1992 RENEWAL
ITEMS 8, 9, 13 updated.

FORM NRC-313 I (3-80) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
x	c. RENEWAL OF: LICENSE NUMBER 06-17253-01

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*
Victor J. Bortolot, Ph.D
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(203) 453-3299

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
same
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)* *(Address to which NRC correspondence, notices, bulletins, etc., should be sent.)*
Daybreak Nuclear & Medical Systems, Inc.
50 Denison Drive Guilford, CT 06437

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*
50 Denison Drive
Guilford, CT 06437

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Victor J. Bortolot, Ph.D.	Research Director
b.		
c.		

7. RADIATION PROTECTION OFFICER
Victor J. Bortolot, Ph.D.

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER (If Sealed Source) C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	Americium 241	sealed source	Amersham/Searle AMM	1 mCi (1 source)
(2)	Strontium 90	sealed source	ICN model 75129	100 mCi (1 source)
(3)	Strontium 90	wipe test std.	ICN model 77241	.01 microcurie
(4)				

DESCRIBE USE OF LICENSED MATERIAL E

(1)	Thermoluminescence sensitivity calibrations of ceramic and other mineral materials
(2)	for the purpose of archaeological dating, where alpha and beta response must both
(3)	be determined (see attachments). Daybreak is one of two commercial labs in the
(4)	world (only in US) doing art authentication, and has over 150 international clients.

ITEMS 8, 9 updated

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Item 8. Radioactive Material (including additions to current license)
(* covered by current license)

A. Strontium 90*	ICN Pharmaceuticals Sealed source model 75129	1 source of 100 mCi
B. Americium 241*	Amersham/Searle Sealed source Model AMM	1 source of 500 uCi
C. Strontium 90*	ICN sealed wipe test standard	1 source of 0.005 uCi
D. Strontium 90	ICN Pharmaceuticals Sealed source model 75144	1 source of 100 mCi
E. Curium 244	Isotope Products Labs. Sealed source Model AFR-244	1 source of 500 uCi

Item 8E. Purposes for which licensed material will be used
With the exception of source C. (for beta wipe test measurements in our radiation safety program), all sources are intended solely for irradiation of mineral dat- erials. The response of these materials to radiation is measured, and used in archaeological dating by thermoluminescence.

Sources A. and B. are stored and used in the irradiators described in application dated 23 December 1981. Source D. is to be housed and used in a very similar, but improved, beta irradiator. Source E. is to be housed and used in an alpha irradiator identical to that in the 1981 application.

Sources D. and E. are required to cope with increased numbers of samples. We now have 500 clients, and remain the only commercial laboratory in North America for thermoluminescence dating of ceramics. The additional sources are for use with an automated measurement system for routine and predictable samples, while the originally licensed sources (A. and B.) will continue to be used for the less routine samples that require individual attention and adjustment of calibration doses during the measurement procedure.

9. Storage of sealed sources
All irradiators are built by the applicant.

A. Sr-90 beta irradiator I (as described in original application 1977, and renewals)
D. Sr-90 beta irradiator II (see enclosure, identified as Daybreak model 740)
B. and E. alpha irradiator (as described in original application and renewals)

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	Sr-90 beta irradiator (see attachment)	applicant	n.a.
(2)	Am-241 alpha irradiator (see attachmt)	applicant	n.a.
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)	scint. counter	applicant	n.a.	2	alpha, beta	$2\text{-}5 \times 10^8$ alpha/hr $200\text{-}10^7$ beta/min
(2)	TL reader	applicant	n.a.	1	alpha, beta, gamma	integrated 25 uR-10^4 R
(3)	(see item 11 attachments for description)					
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

☒ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☒ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☐ (3) OTHER *(Specify)*:	applicant	☐ MONTHLY ☒ QUARTERLY ☐ OTHER *(Specify)*:

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☒ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

n.a.

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

This application is for sealed sources. In the event of leakage, they will be returned to the manufacturer for repair or disposal.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(If needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* $150.00	b. CERTIFYING OFFICIAL *(Signature)* Victor Bortolot
	c. NAME *(Type or print)* Victor J. Bortolot, Ph.D.
(1) LICENSE FEE CATEGORY: $150	d. TITLE Director of Research
(2) LICENSE FEE ENCLOSED: $ 150	e. DATE 12/23/81

ITEM 9. Source storage.

α SOURCES B, E

(1) The Am-241 sealed source is housed and used in the device shown in Figure 1. This has an electrically-operated (solenoid) arm with a fail-safe spring return that carries the source out of the housing over the sample to be irradiated. At all times the active surface of the source is inacces--sible to human contact. By use of an alpha absorber, the gamma component alone is available for use as a calibrator for TL personel monitor badges. This source has been standardized against radium using the same TLD material.

β SOURCE A

(2) The Sr-90 sealed source is stored and used in the shielded device shown in Figure 2. This, like the alpha housing above, is electrically operated. The spring return shutter protects the source against mechanical damage and human contact. When the solenoid is not energized, the shutter remains closed in all orientations, and cannot be opened without dissassembly of the device. The shutter is a composite of 1/16" aluminum alloy and 3/16" lead to minimize brehmstralung production. As measured with an Eberline RO-1 ionization type survey meter, the closed shutter exit exposure rate is 45 mR/hr and the surface exposure rate on the steel enclosure can is about 10 mR/hr. The device is stored in a fireproof safe on and behind lead brick. In use, the device is placed 2 feet from the TL reader on and behind lead brick. When a sample calibration is to be done, the device is placed on the TL reader glow oven directly over the sample, and the shutter opened by an electronic timer. The exposure on the under surface of the glow oven during irradiations is 20 mR/hr. The source is in use about 200 hours annually. Dose monitoring of the applicant has shown less than 250 mR exposure per year during the term of the current license.

β Source D

(3) A new beta irradiator is to be built for source D. Details are given in the enclosure following this page. This irradiator is to be used seated on a sample changing mechanism approximately 30cm square with the irradiator at the rear edge. The irradiator/changer will be covered with a box to exclude light, and act as a barrier to casual access. The source will abut a concrete foundation wall with rock/fill on the other side. The irradiator will be removed and stored when not in use as in item (2) above.

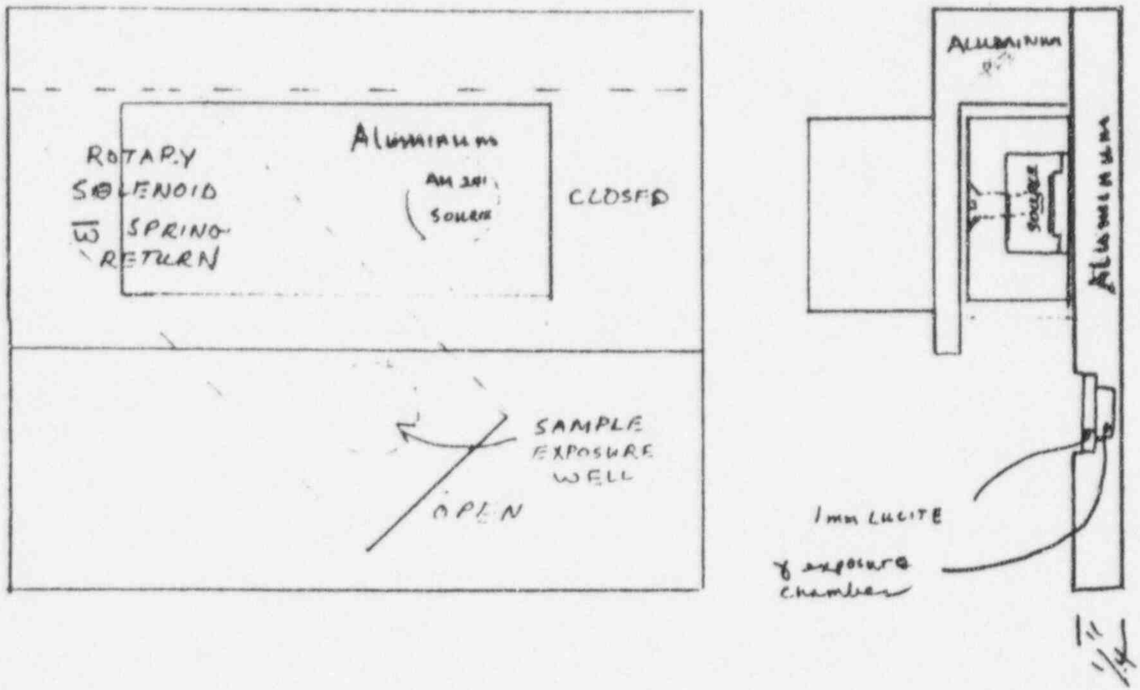


FIGURE 1. Am-241 alpha/gamma exposure device
ANTICIPATED SURFACE EXPOSURE RATE <1 mR/hr.

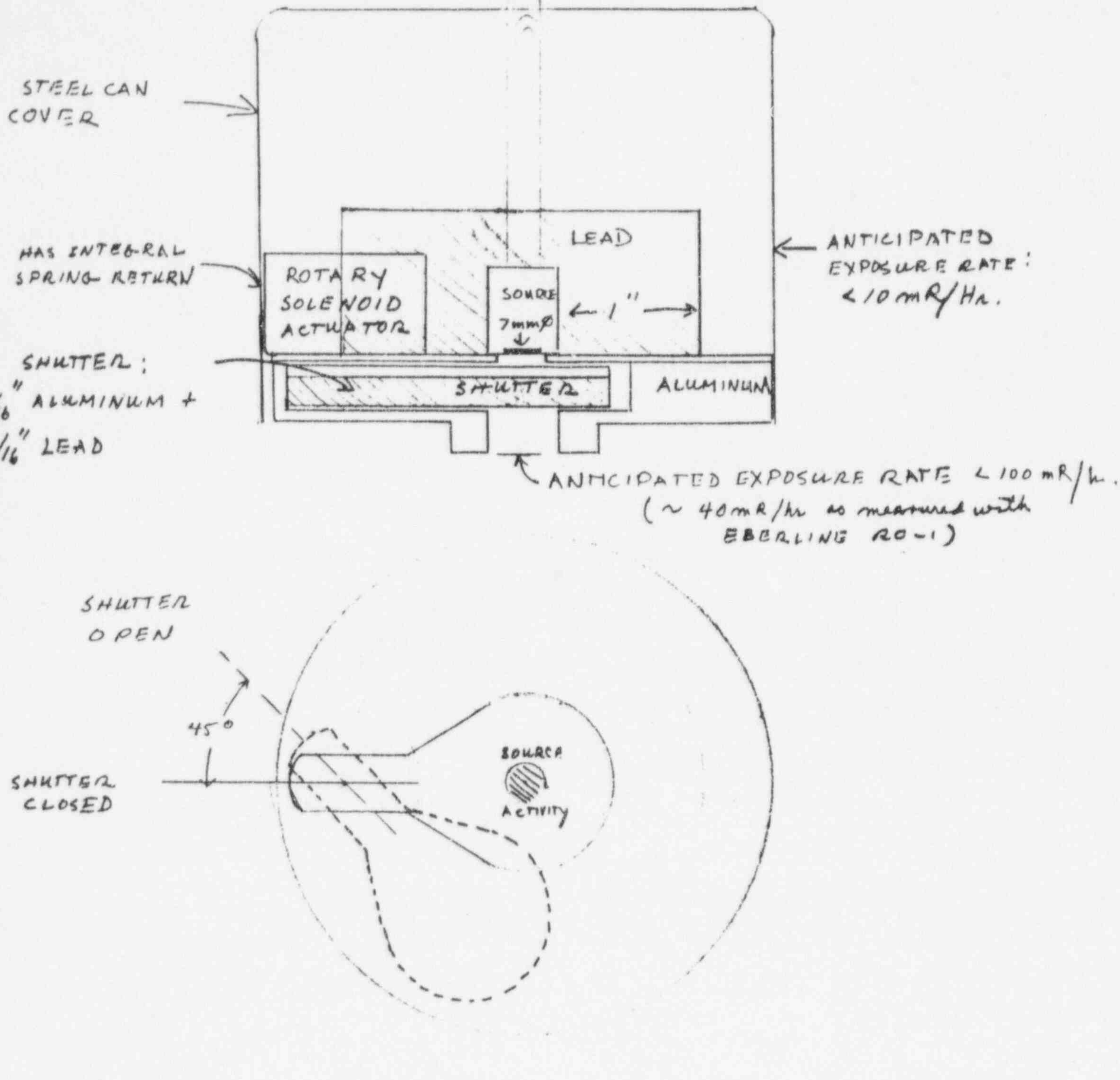


FIGURE 2. Sr^{90} SHIELDED EXPOSURE DEVICE, ACTUAL SIZE.

WHEN NOT IN USE, DEVICE WILL SIT ON 2" LEAD BRICK.

WHEN IN USE, DEVICE WILL SIT ON TL READOUT OVEN (~ 1" ALUMINUM).

DAYBREAK MODEL 740 BETA IRRADIATOR Revision 2 21 November 1984

SUMMARY DESCRIPTION

The 740 beta irradiator is a shielded, solenoid-actuated shutter device for irradiating samples for thermoluminescence dating in place on the glow oven heating plate. The shutter is a composite of aluminum (0.050 in) and lead (0.200 in) to minimize bremstrahlen production, and has a failsafe spring to return the shutter to the closed position when actuating power is removed. The rotary shutter counterweight, together with the failsafe spring, prevent opening without power in any orientation. The shutter is in the form of a disk with an aperture offset 68 degrees from the position of the source. When power is applied, the disk rotates to place the aperture beneath the source, permitting sample exposure to occur. Top and side views of the device are shown in figure 1 and details of the shutter and shield in figure 2. Approximate surface exposure rates measured with an ionization- type survey meter in contact with the surface are given also in figure 1. Because of the relatively high exit exposure rate under the shutter with the shutter in the closed position, it is recommended that the device be stored on and behind 2" lead blocks when not in use. The exposure rate at knee level directly beneath the when the device is in use on the glow oven and the shutter open is under 1 mR/hr. The prototype of this irradiator was approved for use in this application in NRC license 06-17253-01 (V.J. Bortolot, Daybreak Nuclear and Medical Systems, Inc. Guilford, CT 06437). The shield incorporated in the 740 is about twice the thickness of the prototype device. The device is installed in several [illegible] ment states, and several foreign countries, but aside from the prot[illegible]pe, none of these has fallen under the purview of the NRC.

The SR-90 source recommended for use in this device is Isotope Products Laboratory, Inc. (Burbank, CA) model SK-236 having a nominal 125 mCi activity.

HEALTH AND SAFETY DATA

The 740 beta irradiator is ruggedly built, able to withstand extended use in a normal laboratory environment. The solenoid actuator is permanently lubricated and requires no maintainance. All parts except the power cable insulation are metallic and not subject to degradation with exposure to radiation. In case of fire, the lead shield could melt, but the source would remain inside the cover can and baseplate, so that activity would not escape. Because the device is small, any likely explosion would most probably result in translation, rather than fragmentation. In an impact, the soft lead shield surrounding the source would deform and cushion the source, thus tending to protect it.

Leak testing is recommended at six month intervals and no attempt should be made to wipe the source directly (to avoid personnel exposure), but rather to wipe the exterior of the shutter surface, as well as the immediate storage area and glow oven heating plate, which is immediately below the source when in use.

It should be noted that though the source is above a heating plate while in use, this low-power heater is at room temperature at the time. If by accident, the temperature ramp were started during the exposure, the source (at 0.70 in source to sample distance) would not be exposed to temperatures exceeding about 40C.

Pertinent exposure rate measurements at the device surface are given in figure 1.

SOURCE LOADING

Loading the source requires some disassembly of the 740 irradiator. The device was designed purposively to make access to the source difficult, for the protection both of personnel and the source itself.

Before starting, place a piece of tape on the underside of the shutter (the lead shutter shield shows though the aperture in the black anodized base of the irradiator). This prevents the shutter from rotating after the solenoid and shield are removed, making reassembly easier.

First, remove the cover can by removing the three 4-40 screws at its

lower edge. Slide the cover off the base plate carefully to avoid stress on the wires connecting the coax cable to the solenoid. Next, unscrew the four 6-32 shoulder screws that secure the solenoid mounting plate to the hex mounting posts. Lift the solenoid assembly straight up and set aside. The lead source shield is then removed. Three 6-32 screws with washers secure it to the base plate. Note that the hole in the shield though which the solenoid actuating post passes is over the hole in the base plate which exposes the shutter coupling slot. The actuating post fits into this slot and onto the 0.125" steel dowel in the slot.

Place the beta source, active surface down, in the shallow recess provided at the center of the top plate over the shutter opening. BE CAREFUL! OBSERVE EVERY SAFETY PRECAUTION. RADIOISOTOPE SOURCES ARE DANGEROUS WHEN IMPROPERLY HANDLED AND MAY ALSO BE DAMAGED. It would be wise to work from behind a 0.5 inch plexiglass sheet which would absorb any stray beta radiation as the source was handled should the source accidentally be turned toward the installer.

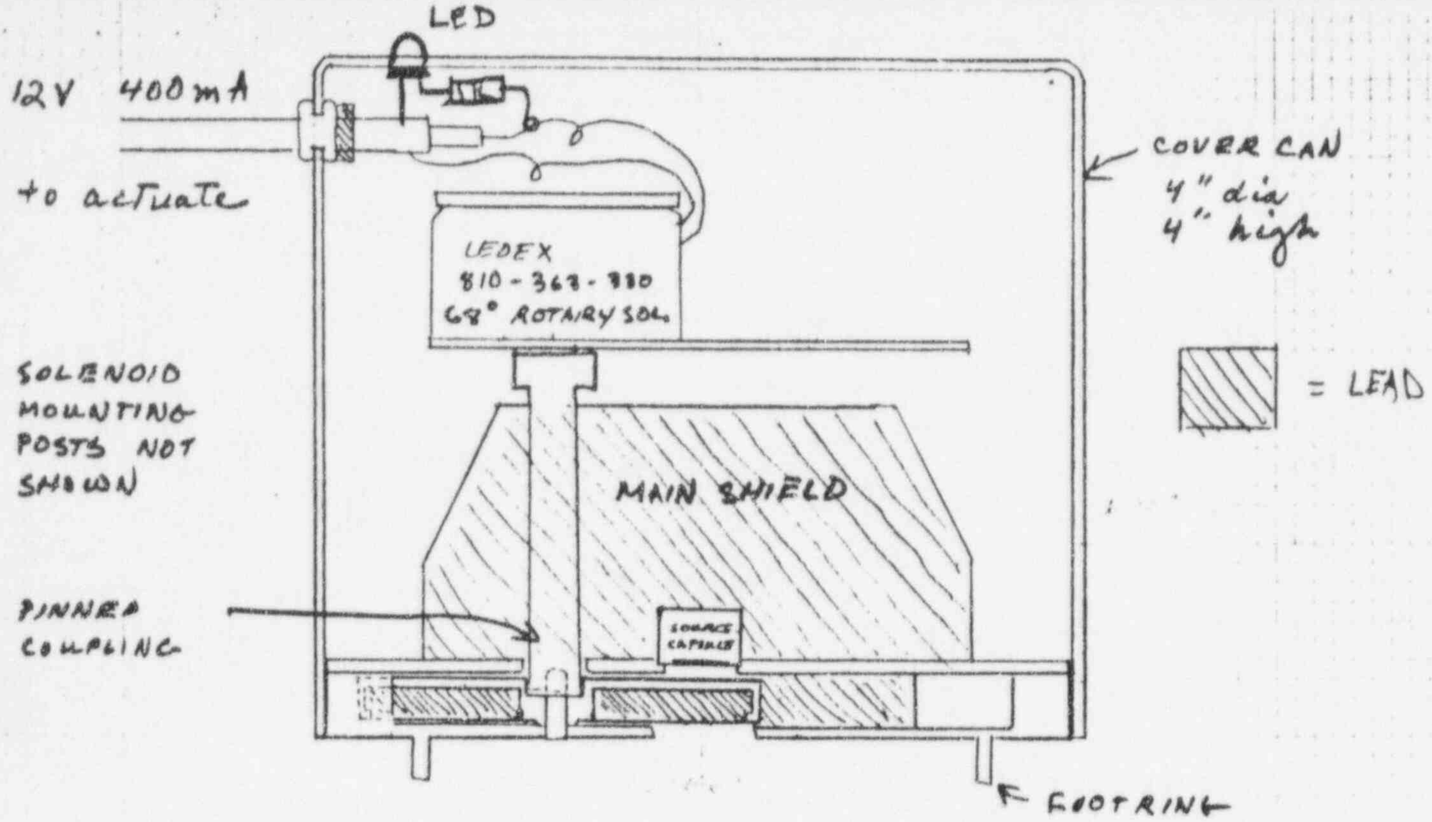
Now, reassemble. Place the shield over the source, taking care not to jostle it out of its recess. Orient the shield so that the holes line up with those in the base plate and re-secure with the three 6-32 screws with washers. Insert the solenoid actuator post though the hole in the shield, and by feel seat it in the shutter. If the shutter was taped before disassembly, the holes on the solenoid assembly will line up with the four posts. Replace the four shoulder screws. The solenoid assemble must have some free play on the shoulder screws. Replace and secure the cover can, making certain that the wires inside are not trapped between the top of the solenoid and the can, as that may prevent the solenoid from moving properly. Remember to remove the tape from the bottom surface of the irradiator.

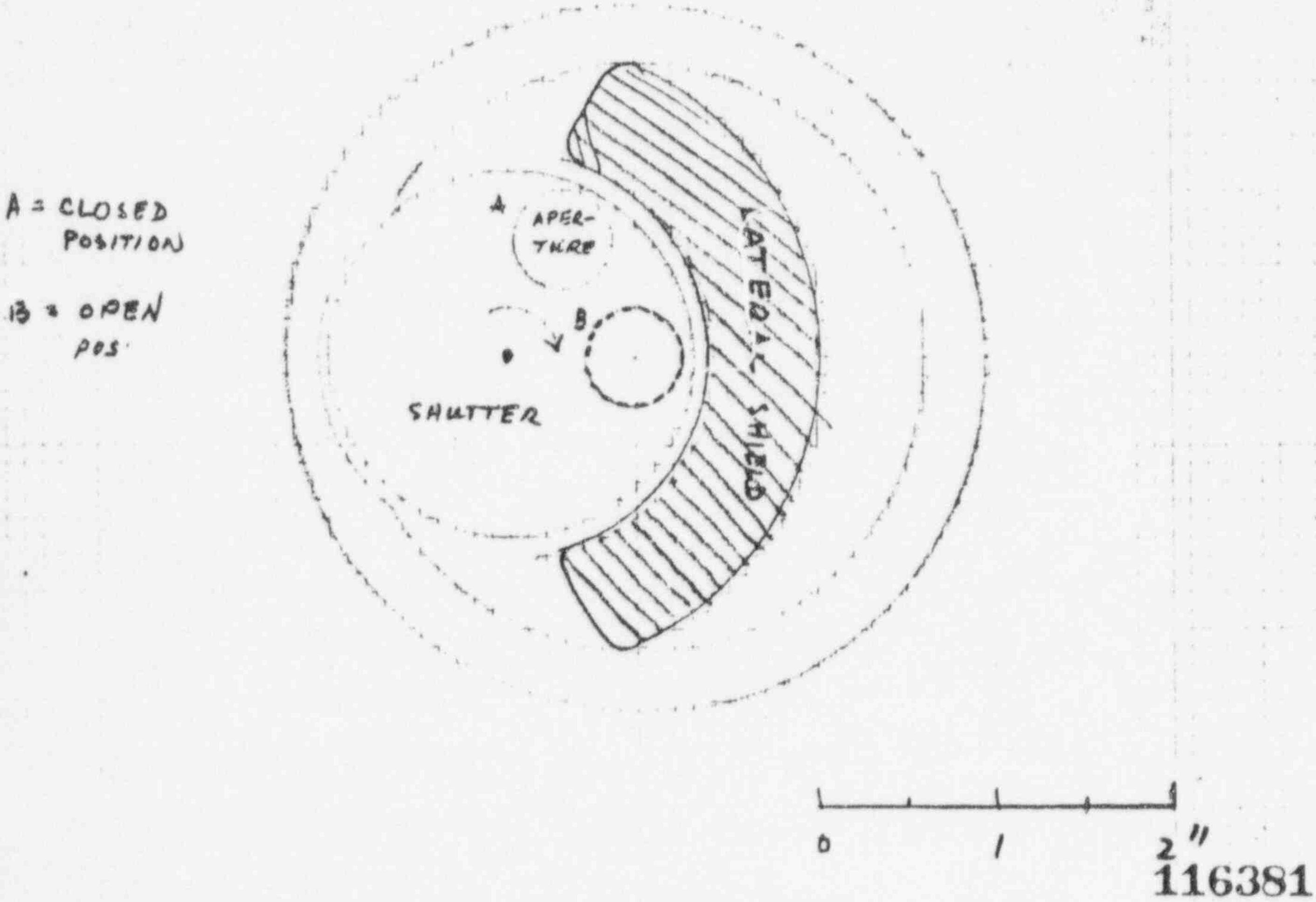
INSTRUCTIONS FOR OPERATION

The 740 is designed to be powered by a Daybreak 590 timer, or other DC source providing 12 V at 400 mA. The BNC connector on the cable is plugged into the BETA socket on the 590 timer front panel and this module's START and STOP pushbutton switches then control the operation of the 740. The 740 solenoid will make an audible "thunk" when power is applied (590 START pressed) and the timer display will be active. The solenoid release is also audible, and the timer display goes to "0000".

For use in irradiating a sample, the foot-ring of the beta irradiator is inserted into the light baffle groove surrounding the glow oven, so that the irradiator sits on the glow oven o-ring, with the active surface of the source facing down toward the sample but blocked by the shutter. This ensures that the irradiator is centered on the sample and that the source to sample distance is always the same. While the surface exposure rates at the irradiator are quite low, whether the shutter is open or not, it would be best for the operator to move away a short distance (say, three feet) from the irradiator. Alternatively, a "castle" shield, made of a U of lead bricks around the glow oven opening will reduce lateral exposure to background while still allowing easy access to the glow oven. Likewise, while the irradiator is not in use during a series of glowcurves, and is to be kept within convenient reach, it should be kept on a lead brick and behind one as well.

THE SHUTTER SHOULD NEVER BE OPENED WHILE THE IRRADIATOR IS OFF THE GLOW OVEN, NOR SHOULD IT BE REMOVED FROM THE GLOW OVEN WHILE AN IRRADIATION IS IN PROGRESS.





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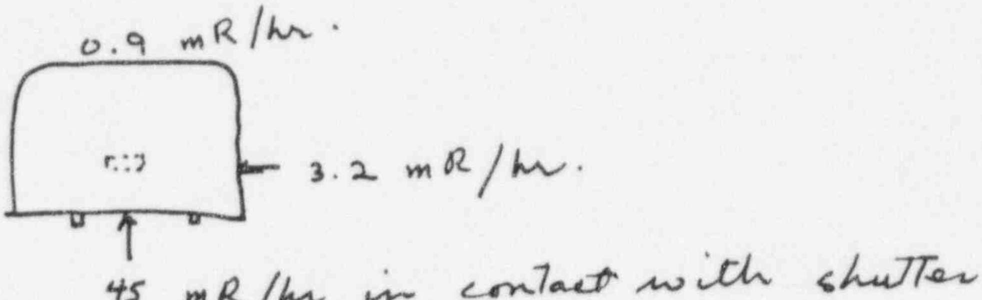
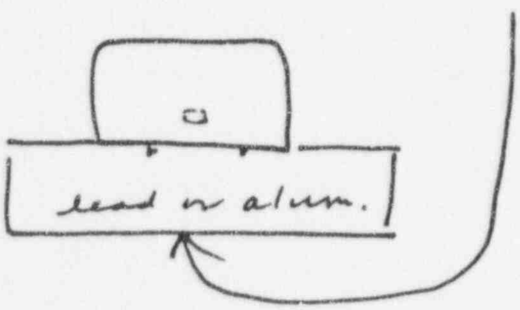
SURVEY OF 740 BETA IRRADIATOR

Loading : 100 mCi SR-90 (Amersham SIF.1177)
measurements made with ionization meter
at York college (Queens, NY) by V. J. Bortolot
on Aug. 1988



15 mR/hr with 1.0" aluminum
0.6 mR/hr with 2.0" lead



ITEM 11. Calibration of instruments.

1. The scintillation counters used in the TL dating laboratory for alpha activity measurements are used additionally for wipe tests using standards for comparison. The counters consist of a scintillator (Wm. Johnson ZnS alpha screens, or a Nuclear Enterprises NE810 plastic foil beta scintillator), PMT (EMI 9656), and NIM-packaged electronics with pulse amplifiers after Lampton and Primsch (RSI 42, 731 (1971)) and conventional integral discriminators and counters. For additional description, see the page on the Daybreak 580-series counters which are functionally the same (see attachment).

These counters were developed by the applicant while he ran the TL laboratory at Mt. Sinai School of Medicine (New York), and have proven successful for low level alpha measurements in dating, and for both alpha and beta wipe tests. Since all wipe tests are made by comparison with standards, there is no need for absolute calibration.

For alpha wipe tests, the amplifier gain and discriminator level are normally set for 85 per cent detection efficiency of alphas from a 1 per cent Th thick source (NBL analyzed sample #79-A) on a ZnS screen. Typical background is 2 counts/hr. For the purpose of wipe tests, the comparison source is a plated planchet containing 1440 dpm of Pu-239 (approximately 0.001 uCi) standardized at the NRC Health and Safety Laboratory in New York.

Beta wipe tests are performed with the plastic scintillator foil, with the gain increased and discriminator threshold lowered to give approximately 4000 counts/min for the wipe test standard and 200 counts/min background.

2. A description of the TL reader system is given in the Daybreak brochure attached, as it is the prototype model. This is a high performance photon-counting TL system capable of measurements down to 25 uR with $CaSO_4$:Dy phosphor with 12 per cent precision, and 1mR with LiF with 3 per cent precision. This instrument is used for personnel monitoring where the gamma component of the Am-241 sealed source is used for calibration each time a TL phosphor is read out. The gamma calibration is by comparison with exposure to a 10 mg radium source at the Yale-New Haven Radiotherapy Dept. LiF-7 1/8" square dosimeters enclosed in $\frac{1}{4}$" delrin wall capsules were placed on the centerline of an Eberline RO-1 survey meter in integration mode during exposure.

ITEM 13. Laboratory facilities.

The laboratory is devoted both to TL authenticity testing and to the development and production of high-performance apparatus for TL dating. It consists of 500 square feet of basement level space in a residential building owned by the applicant, divided into three rooms. The two front rooms house office space, electronics assembly area, and machine shop, while the thirdcontains the TL lab. The equipment here includes a high sensitivity photon counting TL detection apparatus with vacuum/N_2 purge sample oven, linear temperature rise of 0-50C/sec, xy recorder, scintillation counters for alpha activity measurements and ancillary sample preparation and calibration equipment. A flame photometer measures potassium content for K-40 activity. A Daybreak 9900 computer system ~~will shortly~~ is be installed to do data reduction and age computations. The fireproof safe for the sealed sources covered in this application is within a lokked cabinet in this room. The door to the lab may be locked.

In 1992, a Daybreak model 1100 automated TL measurement system will be installed to increase productivity in routine authenticity studies. (see enclosure.)

ITEM 15. Radiation protection program.

The radiation protection program at this laboratory complies with the standards set forth in Part 20 of the U.S. Nuclear Regulatory Commission Rules and Regugations, and will be described below under four headings: security, leak testing, personnel monitoring, and action in case of source leakage.

(a) Security. The section of basement level occupied by Daybreak Nuclear and Medical Systems, Inc. is accessable from the remainder of the basement by one locked solid core door equipped with deadbolt lock, and from the outside by a steel door with deadbolt lockset (main entrance). The door to the TL laboratory where the sources are stored and used is labeled with a "Caution-Radioactive Materials" sign and is locked when the lab is not in use. The sources, in their shielded irradiator housings, are kept in a fireproof safe within a locked cabinet which is against a subterrean concrete foundation wall. Access to the sources is limited to the applicant, and no other person is permitted in the TL lab when the sources are in use.

(b) Leak testing is performed by the applicant semi-annually when the sources are in use. Each source housing is wiped on the surfaces where any leakage is liable to collect with a moistened cotton swab. As described under item 11, a scintillation counter is used to measure leakage activity for each swab by comparison to a wipe test standard (alpha: Pu-239 0.001 uCi plated source, beta: Sr-90 0.0076uCi* leak test standard, ICN model 77241). The results are to be kept on file indefinitely.

(c) Personnel dosimetry. A badge (¼" wall delrin cylinder) containing three 1/8" square LiF-7 TL dosimeters is worn by the applicant whenever the source housings are used, and the dosimeters are read out quarterly when the sources are in use by the TL reader described in item 11. The gamma component of the Am-241 source has been calibrated relative to radium and is used to calibrate the dosimeters at each read out. The results are to be kept on file indefinitely. During the term of this license the dose to the applicant did not exceed 250 mrad/year. Because of the robust construction of the sealed sources, and their being housed in shielded enclosures that prevent mechanical damage, no survey meter or alarm is necessary to supplement the dosimeter badge.

(d) If, in the course of leak testing, removable activity in excess of 0.005 uCi should be discovered, the source will be examined (with plastic gloves worn). The beta source can be checked for a broken window by inspection with a mirror with the shutter energized open. The alpha source has a rolled gold coating that could conceivably become scratched (although the mechanical design of the source arm--the source is slightly recessed--is meant to prevent this). The arm would be removed by disassembling the housing, and the source surface inspected using a mirror. Wipe tests of the safe, shield area near the TL reader, and the path between would then be made to determine the extent of any contamination. A telephone report will be made to the Region I USNRC Office of Inspection and Enforcement, King of Prussia, PA, within 24 hours. A report will also be made to the manufacturer. The source will be kept in the storage safe pending instructions on safe transport to the manufacturer for repair or disposal.

* present activity 0.005 μCi 1/92

ITEM 16. Formal training in radiation safety.

The basics of radioactivity measurement and instrumentation and the mathematics thereof was covered in a modern physics course taken by the application at Boston College in 1963-1964. About two weeks and four laboratory sessions were devoted to this section of the course. A semi-formal course of radiation protection practice, standardization and measurement, and a review of the math and calculations, which consisted both of text reading and practical experience with all instruments and therapy devices available in the department, was given over a two-week period in 1971 at Mount Sinai School of Medicine when the applicant was first employed there. This course of study was given by Howard Hazelkorn, radiation safety officer of the radiotherapy department. The biological effects of radiation were not covered formally, although a great deal of reading in gynecological cancer and its treatment done in preparation for this employment did in fact cover most of the basics.

ITEM 17. Experience.

As research physicist with the radiotherapy department of Mount Sinai School of Medicine in New York, the applicant was concerned with setting up a TL laboratory for high sensitivity in vivo dosimetry of radiotherapy treatment of gynecological cancers by afterloading, where tubes to hold Cs-137 sources are positioned in the uterus, adjusted, their position measured by stereo x-ray, then finally loaded with the radioisotope. A further use of the TL lab was research into TL dating of art objects, then a new field of research. The major sources used in the TL lab were a 100 mCi strontium-90 and a 500 uCi Americium-241 sealed source, used for four years. a 10 mg radium source was used for a six-month period for low level radiation calibrations of TL phosphors. For the entire 4½ year period of employment at Mount Sinai, the applicant did dosimetry on, and unloaded, patients having up to 0.5 Ci of Cs-137, and had responsibility for control of this material.

Having founded Daybreak Nuclear and Medical Systems, Inc. in 1977, the applicant has built up one of two commercial TL authenticity testing services in the world, and the only one in this country, having an international clientele of over 500 museums, collectors, and dealers. Since mid-1977, a 100 mCi Sr-90 and 500 uCi Am-241 source have been used for the sensitivity calibration of ceramic materials. The major activity of the applicant is the development and manufacture of TL systems for archaeological dating, including various shielded irradiator devices. Since 1979, more than 50 TL labs have been completely equipped by the applicant in locations throughout the world.

Resume. ITEMS 16 and 17.

Victor J. Bortolot
50 Denison Drive
Guilford, CT 06437
(203) 453-3299

Born 8/11/44 Norwalk, CT

EDUCATION: Boston College BS (physics) cum laude 1965

Columbia University MA (physics) 1969

New York University Ph.D. (physics) 1972
Dissertation under P. Thaddeus: The Interstellar line Spectra of Zeta Ophiuchi and Zeta Persei and their Relation to the Cosmic Background Radiation.

WORK EXPERIENCE

summers 1963-1966: Perkin-Elmer Corp. Norwalk, CT.
applcations engineering in differential scanning calorimetry and electron spin resonance.

3/66-10/71: NASA (Goddard Institute for Space Studies, New York)
Research assistant. Graduate research including extensive interactive computer programming, microwave spectroscopy, high resolution stellar spectroscopy including 45 nights observation at Lick and Kitt Peak Observatories, low level light detection, and digital electronics design.

11/71-6/76: Mount Sinai School of Medicine, New York.
Radiation research physicist. Set up TL lab fot <u>in vivo</u> dosimetry for radiotherapy and archaeological dating research. Development of high sensitivity photon counting TL detection system. Design and engineering development of high intensity Cs-137 remote afterloading device for treatment of cervical and uterine cancer under N. Simon. High speed data acquisition and processing in nuclear medicine. Considerable digital and analog electronic design experience.

7/76-1/77: consultant in nuclear medicine instrumentation. Developed respiratory motion correction instrument for gamma cameras, later brought into production and marketed by Daybreak Nuclear and Medical Systems, Inc.

1/77-present: Daybreak Nuclear and Medical Systems, Inc. Founder and director of research. Built apparatus and set up TL lab for authenticity testing of art objects. Development and production engineering of modular TL system for archaeology. Development of computer interface and software system for reduction of TL data and date computation.

PUBLICATIONS

Five papers published on interstellar line spectra and four on TL dating and instrumentation.

DAYBREAK systems for TL dating

Daybreak Nuclear and Medical Systems, Inc., is a small, privately held corporation founded in 1977, which specializes in thermoluminescence (TL) dating instruments and services. We are the world's leading manufacturer of systems for TL dating in geology and archaeology with more than 50 systems installed worldwide. Daybreak makes available a wide range of automated and conventional TL systems and accessories, and has developed outstanding applications software for TL. We shortly will introduce the world's first commercially available single sample and automated OSL (optically stimulated luminescence) reader systems.

At a recent international TL specialist meeting, more than 40 per cent on the papers presented data taken with Daybreak instruments.

Another side of Daybreak's TL activities includes authenticity testing of art objects. We are the only commercial TL authenticity service in the Americas, and have the distinct advantage of continually updated state-of-the-art equipment. All dating studies are done by our technical director, Victor J. Bortolot, Ph.D., who has nineteen years' experience in this field. Authenticity studies are made with careful attention to technique, yet quickly enough to assist curators, dealers, and collectors with their decisions. We endeavor to have dating results available within two weeks of obtaining samples, and rush service is available at a premium. Daybreak has trained conservators available for taking samples in many cities, and Dr. Bortolot is available by appointment for sampling in New York City and Guilford, CT. This authenticity dating service is completely confidential, so it is not possible to name our clients (and results are never made available except by the express permission of the client commissioning the study). Certain public institutions, mostly museums, use our services, and where the results are on public record, they may be mentioned. Some of these are listed below.

Metropolitan Museum, New York
Detroit Institute of Art
Houston Museum of Fine Arts
Dallas Museum of Art
Museum of Fine Arts, Boston
National Gallery, Washington
Freer Gallery, Washington
Hirshhorn Museum, Washington
Indianapolis Museum
Cleveland Art Museum
Cinncinati Art Museum
New Orleans Museum of Art
Yale Art Gallery, New Haven
Brooklyn Museum
St. Louis Art Museum
Virginia Art Museum, Richmond

We presently have over 400 clients for our dating services.

50 Denison Drive Guilford, CT 06437 (203) 453-3299

Daybreak Nuclear and Medical Systems, Inc.
Guilford, CT 06437 USA

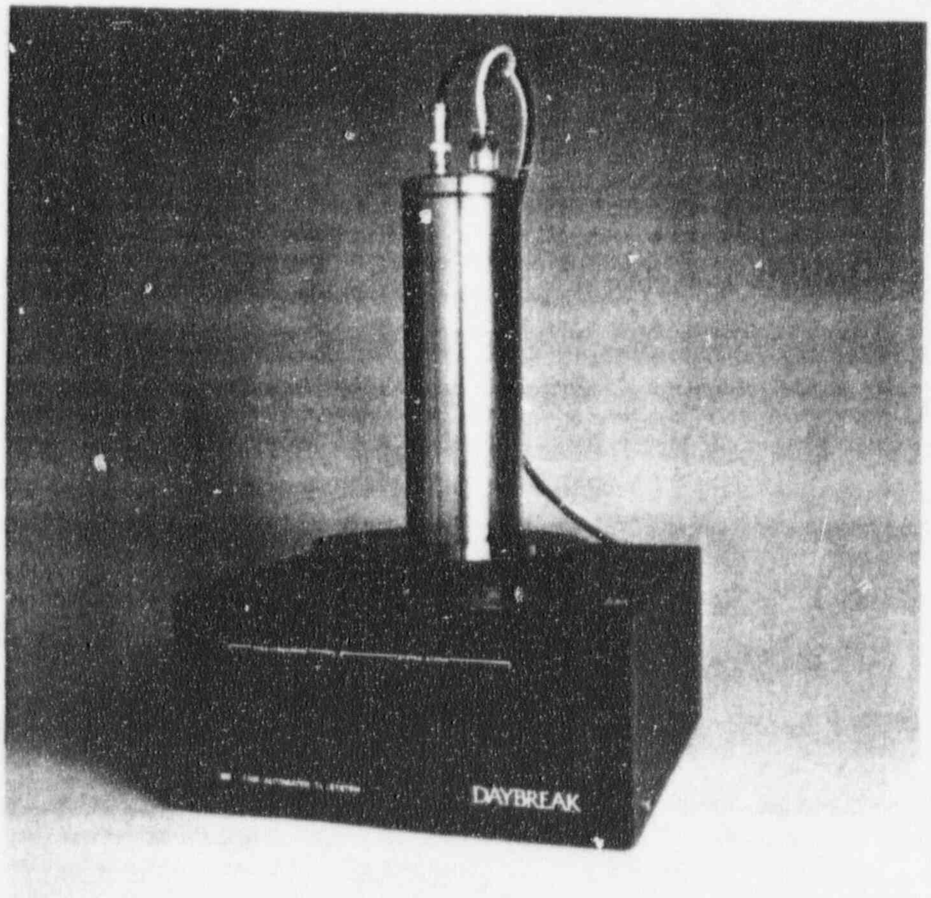
Partial customer list by country:

AUSTRALIA:	Commonwealth of Australia, Jabiru, NT
	University of Adelaide, Adelaide, NSW
	Australian National University, Canberra
AUSTRIA:	Hochschule fur Angewandte Kunst, Vienna
	International Atomic Energy Agency, Vienna
BULGARIA:	Bulgarian Academy of Sciences, Sofia
CANADA:	Simon Fraser University, Burnaby, BC
	University of British Columbia
	University of Quebec at Montreal
CHINA:	State Bureau of Seismology, Beijing
	Chinese Academy of Sciences, Xian
FED. REP. GERMANY:	Staatliche Museen, Berlin
	Kernforschungszentrum, Karlsruhe
	Ges. f. Strahlen-u. Umweltforschung, Munich
FRANCE:	Musée du Louvre, Paris
HUNGARY:	Hungarian Academy of Science, Budapest
INDIA:	Physical Research Laboratory, Ahmedabad
	Indian Institute of Technology, Kharagpur
ITALY:	Universita di Napoli, Naples
	Istituto di Cosmo-Geofisica, Torino
THE NETHERLANDS:	ECN, Petten
PANAMA:	University of Panama
UNITED KINGDOM:	Cambridge University
	Oxford University
	Paisley College of Technology
	University College of Wales
	University of London
	University of Edinburgh
	University of Aberdeen
USA:	City University of New York
	Harvard University
	Metropolitan Museum, New York
	Oklahoma State University
	University of Colorado
	University of Washington
	University of Miami
	University of Maryland
	University of Florida, Gainesville
	University of Pennsylvania
	University of Utah
	University of Arkansas
	Western Washington University
	Beta Analytic, Inc., Miami
	Founder's Society Institute of Arts, Detroit
	Los Angeles County Museum of Art
	State University of New York, Albany
	Western Maryland College
	U.S. Geological Survey. Denver
	Ohio State University

DAYBREAK

Systems for TL Research

Product Description
Model 1100 Automated TL System



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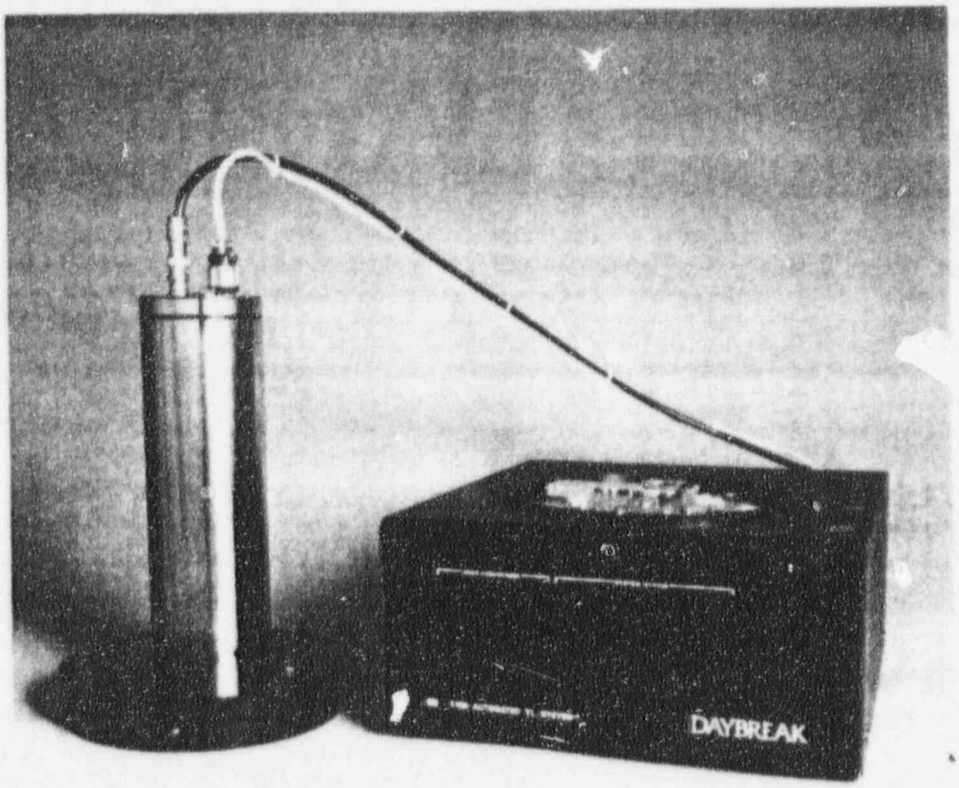
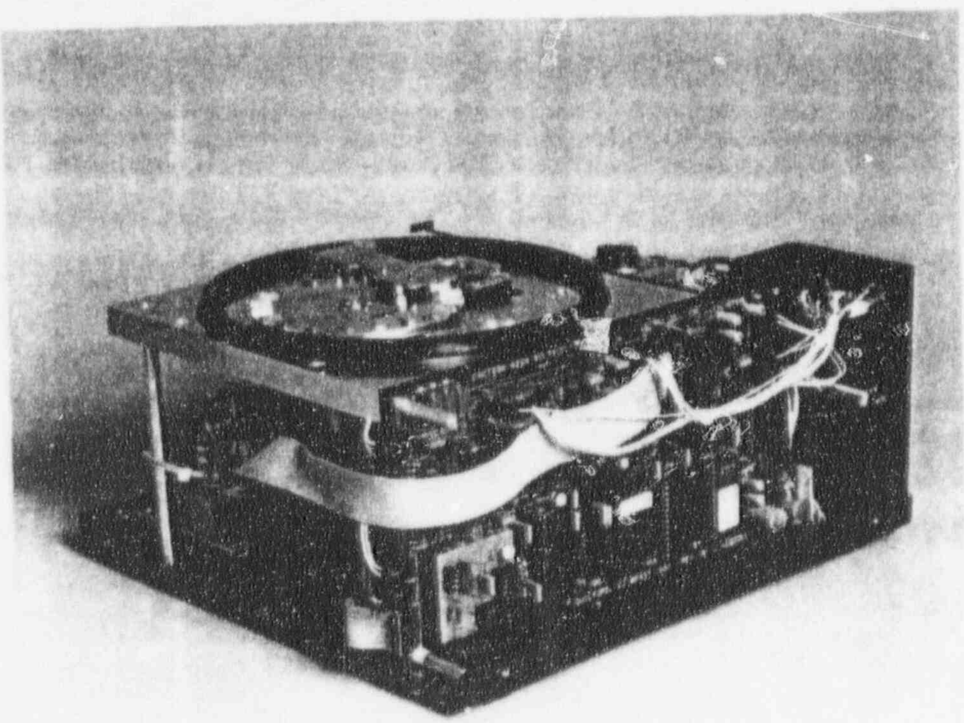

DAYBREAK



Product Description
Model 1100 Automated TL System

Features

- 20 sample automated glow oven
- on-board computer with 19K memory
- RS-232 serial interface to host computer
- software control of all operating parameters
- exceptionally flexible "soft machine"
- single photon counting with digital dead-time correction
- electronic PMT calibration with temperature compensated LED at photocathode
- all major analog signals digitized
- full size heating plate
- 1 to 25C/sec ramp rate with endpoints up to 700C
- thermocouple fault alarm
- hardware overtemperature interlock settable 400-700C
- hardware interlocks of HV and oven power
- cooling jet for fast cool down
- low volume glow oven for fast evacuation
- very compact, takes less than one square foot of bench space
- firmware definition of control function makes updates or re-configuration economical
- hardware expansion capabilities
- timer control and power for auxilliary irradiator

The Daybreak model 1100 combines the best features of the original Daybreak modular TL system with an automatic 20-sample glow oven and integrated supervisory microcomputer to produce a new generation of thermoluminescence equipment for the 1990's. Coupled with the Daybreak TLAPPLIC software, and our extensive line of alpha counters and automatic and manual sample irradiators, you have an integrated TL dating environment that will increase data production dramatically. It presents a combination of performance and price that cannot be beaten, and has enough flexibility and expandability to ensure that it never will. All of our instruments are designed with the end user's needs in mind, based on 16 years' experience in TL and more than 35 Daybreak systems installed throughout the world.

By designing the 1100 around an embedded microcomputer, we have accomplished a number of desirable objectives. These include simplicity of hardware, flexibility, autonomy from host computer, increased reliability, and perhaps most noticable, a great reduction in physical size. Analog circuitry is reduced to a minimum (just the heating plate temperature control loop, vacuum gauge amplifier, and deadtime detection), and all major analog signals are digitized so that the on-board computer can assume complete control. This reduction in circuit complexity, and the use of highly complex digital and data conversion building blocks, has the effect of increased reliability due to fewer packages and interconnections and decreased size while actually increasing functionality. Compact mechanical design, and the use of high frequency switching power supplies for system and heating plate power, together with the small size of the electronics (only one sixth the printed circuit board space for the equivalent function of the original modular TL system), has led to an extraordinarily compact system size: 10.5 inches wide, 11.7 inches deep, 5.6 inches high, plus 3 inch diameter by 9 inch high PMT housing. In doing this, we have paid considerable attention to modular construction techniques to ensure easy access for service and adjustment.

Since all control functions are implemented in firmware, with a rich set of control codes, a great degree of flexibility is possible and most future updating may be done with only a change of firmware or host computer software. There is also the potential for the 1100 to operate alone, as there is sufficient memory onboard to hold more than 20 glow curves, making networking a feasible goal with the present hardware.

Expansion has been allowed for as well, since we fully expect future research to engender need for even greater capabilities. Up to 8 additional input/output ports (up to 128 input and output lines) can be added within the system architecture,and there are 3 additional analog inputs available on the board.

Physical controls have been

replaced by a "soft front panel" on the host computer CRT monitor, using a function key pad (or optional "mouse") to control the 1100. This "front panel" display includes status information for thermocouple vacuum gauge, HV, rate, temperature, and temperature error, as well as "pushbuttons" and the "XY recorder". The 1100 continuously sends 21-byte packets of information to the host computer for continuously monitoring 1100 operation. (For reassurance, we also put a status display panel on the 1100.) With this arrangement, even dramatic changes in system configuration may be made economically.

The sample changing mechanism of the 1100 is simple and reliable. It uses a floating sweep arm to move samples on the turntable to and from a full-size heating plate. Both flat (0.010 inch thickness and above) and dished sample disks from 0.375 inch to 1.0 cm diameter are accommodated (other diameters by special order). Fine grain and inclusion samples may both be analysed due to the smooth motion afforded by precision DC micromotors and worm gear drive. Dynamic braking motor control ensures positional reproducibility. Single samples may also be measured. The small volume of the glow oven (6.0 " diameter by 0.4" deep) makes for fast evacuation. The glow oven is designed for use up to 700C for brief periods, and water cooling is built in. As in the modular system, low heating plate power reduces cooling requirements.

Since the computer industry has been moving quickly toward increased function, lower cost, and greater diversity, we have configured the 1100 with serial interface (RS-232 at 9600 baud) for easy communication with any computer. The parallel, bus- oriented approach to data transmission of our original modular system is certainly fast, but limits the user's choice of computer hardware. TLAPPLIC was originally developed on the Apple II, and we have now ported it to IBM-compatibles, taking advantage of their increased speed (with floating point co-processor), and larger memory and storage space, as well as higher resolution graphics. We chose the UCSD pascal system for development for its ability to handle very large programs (TLAPPLIC source code now exceeds 250 pages), and its portability, making transfer to other computers a relatively simple task.

The 1100 TL system is the flagship of Daybreak's new generation, carrying on our tradition of high quality and reliability, and elegance of design. We are introducing at the same time an economical single sample version, the model 1000, which differs only in having a 701 type of glow oven in place of the automated glow oven. The 1100 is aimed specifically at geological dating where automation is now a virtual necessity, and is intended for use with the 801 multiple sample irradiator. A future model will include a beta irradiator for pre-dose dating. We will continue to produce and support the modular system for those wanting a low-cost stand-alone TL system, and for those building their own systems, who wish to purchase the electronics.

We are quite excited about the 1100 and 1000, but to be honest, they are not revolutionary; they represent a distillation of the concepts pioneered by the Daybreak modular TL system and our experience gained from more than 35 Daybreak systems installed throughout the world. The capabilities built into these small packages are the result of recent advances in the semiconductor and computer industries, and are a logical extension of our original system. Back in 1980, we had complete computer control of the TL system, looking forward to automation. This degree of control, together with many of the features designed into the modular system from its beginnings in 1978, has lately been touted as something new and remarkable. We've had it for years without making much noise, and will continue quietly to add features and new instruments. One thing we promise not to change is our standard of quality, reliability, and customer service, and our one year warranty.

1100 Firmware Specification

Command set

The firmware architecture is that of a command-driven state machine incorporating a generalized ramp whose controller is another state machine. The actual ramping function is timer interrupt driven and subject to hardware and software interlocks for safety. Command codes from the host computer consist of an ASCII character (the set '@'..'_' including the upper case alphabetic characters, 32 altogether), and up to two integer parameters (ASCII decimal strings) as required by the control function, as shown in Table 1. There is sufficient space both in the command character set and the firmware PROM for significant expansion in the future.

The general form of a command is 'c xx yy ' where c is the control character, and xx and yy are ASCII positive decimal integer strings. <space> characters are used as delimiters, and the command string may end with any non-digit character.

Command name	Form	Parameters
Set data space	'D' xx	xx = 1-20 (C/point)
Set ramp rate	'R' xx	xx = 1-25 (C/sec)
Vacuum	'V' xx	xx = 0 (both off) 1 (bleed on, changes to main after partial evacuation) 2 (main on)
Purge	'P' xx	xx = 0 off 1 on
Cool	'C' xx	xx = 0 on 1 off
Ramp ('Go')	'G' xx	xx = 0 stop 1 start
Preheat ('Wash')	'W' xx yy	xx = 0-700 (temperature) yy = preheat time (seconds)
Stage	'S' xx yy	xx = 0-700 (temperature) yy = stage time (seconds)
Endpoint	'E' xx yy	xx = 0-700 (temperature) yy = hold time (seconds)
Cool-temp ('Low')	'L' xx	xx = temperature to start ramp for BG
Send ('Query')	'Q' xx	xx = 0 current status 1 send last curve
HV	'H' xx	xx = 0 high voltage off 1 high voltage on
Calibrate	'K' xx	xx = 0 calibrate off > 0 time on (seconds)
Irradiate	'I' xx	xx = time (seconds)
Advance	'A' xx	xx = sample number. Advances to xx and loads sample
Home ('Base')	'B'	goes to sample 0, no load
Jump	'J' xx	goes to sample xx, no load (for future automated irradiator)
Reset ('Zero')	'Z'	initialize controller
Setpoint ('at')	'@' xx	xx = 0-700 (setpoint temperature)
Oven	'O' xx	xx = 0 oven off 1 oven on

Table 1. 1100 command set

Additional commands for test, alignment, and data communications have been added.

Generalized ramp

The 1100 ramp consists of nine stages, most of which encompass the optional preheat, stage, and hold cycles.

0: idle (ramp off, ambient temperature)
1: ramp up to preheat temperature
2: hold for preheat time
3: cool down to cool temperature (with jet)
4: ramp from ambient to stage temperature
5: hold for stage time
6: resume ramp up to end point temperature
7: end point hold time
8: cool down to cool temperature (with jet)
0: resume idle

Only stages 6, 8, and 0 are required. If preheat or stage hold time is zero, the preheat or stage portions of the ramp cycle are bypassed. The ramp rate may be changed at any time during the ramp.

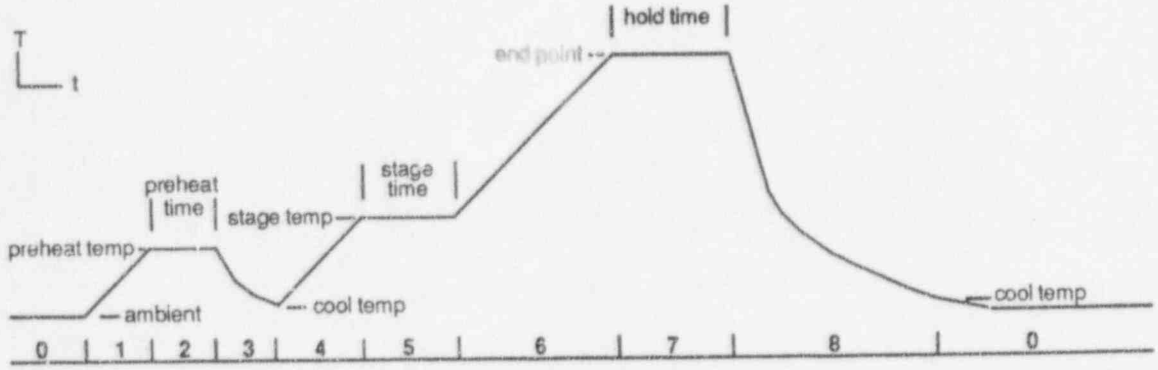
Serial output format

A 42 character string is sent to the host computer every second, or every data point, whichever comes sooner. The data is transmitted in hexadecimal ASCII format, where the characters '0'..'9', 'A'..'F' map onto decimal integers 0..15.

String character assignments

Chars 1-6 = photon count, most significant hex digit first
7-8 = data point number (corresponding temperature depends on data spacing)
9-10 = sample number (0..19)
11-12 = ramp segment or stage number (see above)
13-14 = error code (0 = OK)
15-30 = eight 8-bit ADC channels:
0 = Tmax
1 = T
2 = T error
3 = vacuum gauge
4 = vacuum gauge current
5 = ramp voltage
6 = livetime duty factor
7 = HV sense

31-38 = 32 status bits
39-42 = time since start of operation
<return> s



Generalized ramp

1100 Hardware Specification

Temperature control sub-system
Chromel-alumel thermocouple welded to heating plate
Ice point compensation
Low-drift TC amplifier
TC open alarm
Hardware overtemp detector and interlock settable 400-700C
Hardware and software interlock of heater power supply
Ramp rate software settable 1-25C/second
Endpoint software settable 0-700C (overridden by overtemp)
Arbitrary T(t) software controlled
Fast response switching power supply for heater
1.45 inch long by 1.00 inch wide (active area) heating plate, channeled for stiffness
Analog temperature, temperature error, ramp (for checking) digitized to 8 bits]

Photon counter sub-system
EMI 9635QA PMT
AMP/DISC: 4 nsec risetime, 6 nsec delay time discriminator with 20-1000mV threshold. ECL differential output capable of driving 50 ohm lines
Negative high voltage (600-1600V), software enabled with hardware interlock
24-bit photon counter
Analog dead-time detector, software compensation
Temperature compensated LED photon calibration with fiber optic light guide to photocathode, software controlled
Easily changed optical filter pack, 2.00 inch diameter. Standard pack supplied is Corning 7-59 + Schott BG-39
Digitized HV and dead-time compensation

Glow oven
20-sample changer with 7-second cycle time
Sample form: disks flat or dished 0.010-0.060 inch thickness, 0.375-0.400 inch diameter (other sizes by special order)
Software control of atmosphere control solenoid valves
Two-stage vacuum control (bleed and main)
Heating plate cooling jet
Needle valves for control of purge and cooling jet
Thermocouple vacuum gauge with low-drift, low offset amplifier, digitized output
Low volume for fast evacuation
Expansion relief for heating plate to prevent flexure at high temperature
Water cooling
Purge, cooling, water intake fittings 0.25 inch Swagelock
Vacuum outlet 0.85 inch tube stub for 3/4 inch ID rubber vacuum hose

Microcontroller
2 Mhz 65F12 running FORTH kernal
8 kbytes RAM, 11 kbytes firmware in PROM
Very fast, compact control code
RS-232 serial interface at 9600 baud
Expandable by 8 additional I/O ports, 3 analog inputs
Status panel to show state of valves, sample change, HV, calibration, overtemp/TC fault, and power

Rear panel
HV: SHV connector
AMP/DISC/CAL: 7-pin Amphenol 126-series female connector

Serial port: standard DB-25 female connector

Irradiator: 9-pin Amphenol 126-series female connector

Reset switch

Power input: IEC standard cord set, 115/230 VAC selection, ON/OFF switch, fuse

General

Size: 10.5 inch wide, 11.7 inch deep, 14.6 inch high overall

Weight: 17.7 lb. (7.9 kg)

Power: 115/230 VAC 50-60 Hz, 250 VA

Auxiliary irradiator control: 24V at 400 mA power available, timer output and two sensor inputs

Designed to meet UL, CSA, VDE requirements

Standard host computer configuration

See price list for current hardware configuration. Daybreak is presently using the Dell 210 12MHz AT-compatible as its basic platform for TLAPPLIC.

CURRENT computer PLATFORM IS DELL 316SX 1 Mb RAM, 40Mb HHD, 1 5¼" FDD, Super VGA color monitor, Epson-compatible printer

MS-DOS operating system

UCSD p-System (complete Pascal development systemfrom Pecan Software Systems, including advanced word processor and print formatter, print spooler, RAM disk support, MS-DOS compatibility)

Daybreak TLAPPLIC software license (for single TL system. Additional systems in department licensed at small additional cost.) Two years' free software updates. The software is configured as a group of utilities in the system library, with source code for the major computational portions provided, as it is intended that users who need special procedures and modifications shouldhave the tools necessary to write customized applications code quickly and easily. A complete description of all utilities and pre-declared data structures is contained in the manual, and parts of the growth curve analysis are commented line-by-line as an aid to programmers. The program structure for non-linear fits is in place and a general user-specified functional fit is the next enhancement scheduled.

Additional standard equipment

75 l/min two-stage vacuum pump (0.1 uHg ultimate vacuum), Precision D-75 (69076 for 120VAC/60Hz, 69088 for 230VAC/50Hz

200 sample disks

NOTE: This computer configuration available for U.S. only. Overseas purchasers may buy computer hardware to the specifications above locally, or purchase equivalent IBM or NEC computers from us (prices will vary) in accordance with availability of local service and preference.

TL Applications Software

TLAPPLIC FEATURES

- Complete turn-key computer system for archaeological and geological dating
- Mouse-driven (or single keystroke) hierarchical organization provides flexible, 'user-friendly' operating environment
- Complete UCSD p-system running in 640K memory
- Segmented (memory overlay) architecture for maximum efficiency of memory use
- All software on line all the time, no reloading of data or program to redo an operation
- Open-ended to support new analysis techniques as they arise
- Software organized as set of fully-documented library units with full complement of utilities for ease of customization
- Example source code for user-written programs provided plus computational portions of application software
- Handles up to 80 glow curves in one file
- Many modes of numerical filtering, temperature shifting, and normalization included
- Hard copy graphics output on printer (720 x 348)
- Plateau and fade tests allow averaging of multiple curves and computation and display of errors
- Flexible growth curve analysis for conventional equivalent dose and intercept computation and the currently most useful optical bleach techniques of sediment dating with error analysis
- Complete age computation with rigorous error analysis
- System configuration file holds system and source parameters to minimize set-up time
- Free update service for two years

Flexible batch program generation and editing
Data and status presented graphically in real time

The Daybreak TLAPPLIC software package integrates with the Daybreak1100 automated TL system to record glowcurves on hard or floppy disk media, to reduce these to equivalent dose, intercept, and alpha efficiency measurements, and finally to TL dates with full error analysis. Raw or background-subtracted data as well as graphs of computational results may be plotted either on the system XY recorder or printer. All TL applications software is in the form of fully-documented system library units for the use of those users who need to write special code for their particular applications. The current software version is implemented on an enhanced version of the UCSD p-system.

SOFTWARE DESCRIPTION

The applications software has been written in UCSD Pascal, a fast, block structured compiled language which has become the standard for serious programming of small computers. FORTRAN is available as an option, and Pascal and FORTRAN code may be mixed in this implementation.

The Daybreak TLAPPLIC software package integrates a number of highly interactive procedures for data taking, for dose and date computations, and being organized as system library units with only a short skeleton calling program, makes writing of user special code extremely convenient. The package is written to be immediately usable by someone with experience with TL but no special knowledge or experience with computers. The software is menu-driven and extensive prompts make it almost self explanatory.

The major program TLAPPLIC, takes glowcurve data and records it on disk, afterwards processing it to obtain plateau information, growth curves, equivalent dose, and alpha efficiency, while providing hard copy plots as desired. Data is taken at 5C intervals, in the form of 100-point arrays (0-500C), or for those with high temperature ovens, 140 point arrays (0-700C). A second program, TLDATE, computes the TL age and errors according to Aitken (ARCHAEOMETRY 18(2), 233 (1976); with all corrections to date (Aitken, private communication).

TLAPPLIC has two major functions. The first is data taking. Very little beyond the usual setup time for a glowcurve is required to enter runtime information. Data for sample ID, irradiation source information and general running parameters are entered menu-fashion, mostly with single keystrokes, on opening a new data file (and many of these are on the system configuration file, updated only as required). As a new file is opened, there is a check made to make certain that sufficient space exists on the disk. For each glowcurve, a run type (N, N+Beta, etc.), irradiation time and optical bleach parameters if applicable, and optional remark are entered before starting the ramp. A useful optional feature is automatic entry of the background glowcurve without operator intervention. After each glowcurve is recorded, it may be rescaled and plotted on the printer. Finally, on closing the file, disk space for the background subtracted data generated later, and used for subsequent computation, is reserved.

For the 1100 automated system, the run type information for all the samples is entered interactively as a batch file, and the host computer will then oversee operation of the TL reader and issue commands unattended. At all times a virtual front panel with mouse or keystroke control of all functions and data display (graphical if in data-taking mode) by hitting the right hand mouse button. This is available no matter what part of the program you happen to be executing, and you will resume at that point when finished with the front panel.

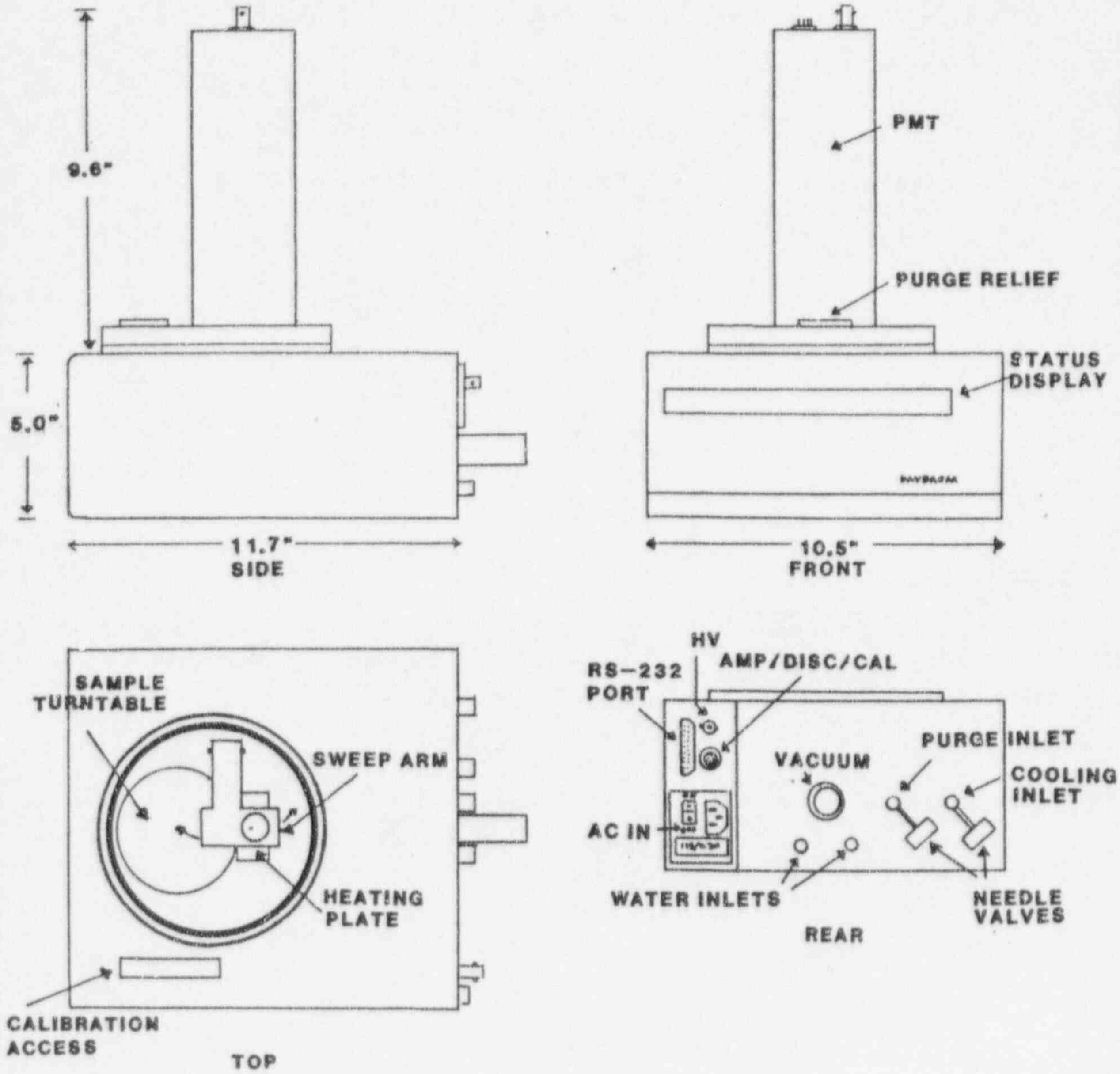
The second, and much more complex, function of TLAPPLIC is data reduction. Up to 80 glowcurves (of which one at least must be a background curve) are supported. After specifying an input file, it is read in and a directory of curves within the file is generated and printed, and may be displayed at several points in the program for reference. In most cases, this is displayed on the right half of the screen, while the current calculation input/output is shown on the left. The operator may then look over the raw data, numerically filter, shift, and plot as desired. Background subtraction is then performed, with filtering and with manual or automatic correction for any temperature shifts that can occur at high ramp rates due to variable thermal contact of the sample with the heating plate. Because of this possibility, it is recommended that a background glowcurve be recorded with each TL curve; the automatic background recording, together with the fast cooling Daybreak glow oven facilitate this. The subtracted glowcurves are then written into their own disk file for further reduction, and may be weight normalized, inspected, and plotted. Further shifting, by lining up curves against one chosen as a 'master', may be done semi-automatically and interactively. The plateau and integration procedures operate on this data. The plateau is computed in the usual fashion with up to five each of N and N+dose curves averaged together and displayed and plotted with error bars. Similarly, a fade test can be made. Finally, the growth curve analysis with linear (or future user-specified non-linear) fit is made to obtain equivalent dose and alpha efficiency. Here, a menu of the various techniques implemented (standard TL plus the three presently used sediment techniques -- R-Beta (or gamma), regeneration, and total bleach (N + dose- bleached N) is displayed. After a choice is made, and further choices as to optical bleach parameters if applicable, the categories of growth curves required are set up and then computed interactively to discard bad data, or automatically over a temperature range. During the interactive process, it is possible to back up and redo portions of the calculation, delete or replace points, and plot at will. The end results, equivalent dose, intercept, and alpha efficiency, are plotted against temperature.

A great advantage of the open-ended approach embodied in the Daybreak software is the ease with which new computations can be accommodated. For the active research scientist, a 'canned' program is never enough and certainly we cannot anticipate everyone's special needs, although we have made a great effort to do so. For this reason, we have made it very convenient to add functions or computations by configuring the software as a set of fully-documented library units with a wide range of utilities for file and screen management, graphics, and interface control. Thus, the user has but to embed his own special code using the utilities and predefined data structures in the library in one of the skeleton calling programs provided. The growth curve procedure is provided with general purpose and flexible sort and fit routines and a model given for adaptation. Up to about 40 user procedure segments can be accommodated.

The final result, TL age, is then computed. TLDATE follows the method of Aitken very closely, and the program text file is included for alteration as required by the user's specific needs. All data, partial doserates, and very detailed error analysis are printed in concise and readable form.

The time required by an experienced operator to go through the data reduction of a routine 50 curve traditional TL file is under 15 minutes, plus plotting time, and an age computation using TLDATE should be less than five minutes' work. For sediment dating, time is difficult to judge, as there are so many options, but the hierarchical structure, with the ability to retrace one's steps at will, makes for efficient and convenient operation.

Except for TLDATE and example user programs, software is provided in binary form only under the terms of the licensing agreement (copy available on request). Special programming and customer assistance are available, and updates are provided free of charge (beyond air express shipping cost) for two years after installation.



DAYBREAK MODEL 1100

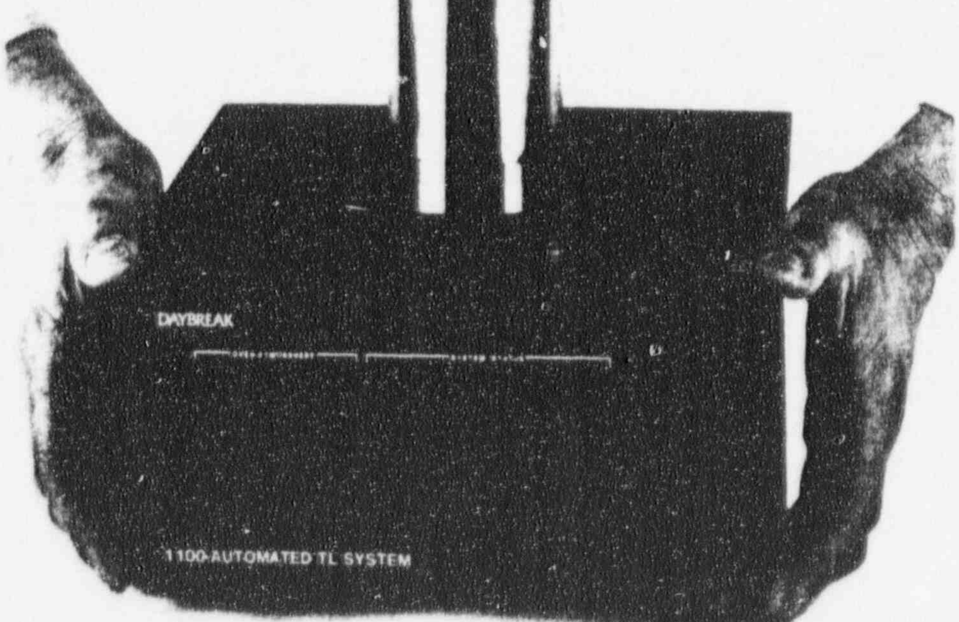
SMALL WONDERS.

Daybreak's new integrated TL systems, automated and otherwise

We are introducing two major additions to our extensive line of TL measurement instruments, the *1100 Automated TL System* with 20 sample glow oven (and full sized heating plate) and the *1000 Single Sample System.* They each take up less than one square foot of bench space, a feat of packaging made possible by integrating all the electronics around a powerful microcontroller on a single small board. Both are "soft machines" completely characterized by firmware for easy updates, and communicate via a fast serial channel with the host computer, an IBM PCXT or compatible with 30Mb hard disk running Daybreak's versatile TLAPPLIC software. System control is by a mouse or function keypad on a "virtual front panel" displayed on the computer monitor. We can't begin to tell you about the features of these systems in an ad. Write or phone us for a brochure.

P.S. The other good news is that they also cost less, function for function, than our original modular system.

Daybreak Nuclear and Medical Systems, Inc.
50 Denison Drive
Guilford, CT 06437 USA
(203) 453-3299



DAYBREAK

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