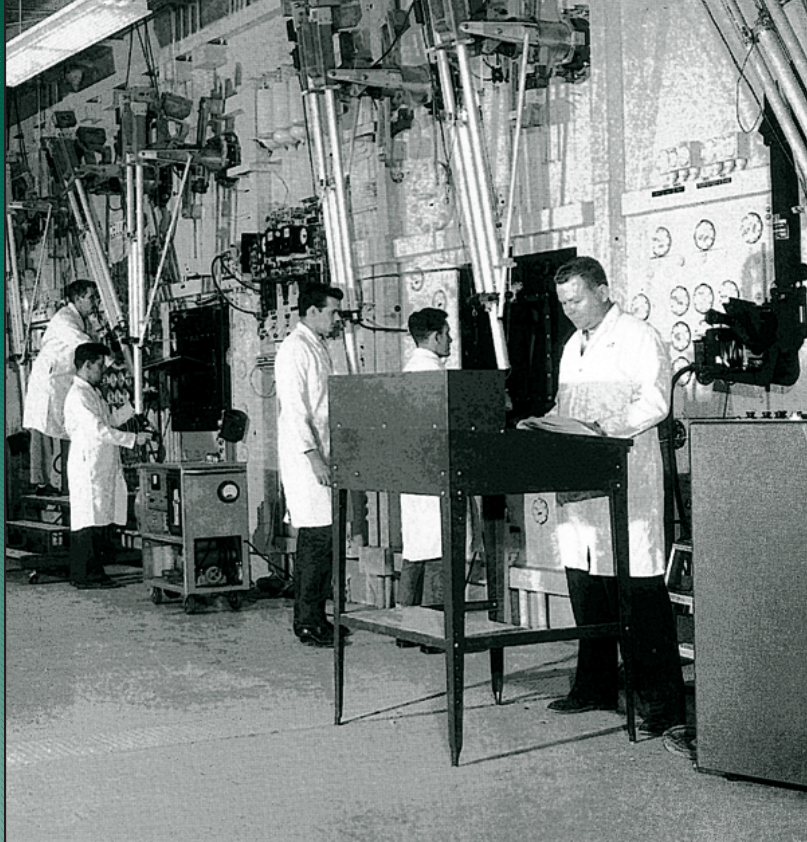


Understanding the Rocketdyne Follow-on Worker Health Study



Over 46,000 workers have worked at Rocketdyne since it opened its doors in 1948. These workers have provided the propulsion systems that have put our astronauts safely into space. The Mercury, Gemini, Apollo and Space Shuttle programs all have utilized engines developed by Rocketdyne workers and tested at the Santa Susana Field Laboratory (SSFL). Workers in the Atomics International division developed and tested new technologies in the then developing nuclear energy industry. This health study was performed to answer questions raised about the long-term health of workers involved in these activities at the Field Laboratory.

March 2005

**Employee and Retiree
Meetings will be held
on April 7th and 8th**

*Sponsored by the Boeing Company,
in partnership with the
United Aerospace Workers (UAW)*



Why was this Follow-on Study Done?

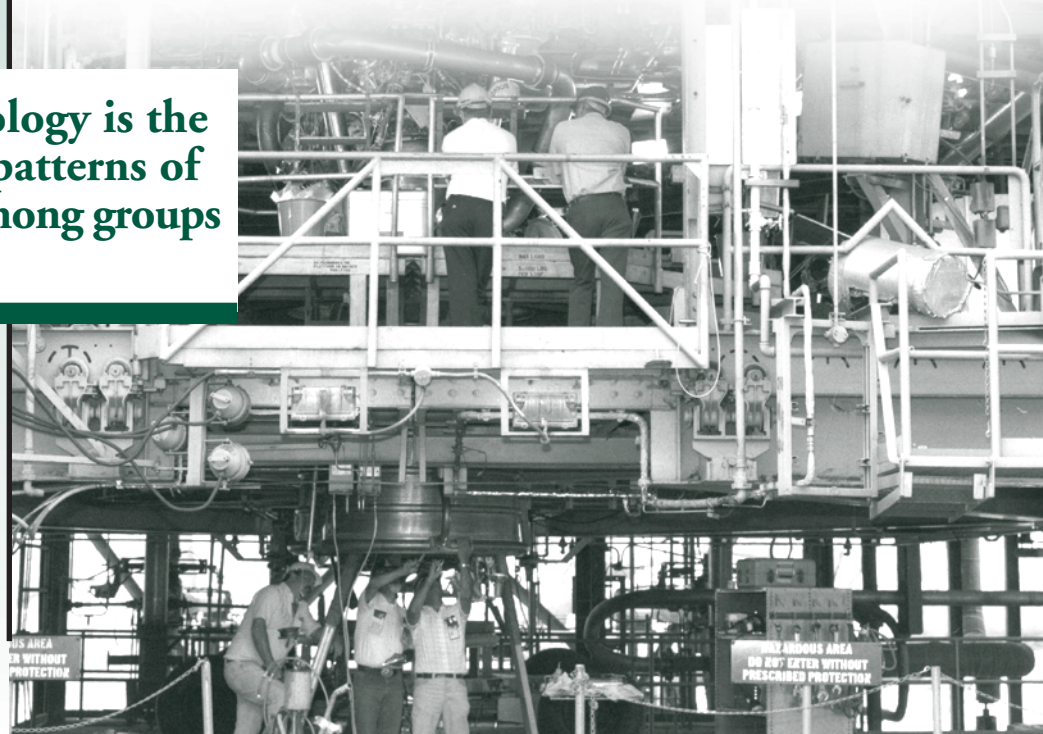
You probably recall that in the 1990's the University of California at Los Angeles (UCLA) conducted a health study of Rocketdyne employees that focused on workers who may have been exposed to radiation during the development of nuclear energy technologies or to chemicals during the testing of rocket engines. The UCLA researchers concluded that their results required "confirmation through further follow-up". In addition, many of the Rocketdyne workers evaluated in the UCLA study raised questions about the results. In response to these questions, the Boeing Company (Boeing) and the United Aerospace Workers (UAW) jointly sponsored a follow-on health study of Rocketdyne workers. This follow-on study recently has been completed, and the researchers are preparing to present their results to the workforce and retirees in early April. In the meantime, here are answers to some of the questions you may have now about the follow-on study.

What is an Epidemiologic (epi) Study?

An epi study evaluates a group of people who share common exposures, in this case, workers at rocket engine test stands and workers monitored for radiation exposure. By comparing the health of an exposed group to a similar but unexposed group, epi studies help scientists determine if particular exposures may be associated with an increased risk for certain diseases. An epi study can reveal whether an association exists between an exposure and a disease within the study group.

Because epidemiologists look only at groups of people, they cannot tell why a certain individual has a particular disease, or if a person is likely to get a particular disease. Whether or not an individual gets a disease depends on many factors in addition to workplace exposure. These other factors include genetics, gender, age, diet, smoking, exercise habits, and environmental exposures.

Epidemiology is the study of patterns of disease among groups of people



How Was The Study Done?

The researchers followed a plan that was developed by an independent team of scientists (the Science Committee). These scientists are researchers and professors from leading universities and institutions from across North America who were chosen jointly by Boeing and the UAW. The Science Committee oversaw all aspects of the study.

Who is included in the Follow-on Study?

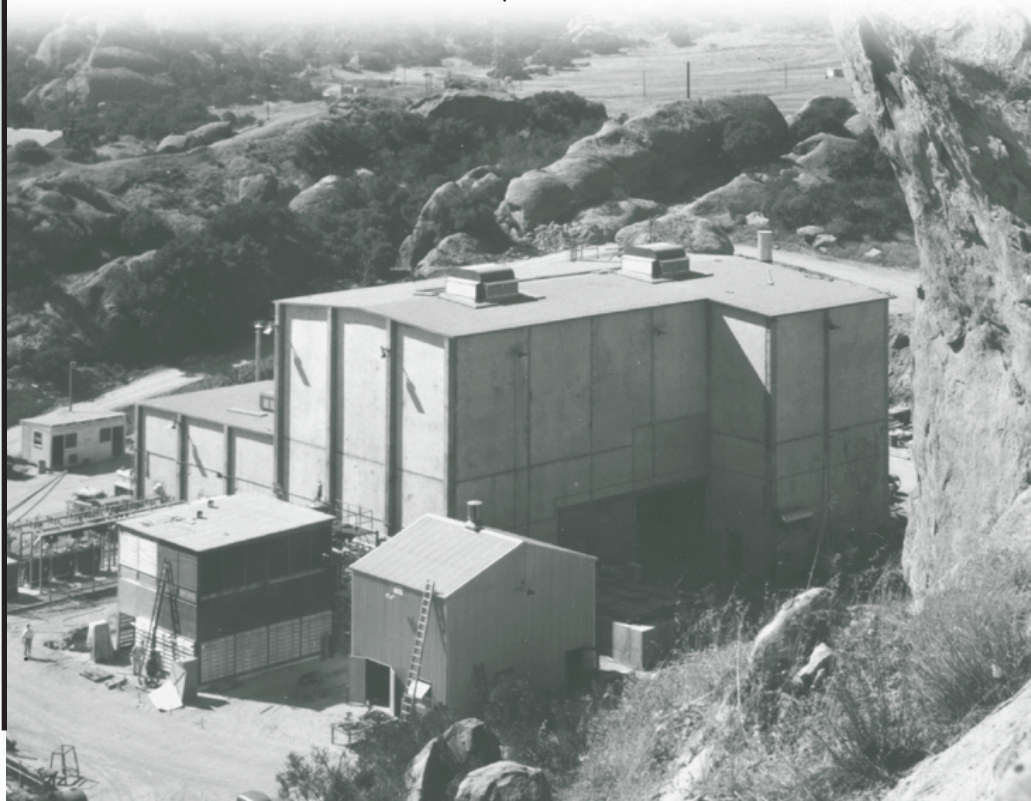
The follow-on study considered all Rocketdyne workers who were employed for at least 6 months (from 1948 to 1999) at SSFL or nearby facilities, including Canoga Avenue and De Soto Avenue. Among the more than 46,000 Rocketdyne workers included in the study, the researchers focused on two groups of workers: those monitored for radiation exposure and SSFL workers who may have been exposed to chemicals such as trichloroethylene (TCE) and hydrazines.

What diseases are included in the Follow-on Study?

The follow-on study looked at the overall death rate from all causes, and specifically analyzed more than 40 causes of death. Because the study looked only at actual causes of death, it did not include diseases in workers who are still living. This type of study is called a mortality study, as opposed to morbidity (sickness) study, and is a standard method used in workplace settings.

Does this mean that if a particular disease was not identified as the cause of death it is not included in the Follow-on Study?

That's correct. The study analyzed only causes of death that were reported on death certificates. Any other diseases that a person may have had were not included in the study.



How Was Information About Employees Collected?

A variety of sources were used to get as complete a record as possible of individual employee work histories. The following list provides some of the important sources.

- **EMPLOYEE WORK HISTORIES.** Researchers used employment-related information such as Kardex job history cards and personnel files.
- **EMPLOYEE DISCUSSIONS.** Researchers also conducted group discussions with current employees and retirees to get a better understanding of workplace activities.
- **RADIATION MONITORING RECORDS.** Radiation Safety folders which recorded individual employee exposure history were used. Additional radiation information for workers was obtained from national databases such as the Department of Energy, the Nuclear Regulatory Commission, and Landauer Dosimetry Company.
- **OTHER EMPLOYEE INFORMATION.** Personnel listings such as internal company phone directories, medical index cards, transfer lists and pension data bases were used to confirm and refine employee work histories.
- **EMPLOYEE HEALTH OUTCOMES.** Identification of employees who had died and causes of death were obtained from a variety of sources such as Rocketdyne personnel and retirement records, the Social Security Administration, California Surveillance Program, the California Death Tape and the National Death Index.

But aren't my records confidential?

Yes, they are. The study authors are required to keep all employee records confidential. Nothing that could identify a specific individual (such as names and social security numbers) will be included in publicly released information. In order to complete this study, the researchers had to get approval from of a number of Institutional Review Boards and Human Subjects Review Committees to ensure that all sensitive data would be handled appropriately.

The basis of an EPI study is making comparisons between groups

Epidemiologists use a number of approaches to evaluate if workplace exposure may be associated with increases in death from certain diseases.

FIRST... To determine whether workers exposed to a particular factor have died at a rate greater than expected, epidemiologists summarize results using standardized mortality ratios (SMRs). The SMR is the number of deaths observed in the study group divided by the number expected in the general population. An SMR greater than 1.0 suggests that the worker group studied had a death rate greater than the general population, whereas an SMR below 1.0 suggests that workers had a death rate lower than the general population. In the follow-on study, researchers compared deaths among Rocketdyne workers to the general population of California.

$$\text{SMR} = \frac{\text{Observed Number of Deaths}}{\text{Expected Number of Deaths}}$$

SECOND... Epidemiologists evaluate whether higher workplace exposures may increase the risk of dying from a certain disease by comparing exposed workers to non-exposed or minimally-exposed workers. This type of comparison is called the relative risk (RR). In the follow-on study, researchers identified Rocketdyne workers potentially exposed to chemicals such as hydrazines and compared their rate of death with Rocketdyne workers who had no exposure or low exposure. Similar comparisons were made for workers exposed to radiation.

- If the Relative Risk is:***
- equal to 1.0, the relative risk is the same for both groups.
 - lower than 1.0, the relative risk is lower for the more highly exposed group.
 - greater than 1.0, the relative risk is higher for the more highly exposed group.

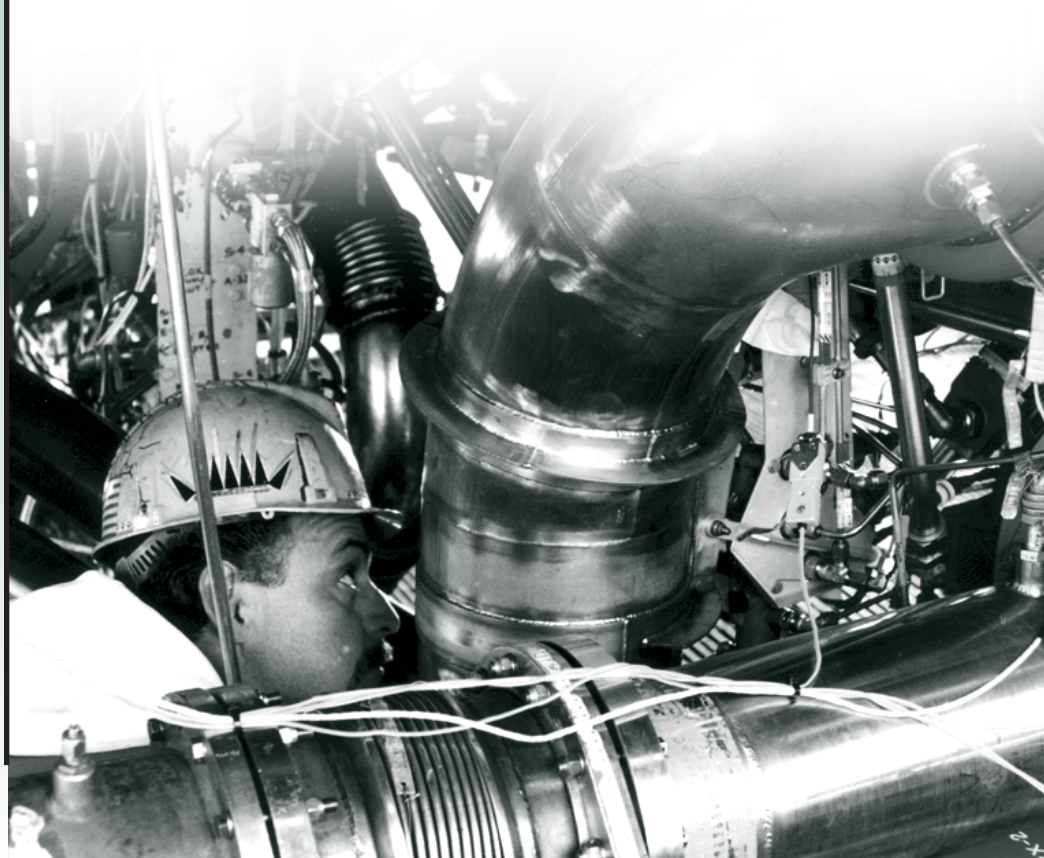
THIRD... Another way in which epidemiologists determine whether exposure increases the risk of dying is by conducting dose response analyses. The dose response analysis evaluates whether increasing levels of exposure are associated with corresponding increases in the rate of death. While the relative risk considers only two levels of exposure, dose response analyses look for trends over a number of exposure levels. Epidemiologists evaluate these trends to help understand the strength of the association between exposure and a particular disease.

Showing confidence in the results

All epidemiologic studies are based on samples from larger populations. Observed differences between groups of people may be due to chance rather than due to real differences. Epidemiologists typically use statistics to evaluate differences observed among groups to know whether chance can be ruled out as an explanation. It is important to remember that these statistics simply tell us whether or not the result may be due to chance, and not if exposure actually caused the disease being studied.

Confidence Intervals: In addition to reporting a numerical result, such as the SMR or relative risk, most studies include the confidence interval for a result. Estimates of risk based on limited data cannot perfectly reflect reality, and the confidence interval is a measure of the uncertainty associated with the result. The wider the confidence interval, the more uncertainty there is in the result. Typically, there is less confidence in a result based on a small number of cases than a result based on a larger number of cases.

P values: Research scientists also use the probability value (or p-value) to evaluate the statistical significance of a result. The p-value is similar to the confidence limit and gives an indication as to whether the outcome could have happened by chance. The lower the p-value, the less likely it is that chance can explain the observed results. Traditionally p-values less than 0.05 (or 1 in 20) are accepted as evidence of a statistically significant difference between groups. In an epi study, a statistically significant result does not mean that the exposure actually caused the disease, only that chance can be ruled out as an explanation. In contrast, a non-statistically significant result does not mean that a meaningful association has not been found, only that chance cannot be ruled out as an explanation.



How else can the researchers be confident of their results?

In any epidemiologic study, the interpretation of the results depends on how well researchers have accounted for things other than exposure that could affect the outcome. In addition to chance, other things that may influence study results include study biases and confounding factors.

- **BIAS.** Bias is the presence of a flaw in the overall design of the study (such as the selection of subjects or collection of data) that results in some systematic error. Bias is a technical term for “playing favorites”. It is important that individuals in the study group be selected uniformly, and that information about exposure and health status be collected consistently.

- **CONFOUNDING.** Confounding is a technical term for finding an association for the wrong reason. Failure to account for potential confounders may lead to misleading results about the potential risk of exposure. Confounders include not only personal behavior factors, but may also be linked to genetic and environmental factors. An example of confounding in an epidemiologic study of lung cancer would be if exposed workers were heavy smokers and non-exposed workers were light smokers. Any differences between disease rates might be due to differences in smoking habits and have nothing to do with the actual workplace exposure.

How do scientists determine whether an association is real or due to other factors?

Epidemiologists rarely have all the information they would like when conducting a study. Because epidemiology is not an experimental science, judgment is always involved when evaluating whether an association is meaningful once chance, bias and confounding are ruled out as possible explanations. Typically, this judgment considers:

- What is the strength of the association between exposure and disease (is the SMR or relative risk high)?
- Are the study results consistent with other epidemiologic studies?
- Do increasing levels of exposure show increasing rates of death?
- Do experimental animal and cellular studies indicate a potential health hazard from the exposure and do the findings make sense biologically?

How will I find out about the study results?

Meetings to present the study results and answer questions will be held for employees and retirees in April. Information will be posted on the Rocketdyne website, or you can call (800) 808-1160 and request information of the study. In addition, scientific papers summarizing the research will be published in journals so that other scientists can review the methods used and the conclusions reached. Links to these papers will also be added to the Rocketdyne website as the papers become available.

Will there be any public meetings where the results of the study are presented?

There are no public meetings planned specifically to discuss the study. However, a summary of the study results will be posted on the Rocketdyne website at after the April meeting. The researchers will present study results and answer questions at several meetings planned for workers and retirees in April.

I never worked at SSFL or on Department of Energy projects, but I live near the SSFL facility. Will the study tell me if I will get a particular disease as a result of radiation or chemical exposure?

No. The follow-on study focused on workplace exposures where exposures to radiation could be determined from personal monitoring devices and where exposure to chemicals could be estimated from job title and length of employment. The study was not designed to look at community health effects.

Who do I call if I have questions?

The Boeing Company has set up a toll-free number to use if you have questions. That number is (800) 808-1160. Members of the Boeing Medical and Safety staff will be available to help answer your questions.

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