# ROCKETDYNE WORKER HEALTH STUDY

## Appendix F

INTERNATIONAL
EPIDEMIOLOGY
INSTITUTE

## Glossary of Terms

**July 13, 2005**

**Appendix F. Glossary of Terms**

This glossary contains brief explanations for terms or concepts that are used throughout the Final Report and in the radiation and chemical papers.

*Alpha particles*. Alpha particles are the largest and slowest moving type of radiation. They are helium nuclei consisting of 2 neutrons and 2 protons. Alpha particles can move through the air only for a few inches before being stopped by air molecules, and would, for example, be stopped easily by a sheet of paper or the skin. The biological hazard is greatest when alpha particle emitters are ingested or inhaled.

*Atomics International.* Atomics International was dedicated to the research and development of nuclear energy and operated ten nuclear reactors and seven criticality facilities over the years. Nine of the ten reactors operated at power levels below one megawatt. Other radiation-related activities included fabricating nuclear fuel, dissembling and decontaminating reactor facilities, decladding spent nuclear fuel, and storing nuclear material. The radiation work at the Rocketdyne facilities did not involve any nuclear weapons activities or the production or testing of nuclear weapons components. During the years 1958 through 1983, enriched uranium and plutonium fuels were fabricated for research, space and power reactors. Rocketdyne, a rocket engine test facility, merged with Atomics International in the 1950s. The company was owned and operated by various companies including North American Aviation, Rockwell International and now the Boeing Company. Currently, the SSFL is operated by the Rocketdyne Propulsion and Power Division of Boeing and is jointly owned by Boeing and the National Aeronautical and Space Administration. Throughout these reports, “Rocketdyne” is used to represent all corporate names under which radiation work was conducted over the past 50 years.

*Beta particles.* Beta particles are much smaller and faster moving than alpha particles. They are electrons that are emitted from the nucleus. Beta particles pass through paper and can travel in the air for about 10 feet. However, they can be stopped by thin shielding such as a sheet of aluminum foil and would not penetrate much beyond the skin.

*Hydrazine.* Hydrazine is a white or colorless liquid with an ammonia-like odor that is used in rocket fuels, chemical manufacturing and as an oxygen scavenger in the treatment of boiler water.

*Committed Effective Dose.* Following an intake of a radioactive material, there is a period of time during which the radioactive substance remains in the body and exposes specific tissues at varying rates. For the purpose of radiation protection and to limit the intake of future radioactive materials when a prior intake remains in the body, the effective dose received over a 50 year period for adults is computed and called the committed effective dose; committed because much of the dose is received in the future while the radioactive substance remains in the body. For individual risk assessment the committed effective dose is an inappropriate unit. The proper unit would be the radiation absorbed dose or equivalent dose to the tissue of interest received during an appropriate time period, and should not include the future dose estimated to be received beyond the current date an individual developed cancer.

*Cox Proportional Hazards Modeling.* One of three multiplicative models commonly employed in the analysis of occupational cohort studies, the other two techniques being logistic regression and Poisson regression. Cox proposed the proportional hazards model for analysis of continuous survival time data. The model relates the hazard rate $\lambda(t)$ to the covariate vector $x$ as $\lambda(t,x)=\lambda_o(t)exp\ (\beta x)$. Analysis focuses on the risk set of all subjects in the cohort at risk at the time (age) each event occurred, using the covariate values at that particular point in time. In this way, the proportional hazards model accounts for changes over time in subjects at risk and in covariates.

*Effective Dose.* Effective dose is a quantity used in radiation protection and is also expressed in units of sievert (see also *Equivalent dose*). Effective dose allows one to compare risks of partial body exposures either from external or internal radiations to any site with those from whole body exposure by applying tissue weighting factors (ICRP 1991). This unit is not appropriate for individual risk assessment because it does not relate directly to tissue dose. For example, equivalent dose each year to the lung from inhaled radon can be computed to be about 1,000 mrem (10 mSv). Applying the tissue weighting factor of 0.12 for the lung results in an effective dose of 120 mrem. This effective dose is helpful when estimating the total consequences or detriment from different types of radiation exposures to an individual.

*Epidemiology.* Epidemiology can be defined as the study of the distribution and causes of disease in human populations. More simply, epidemiology is the study of what causes illness in people. The radiation and chemical studies are cohort studies where workers are identified, classified with regard to exposure, and then followed forward in time to record subsequent deaths.

*Equivalent dose.* Not all types of radiation are similar in their ability to produce a specific effect. The relative biological effectiveness (RBE) of radiation characterizes its ability to produce a specific disorder compared to a standard, usually x-rays. The international unit of biological equivalent dose is the sievert (Sv). The sievert represents the absorbed dose in gray multiplied by an appropriate radiation weighting factor. For x-rays, gamma rays, beta particles and electrons this weighting factor is 1, whereas for alpha particles the weighting factor is 20. The previous unit of equivalent dose was the rem with 1 Sv = 100 rem = 100,000 mrem. For x-rays, gamma rays and beta particles 1 Sv = 100 rem = 100 rad.

*External Radiation.* Penetrating radiation from sources of radiation outside the body, such as gamma rays and x-rays.

*Gamma rays.* Gamma rays travel at the speed of light and penetrate matter more easily than either alpha or beta particles. They are very high frequency electromagnetic rays. It takes a thick shield of steel, lead, or concrete to stop gamma rays. X-rays and gamma rays are identical except for their source of origin. Gamma rays originate from the nucleus of decaying radionuclides and x-rays originate from outside the nucleus, such as when speeding electrons are slowed within x-ray tubes (*i.e.*, an x-ray machine).

*Health Worker Effect.* The healthy worker effect usually refers to the potential bias in using a general population for comparison with an occupational group. The general population differs from a working populations in ways that are likely to affect the risk of dying. The bias is related to selection processes that are in force when a worker enters the workforce and to the health characteristics that enable a worker to continue on the job for many years. Workers in general are healthier than the general population and as such are less likely to die at a young age. These selection factors, however, usually diminish over time, especially for causes of death due to cancer. Analyses are often conducted excluding the first 10 years of follow-up after a worker to remove some of the influence of the healthy worker effect. More importantly, though, internal cohort dose-response analyses are conducted comparing workers to workers at the same facility and thus eliminate the possible bias when comparing to an external general population.

*Internal Radiation.* Radioactive substances (radionuclides) can be ingested or inhaled into the body and the release of radioactive energy in tissue is termed internal radiation.

*Lagging.* A concept used in the analysis of radiation cohort data for which the exposure occurring prior to the outcome of interest is excluded. For leukemia data, the exposure received 2 years prior to the date of death from leukemia is often excluded. For solid cancer data, the exposure received 10 years prior to the date of death from cancer is usually excluded from the analyses. The concept of lagging is that it takes some time before an exposure can damage a cell/s that would eventually be diagnosed as a malignancy. Exposure the day before the diagnosis of a cancer, for example, could not be linked etiologically to the cancer.

*Monitoring for Radiation.* Workers in an area with potential exposure to ionizing radiation would be monitored for the amount of radiation received so as to be in compliance with occupational standards. If the potential exposure were from external (penetrating) sources of radiation such as gamma rays or x-rays, the worker would wear a monitoring device such a a film badge or TLD (thermoluminescence dosimeter). If the potential exposure were to radioactive material that could be ingested or inhaled, the worker would be monitored with bioassays such as urine samples. The radioactivity in collected samples of urine would be measured and the amount of radioactive material intake estimated.

*mSv.* mSv (milliSievert) is the international unit of radiation equivalent dose (and also radiation effective dose). 1 mSv is equal to 10 mrem.

*Non-SSFL.* Rocketdyne facilities other than SSFL, i.e., mainly those at Canoga Park and De Soto Avenue.

*Radiation absorbed dose.* Biological effects are related to the amount of radiation energy absorbed by specific tissues. Radiation dose is the amount of energy absorbed in tissue and is measured in gray (Gy). The unit for dose used to be the rad, but the conversion is simple 1 Gy = 100 rad.

*Radionuclides.* Radionuclides are unstable elements that will eventually transform into another element by changing the number of protons in the nucleus. This change causes the atom to release either beta particles (electrons) or alpha particles (helium nuclei) and possibly energy in the form of gamma rays. Beta particles, alpha particles, and gamma rays emitted from changing atoms are different forms of ionizing radiation.

*Rocketdyne.* In 1948, North American Aviation established the Santa Susana Field Laboratory (SSFL) at the boundary of Los Angeles and Ventura counties as a rocket engine testing facility. During the next 50 years, 11 major rocket engine and component test areas were developed at SSFL. North American Rockwell (1967-1973), Rockwell International (1973-1996), and now the Boeing Company (1996+) have been the corporate owners of the test facilities. The Rocketdyne Propulsion Division was created in 1955 and “Rocketdyne” is used throughout the reports to include all Rocketdyne workers at SSFL and nearby facilities regardless of corporate affiliation.

*SMR.* Standardized Mortality Ratio. The ratio of the observed number of deaths divided by the expected number of deaths computed from external rates of disease available in the general population. Occasionally the ratio of observed to expected deaths is multiplied by 100 in presentations.

*SSFL.* Santa Suzana Field Laboratory.

*Test Stand Mechanic.* Hourly workers who had the greatest potential for exposure to chemicals in the course of rocket engine testing.

*Test Stand Worker.* Although Test Stand Mechanics had hands on experience during the testing of rocket engines and thus the greatest potential exposure to chemicals (fuels and solvents), there were other Test Stand Workers who had much lower potential for such chemical exposure. These were the Research Engineer, Test Stand Engineer, Instrument Mechanic, and Inspector. All of these workers can be generally classified as Test Stand Workers, but it was mainly the Test Stand Mechanic who received special physical examination because of his or her potential exposure to toxic chemicals.

*Trichloroethylene (TCE).* TCE is a colorless and sweet smelling liquid that was widely used after World War II as a solvent to remove grease from metal parts.