



# Californium-252 Newsletter

*"To promote the exchange of information among <sup>252</sup>Cf users"*

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## Upcoming <sup>252</sup>Cf Technical Sessions

Two technical sessions on Medical and Industrial Applications of <sup>252</sup>Cf will be held on November 15 in Washington, D.C., as part of the International Meeting of the American Nuclear Society/European Nuclear Society (November 12-16, 2000). Information on the meeting may be found at <http://www.ans.org/meetings/winter/>. The <sup>252</sup>Cf sessions are listed on pp. 24 and 26 of the Preliminary Program, as follows.

### Session I (8:30 a.m.)

- J. C. Arbo and R. N. Pierson, Jr., "In Vivo Neutron Activation Measurement of Nitrogen and Carbon"  
J. Fontanesi, "Californium-252 in the Treatment of Soft Tissue Sarcomas"  
R. C. Martin, "Early Development of <sup>252</sup>Cf Neutron Brachytherapy"  
C. White et al., "Beam-Port Design of a Radiobiological Dosimetry Experiment for <sup>10</sup>B-Enhanced <sup>252</sup>Cf Brachytherapy"  
S. X. Zeng and J. H. Gu, "Californium-252 Neutron Therapy in China"  
A. Mahajan et al., "A Phase I/II Protocol Using <sup>252</sup>Cf for the Treatment of Cervical Carcinoma"  
M. J. Rivard and A. Mahajan, "Plaque Therapy and Scatter Dose Using <sup>252</sup>Cf Sources"

### Session II (1:00 p.m.)

- M. J. Rivard et al., "Investigation of a Diamond Detector for Mixed-Field Dosimetry of <sup>252</sup>Cf"  
K. Waggoner and L. F. Miller, "Neutron Shielding Effectiveness of Goethite Concrete"  
H. H. Saleh and R. A. Livingston, "Figure of Merit for Chlorine Measurement in Reinforced Concrete Using <sup>252</sup>Cf-Based Nondestructive Testing Method"  
J. V. Pace III, "The Search for Permanent Shielding Materials for Use in the New DOE Type-B <sup>252</sup>Cf Shipping Cask"

- E. M. A. Hussein and E. J. Waller, "Direct Use of <sup>252</sup>Cf for Land-Mine Detection"  
I. Ahmad, "Nuclear Structure Studies from Prompt-Gamma-Ray Spectroscopy of Fission Fragments"  
P. C. Womble et al., "Elemental Characterization Using Pulsed Fast/Thermal Neutron Analysis"  
E. Johnson, L. Robinson, and L. Zhao, "Design and Applications of a <sup>252</sup>Cf Cold Neutron Source"  
H. R. Vega-Carrillo and A. M. Becerra-Ferreiro, "Study of Two Isotopic Neutron Sources"

## Heavy Element Community Contractors' Meeting at Argonne

This workshop will provide an opportunity for the exchange of research results and perspectives among scientists in the Heavy Element Chemistry Program, as well as a forum for discussions of future challenges and opportunities involving heavy element research. The workshop will be held at the Advanced Photon Source office building at Argonne National Laboratory on Nov. 20-21, 2000. Any non-U.S. citizens interested in attending must make inquiries ASAP. Questions should be addressed to

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## Isotope News from ORNL

- In August the REDC <sup>252</sup>Cf Source Fabrication Group completed and shipped what is probably the most intense single source of <sup>252</sup>Cf ever fabricated. The assay indicated 58.7 mg of <sup>252</sup>Cf ( $1.36 \times 10^{11}$  neutrons/s from a source the size of one's little finger). Hats off to Gary Owen and Ed Smith, master source fabricators!

- Heavy element campaign 72 began on schedule with dissolution of the irradiated curium oxide target rods at the REDC in mid-September. The  $^{252}\text{Cf}$  content is estimated to be between 275 and 300 mg, which will augment the current inventory of >80 mg. Production of other heavy element isotopes for distribution to the research community is estimated as follows:

$^{249}\text{Bk}$	35 to 40 mg
$^{253}\text{Es}$	0.2 to 0.5 mg (isotopically mixed)
$^{253}\text{Es}$	90 to 100 $\mu\text{g}$ (isotopically pure)
$^{254}\text{Es}$	3 to 5 $\mu\text{g}$ (isotopically pure)
$^{255}\text{Fm}$	2 to 4 ng (per milking from Es product)
$^{257}\text{Fm}$	0.5 pg

- Other transcurium isotopic products available on request from the REDC include  $^{249}\text{Cf}$ ,  $^{251}\text{Cf}$ ,  $^{244}\text{Cm}$ ,  $^{245}\text{Cm}$ , and  $^{248}\text{Cm}$ . Other available radioisotopes include  $^{234}\text{U}$ , plutonium isotopes from  $^{238}\text{Pu}$  to  $^{242}\text{Pu}$ ,  $^{99}\text{Tc}$ , and  $^{209}\text{Po}$ .
- Irradiation of target rods for future campaign 73 began prior to the initiation of the High Flux Isotope Reactor's scheduled 6-month shutdown in October 2000. After HFIR restart and completion of irradiation, processing of these targets should provide customers with an uninterrupted supply of  $^{252}\text{Cf}$  into mid-decade.

## Transportation Regulation Update

Previously we reported concern with the International Atomic Energy Agency's (IAEA's)  $A_1$  value for  $^{252}\text{Cf}$  (the maximum special form activity allowed in a Type A package). This value was revised in 1996 to a level 50% of the current 5.04 mg (i.e., ~2.5 mg). Our concern was compounded by the U.S. Department of Transportation proposal to make the same change. More recently (*Federal Register*, July 17, 2000), the Nuclear Regulatory Commission proposed an identical standard for Type A container limits.

We also reported that DOE advocated reinstating the  $A_1$  equivalent of 5.04 mg in the next edition of the IAEA Transport Regulations, based on analysis by ORNL staff that suggested overconservatism in the IAEA calculations. **We are very happy to report that the IAEA Revision Panel, which met in September 2000, has accepted these recalculations as valid.** Although this is only the first step in a two-year cycle toward regulatory revision, it is a very positive move toward standardization of domestic and international  $^{252}\text{Cf}$  Type A limits at ~5 mg. We will provide future updates.

## Geophysical Logging at INEEL's Waste Pit 9

The following is condensed from a presentation made by R. C. Martin and S. E. Kos, "Applications and Availability of Californium-252 Neutron Sources for Waste Characterization," at the Spectrum 2000 International Conference on Nuclear and Hazardous Waste Management, Chattanooga, Tennessee, September 24-28, 2000 (available from the newsletter editor).

A borehole geophysical logging tool developed by Waste Management Technical Services, Inc. (WMTS), was used for subsurface characterization of chlorinated compounds and transuranic elements in Pit 9 of the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory. Borehole measurements were made of elemental chlorine using  $^{252}\text{Cf}$  prompt gamma activation analysis (PGAA), with a high-purity germanium (HPGe) gamma detector (20% efficiency) and a 5.3- $\mu\text{g}$   $^{252}\text{Cf}$  source. The cylindrical PGAA tool is ~9 cm in diameter and 1.8 m long, with a source-to-detector distance of ~40 cm. The detector is shielded from  $^{252}\text{Cf}$  neutrons and gamma rays by tungsten metal. The logging tool also contains the high-voltage power supply, preamplifier, and liquid nitrogen dewar and cryostat assembly. A long source-handling tool is used to transfer the source from a small shielded container to the lower end of the logging tool.

The logging system is self-contained in a truck with a winch system. In early 2000, PGAA measurements were made within twenty 4-m-deep steel-cased boreholes drilled within a 12  $\times$  12 m area of Pit 9. The data acquisition time was 300 s for each 15-cm incremental location. The minimum detection limit for chlorine was 300 ppm. Chlorine was detected in all 20 boreholes, at concentrations ranging from 1000 to 30,000 ppm. Noncalibrated measurements of H, Si, Ca, Fe, and Al were also obtained. Other detectors were used to measure the ambient photon spectrum (high-resolution HPGe detector), moisture profile (50-mCi Am-Be source and  $^3\text{He}$  detector), and passive thermal neutron background ( $^3\text{He}$  detector). The depth of the waste seam was determined by borehole measurements of moisture content. Plutonium-239 was detected via gamma spectroscopy at concentrations from 18 to 124,000 nCi/g,  $^{238}\text{U}$  from 24 to 2500 pCi/g, and  $^{235}\text{U}$  from 4 to 33 pCi/g. Americium-241 and  $^{137}\text{Cs}$  were also detected at low levels.

## For Further Information

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$^{252}\text{Cf}$  applications and the ORNL Californium User Facility for Neutron Science <http://www.ornl.gov/divisions/ctd/cuf.htm>