associated primarily with external radiation sources in the four principal HNRAs and in areas with natural radiation in the fairly normal range were compiled without passing value judgements on quality. The conclusion from this recent review supports previous judgements. Some studies show an increase in chromosome aberrations in peripheral blood lymphocytes but the major cancer studies, which are of populations in China and India, do not indicate noticeable differences.

24.
EXPOSURE TO RESIDENTIAL RADON. ***Jay Lubin**, Division of Cancer Epidemiology and Genetics, National Cancer Institute, 6120 Executive Blvd, Bethesda, MD 20892-7244, Fax: 301-402-0081, lubinj@exchange.nih.gov*

Studies of underground mines show unambiguously that exposure to radioactive radon and its decay products increases risk of lung cancer. Since radon can accumulate in houses, there is concern about the health consequences of exposure to a known carcinogen. Extrapolations using miner–based risk models predict that long–term residence in a house at 148 becquerels per cubic meter (or 4 pico-curies/liter), which is the remediation action level recommended by the Environmental Protection Agency and which occurs in 4–6 percent of U.S. houses, may increase lung cancer risk by 20 to 40 percent. It is also estimated that residential radon may cause 10-12 percent of all lung cancer deaths in the U.S. or about 15,000 to 20,000 deaths per year. There is substantial uncertainty in these estimates, and studies are underway to evaluate the extent to which extrapolations of lung cancer risk from miner–based models are appropriate for residential exposures.

25.
THE "ADAPTIVE RESPONSE" TO IONIZING RADIATION: IS IT REAL, AND WHAT MIGHT IT MEAN FOR HUMAN HEALTH? ***James D. Tucker**, L-448, Lawrence Livermore National Laboratory, P.O.Box 808, Livermore, CA 94551-0808, Fax: 925-422-2282, tucker5@llnl.gov*

The adaptive response (AR) is the ability of a low priming dose of ionizing radiation (<0.1 Gy) to modify the effects of a subsequent challenge dose (~1-2 Gy), causing less genetic damage than the challenge dose alone. The AR has been evaluated in numerous test systems but the results have not always been reproducible. For example, the AR does not occur consistently between individuals or within an individual over time, and the reason for this variability is not understood. However, adaptation cannot be easily dismissed because the frequency and magnitude of the responses are too large to be random. The existence of an adaptive response suggests that low level radiation exposure might have fewer health consequences than estimated by current linear extrapolation models. An understanding of the mechanism of the adaptive response is required for addressing its potential role in minimizing the health consequences of exposure to ionizing radiation. Work performed under auspices of US DOE contract W-7405-ENG-48.

26.
USING SCIENCE TO APPLY LOW-DOSE RADIATION TO MEDICAL/HEALTH BENEFITS. ***James Muckerheide**, Worcester Polytechnic Institute, Center for Nuclear Technology and Society at WPI, 100 Institute Road, Worcester, MA 01609, Fax: 781-449-6464, muckerheide@mediaone.net*

Low-dose radiation (LDR) stimulates beneficial biological responses. Bi-phasic dose-response is found in immunologically whole organisms: at cellular and molecular levels, in organisms and populations—as with chemicals (chemical hormesis), plus beneficial enzyme, hormone, and physiological responses, e.g., heat-shock stress-response proteins. Prof. Schrader (1896) U. Missouri-Columbia tested J.J. Thompson's doubt that Roentgen's rays were bactericidal. Guinea pigs received sufficient diphtheria toxin to die in 24 hours. Most x-ray stimulated survived; extensively confirmed in the following decades. X-rays successfully treated infection (and wounds, inflammations, and cancer) before penicillin. After WWII the combination of cheap antibiotics and radiation fear caused this promising therapy to fall into disfavor. Antibiotic overuse is reducing their effectiveness. Immune control of cancer is extensively recognized. LDR stimulation prevents and successfully treats some cancers, back to the 1920's, plus recent clinical trials. Medical research should be undertaken to optimize doses, dose-rates, and modalities that stimulate immune functions, enzymatic repair, hormone and gene responses, and apoptosis, and specific LDR applications.

27.
CANCER STUDIES IN RADIATION WORKER POPULATIONS. ***Ethel Gilbert**, National Institutes of Health, Bethesda, MD 20892, gilberte@exchange.nih.gov*

Several epidemiological studies of workers who have been exposed occupationally to low levels of radiation have been conducted in the United States, Great Britain, and Canada. These studies provide a direct assessment of risk based on data on persons at low doses and dose rates, and thus serve as a check on the validity of risk estimates obtained through extrapolation from studies of persons exposed at high doses, such as the Japanese atomic bomb survivors. Risk estimates obtained thus far from worker studies have generally supported predictions from high dose studies, but are subject to large uncertainties. This paper reviews results of these studies emphasizing results based on larger cohorts including those from a combined analyses of data from several studies in three countries. Limitations and difficulties in interpreting worker studies will be discussed.

28.
CHERNOBYL - AFTER 15 YEARS WHAT HAVE WE LEARNED? ***Geoffery R. Howe**, Gelman Professor of Public Health (Epidemiology), Mailman School of Public Health of Columbia University, 630 West 168th Street, New York, NY 10032-3702, as16@columbia.edu*

On April 26, 1986, an explosion and fire at the Chernobyl Nuclear Power Plant in Northern Ukraine led to the deposition of radioactive materials over a wide areas of Ukraine, Belarus and Western Russia. The main health concern of the accident is cancer, in particular, thyroid cancer, from high dose exposure to I131. In addition, cleanup workers at the site, totaling many hundreds of thousands of people, could have an increased risk of leukemia. Evidence accumulated to date with respect to these two cancers will be summarized, and three ongoing studies which will address these issues in more detail will be described. Other possible health consequences, both physical and psychological, such as reproductive effects and increased risk of suicide amongst cleanup workers will also be assessed. Finally, lessons to be learned from the Chernobyl accident will be discussed.

29.
FUSION: OLD PUZZLES AND NEW PROBES. ***Robert Vandenbosch**, Dept. of Chemistry, U. of Washington, Box 351700, Seattle, WA 98195, v@npl.washington.edu*

The wealth of information about subbarrier fusion enhancement obtainable from precise fusion excitation functions will be reviewed. Signatures of shape and nucleon transfer degrees of freedom in barrier distributions will be discussed. The extra-extra push concept and its compatibility with cold fusion pathways to superheavy elements will be considered. The evidence for survival of fusion as a significant reaction channel at higher bombarding energies will be presented.

30.
HEAVY-ION FUSION AND FISSION: DETERMINED DOMINANTLY BY DYNAMICS? ***D. J. Hinde**, A. C. Berriman, R.D. Butt, M. Dasgupta, C. R. Morton, A. Mukherjee, and J. O. Newton, Department of Nuclear Physics, Research School of Physical Sciences, Australian National University, Canberra ACT 0200, Australia*

Recent experimental data, from the Australian National University and elsewhere, for both heavy-ion fusion and fission, have shown that models describing the processes in terms of passage inside a single fusion barrier, and for fission, back out over the fission barrier, are not adequate. Evidence will be shown of the decisive role played by static and dynamical deformation in the entrance-channel on the fusion process, and more remarkably, on the subsequent fission processes. The effect of entrance-channel mass-asymmetry, and of the angular momentum brought into the composite nucleus, will be discussed. It appears increasingly certain that the classic fusion/statistical decay model is unable to give a good description of many heavy-ion reactions.