RADIOACTIVITY ON UNOLS VESSELS

Position Paper on Radioisotope Use on UNOLS Vessels

Introduction

Radioisotopes have become an essential tool in the investigations of many ocean processes. Studies of both natural and fallout radioactivity have revealed, and will continue to reveal, details of ocean circulation, biological and chemical interactions within the ocean and fluxes of materials through the ocean. At the same time, the use of artificial radioactivity as a tracer of biological and chemical processes has become an almost indispensible technique. A conflict arises, particularly with carbon-14 and tritium, between artificial tracer studies which require relatively large amounts of radioactive chemicals to be present on a vessel, and ocean studies in which exceedingly low levels of activity are to be determined on samples of sea water or sediments. Careless use or disposal of the tracer chemicals could cause severe contamination problems for the ultra low level measurements.

Most tracer studies utilizing carbon-14 or tritium require amounts of radioactivity that are from 10^7 to 10^{11} greater than the precision currently required of low level measurements.

UNOLS and the Advisory Council have been asked to consider this problem and attempt to formulate a solution. At the present time several solutions have been proposed that include one or more of the following:

1. Maintain one or two vessels within the academic fleet that have an absolute ban on the use of artificial radioactivity on or from the vessel(s). According to some testimony this (these) vessels need to be large in order to accomodate the multi-institutional programs that are likely to be one of the principal vehicles for the determination of low level radioactivity in ocean samples. The R/V's MELVILLE and/or KNORR have been suggested as the "isotope free" vessels.

2. Establish, with or without 1. above, a national policy for the use of artificial radioactivity on UNOLS vessels. Such a policy would contain limits on the levels of activity, stringent regulations on isotope handling and experimental procedures and on the reporting of isotope use on vessels. The policy may be set by a national body such as UNOLS and the use of radioactivity on all (or a selected subset) of UNOLS vessels be authorized by a national review committee consisting of individuals from the chemical and biological communities who are well versed in isotope procedures.

3. Establish, with or without 1. and 2. above, designated areas on vessels (either fixed or portable laboratories) and restrict isotope usage to these areas.

Considerations

In its considerations of this problem and the proposed solutions, the Advisory Council has noted the following:

a. Radioisotopes that have been used or are likely to be used on UNOLS vessels include (half life):
H-3 (12.26y), Be-7 (53.6d), C-14 (5770y), Na-22 (2.58y), P-32 (14.3d), S-35 (86.7d), Mn-54 (291d), Co-57 (270d), Co-58 (71d), Co-60 (5.27y), Fe-59 (45d), Zn-65 (245d), Sn-85 (64d), Sn-113 (118d), Ba-133 (7.5y), Cs-134 (2.19y), Mg-203 (47d), Po-208 (2.9y), Pb-210 (22y), Ra-226 (1622y), Pa-233 (27.4d), Th-228 (1.91y), Th-229 (7340y), Th-234 (24.1d), U-232 (73.6y), U-236 ($2.4\ 10^{7}$y).

Those isotopes with short half lives represent the minimum problem for cross contamination. However, spills of isotopes with half lives of 5 years or greater, if not adequately cleaned up, could be a problem for the useful working life of a vessel.

b. The activity levels used vary from a few micro-curies to several tens of milli-curies depending upon the experiment. At the present time those isotopes that are used at activity levels exceeding 1 milli-curie are principally H-3, C-14, P-32, and S-35.

c. The chemical forms utilized for various experimental procedures may vary greatly even for a single isotope. The behavior of an isotope after it is spilled or released will depend to a great extent on its chemical form and reactivity.

d. Radioisotopes are only a subset of the total chemicals that are, or have been, carried aboard and used on vessels. Stable isotopes such as C-13, N-15 and O-18 are occasionally used as tracers. Stable trace element and trace organic studies have faced and have now largely overcome very severe contamination problems from the structure of the vessels.

e. At this time, there is no evidence that documents that any UNOLS vessel is contaminated with radioactivity beyond the level to be expected from normal use (i.e., with no deliberate introduction of artificial radioactivity). However, with the exception of recent extensive swab testing of the R/V's KNORR and MELVILLE, there is no evidence that they are clean.

f. At the present time G. Ostlund has conducted the swab tests on the KNORR and MELVILLE and there is a proposal that he carry this testing over to other UNOLS vessels.

g. Both artificial tracer studies and low level activity studies will continue to be important and necessary components of our science for the forseeable future.

h. UNOLS vessels are operated by individual institutions in order to provide facilities for the progress of all disciplines involved in ocean studies. It is neither possible nor profitable for institutions, either collectively or individually, to advocate the merits of one discipline relative to another, and the establishment of policies that may be detrimental in the long term to any discipline must be avoided. However, short term restrictions on certain experiments on a subset of vessels may be advisable.

i. No scientist should have to work on vessels that are contaminated with radioactive tracers due to careless procedures. This statement also applies to any other chemical that is carried aboard a vessel. Good handling procedures can minimize the risk of accidental chemical spillage and the attendant hazard to the programs or health of others.

j. All institutions currently have some regulation on the use of radioisotopes. These regulations relate principally to the health hazards and are determined largely by state and federal regulations governing the acquisition, transport, handling and disposal of radioactivity. It must be recognized that amounts of radioactivity which may be trivial from a health viewpoint may be a serious problem for a low level measurement program.

k. Unreported chemical spills that have been followed by no or inadequate clean-up procedures are a significantly greater source of concern than are well-documented accidents.

l. An ad-hoc group meeting at Scripps Institution of Oceanography has produced a draft report (attached) containing five major guidelines and recommendations under the headings:

1. Development of an isotope survey and monitoring program (for C-14 and H-3).
2. Regulation of radioisotope tracers on UNOLS vessels.
3. The need for improved sampling and extraction procedures for low level measurements.
4. SIO ahd WHOI are strongly urged to continue to seek alternate vessels for high level radioactivity experiments.
5. Establish an executive group of UNOLS to schedule "isotope restricted vessels".

m. Responses to this draft document from E. Swift, H. Livingston, P. Brewer, R. Eppley, J. Marra and L. Small, and further comments from P. Santchi and G. Shor.

RADIOACTIVITY ON UNOLS VESSELS

**** RECOMMENDATIONS *****

On the basis of the above and other considerations the UNOLS Advisory Council has the following recommendations.

****

AN ABSOLUTE BAN ON THE USE OF RADIOISOTOPES ON ANY VESSEL IN THE UNOLS FLEET SHOULD NOT BE INSTITUTED OR UPHELD.

****

RADIOISOTOPE USE ON ALL VESSELS SHOULD BE MONITORED BY THE OPERATING INSTITUTION WHICH SHOULD KEEP CAREFUL RECORDS OF THE USE AND DOCUMENTATION OF ACCIDENTAL SPILLS.

****

THE AUTHORITY TO USE RADIOISOTOPES ABOARD A UNOLS VESSEL MUST REST WITH THE OPERATING INSTITUTION WHICH IS ULTIMATELY RESPONSIBLE FOR THE SAFETY AND OPERATING CONDITION OF ITS VESSEL (s).

****

AS PART OF ITS NORMAL OPERATING PROCEDURES AN INSTITUTION SHOULD INSIST ON PRIOR NOTIFICATION OF THE USE OF RADIOISOTOPES AND SHOULD ESTABLISH EXPERT REVIEW OF PROPOSED RADIOISOTOPE EXPERIMENTS BEFORE AUTHORIZING THEIR USE.

****

THE CURRENT TESTING PROGRAM OF G. OSTLUND SHOULD BE EXTENDED TO ALL LARGE AND INTERMEDIATE SIZE VESSELS.

****

THE DEVELOPMENT OF CONTAMINATIONPROOF, LARGE VOLUME SAMPLING AND EXTRACTION PROCEDURES FOR LOW LEVEL RADIOISOTOPES IS OF PRIME IMPORTANCE. COMPETENT SCIENTISTS ARE URGED TO SUBMIT PROPOSALS AND FUNDING AGENCIES ARE URGED TO RESPOND TO PROPOSALS FOR SUCH DEVELOPMENT.

****

SIO AND WHOI AS OPERATORS OF THE R/V'S MELVILLE AND KNORR AND AS OPERATORS OF MULTI-VESSEL FLEETS ARE URGED, AS FAR AS IS CONSISTENT WITH THE DEVELOPMENT OF ALL DISCIPLINES AND UNTIL THE STATUS OF OTHER UNOLS VESSELS IS CLARIFIED, TO ATTEMPT TO SCHEDULE RADIOISOTOPE USE ON OTHER VESSELS. IN CASES WHERE LOGISTICS, SCIENTIFIC PROGRAM CONSTRAINTS OR OTHER FACTORS DICTATE THE USE OF THESE VESSELS THE EXISTING ISOTOPE REVIEW COMMITTEES SHOULD THOROUGHLY EVALUATE THE PROPOSED EXPERIMENT TO ESTABLISH REASONABLE SAFEGUARDS AGAINST ACCIDENTAL SPILLAGE AND TO RECOMMEND FOR OR AGAINST THE ACCEPTANCE OF THE ISOTOPE PROGRAM.

In making these recommendations the UNOLS Advisory Council accepts the importance of the current and future programs that involve both low level radioactivity studies and higher level tracer studies. The proposed "ideal solution" of isotope-free vessel(s) has many difficulties associated with its implementation, including:

a. The policing of an absolute ban on radioisotope use would be almost impossible, particularly on extended cruises, or it would be very costly to maintain.

b. An absolute ban without policing would encourage unauthorized use and increase the likelihood of unreported spills.

c. The large vessels that have been proposed as the isotope--free vessels are among the few available that can conduct work in distant locations and in high latitudes, etc. The permanent removal of these vessels from those available for artificial tracer studies would create a severe handicap for future studies in these locations.

d. Conversely, in view of the importance of current and future studies of low level radioisotope distributions, a solution that restricts these programs to one or two vessels seems highly undesirable. There will certainly be a need, over the next several years, to obtain samples in all ocean locations and the ability to sample from any vessel would greatly increase scientific progress in this field.

The suggestion that there be established standards to regulate the activity levels allowed on UNOLS vessels is also difficult to implement in the abstract. UNOLS may convene a committee, or workshop, to set such standards but they could only refer to standard conditions, experiments and ships. Unfortunately, in this case, such standards do not exist nor is the position that they should exist easily defended in the face of changing scientific needs. It is only when an experiment is precisely defined that it is possible to make judgements on the hazards entailed in that experiment. The same activity levels of a given isotope may pose quite different hazards depending upon the chemical form, on the location of the spill, on the experimental apparatus, on the skill and knowledge of the investigator, to mention only a few of the variables involved. Despite these comments it is nevertheless true that artificial radioactivity at some high level may be a serious problem for low level measurements. This situation needs to be recognized by all vessel operators who must also recognize their obligation to provide facilities suitable for the advancement of all of the disciplines involved in ocean science. Each operating institution should require prior notification of any proposed isotope use aboard its vessel(s). This notification should include sufficient detail concerning the experiment so that potential hazards may be assessed by a group of individuals

knowledgeable and experienced with radioisotope procedures. The set of regulations proposed by the ad-hoc group at SIO (item 2 of the draft manuscript) provides guidance for good isotope handling procedures, but it should be emphasized that several entirely safe and important experiments may not require adherence to all of the proposed regulations. It is also quite conceivable that some experiments involving very high levels of radioactivity may require much more stringent precautions. These judgements can be made only by those with knowledge of the particular experiment. For these reasons the Advisory Council recommends that an attempt to formulate rigid standards of compliance for experiments involving artificial radioactivity at sea is likely to be an unproductive exercise which, if implemented, may be an impediment to scientific progress. However, all operating institutions are strongly urged to establish review procedures for the use of radioisotopes on their vessels and to maintain records of isotope use, accidental spills and disposal. The review process should be conducted by a group of individuals experienced and competent in isotope handling procedures and should consider at least:

a. The isotope(s) to be used, their half-lives and chemical forms during the proposed experiments

b. The total activity taken aboard a vessel should not greatly exceed that required for the successful performance of the experiment(s)

c. The location(s), on the ship, of the proposed experiment(s) and the adequacy of precautions against accidental spillage

d. The need for isolation, (vans etc.) of one or more stages in the experiment(s)

e. Proposed clean up procedures in the event of accidental spills

f. Proposed disposal procedures

g. The experience of the investigator(s) relative to the hazard posed by the experiment(s)

In view of the importance of low level measurements of C-14 and H-3, the current testing program conducted by G. Ostlund should be extended to all of the intermediate and large size vessels in the UNOLS fleet. The ability to conduct isotope sampling on a wide range of UNOLS vessels will be an important asset to future programs. In this regard, it is no less important that methods of sampling and extraction of low level radioiostopes be improved so that uncontaminated samples may be obtained even though some elevated activity levels may exist on the sampling platform. The success of many recent endeavors in the measurement of stable trace elements and trace organics in

the presence of high ambient levels aboard research vessels is testimony to the technical feasibility of such improvements. Competent scientists are urged to submit proposals for the development of these improvements and funding agencies are urged to respond.

Recently the R/V's MELVILLE and KNORR have been subject to extensive swab testing by G. Ostlund. The testing of the KNORR took place both before and after a cruise in which milli-curie levels of C-14 and H-3 were employed in productivity studies and the MELVILLE tests followed the use of similar levels of C-14. At this time the results from the MELVILLE tests are not completed but preliminary counting suggests little activity above the normal background expected from unavoidable sources. The tests of the R/V KNORR, which has experienced several well documented uses of radioisotopes with no reports of spills, reveal similar results with the exception of somewhat elevated radioactivity levels in the principal passageway area of the main laboratory. These levels may be caused by unreported spills but may be due just as easily to the breakage of a fluorescent watch. At the current levels there is little hazard to low level sampling provided samples are not unduly exposed to the atmosphere in the area of the elevated levels (G. Ostlund, personal communication). Until further testing is done, it is clear that both the MELVILLE and the KNORR are the vessels of choice for low level C-14 and H-3 measurements. Given the current uncertainties of the status of other vessels, SIO and WHOI as operators of these vessels are urged to attempt to schedule the use of H-3 and C-14 tracers on other vessels.This does not imply that an absolute ban on the use of these isotopes be instituted for either vessel, but rather where technically and logistically feasible that isotope use be scheduled on other vessels. In the event that logistical, scientific program constraints or other factors dictate the use of the MELVILLE or KNORR, the proposed programs should be subjected to a thorough review to establish reasonable safeguards against accidental spillage and to recommend for or against the acceptance of the isotope tracer program. The staff of each of these institutions has many knowledgeable and experienced scientists who can provide mature and responsible opinions. We would emphasize that the principal difficulties in the incompatibility of high level tracer studies and low level measurements lie in the experiment and the investigator, and not in the discipline or the isotope. The judgements concerning the values or hazards of any given experiment can be made only by those who have full knowledge of the experiment and certainly not by any national committee working with abstract issues.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D C 20550

MAR 24 1981

TO: Distribution

FROM: Neil Andersen

SUBJECT: Report of the meeting 13 Feb. 81 at SIO regarding clean ship operations and resulting recommendations.

As we are all aware, the unrestricted and undocumented use of isotopic tracers in concentrations above their natural levels on board research vessels is not acceptable. Operations regarding the use of such substances and the sample collection and analysis of the same isotopes at ambient levels must be kept mutually exclusive. In large measure this has been accomplished by the various institutions operating the research vessels involved in a wide variety of oceanographic research programs. However, there have been instances where the systems being employed for this purpose appear to have broken down, resulting in questions being raised concerning the cleanliness of vessels, particularly with regard to C^{14} and tritium. This of course is an extremely important problem to be dealt with due to the importance of present investigations concerning the CO_2 cycle, as well as other studies employing natural levels of certain isotopes for elucidating oceanographic processes (e.g.TTO). As a result, an ad hoc meeting was convened at the Scripps Institution of Oceanography on 13 February 1981 to discuss the over-all problems relating to "clean-ship" operations and to attempt to develop procedures whereby clean open ocean platforms can be assured for those programs requiring such facilities.

The following individuals attended all or some portion of the two sessions:

Neil Andersen, NSF	Joseph Reid, SIO
Farooq Azam, SIO	Roger Revelle, SIO
Robert Dinsmore, WHOI	George Shor, SIO
Ellen Druffel, SIO	Kenneth Smith, SIO
Keith Kaulum, ONR	Derek Spencer, WHOI
Charles Keeling, SIO	Robert Stevenson, ONRWEST
Timothy Linick, SIO	Ray Weiss, SIO
Göte Östlund, MIAMI	Peter Williams, SIO

It was pointed out that quantities of C^{14} and tritium typically used on board research vessels for such measurements as biological productivity exceeded the measurement sensitivity and resolution applied to natural levels of these isotopes by 10^{11}. As a result, there is extreme high risk of invalidating all studies employing measurements of natural levels of C^{14} and tritium, if artificial levels are not prudently handled, documented and restricted/controlled on mutually employed research

b. G. Östlund will submit a proposal for continued surveys of large and intermediate vessels in the UNOLS fleet, with the program to begin in the fall of 1981. The program will establish, for the first time, information on the relative levels of C^{14} and H^3 background activity on the vessels which, in the absence of severe contamination, could be platforms for future low level tracer studies.

(2) Regulation of Radioisotope Tracers on UNOLS Vessels.

No scientist should have to work on vessels that are contaminated with radioactive tracers due to careless procedures. Good handling procedures can minimize the risk of accidental radioisotope spillage.

A suggested set of regulations for users of radioisotopes and for ship operators include the following:

a. Transport of radioisotopes from one area to another on a vessel must be accomplished in non-breakable, leak tight containers.

b. All procedures where open transfers of radioisotopes take place must be conducted in vans suitably designed and constructed for the handling of radioactive material, or other contained areas.

c. All radioisotope operations, in vans or on deck, must be conducted over adsorbent paper, or equivalent, so that accidental spillage may be confined.

d. Scientists conducting operations within a radioisotope van must wear lab coats and plastic slippers or stockings, which must be removed before exiting the van.

e. Users of radioisotopes must submit to the ship operators detailed plans of the scheduled experiments. These plans must include information on the chemical form of the radioactivity during all stages of the experiment, total activity levels proposed, and regular schedules of van cleaning should be established.

f. All accidental spillage must be reported to the ship operator, at the earliest possible time, along with details of procedures used to clean up the spill.