions are 17.78 in (45.16 cm) long with a body diameter of 0.38 in (0.96 cm) and solid stainless steel end caps 0.437 in (1.11 cm). (Refer AECL Specification AC-195 and C-188).

Source pencils are housed in modular frames to form a plaque source. The plaque frame contains six modules with each module handling up to 18 pencils; a maximum plaque capacity of 108 pencils.

## CONTROL CONSOLE

Refer to Figure 4.

A single sectioned control console is provided and is wall-mounted in the control area near the viewing window.

The control console includes the following controls and indicators:

- Power Switch (SW1) ... a three position key switch with an "Off", "On", and a spring-loaded "Reset" position to control the power supply to the unit.
- 2. Machine Switch (SW3) ... a three position key switch with an "Off", "On" and a spring loaded "Start" position. This switch controls both the source hoist and conveyors for automatic machine operation. With SW3 in the OFF position, the machine is ready for "MANUAL" operation.
- 3. Reset Lamp (LP1) ... a lamp (yellow) that when illuminated, will indicate that the Master Power Switch must be turned to RESET and released to the ON position which will then extinguish LP1.
- 4. Source Down Lamp (LP2) ... a lamp (green) which illuminates when the source is in the fully down (safe) position.
- 5. Source Up Lamp (LP3) ... a lamp (red) which indicates that the source rack is in the irradiate position.

- 6. Machine Ready Lamp (LP4) ... a lamp (blue) which indicates that the Safety Delay Timer (TD1) has not "timed out", and that the unit is ready for operation.
- Machine On Lamp (LP5) ... a lamp (blue) which indicates that the machine is running automatically.
- 8. Stop (Indicator) Switch (S50) ... an illuminated push button switch. The pilot light (red) indicates that the machine has stopped due to trouble such as:
  - a) Delay of batch operation. (TD2 timed out).
  - b) Source rack does not reach full up position.
     (TD3 timed out).
  - Low Air Pressure (Pneumatic Switch (S57)
     closes).
  - d) High Cell Temperature (Thermal Switch (\$56))
     closes).
  - e) Maze door opened (Relay K111 is open).
  - f) Emergency Pushbutton (S51) in the irradiator room actuated.
  - g) Stop Button. The machine stops and source drops into pool. (S50 activated).
  - h) Overdose Timer (ST1) is designed to shut down the facility in the event of a malfunction in the master timer (TT1).
- Master Timer (TT1) ... a key operated timer which controls the machine cycle period.

10. Counter (CT2) ... a digital counter used to control the number of cycles completed by the source pass mechanism during batch operation.

### RADIATION MONITORING

One fixed monitor is provided in the irradiation room and is designed to measure the radiation level in the irradiation room when the source is in the fully down ("Off") position in the storage pool. The meter connected to this monitor is mounted near the control panel and provides a visual indication that it is safe for personnel to enter the irradiation room.

The single probe monitor includes the following controls and indicators:

 Monitor "Meter" - a wall-mounted ratemeter (near the irradiation room door controls), to indicate relative radiation levels inside the irradiation room with the source in the down (or safe position), as compared to normal background levels.

2. Monitor "Alarm" and "Memory" - a split pilot light to indicate a) when radiation levels inside the irradiation room exceed the permissible limit and b) after an alarm condition has ceased or has been rectified, the "Memory" pilot light will remain illuminated until the "Alarm" and "Memory" button has been actuated. An alarm horn, which is wired

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in parallel with the "Alarm" pilot light, will emit a loud piercing signal if an alarm condition occurs. The critical level in the alarm circuit will normally be set at 80% of the full scale ratemeter deflection, which is about 8 times the normal background level.

- 3. Monitor "Check" a pilot light to indicate a steady "On" or "Off" condition as well as momentary (norma.) pulsing. The "Check" light will pulse to show that the ratemeter circuits are functioning.
- 4. Monitor "Test" an illuminated push button switch. When the switch is actuated an alarm condition is induced into the ratemeter circuit to verify that the meter circuit is functioning properly.
- NOTE: Part 5 of this manual provides a detailed description of the single probe monitor.

A portable monitor will be provided attached to the operating keys. This monitor is of the audible type and will sound off in the event of abnormal radiation levels in its vicinity.

## EMERGENCY AND SAFETY FEATURES

## EMERGENCY STOP CONTROLS

An emergency pushbutton (S51) is positioned in the irradiation room, and a stop pushbutton (S50) is located on

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the control console. If either of these controls are actuated, the source pass mechanism will stop and the source will be lowered.

## POWER FAILURE

In the event of a prolonged power failure the source rack will be automatically lowered into the pool. This will prevent overexposure of the product. Operation will automatically re-commence (TD4 timed in) if the power failure is of less than 30 seconds duration.

## IRRADIATION ROOM DOOR INTERLOCK

A door interlock is provided on the irradiation room door which prevents access into the irradiation room during irradiation operations. The interlock solenoid is of the normally engaged type. The solenoid must be energized with the "Irradiation Room Door" key switch before the room is accessible. A mechanical interlock release is provided inside the irradiation room to permit personnel to leave if the door shuts accidentally.

A microswitch mounted on the door frame ensures that the unit is only operable when the door is closed and locked. Overall control of the door interlock is maintained with the "Power" key switch on the control console.

## OVERDOSE TIMER

The unit is equipped with an overdose timer. This timer is designed to shut down the facility in the event of a malfunction in the master timer.

## SOURCE STORAGE RACK

A storage rack, with a capacity to store all the source modules, is provided for use in the pool. The source rack may then be raised for examination as required.

### TEMPERATURE SENSING DEVICE

A temperature sensing and control unit, ourted with its probe inside the irradiation room, will detect a significant rise in temperature, lower the source, and stop the machine.

## SOURCE PASS MECHANISM

If the source pass mechanism does not complete its batch operation cycle within a preset time interval of 180 seconds (approx) as preset by timer TD2, TD2A, the machine will automatically shut down and the source lower.

## POOL WATER LEVEL (Provided by Customer)

The water in the pool is automatically maintained within preset levels by a switch controlling a water make-up since. A naw water meter measures the amount of make-up water being automatically introduced into the storage pool.

## SOURCE HOIST

If the source plaque does not complete the transition source "Off" position/source "On" position within 90 seconds (approx) as preset by timer TD3, the machine will shut down.

## SOURCE ALARM

While the source is in motion an audible alarm will signal continuously. Pilot lights on the control console will indicate the position of the source.

## AIR PRESSURE

Failure of the compressed air system will shut down the conveyor system and lower the source.

## START-UP SAFETY DELAY TIMER

A 90 second timer controlled by the "Safety" delay key switch installed inside the irradiation room, must be actuated with the "Master" key before irradiation operations can commence. This ensures that the operator enters the room and checks for the presence of personnel and eliminates the possibility of personnel being inadvertently shut inside the irradiation room.

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## SOURCE INTERLOCK

The source interlock will drop out 90 seconds after the "Safety" key switch is actuated. If any stop device is actuated while the source interlock procedure is being carried out, the operator must return to the control console and reset the machine before repeating the start-up procedure. The operator cannot open the irradiation room door from the outside unless the source is fully down (or safe) and there is a positive safe reading indicated by the irradiation room monitor.

## CHECK OUT PROCEDURE PRIOR TO

## COBALT 60 INSTALLATION

As each facility component is installed it is checked for correct operation before proceeding with the next stage of assembly. These component checks include:

- A full operation check out of the source rack (unloaded). Limit switch settings are adjusted to provide smooth operation and the rack is cycled at least 20 times.
- The ventilation fan is checked for satisfactory operation and filters are installed.
- 3. Standby compressor operation.
- 4. Water level float switch and water filtration unit.
- The source pass mechanism (using dummy product boxes) for smooth operation.
- 6. Interlock procedures and safety switches. The start-up procedures are simulated and machine functions are checked for satisfactory operation. All safety interlocks, emergency stops and alarms are actuated to check for correct operation.
- 7. The monitor is checked against the test source.

# CHECK OUT PROCEDURE AFTER COBALT 60 INSTALLATION

 The operating area is monitored with an appropriate survey meter during and after source replenishment. The source pencils and associated components are wipe tested.

- The first time that the radiation source is raised from the pool the following items must be checked:
  - a) The correct interlock procedure is carried out; authorized persons only are in attendance during the test.
  - D) The monitor is checked for radiation readings.
  - c) A complete radiation survey of the building is conducted with the source in the raised position.
- The source rack is then lowered. The monitor is rechecked against the test source.
- 4. Final test of complete machine.



IR68 IRRADIATOR

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PRODUCT FLOW DIAGRAM - ONE BATCH OPERATION CYCLE -

FIGURE 2:



SOURCE RACK

FIGURE 3:



## IR68 CONTROL CONSOLE

## FIGURE 4:

PART 2 OPERATION

## AUTHORIZED OPERATORS

The operating instructions presented in this manua. are intended for use by licensed personnel only.

Each control technician is required to have the qualifications as specified jointly by the Local Competent Licensing Authority and Principal Owner Licensee.

All supervisory personnel, and control technicians must have successfully completed an in-plant course of instruction on the theory and operation of the irradiation unit, safety concepts and a review of basic nuclear physics.

The Local Competent Licensing Authority usually provide or arrange for the provision of a Basic Nuclear Physics Course to all authorized personnel.

Authorized personnel must be approved by the Loca! Competent Licensing Authority.

## OPERATOR TRAINING

An in-plant course on irradiator operations would include instruction in the following areas:

- a) Purpose of Industrial Irradiator;
- b) Familiarization Tour of Facility;
- c) Monitors;

- d) Control Console;
- e) Auxiliary Equipment;
- Operating Procedures;
- g) Administrative Procedures;
- h) Emergency and Safety Procedures;
- i) Maintenance Procedures;
- j) Contamination Detection Procedures.

A more detailed general manual and training course conducted at AECL "Training Course - Industrial Irradiators", is available through AECL Marketing Division at a nominal charge. This course covers Food Irradiation; General Design; Manufacture and Operation of Irradiators; Electrical Aspects of Industrial Irradiators; Technical Aspects of Source Pencil Manufacturing; Physics; Effects on Materials; Maintenance and Liconsing.

## OPERATOR SAFETY

The machine is fully interlocked for operator safety and protection, and operation cannot commence unless the correct procedure has been carried out. A portable monitor is attached at all times to the "Master" key. The operator must turn this monitor "On" and carry the instrument with him while conducting the start-up procedures. An audible alarm is incorporated into the portable monitor to signal when high radiation fields are evident.

#### WARNING:

IF THE FACILITY IS LEFT UNATTENDED THE OPERATOR MUST ENSURE THAT THE: (i) IRRADIATION ROOM DOOR IS CLOSED AND LOCKED; (ii) POWER KEYSWITCH IS LEFT IN THE "ON" POSITION; (iii) MASTER KEY IS REMOVED AND SECURED.

## AUTOMATIC OPERATION

To start the machine the operator should proceed as follows:

- in the Equipment Room Turn on the main power supply to the control console.
- NOTE: The monitor alarm horn will signal for a short period on initial start-up until all the monitor condensers are charged.
- 2. At the Control Console Turn the "Power" key switch through the "On" position to the "Reset" position with the "Master" key and release. The yellow "Reset" pilot light will illuminate and extinguisn and the "Source Down" pilot light should illuminate to indicate the condition of the facility.
- NOTE: If the air pressure is low, the control console stop light will illuminate indicating a low pressure in the system.
  - 3. At the Monitor Cabinet Check that the monitor readout on the console is functioning and that the indicated radiation level is normal. The monitor "Check" pilot light should be flashing at all times. If the reading is not normal or an alarm is indicated leave the facility as described in this manual under "Contamination Detection".

- 4. At the Control Console Check that the radiation "Master Timer" setting is correct for the product to be irradiated, and the "Overdose Timer" is set to approximately 5 minutes longer than the "Master Timer". Enter the setting in the Log Book. If the "Master Timer" setting is to be changed, obtain the "Timer" key from the facility supervisor and alter the time cycles accordingly. Enter the new setting in the Log Book and return the "Timer" key to the supervisor.
- 5. At the Control Console Set or reset the "Shuffle" counter (CT2) to the required setting.
  - To set the shuffle counter insert the counter key into the keyswitch and unlock. Depress and hold the red button while operating the grey buttons so that the counter numeric display is identical to the number of boxes loaded into the source pass mechanism i.e.,
    21 boxes loaded, then the read-out should read 21. Release the red button, lock the counter and remove the key. Using the number 21 as previously stated, each product box will be shuffled 21 times for a period of time as determined by the Master Timer (TT1) e.g., Master Timer setting 20 minutes x Shuffle

counter setting 21 = 420 minutes total time for one complete shuffle cycle. At the end of 420 minutes, the shuffle counter will read zero and the facility will shut gown.

- To reset the shuffle counter insert the counter key into the keyswitch and unlock.
   Depress the red reset button and release. The counter numeric display will now read as previously set.
- 6. At the Control Console Remove the "Master" key from the "Power" key switch leaving the key switch in the "On" position.
- At the Monitor Cabinet Press the "Monitor Test" putton and hold until the monitor alarms.
- NOTE: The "Monitor Test" pilot light will remain illuminated until the irradiation room door is opened.
  - 8. At the Irradiation Room Door Check the portable hand monitor with the test source (stored in the irradiation room door key switch box) to ascertain that the audible alarm is functioning correctly.
    9. At the Irradiation Room Door - Insert the "Master" key

into the door key switch, open the door and enter the room. If a noticeable increase in monitor "crackle" rate is evident on entering, leave the

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room and notify the facility supervisor immediately. The supervisor will check the radiation levels with the survey instrument and will notify the Pertinent Licensing Authority and Atomic Energy of Canada Limited, or their Agent, of unusual conditions or incidents.

- 10. In the Irradiation Room Check that the source pass mechanism pneumatic cylinders are in their normal positions.
- 11. In the Irradiation Room Check that the source pass mechanism is correctly loaded with product boxes.
- 12. In the Irradiation Room Under norma! conditions there should be no personnel in the irradiation room. However, a check must now be made to ensure that the room is vacated.
- NOTE: The operator must follow behind all visitors when they are present.
- 13. In the Irradiation Room Actuate the "Safety Timer" key switch with the "Master" key. This will start the 90 second safety delay timer.
- 14. In the Irradiation Room Leave the room (at a normal walking pace) closing the irradiation room door on the way out. (The Blue "Machine Ready" pilot light on the control console will illuminate).

- 15. At the Control Console Check that the "Source Down" light (green) on the console is Illuminated. If the blue "Machine Ready" pilot light is extinguished it will be evident that the safety delay time period has been exceeded and the internal interlock has disengaged. In this event it will be necessary for the operator to repeat the start-up procedure.
- 16. At the Control Console Check that the red hand on the "Master Timer" is set at the zero mark, and that the "Overdose Timer" is not at zero time. Check that the "Shuffle Counter" is properly set.
- 17. At the Control Console Insert the "Master" key into the "Machine" key switch and turn the key clockwise through the "On" position to the "Start" position. Release the key and it will return to the "On" position and the "Machine On" pilot light should now be illuminated. The source alarm bell will commence to signal and the red "Source Up" and green "Source Down" indicating lights will both be extinguished. When the source reaches the "Irradiate" position the "Source Up" light will illuminate. The source pass system will then begin to operate automatically.

18. At the Control Console - Make a complete entry in the Log Book. Entries will include the monitor reading,

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calendar reading, counter reading and time of start-up. Once per month the portable survey meter should be used to check the air filter bank, water filter bec and resin bed. The maximum readings at each location should be entered in the Log Book.

## NORMAL SHUT-DOWN PROCEDURE

Normal shut-down is construed as the termination of operations not dictated by emergency or abnormal circumstances.

To shut down the machine the operator should proceed as follows:

 At the Control Console - Turn the "Machine" key into the "Off" position (anti-clockwise) as the "Master Time-"
 approaches zero, and remove. The source will lower and the alarm bell will ring until the source is fully down.

## OVERDOSE TIMER

The unit is equipped with an overdose timer. This timer (ST1) is designed to shut down the facility in the event of a malfunction in the master timer (TT1).

The overdose timer should be set to approximately 5 minutes longer duration than the setting on the master timer. When the main timer runs out to zero time the facility will recycle as usual and the overdose timer (with 5 minutes remaining) will be reset with the master timer; facility operation will not be interrupted. In the event the master timer fails during the pre-set time period then the overdose timer will continue to time out. With the master timer in a non-reset condition the overdose timer will run out to zero time and close the contacts. The emergency shut-down circuit will operate and lower the source plaque.

The overdose timer will automatically reset when the power key is turned to the reset position. As with any emergency shut-down condition, the cause should be determined and the fault rectified before resuming operations.

Overdose timer ST1 should be checked once per month for correct operation. The timerperiod should be set to a value less than that set on the master timer TT1. When the unit is test run in this condition the machine should shut-down when the overdose timer reaches zero time. Before resuming normal operations, the overdose timer setting must be re-adjusted to approximately 5 minutes longer duration than that set on the master timer.

#### EMERGENCY SHUT-DOWN PROCEDURE

In an emergency the machine can be immediately shut down as follows:

 At the Control Console or Irradiation Room - Depress the stop or safety switch at these locations. The radiation source will be lowered and the source pass conveyor system will stop immediately,

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irrespective of the stage attained in the machine cycle, and the "Stop" pilot light on the control console will illuminate. When the radiation source is in the "Safe" position, check that the irradiation room monitor is back in operation. If the radiation level is normal, press the "Monitor Test" button and hold until the monitor alarms. The alarm signal will continue shortly after the button is released. The "Monitor Test" pilot light will remain illuminated until the irradiation room door is opened. All emergency procedures must be entered in the Log Book which is provided with this manual.

#### NOTE:

- a) The irradiation room monitor is automatically cut out when the source is in the "On" (or irradiate) position.
- b) The irradiation room door can only be opened by the operator when the source is fully down and no alarm condition exists.
- c) The first time each day that the operator is required to open the irradiation room door, the portable monitor must be checked with the test source to ascertain that the audible alarm is functioning.
- After an emergency shut-down, the irradiator should be started up as per "Start-Up After Emergency or Inadvertent Shut-Down".

## INADVERTENT SHUT-DOWN

During operation a number of conditions or occurrences may cause irradiator shut-down at any stage. In this event this will be indicated by the red shut-down pilot light on the control console. The red shut-down pilot light will remain illuminated until the fault is rectified and the "Master" key is turned to the "Reset" position in the "Power" key switch and released.

In order to restart the machine it will be necessary for the operator to rectify the fault and then proceed as per "Start-Up After Emergency or Inadvertent Shut-Down".

## START-UP AFTER EMERGENCY 'OR

## INADVERTENT SHUT-DOWN

Typical shut-down conditions, with their associated rectification procedures:

1. "Safety"

A shut-down has occurred via the stop button on the console or the safety switch located inside the irradiation room, or an attempt has been made to gain access into the irradiation room by force.

At the Control Console - Reset the machine controls
 by turning the "Master" key in the "Power" key
 switch into the "Reset" position and release.
 The key will return to the "On" position.

Resetting the machine will clear the shut-down indication on the control panel lamp and the lamp will now extinguish.

- b) At the Control Console Remove the "Master" key from the "Power" key switch taking care to leave the switch in the "On" position.
- c) At the Irradiation Room Door Proceed as detailed under heading "To Open Irradiation Room Door".
   d) Ascertain the cause of the emergency condition and

rectify the fault.

IMPORTANT:

DO NOT ATTEMPT TO ALTER THE POSITION OF MACHINE

- e) In the Irradiation Room Actuate the "Safety Delay" switch with the "Master" key. This will start the 90 second safety delay timer.
  f) In the Irradiation Room - Leave the room (at a normal walking pace) and close the door on the way out.
- g) At the Control Console Insert the "Master" key into the "Machine" key switch and turn the key clockwise through the "On" position to the "Start" position. Release the key and it will return to the "On" position.

The "Machine On" pilot light will now be

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illuminated. The source alarm bell will signal until the source reaches the irradiate position and the "Source Up" pilot light illuminates. The product conveying system will then resume operations automatically.

- h) At the Control Console Make a complete entry in the Log Book.
- 2. "High Temperature"

A machine shut-down has been caused by the detection of temperatures above normal in the irradiation room.

- NOTE: For the resumption of operations proceed as detailed under heading 1. "Safety".
  - 3. "Low Air Pressure"

A machine shut-down has been caused by a failure in the pneumatic system.

NOTE: For the resumption of operations proceed as detailed under heading 1. "Safety".

4. "Source Rack"

A machine shut-down has been caused by a malfunction in source rack operation; the source rack has not assumed the fully exposed position in the preset time period.

NOTE: Before resuming operations the operator must notify the facility supervisor of the conditions existing at the unit. Subject to supervisor approval the operator can then proceed as detailed under heading 1. "Safety".

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5. "Internal Conveyor"

A machine shut-down has occurred due to a malfunction in the internal conveyor system. See the following procedure which is detailed under headings "Internal Conveyor Malfunction".

- TO OPEN THE IRRADIATION ROOM DOOR
- At the Control Console Insert the "Master" key in the "Power" keyswitch and turn through the "On" position to the "Reset" position and release.
- 2. At the Control Console Check that the source is in the safe position. This will be indicated by the "Source Down" pilot light.
- 3. At the Monitor Panel Check that the monitor reac-out on the console is functioning and that the indicated radiation level is normal. The monitor "Check" pilot light should be flashing at all times. If the reading is not normal or an alarm is indicated, leave the facility as described in this manual under "Contamination Detection Procedures".
- 4. At the Monitor Panel Press the "Monitor Test" button and hold until the monitor alarms.
- NOTE: The "Monitor Test" pilot light (yellow) will remain illuminated until the irradiation room door is opened.

- 5. At the Control Console Remove the "Master" key from the "Power" key switch taking care not to turn the machine off.
- 6. At the Irradiation Room Door Check the portable hand monitor with the test source to ascertain that the audible alarm is functioning correctly.
- 7. At the Irradiation Room Door Insert the "Power" key into the door key switch and open the door.
- 8. In the Irradiation Room If a noticeable increase in monitor "crackle" rate is evident on entering, leave the room and notify the facility upervisor immediately. The supervisor will check the radiation levels with a survey instrument and will notify the Pertinent Licensing Authority and Atomic Energy of Canada Limited, or their Agent, of unusual conditions or incidents. If conditions are normal proceed as required.

HAND OPERATION OF UNIT

(MAINTENANCE OR INSPECTION PURPOSES)

1. At the Irradiation Room Door - Proceed as detailed under heading "To Open Irradiation Room Door".

- At the Control Console Check that the "Power" keyswitch is in the "On" position.
- 3. At the Control Console Ensure that the "Machine" keyswitch is in the "Off" position, and that toggle switch

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S40 is selected to "Auto". The toggle switch is located on the relay panel, behind the control panel.

4. In the Irradiation Room - Operate the pneumatic cylinders as desired by pressing the appropriate push buttons mounted on the switch stations. The four switch stations are mounted on the source pass mechanism. Cylinders can be timed with a stop watch by checking the appropriate cylinders. Refer to Figures 6 and 7.

Care must be exercised during hand cylinder operation to ensure that the cylinders are free to move without obstruction from product boxes.

NOTE: Toggle switch S40 is used in "Test" select when a complete cycle of operation is desired with source down. (Machine Switch in ON position).

## AUTOMATIC OPERATION OF MACHINE

## MAINTENANCE OR INSPECTION PURPOSES

- At the Irradiation Room Door Proceed as detailed under heading "To Open Irradiation Room Door".
- 2. At the Source Pass Mechanism To operate the machine with product boxes it is necessary to check that all boxes in the source pass mechanism are in their proper positions.
- 3. At the Control Console Check that the "Power" keyswitch is in the "On" position.

- At the Control Console Open the control console door, and select toggle switch S40 from "Auto" to "Test".
- 5. At the Control Console Turn the "Machine" key into the "On" position. The machine will now assume automatic operation. The machine will only operate with product boxes.

WARNING: ENSURE S40 IS SWITCHED TO "AUTO" AFTER \_ST.

## SOURCE PASS MECHANISM MALFUNCTION

In the event of a source pass mechanism malfunction which would indicate a box jam or limit switch malfunction, the following procedure should be adopted before the resumption of operation.

- At the Irradiation Room Door Proceed as detailed under heading, "TO OPEN THE IRRADIATION ROOM DOOR".
- 2. Ascertain the cause of machine shut-down.
- 3. Should it be necessary to actuate a cylinder in order to rectify the malfunction, it is important to make sure that the various cylinder positions are not changed from those they assumed at machine shut-down. It is important for the operator to familiarize himself with the operating sequence of the source pass mechanism cylinders as described in Part 3 of this manual under heading "Source Pass Conveyor - Operating Sequence". Each cylinder operation is dependent upon the completion of preceding cylinder movements. For example, cylinder

P3 discharging and would require P4 in the receive

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position with no product box in front of P4, and a product box in front of P3. If P3 cylinder does not complete its stroke and actuate the respective limit switch, LS4, then the cycling sequence will stop. The succeeding cylinders in the operating sequence require actuation and completion of preceding cylinder movements before they can function. Therefore, if a given cylinder does not complete its stroke and actuate the respective discharge or receive limit switch (whether this is caused by a faulty switch or a box jam) then the cylinder operation sequence will stop, the timer TD2 will run out and the machine will shut down. In rectifying the problem (by clearing the jam and allowing the cylinder to complete its stroke, or by adjusting or replacing the respective limit switch), the operator must not change the position of the cylinder pushers from that in which they were found when the unit shut down. It may be necessary to actuate a given cylinder employing the hand operation method to rectify the problem, but the operator must return the cylinder pusher to the position which it had attained or was attempting to attain when the shut down occurred.

 After rectifying the malfunction, operation can be resumed by proceeding as detailed under heading

 "Safety".

## PRODUCT BOX LOADING PROCEDURE

Refer to Figures 5, 6 and 7.

NOTE: The following loading description will apply to Box Units A, C, D and E, as described in Part 1 of this manual.

PRODUCT BOX LOADING - MANUALLY

Refer to Figures 5, 6 and 7.

(Assuming a 0.1 g/cc maximum product density (maximum weight approximately 60 lbs), it is possible to manually load the source pass mechanism.

The following procedure should be followed:

- Proceed as detailed under heading, "TO OPEN THE IRRADIATION ROOM DOOR".
- 2. In the Irradiation Room Check that elevators P8 and Pi6 are down and that the pneumatic cylinders are in the positions as shown in Figure 7.
- 3. It may be necessary to correctly position the elevators and/or the pneumatic cylinders by operating the switch stations. Refer to Figure 6.

Proceed as detailed under heading, "HAND OPERATION OF UNIT".

4. Proceed to the load station located next to elevator P16 (Refer to Figure 5), loosen the locking screws on the removable side rail and detach the rail.

- Manually load the lower level mechanism with eleven product boxes as illustrated in Figure 7, and ensure a void exists at limit switches LS2 and LS2A.
- 6. Install the removable side rail and lock in position.
- 7. In the upper level, manually load and position ten product boxes as illustrated in Figure 7.
- 8. It is now possible to test the unit for one complete cycle of operation (source down), by following the procedure outlined under heading, "AUTOMATIC OPERATION OF MACHINE - MAINTENANCE OR INSPECTION PURPOSES".
- 9. After testing the unit for proper operation, the operator may start the unit for batch irradiation by following the procedures outlined under heading, "AUTOMATIC OPERATION".

PRODUCT BOX LOADING - USING PNEUMATIC CYLINDERS

Refer to Figures 5, 6 and 7.

Assuming a 0.3 g/cc maximum product density, maximum weight approximately 180 lbs.

It will be necessary to use the pneumatic cylinders when loading product boxes of this weight.

The following procedure should be followed:

- At the Irradiation Room Door Proceed as detailed under heading, "To Open Irradiation Room Door".
- At the Control Console Check that the "Power" keyswitch is in the "On" position.

- 3. At the Control Console Ensure that the "Machine" keyswitch is in the "Off" position, and that toggie switch S40 is selected to "Auto". S40 is located on the relay panel.
- 4. In the Irradiation Room -

Lower Level Loading

Use the following procedures for Pneumatic Cylinder operation:

- Proceed to the load station (Refer to Figure 5. and detach the removable side rail as described under heading, "MANUAL PRODUCT BOX LOADING".
- (2) After detaching the removable rail, load the first product box through the opening and push the box to the right against limit switches LS2 and LS2A (Refer to Figure 7).
- NOTE: Refer to Figure 6 for correct switch station identification, and Figure 7 for correct pneumatic cylinder identification when operating the cylinders.
  - (3) P2 to Discharge and Receive.
  - (4) P3 to Discharge and Receive.
  - (5) Repeat steps (2) to (4) inclusive.
  - (6) P4 to Discharge and Receive.
  - (7) P5 to Discharge and Receive.
  - (8) Repeat steps (2) to (7) inclusive.
  - (9) P6 to Discharge and Receive.

	(10)	P7 to 1	Discha	rge i	and Red	ceive.	
	(11)	Repeat	steps	(2)	to (10	) inclusive.	
	Upper	Level	.oading	2			
	(12)	Elevato	or 1 (F	8) (	Up.		
	(13)	P9 to D	ischar	ge a	and Red	eive.	
	(14)	Elevato	or 1 (F	8) [	Down.		
	(15)	Repeat	steps	(2)	to (14	) inclusive.	
	(16)	P10 to	Discha	rge	and Re	ceive.	
	(17)	P11 to	Discha	rge	and Re	ceive.	
	(18)	Repeat	steps	(2)	to (17	) inclusive.	
	(19)	P12 to	Discha	rge	and Re	ceive.	
	(20)	P13 to	Discha	rge	and Re	ceive.	
	(21)	Repeat	steps	(2)	to (20	) inclusive.	
	(22)	P14 to	Discha	rge	and Re	ceive.	
	(23)	F15 to	Discha	rge	and Re	ceive.	
	(24)	Repeat	steps	(2)	to (22	) inclusive.	
	(25)	Repeat	steps	(2)	to (20	) inclusive.	
	(26)	Repeat	steps	(2)	to (19	) inclusive.	
	(27)	Repeat	steps	(2)	to (17	) inclusive.	
	(28)	Repeat	steps	(2)	to (16	) inclusive.	
	(29)	Repeat	steps	(2)	to (14	) inclusive.	
NOTE :	The up	per lev	el wil	l no	w be l	oaded.	
	(30)	Repeat	steps	(2)	to (10	) inclusive.	
	(31)	Repeat	steps	(2)	to (9)	inclusive.	

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- (32) Repeat steps (2) to (7) inclusive.
- (33) Repeat steps (2) to (6) inclusive.
- (34) Repeat steps (2) to (4) inclusive.
- (35) Repeat steps (2) to (3) inclusive.
- (36) Load a product box into loading station and push left into Elevator 2 (P16).
- (37) Load the last product box into the removable side rail position and replace rail.

NOTE: . The lower level will now be loaded.

- (38) Ensure the product boxes are properly positioned as shown in Figure 7.
- (39) The unit is now ready for "AUTOMATIC BATCH OPERATION".

PRODUCT BOX UNLOADING - USING PNEUMATIC CYLINDERS

Refer to Figures 5, 6 and 7.

Proceed as detailed in steps 1, 2, and 3, under heading, "PRODUCT BOX LOADING - USING PNEUMATIC CYLINDERS".

- Proceed to the load station, detach the removable rail and remove the product box in the unload station.
- NOTE: Refer to Figure 6 for correct switch station identification and Figure 7 for correct pneumatic cylinder identification when operating the cylinders.
  - 2. P1 to Discharge and Receive.

3. Remove box.

NOTE:		T	he	up	pe	r	Ze	ve	Z	wi	27	2	be	2	unloaded	first.	
4.	Elev	ato	or	2	(P	16	;)	Up									
5.	P15	то	DI	sc	ha	rg	e	and	1	Re	ce	e i	ve				
6.	Elev	ato	or	2	(P	16	)	Dov	N n								
7.	P1 1	0 0	lis	ch	ar	ge	a	nd	R	lec	ei	v	θ.				
8.	Elev	ato	or	2	(P	16	)	Up.									
9.	Remo	ve	bo	×.													
10.	P14	to	DI	sc	ha	rg	е	and	t	Re	ce	i	ve				
11.	Repe	at	s †	ep	s	5	to	9	i	nc	1 u	s	iv	e			
12.	P13	to	DI	sc	ha	rg	е	and	i	Re	ce	i	ve				
13.	P14	to	DI	sci	ha	rg	e	and	1	Re	ce	i	ve				
14.	Repe	at	st	ep	s	5	to	9	i	nc	lu	s	iv	e			
15.	P12	to	DI	sci	ha	rg	e	and	t	Re	ce	i	ve				
16.	P13	to	DI	sci	ha	rg	e	and	ł	Re	ce	i	ve				
17.	P14	to	01	sci	ha	rg	e	and	1	Re	ce	i	ve				
18.	Repe	at	st	ep	s	5	to	9	1	nc	lu	s	iv	0			
19.	P11	to	DI	sci	ha	rg	e	and	1	Re	ce	1	ve				
20.	P12	to	DI	sc	ha	rg	е	and	i	Re	ce	1	ve				
21.	P13	to	DI	sc	ha	rg	e	and	t	Re	ce	1	ve				
 22.	P14	to	DI	sc	ha	rg	е	and	1	Re	ce	i	ve				
23.	Repé	a†	s †	ep	s	5	to	9	i	nc	lu	s	iv	e			
24.	P10	to	DI	sc	ha	rg	e	and	ł	Re	ce	i	ve				
25.	P11	to	DI	sc	ha	rg	e	and	t	Re	ce	i	ve				
26.	P12	to	DI	sc	ha	rg	e	and	t	Re	ce	i	ve				
27.	P13	to	Di	sc	ha	ra	e	and	i	Re	ce	i	ve				

28. P14 to Discharge and Receive.

29. Repeat steps 5 to 9 inclusive.

30. Elevator 1 (P8) Up.

31. P9 to Discharge and Receive.

32. P10 to Discharge and Receive.

33. P11 to Discharge and Receive.

34. P12 to Discharge and Receive.

35. P13 to Discharge and Receive.

36. P14 to Discharge and Receive.

37. Repeat steps 5 to 9 inclusive.

NOTE: Commence unloading the lower level.

38. Elevator 1 (P8) Down.

39. P7 to Discharge and Receive.

40. Elevator 1 (P8) Up.

41. Repeat steps 31 to 37 inclusive.

42. Elevator 1 (P8) Down.

43. P7 to Discharge and Receive.

44. Repeat steps 40, 41 and 42 inclusive.

45. P6 to Discharge and Receive.

46. P7 to Discharge and Receive.

47. Repeat steps 40, 41 and 42 inclusive.

48. P5 to Discharge and Receive.

49. P6 to Discharge and Receive.

50. .P7 to Discharge and Receive.

51. Repeat steps 40, 41 and 42 inclusive.

- 52. P4 to Discharge and Receive.
- 53. P5 to Discharge and Receive.
- 54. P6 to Discharge and Receive.
- 55. P7 to Discharge and Receive.
- 56. Repear steps 40, 41 and 42 inclusive.
- 57. P3 to Discharge and Receive.
- 58. P4 to Discharge and Receive.
- 59. P5 to Discharge and Receive.
- 60. P6 to Discharge and Receive.
- 61. P7 to Discharge and Receive.
- 62. Repeat steps 40, 41 and 42 inclusive.
- 63. Manually push the remaining box in front of P3 to P4.
- 64. P5 to Discharge and Receive.
- 65. P5 to Discharge and Receive.
- 66. P6 to Discharge and Receive.
- 67. P7 to Discharge and Receive.
- 68. Repeat steps 40, 41 and 42 inclusive.
- 69. Manually push the next box to P6.
- 70. P6 to Discharge and Receive.
- 71, P7 to Discharge and Receive.
- 72. Repeat steps 40, 41 and 42 inclusive.
- 73. Manually push the last box into Elevator 1 (P8).
- 74. Repeat steps 40, 41 and 42 inclusive.
- 75. At the upper level manually push the next box to P10.
- 76. Repeat steps 24 to 29 inclusive.

- 77. Manually push the next box to P12.
- 78. Repeat steps 15 to 18 inclusive.
- 79. Manually push the next box to P.3.
- 80. Repeat steps 10 and 11 Inclusive.
- 81. Manually push the last box to Elevator 2 (P16).
- 82. Lower Elevator 2 (P16).
- 83. P1 to Discharge and Receive.
- 84. Remove the last box from the load station.
- 85. Replace the removable rail.



## LOADING STATION

AT ATOMIC INTERT OF CANADA LIMITED	A ATOMIC IMAN ANDA LIM
STATION 1	STATION 2
P13 O RECEIVE DISCHARGE	DISCHARGE P15 ORECEIVE
P12 O RECEIVE DISCHARGE	DISCHARGE PIG ORECEIVE
PI O RECEIVE DISCHARGE	
ATOMIC ENERGY OF CANADA LIMITED COMMERCIAL FRODUCTS	
STATION 3	
RECEIVE DISCHARGE	STATION 4
PID O RECEIVE DISCHARGE	DISCHARGE RECEIVE
C P7 O RECEIVE DISCHARGE	
PE O RECEIVE DISCHARGE	DISCHARGE RECEIVE
	DISCHARGE RECEIVE

- MANUAL SWITCH STATIONS -



PRODUCT BOX POSITIONS - MANUAL LOADING

FIGURE 7:

## COBALT 60 IRRADIATOR TYPE IR68 BASIC OPERATING INSTRUCTIONS

NOTE: Before starting unit ensure test switch (S40), located on relay panel, is selected to "Auto".

## TO START

- 1. CHECK POWER IS "ON".
- 2. TURN "POWER" KEYSWITCH TO RESET AND RELEASE.
- 3. CHECK MONITOR READING IS NORMAL.
- 4. CHECK TIMER AND COUNTER SETTINGS FOR PRODUCT BEING IRRADIATED.
- 5. CHECK THAT DEIONIZER WATER PUMP IS OPERATING.
- 6. CHECK THAT COMPRESSORS ARE OPERATING.
- 7. CHECK THAT CELL VENTILATING FAN IS OPERATING.
- 8. REMOVE "MASTER" KEY FROM "POWER" KEYSWITCH.
- 9. CHECK HAND MONITOR FOR AUDIBLE SIGNAL WITH TEST SOURCE (ONCE DAILY).
- 10. OPEN IRRADIATION ROOM ENTRANCE DOOR WITH "MASTER" KEY.
- 11. CHECK POSITION OF PRODUCT BOXES IN SOURCE PASS MECHANISM.
- 12. CHECK THAT IRRADIATION ROOM IS VACATED.
- 13. SET "SAFETY INTERLOCK" SWITCH.
- 14. CLOSE IRRADIATION ROOM DOOR.
- 15. TURN "MACHINE" KEYSWITCH WITH "MASTER" KEY TO "START" POSITION AND RELEASE.

## TO STOP

- 1. TURN "MASTER" KEY IN "MACHINE" KEYSWITCH TO THE "OFF" POSITION, AS THE TIMER APPROACHES ZERO; OR PRESS STOP BUTTON ON CONSOLE.
- 2. REMOVE THE KEY.
- 3. CHECK MONITOR READING IS NORMAL.

## IN AN EMERGENCY PRESS THE STOP SWITCH OR EMERGENCY PUSHBUTTON

## POST IN A PROMINENT POSITION CLOSE TO THE CONTROL STATION

# MPORTANT

## COBALT 60 IRRADIATOR TYPE IR68 EMERGENCY CONDITIONS

NOTE: Before entering the irradiation room check that the cell monitor is functioning.

## 1. PERSONNEL IN IRRADIATION ROOM AT START-UP

- A) DEPRESS EMERGENCY PUSHBUTTON IN THE IRRADIATION ROOM AND/OR
- B) PUSH STOP BUTTON AT THE CONTROL CONSOLE
- C) VACATE THE IRRADIATION ROOM

#### 2. MONITOR ALARM SIGNALS

- A) CHECK MONITOR FOR MALFUNCTION
- B) SWITCH OFF "POWER" KEY
   C) NOTIFY ATOMIC ENERGY OF CANADA LIMITED IF OTHER THAN MECHANICAL OR ELECTRICAL FAILURE

#### **3. POWER FAILURE**

- A) TURN OFF "POWER" SWITCH
- B) WHEN POWER IS RESTORED RESTART THE MACHINE

#### 4. STOP LIGHT ILLUMINATES

- A) TURN OFF "MACHINE" KEYSWITCH
- B) INVESTIGATE AND RECTIFY FAULTS IN ANY OF THE FOLLOWING AREAS:
  - (1.) SOURCE PASS MECHANISM i) INTERNAL MECHANISM DELAYED
  - (2.) AIR PRESSURE

i) PRESSURE HAS FALLEN BELOW PREDETERMINED LEVEL

- (3.) SOURCE RACK i) IF SOURCE IS JAMMED IN A SEMI-EXPOSED CR EXPOSED POSITION NOTIFY ATOMIC ENERGY OF CANADA LIMITED IMMEDIATELY
- (4.) HIGH TEMPERATURE i) IRRADIATION ROOM TEMPERATURE IS EXCESSIVE
- (5.) IRFADIATION FOOM DOOR i) IF DOOR IS TAMPERED WITH WHILE SOURCE RACK IS IN AN UP POSITION
- 16. CVSIERISS TRUES i) MAIN TIMER MALFUNCTION

## FOR EMERGENCY SERVICE

053-4162 CABLE: TELEPHONE: 613-592-2790 ALUMIC ENERGY OF CANADA LINLIED COMMERCIAL PRODUCTS P.O. BOX 6300 POSTAL STATION "J" OTTAWA, CANADA K2A 3W3

## PART 3 MAINTENANCE

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## GENERAL

Procedures have been tabulated periodically to assist in the setting up and carrying out of a preventive maintenance programme. Recommended equipment inspections are those considered necessary for the continuing efficient operation of the unit.

It can not be stressed too emphatically that a preventive maintenance programme involving a few hours of planned weekly maintenance will greatly assist in unit operation in the most economical manner.

#### DAILY

## PNEUMATIC SYSTEM

- Drain water from the compressor storage tanks by opening the drain line valve. Allow the valve to remain open until clean air passes and then close tightly.
- Drain water from the air filters located on the pneumatic valve board.

#### WEEKLY

#### AIR COMPRESSORS

- 1. Inspect the oil level in the compressor crank case.
- 2. Clean the air filter.
- 3. Check for air leaks.
- 4. Check V-belt for wear.

WATER FILTRATION PLANT (Provided by Customer)

- 1. Check the regeneration requirements.
- 2. Check the water circulation pump.
- 3. Check the water level float switch.
- 4. Check for water leaks.

#### BOX SENSING LIMIT SWITCHES

Inspect weekly and replace as required.

## AIR LUBRICATORS AND FILTERS

- Check the oil level in the air line lubricators. If necessary refill with SAE 5 or SAE 10 regulator motor c... The oil consumption of the internal conveyor, the load/ unload device and the storage conveyor should be adjusted to approximately 0.75 pint (0.43 litres) each per month.
- Empty the oil drip cans on the pneumatic valve board assembly.
- 3. Check for oil and air leaks.
- Check speed of cylinders on the load/unload mechanism and internal conveyor.

### MONTHLY

#### EMERGENCY SHUT-DOWN DEVICE

- All emergency shut-down controls should be checked for efficient operation. These would include:
  - a) Stop button on the control panel.
  - b) Emergency pushbutton in the irradiation room.
  - c) Internal Time Delay (TD.2) Check that the time delay is running when the source pass mechanism is operating. Operate the time delay switch manually during cycle.
  - d) Source Hoist Time Delay (TD.3) Check that the time delay is running during source travel. Operate the time delay switch manually.
  - e) Overdose Timer (ST.1) Remove the overdose timer from its case when the main timer has only 5 minutes remaining in cycle. When the cycle has finished and the main timer has completed the reset cycle, replace overdose timer securely in case. The time remaining on the overdose timer will be less than the time on the main timer; when the overdose timer runs out it will automatically show down the unit.
  - f) Power Interruption Time Delay (TD.4) Using a stop watch, shut the facility main power switch off for 28 seconds or less, then switch on and the facility should resume normal operation. Repeat this

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operation except wait for 32 seconds before restoring power; the facility should not start up again.

 All of the above items should be tested under normal operating conditions.

## SOURCE HOIST AND ANCHOR CABLES

- The source hoist and anchor cables should be inspected for broken strands and signs of undue wear. Defects should be reported immediately to the Installation and Services Department of AECL.
- The cables should also be checked for strotch. The hoist cable can be checked by the pilot light indicuting the source up position on the control console.

POOL WATER SKIMMER (Provided by Customer)

 Debris should be removed at least once a month from the skimmer.

## MONITOR OPERATION

 The test source should be exposed to the monitor. If functioning correctly the monitor will signal an alarm.

## VENTILATION FILTER

- 1. Check the V-belts on the exhaust fan motor.
- 2. Lubricate the fan.

## SEMI-ANNUALLY

## SOURCE PASS MECHANISM

- The air cylinder front packing should be routinely changed at least once a year. It is suggested that hast of the air cylinder packings be replaced every six months, thus minimizing the required irradiation down time.
- Lubricate the internal conveyor roller bearings, ball transfers and limit switch guide rods with a graphite solution or moly disulphide.

## AIR VENTILATION FILTER

- Check the pressure drop across the filters and replace if the pressure drop exceeds 3.50 in (8.89 cm) of water.
- 2. Adjust the exhaust fan dampers when required to maintain an air flow of approximately 1,000 cfm (equivalent to an air velocity of 1,275 fpm in the centre of the duct or a velocity pressure of approximately 0.12 in of water).

## ELECTRICAL CONTROL RELAYS

 Visually check all the electrical relays in the control console and all control panels. Any relay which shows signs of "pitting" or "darkening" on any contacts should be replaced even though it may appear to be operating normally.

POOL WATER LEVEL CONTROL SWITCH (Provided by Customer) 1. Inspect the switch assembly and replace defective parts as required.

## ROUTINE CHECKS

WATER LEVEL SWITCH (Provided by Customer)

 Every three months depress the float switch by hand and have an additional man check that the solenoid make-up valve opens.

## TEMPERATURE SWITCH

 This switch is set to operate at 40 degrees F. (5 degrees C.) above normal room temperature. Every six months check the operation of the switch by immersing the bulb in water of the correct temperature.

#### AIR PRESSURE SWITCH

 Every three months check for normal operation of the pressure switch.

## ANNUALLY

## MICRO SWITCHES

 Replace the pneumatic cylinder microswitches located in the irradiation chamber. Replacements should be made rotationally such that each switch will remain in service for a maximum of two years.

## CYLINDER PACKINGS

1. The air cylinder internal packings have a life expectancy of approximately two years within the irradiation chamber. It is suggested that after the facility has been in operation for one year, one or two air cylinders at a time be repacked every month.

The life expectancy of the internal air cylinder packings outside the irradiation chamber is considerably longer.

NOTE: A decrease in air cylinder operating speed (or conversely an increase in air and oil consumption) will indicate the need for air cylinder packing replacement.

## GENERAL

## DETAILED DESCRIPTION OF SOURCE PASS MECHANISM

The source pass mechanism must be properly loaded with product boxes before the machine will operate.

On starting the operating sequence with the safety interlock set, the radiation source will start to rise as soon as the "Master" key is turned against the spring-loaded stop on the "Machine" key switch and released. Both "Source" pilot lights will extinguish on the control panel, and the radiation hazard light at the interlock door will illuminate and the alarm bell will signal.

When the source is fully raised the alarm signal will stop and the "Source Up" pilot light on the control panel will illuminate. At the same time the Internal conveyor sequence will start.

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To stop the machine the "Machine" key must be turned into the "Off" position. At this point the source will start to descend and the alarm bell will ring. When the source reaches the bottom of the storage pool the green "Source Down" pilot light on the control panel will illuminate and the radiation hazard light at the interlock door will extinguish.

## SOURCE PASS MECHANISM

## - OPERATING SEQUENCE

Refer to Figures 8, 9, and 10.

The source pass pneumatic cylinders are designated P1 to P15 inclusive. P8 and P16 are referred to as Elevators.

1. Elevator 1 (P8), Elevator 2 (P16) Down.

2. P1 to Discharge.

3. Elevator 1 (P8) Up.

4. P1 to Receive.

5. Elevator 2 (P16) Up.

6. P15 to Discharge.

7. Elevator 2 (P16) Down.

8. P15 to Receive.

9. P14 to Discharge and Receive.

10. P13 to Discharge and Receive.

11, P12 to Discharge and Receive.

- 12. P11 to discharge and receive.
- 13. P10 to discharge and receive.
- 14. P9 to discharge.
- 15. Elevator 1 (P8) down.
- 16. P9 to receive.
- 17. P7 to discharge and receive.
- 18. P6 to discharge and receive.
- 19. P5 to discharge and receive.
- 20. P4 to discharge and receive.
- 21. P3 to discharge and receive.
- 22. P2 to discharge and receive.

This completes one shuffle cycle. The shuffle counter will have counted down one number from its previous setting; the master timer will have run down to zero and reset to the time previously selected.

Automatic Batch operation will continue until the shuffle counter runs down to zero, the unit will cease operation and the source will go to its safe position.

## REFERENCE DRAWINGS

A complete set of reference drawings is included under separate cover for the IR68 irradiator. Where deviations from the manual are apparent, they will be reflected in the reference drawings. In AECL previous submittion

## RECORDS

### SUMMARY OF RECORDED UNPLANNED DOWNTIME

AECL would appreciate provision of a summary of unplanned downtime to be completed on a quarterly basis by the facility supervisor. This document would include a summary of the Daily Log Book (a sample log sneet is included in this manual) and other pertinent data which will assist AECL in improving existing and future irradiation units. Ary comments or suggestions based on operating experience regarding the operation and/or design would be equally appreciated. A sample copy of the Summary of Recorded Unplanned Downtime is included in this manual. These summaries should be sent quarterly to:

> Atomic Energy of Canada Limited, Commercial Products, P.O. Box 6300, Postal Station "J", Ottawa, Canada, K2A 3W3 Attention: Installation and Services Branco.

> > Part 3 - iRós

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REMA	
CELL MONITOR READING	TORIOG
OPERATION	IRRADIA
COUNTER READING	
TIME	V OF CANADA LIN
DATE	A LOMIC ENERGY

SOURCE PASS CONVEYOR		MAZE CONVEYOR		LOAD	UNLOAD	STO	VEYORS	MISCEL	LANEOUS		
AINUTES	FREQUENCY	MINUTES	FREQUENCY	MINUTES	FREQUENCY	MINUTES	FREQUENCY	MINUTES	FREQUENCY	1	PAULT
										1	RAM MALFUNCTION
										2	PRODUCT BOX JAM
					,					3	MICROSWITCH MALFUNCTION
										4	ELECTRICAL MALFUNCTION
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## PRODUCT FLOW DIAGRAM

Part 3 - 1868

FIGURE 9:

PNEUMATIC CYLINDER SEQUENCE DIAGRAM











LOWER LEVEL



P12

614

P14

514

No. 2 UP

8

No.1 DOWN

LOWER LEVEL

2

FLEV No. 1 UP

UPPER LEVEL

7





5



5











































FIGURE 10:

PNEUMATIC CYLINDER SEQUENCE CHART

Part 3 - 1968

3.73

PART 4

## CONTAMINATION DETECTION PROCEDURES

## OZONE DETECTION

Ozone, an allotropic form of oxygen, is a light blue gas having a characteristic odour even in concentrations of 0.01 to 0.05 ppm by volume. The irradiation of air with gamma rays produces Ozone and toxic levels are easily achieved if proper venitlation is not provided.

Ozone is generally accepted as being one of the most toxic gases known. The maximum allowable concentration value, as proposed by the American Conference of Governmental Industria. Hygienists, is given as 0.1 ppm in air for an exposure period of eight hours per day.

Presently there is no specific treatment for Ozone poisoning, however, suspected victims should be immediately referred to medical care. When Ozone is detected in any area in which personnel are stationed, accurate measurements of Ozone concentration should be immediately carried out and ventilation characteristics adjusted to maintain levels below the maximum allowable concentration value.

Individuals with existing pulmonary disease or those highly susceptible to respiratory infections should not be exposed to even low concentrations of Ozone. Personnel repeatedly exposed to Ozone should have a yearly medical examination including a chest x-ray.
# NOMOGRAM RELATING OZONE CONCENTRATION TO ROOM VOLUME, SOURCE SIZE AND AIR CHANGES



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# NOTE ON OZONE MEASUREMENT

A recommended survey instrument for Ozone measurement is the Drager Multi-Gas Detector, Model 21/31, which has an effective range of 0.05 to 1.4 ppm.

### NOTE ON MEASUREMENT

Tests should be made with equipment comparable to the BERTHOLD RATO/F Survey Meter as used by the Installation and Services Department of AECL.

The BERTHOLD RATO/F Meter has been calibrated against an AECL standard <sup>60</sup>Co source. Using the styrofoam pad(s) provided by AECL for wipe testing submerged <sup>60</sup>Co sources, a scale reading of 400 counts per minute is equal to 0.05 microcuries of contamination.

### NOTIFICATION OF INCIDENTS

EACH LICENSEE OR REGISTRANT SHALL IMMEDIATELY NOTIFY THE PERTINENT LICENSING AUTHORITY AND ATOMIC ENERGY OF CANADA LIMITED, OTTAWA, ONTARIO BY TELEPHONE OR TELEGRAPH, OF ANY INCIDENT INVOLVING ANY SOURCE OF RADIATION POSSESSED BY HIM AND WHICH MAY HAVE OR THREATENS TO CAUSE A RADIATION HAZARD. IN THE EVENT OF AN INCIDENT WHICH ENDANGERS OR THREATENS TO ENDANGER PLANT PERSONNEL OR THE PUBLIC, THE LICENSING AUTHORITY WILL TAKE ANY STEPS NECESSARY TO REMOVE THE DANGER. ANY FURTHER ACTION TO DECONTAMINATE THE PLANT AND RETURN IT TO OPERATING CONDITION WILL BE TAKEN BY AECL. IF FOR ANY REASON AECL PERSONNEL CANNOT REACH THE PLANT IN A REASONABLE TIME, FURTHER ACTION MAY BE TAKEN BY THE LICENSEE AT THE SPECIFIC REQUEST OF AECL.

# INITIAL EMERGENCY ACTION FOLLOWING

# A SUSPECTED RADIATION INCIDENT

Immediately following any suspected radiation incident the licensee will take the following action:

- No immediate attempt shall be made to clean up the suspected "spill".
- All openings shall be closed; fans, water filtration plant and air conditioners shall be shut off, and everyone shall leave the irradiction facility.
- 3. All doors shall be closed and locked.
- All operating personnel shall be checked for possible contamination and immediate steps taken to remove any radioactive contamination.
- Entrance to the suspected contamination area shall be prohibited.

ROUTINE CONTAMINATION TEST FOR

COBALT 60 SOURCE ASSEMBLIES

#### METHOD

To ensure that there is no loose contamination, four series of tests will be conducted with all radiation source elements in the submerged (or "Safe") position:

a) On the source capsules (or "elements").

- b) On selected accessible submerged surfaces of the facility on which one might expect contamination (if there were to be a leakage) to accumulate.
- c) On the deionizer filter bed.
- d) On the air filter bed.

The following procedure for wipe testing should be adopted:

- Check that the radiation source is in the submerged ("Safe") position.
- Before proceeding observe and adhere to the safety precautions recommended in the operating manual supplied with the facility.
- 3. Enter the irradiation room and using suitably sized pads of styrofoam perform wipe tests on the exposed surfaces of the capsules (or "elements"). The facility is equipped with source element handling tools for remote operations of this type.
- 4. Allow excess water to drain from the wipes.
- Perform similar wipe tests on selected surfaces of the radiation source assembly which are suspect to contamination.
- Count the wipes by placing in contact with a geiger counter operating in a background field of no more than 0.025 mrh.
- 7. If the counter indicates contamination on the test sample(s) exceeding the permissable level indicated on the Radioactive Material License suspend operations and immediately notify the Pertinent Licensing Authority and Atomic Energy of Canada Limited.

- 8. It is recommended that a monthly radiation survey be made of the carbon filter and resin bed on the demineralizing unit to ensure that the pool is not contaminated. Any indication of a change in the amount of radioactivity present should be reported to the Pertinent Licensing Authority and Atomic Energy of Canada Limited, and source wipe test procedures carried out immediately.
- 9. It is recommended that a monthly radiation survey be made of the air filter bank to ensure that there is no contaminated air within the irradiation chamber.

#### DECONTAMINATION PROCEDURES

#### GENERAL.

In the event of any indication of contamination by any of the monitors or from routine wipe tests, the licensee will immediately close down the facility, restrict entrance and quarantine all products in the suspected area, and will notify Atomic Energy of Canada Limited by cable. The licensee will immediately advise the Pertinent Licensing Authority, that an incident is suspected and will effect the safety control measures as listed below:

- No immediate attempt shall be made to clean up the contamination.
- All windows shall be closed; fans, water filtration plant and air conditioners shall be shut off, and everyone shall leave the facility.

- 3. All doors shall be closed and locked.
- 4. All personnel who may have been contaminated shall be thoroughly tested for contamination and immediate steps taken to remove any radioactive contamination.
- 5. Entrance to the facility (or contaminated area) shall be prohibited except to authorized personnel requiring access in the performance of their special duties.
- Under no circumstances shall any unauthorized or untrained persons attempt to examine or clean up any "spilled" radioactive material.

The clean-up technique should be planned with the same care as is used in quantitative chemical analysis or in bacteriological handling of extremely virulent organisms.

Fans or ventilating apparatus shall not be used in an attempt to disperse the radioactive material or its decay products. Such a manoeuvre will only disseminate the radioactive contamination throughout the area.

Atomic Energy of Canada Limited will dispatch qualified personnel to the site to assess the situation and to confirm or deny the presence of contamination, and will report their findings to the Pertinent Licensing Authority.

Atomic Energy of Canada Limited, or their Agent, have available, and will provide if necessary, emergency equipment as listed in Part 4 of this manual.

If it is confirmed that contamination has been detected, Atomic Energy of Canada will dispatch a Senior Radiation Protection Officer together with qualified personnel to institute corrective action.

#### EMERGENCY EQUIPMENT

Atomic Energy of Canada Limited, or their Agent, have available and will provide if necessary, the emergency equipment listed hereunder:

- Personnel protective clothing, including plastic suits, special footwear, plastic hoods, gloves, etcetera.
- Respiratory equipment including demand air packs (MSA), canister type respirators, and supplied air respirators.
- Decontamination supplies, including polyethelene sheeting,
  disposal bags and containers.
- 4. Approved radiation monitoring devices and personel exposure dosimeters for all personnel involved.
- Instruments of adequate sensitivity for the measurement of low level beta-gamma contamination.
- 6. Area radiation monitors with alarm.
- General safety protective equipment such as safety helmets, gloves, shoes, etcetera.