

**SANTA SUSANA FIELD LABORATORY
EPIDEMIOLOGICAL STUDY, PART II:
EXPOSURES TO SELECTED CHEMICALS**

**REPORT OF THE
OVERSIGHT PANEL CO-CHAIRS**

**APRIL 1999
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PART II: EXPOSURE TO SELECTED CHEMICALS**

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Summary

The epidemiological study of Santa Susana Field Laboratory (SSFL) workers was triggered out of two concerns: that workers on-site may have been affected by workplace exposures to radioactive and chemically hazardous materials and that releases of such materials from the facility may have harmed members of the neighboring community. SSFL workers operated nuclear reactors, handled plutonium and conducted rocket-engine tests. The events leading up to the establishment of the study included disclosures of a number of accidents involving nuclear reactors on the property, radioactive and chemical contamination affecting both on- and off-site areas, and a preliminary study suggesting elevated incidence of bladder cancers in census tracts closest to the facility that, although not definitive, pointed to the need for a full-scale investigation.

Since SSFL workers were expected to have higher exposures to the relevant radioactive and chemical materials than the nearby general population, it was decided that the appropriate next step was a detailed epidemiological study of the workers. If the study concluded there was no risk to workers, the issue of potential impacts on the neighboring community could also be put to rest. If the study did find deaths among the workers attributable to their exposures, additional follow-up study of the neighboring community might be in order.

The first phase of the worker study, released in 1997, found SSFL worker exposure to radiation appears to have increased the risk of dying from lung cancer, cancers of the blood and lymph system, and cancers of the upper-aerodigestive-tract (including cancers of the oral cavity, pharynx, esophagus, and stomach). The second part of the worker study, now being released, observed positive associations between occupational exposure to hydrazine (and/or other chemicals associated with rocket-engine testing) and the rates of dying from cancers of the lung, the blood and lymph system, and bladder and kidney.

In light of the results from both phases of the worker study, indicating that occupational exposures to radioactivity and hazardous chemicals at the site appear

to have resulted in excess cancer deaths among the workforce, we recommend that a follow-up study of the neighboring community be conducted, if technically feasible. As a first step to that end an evaluation of possible approaches to such a community study should be performed.

In order to assure public confidence, we recommend that both the feasibility study and any actual community study be conducted, as was the worker study, under the auspices and direction of the Panel. Any independent contractor involved in the work should be selected and overseen by the Panel, as was the case with the UCLA team. We emphasize that it is important for the credibility of the follow-up work that it be kept independent of both the company and the governmental agencies that were responsible for regulating or sponsoring work at the facility.

The next step is for the Panel, with a contractor it selects, as needed, to commence the feasibility study of various possible approaches to a follow-up community study. We recommend that the Panel be provided the financial resources necessary for it to continue and for it to be able to carry out those tasks.

The worker study was conducted on the premise that if it found no health detriment attributable to on-site exposures, no off-site follow-up study would probably be needed. However, both the radiation and chemical components of the study have found positive associations between exposure and the risk of dying from cancer. The commitment to the public was that, if that proved true, a follow-up independent study of the community would, if technically feasible, be conducted. We believe that commitment now needs to be carried out.

Background

The Site

The Santa Susana Field Laboratory (SSFL), is a nuclear reactor and rocket-engine testing facility located near Simi Valley, California, at the boundary of Los Angeles and Ventura Counties. Over the years, SSFL has housed approximately a dozen nuclear reactors, a plutonium fuel fabrication facility, an irradiated reactor fuel decladding facility, a number of rocket test stands, and lasers for the Strategic Defense Initiative (SDI), among other facilities.

The nuclear development work was done for the U.S. Department of Energy (DOE) and its predecessor agency, the Atomic Energy Commission (AEC). Work developing and testing missile and rocket engines was performed for various Defense Department and NASA projects. The facility is operated by Rocketdyne, currently a division of Boeing North American, Inc. In its early years, the nuclear activities were conducted by a unit known as Atomics International (AI). Former owners of the facility include North American Aviation and Rockwell International.

Originally conceived in the late 1940s as a remote field laboratory for testing too hazardous to conduct at Rocketdyne's facilities in Canoga Park, the rapid population growth in the Los Angeles region resulted in the field lab being essentially surrounded by ever-growing communities such as Simi Valley, West Hills, Bell Canyon, and Thousand Oaks. Half a million people now reside within ten miles of the facility.

Origins of the Study

In 1979, disclosure of a series of past reactor accidents at SSFL, including a 1959 partial reactor core meltdown, led to substantial public concern about possible ill effects upon the neighboring community that may have resulted from radioactive releases. In 1989, the news media revealed the results of an internal DOE investigation of the site finding widespread radioactive and chemical contamination. Later that year, the United States Environmental Protection Agency (EPA) released a report raising questions about the adequacy of the environmental monitoring performed by Rocketdyne and DOE at the site. In subsequent years, reports by various agencies and Rocketdyne have identified additional contamination, including some in nearby off-site areas and ground water.

These and other events increased community concern. In 1989, after disclosure of the site contamination, three legislators representing the area called – unsuccessfully at the time – for an epidemiological study of the workers.

In 1991, the press obtained a 1990 DHS study that found an elevated level of urinary bladder cancers in the census tracts in Los Angeles County closest to the facility. (Because the Ventura County cancer registry had only recently commenced operations, the analysis had been restricted to the Los Angeles County side of the site.)

In the wake of the disclosure of the DHS study, members of the California State Assembly then representing the nearby community – Assemblymembers Richard Katz, Terry Friedman, and Cathie Wright – convened a hearing in the matter. The legislators directed that the long-deferred worker epidemiological study now be conducted and that steps be taken to obtain access to the worker records necessary for the study.

Since SSFL workers were expected to have higher exposures to the relevant radioactive and chemical materials than the nearby general population, it had been decided that the appropriate next step, in light of the off-site bladder cancer findings, was a detailed epidemiological study of the workers. If the study concluded there was no risk to workers, the issue of potential impacts on the neighboring community could also be put to rest. If the study did find deaths among the workers attributable to their exposures, additional follow-up study of the neighboring community might be in order.

Origins of the Oversight Panel

The 1991 legislators' hearing identified a significant level of distrust on the part of many in the community regarding the company and the agencies charged with regulating it. In addition, there was concern about a potential conflict if the investigation of impacts from the site were conducted by entities that arguably may have had some degree of responsibility for the exposures, either as operator or regulator of the facility.

In order to assure that the results of any follow-up epidemiological study would be credible to the community, the legislators directed that the study be conducted independently of DHS, DOE, and Rocketdyne. To this end, they arranged for the selection and formation of an Oversight Panel that would have the authority to pick and oversee an outside contractor to conduct the study and to approve the study design. DOE would have one non-voting member on the Panel; DHS would have one representative on the Panel, not able to vote on the choice of contractor. The rest of the Panel would be composed of technical specialists and community representatives, with the elected officials instrumental in their selection.

The Panel selected a team of researchers from UCLA to conduct the worker epidemiological study. The Panel provided oversight of the study as it progressed and also served as the peer review panel for the draft reports.

The Worker Health Study

The study was conducted in two parts. The first report, released in 1997, examined whether exposure to radiation had increased the risk of dying from cancer among exposed workers. The second report, being released now, examined whether exposure to selected chemicals was associated with increased cancers deaths among exposed workers.

The Radiation Findings

The primary question the radiation component of the study was designed to answer was whether workers at Rocketdyne / AI's nuclear sites have experienced excess deaths from cancer associated with their work-related exposures to radiation. The answer was yes.

The study found that exposure of workers at SSFL to external (penetrating) radiation was associated with an elevated rate of dying from cancers of the blood and lymph systems and from lung cancer. Cancer death rates for all cancers and for "radiosensitive" solid cancers were found to increase as external radiation dose increased. Exposure to internal radiation (i.e., from inhaled or ingested radioactive materials) similarly resulted in increased mortality rates for blood and lymph system cancers and for cancers grouped together by the investigators as the upper-aero-digestive tract, including cancers of the oral cavity, pharynx, esophagus, and stomach.

Importantly, the study found that although the cancer deaths at SSFL attributable to radiation exposure were dose-related, they occurred at doses substantially below those considered permissible by official U.S. and international regulatory bodies, thus raising questions about the adequacy of current regulations. The excess relative risk of "low-dose" radiation was at least 6 to 8 times greater than risks previously assumed on the basis of atomic bomb survivor data. Furthermore, older workers were found to be significantly more susceptible to dying from

radiation-induced cancer than the younger workers upon whom regulatory standards are currently based.

These findings mirror several other recent studies. The Panel recommended that national and international radiation protection bodies consider strengthening radiation standards in light of the findings suggesting that current radiation limits may be insufficiently protective.

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The Chemical Study Now Being Released

The second and final phase of the worker health study assesses the impact of selected chemicals. Dozens of different hazardous chemicals were used at various times at the site, but because of resource limitations and problems obtaining access to data regarding chemical exposures, the researchers focused primarily on hydrazines used at rocket-engine test stands.

Study Methods

The researchers conducting the chemical phase of the study faced some hurdles that were not experienced in the radiation component of the study. For the radiation study, Rocketdyne made available radiation monitoring data for the workers who were in the health physics, or radiation-monitoring program. The researchers thus had data for each such worker, identifying how much radiation he or she had received each year. The research team could thus compare the cancer death rates of those workers who had higher exposures with those with lower exposures. They found that increasing radiation exposure was associated with increased risk of dying from certain cancers.

The researchers, however, were not able to obtain from Rocketdyne chemical exposure data. Rocketdyne reported that all air monitoring data for chemicals for the period of prime interest to the researchers, those prior to 1985, had been destroyed. The Panel was given different explanations at different times for the loss of these data, and we were never able to resolve definitively what had occurred. The UCLA researchers were thus unable to obtain and utilize air monitoring data.

In addition, the researchers were hampered by a lack of job location records that would show where individual workers had worked. Such records could have been used to connect individual workers with sites where particular chemicals had been used. Instead, the researchers had to use job title, job code, and employment period information to assign those who had worked at rocket-engine test stands into four categories of presumptive exposure – those with a high presumed probability of exposure to hydrazine, those with a medium probability, those with a low probability, and those assumed to have little or no probability of exposure to significant amounts of hydrazine. Note that this categorization is not based on the degree of exposure, but on the probability of exposure.

Although the researchers note that certain rocket-engine testing personnel were probably exposed to asbestos, they could not obtain records to help identify which workers those were. They therefore focused instead on radiation workers who may have been exposed to asbestos at the reactors. A similar categorization based on probability of exposure was performed.

The researchers then compared health outcomes (how many had died of various cancers) in the higher probability categories with workers in the lowest category.

Results

- The researchers observed positive associations between their proxy measure of hydrazine exposure and the rates of dying from cancers of the lung, blood and lymph system, and bladder and kidney.
- The mortality rates for these cancers were approximately twice as great among workers classified in the high-exposure group as they were among workers classified in the unexposed group.
- Among workers with a medium probability of exposure to hydrazines, the data suggest there may be a possible association with cancers of the blood and lymph system, pancreas, and the upper-aerodigestive-tract, but the results were not entirely consistent and the study was not able to determine precisely if

there was or was not an increased risk of dying from cancer in this group.

- In the group of workers monitored for external radiation, the association between asbestos exposure and lung cancer mortality was small and too imprecise to draw any firm conclusions. It is, however, well known from other studies that exposure to asbestos can cause lung cancer.

Limitations

- The UCLA study team was not able to obtain information about the amount of exposure to hydrazines, and couldn't take into account exposure from accidental leaks or spills. Classifying exposure probability based solely on job titles likely led to some people who had a high probability of exposure being classified in the low probability group, and vice versa. For example, certain rocket engine test stands used most of the hydrazines, and other test stands used little or no hydrazines. However, the classification problem is likely to **underestimate** the effect of exposures to hydrazines on cancer death rates.
- Exposure to other chemicals at Rocketdyne may also increase the risk of dying from cancer. The UCLA study team was not able to obtain from Rocketdyne information about the amount or duration of exposure to these other chemicals. It is possible that workers on the rocket-engine test stands were also exposed to other chemicals that increase the risk of dying from lung cancer (such as trichloroethylene or nitrosamines).
- Other factors besides exposure to hydrazines (such as smoking or diet) may also increase the risk of cancer. The UCLA study team looked at the effects of tobacco on some workers to see if this factor would change the effect of exposure to hydrazines on the risk of dying from lung cancer. After analyzing this factor, the results of the study did not change.

Peer Review of the SSFL Study

- The UCLA research team was selected by the Panel after review of applications from all research groups who responded to an open Request for Proposals. The review included evaluation of the methods to be used and the analysis proposed to be performed.
- The UCLA team conducted the study according to those protocols and generally accepted research methods for studies of this type. The UCLA team reported periodically to the Oversight Panel in writing and in person. The Panel provided peer review of the draft report.
- The principal limitations of the study were lack of access to records on chemical exposures and workers' job locations. These limitations do not compromise our confidence in the study's finding that occupational exposure to hydrazine or other chemicals associated with rocket-engine testing at SSFL appears to have increased the risk of dying from lung cancer, and possibly other cancers.

Recommendations

The purpose of the worker health study, nearly a decade in the making, was to determine if workplace exposures to radioactivity and/or chemicals from the site led to cancer deaths among those exposed. The previous phase of the study confirmed that radiation exposures at the site had increased the risk of dying from cancer. This phase similarly indicates that exposure to certain chemicals associated with the SSFL rocket-engine test stands appears to have increased the cancer death rate.

The study was conducted on the premise that if no health effects were observed in the exposed workers, no follow-up study of the neighboring community would probably be needed. If, however, exposures on site indicated increased rates of dying from cancer, an off-site study, if feasible, would be performed.

Since both the radiation and chemical components of the study have indicated that exposures have apparently resulted in increased risks of dying among the exposed workers, work should now commence to perform the promised health

study of the community, if it is technically feasible to do so. To that end, we recommend as a first step the performance of a feasibility review, examining a range of possible approaches to such a study.

In order to enhance the credibility of the worker study, it was performed independently of Rocketdyne and the agencies involved with the SSFL. The Oversight Panel chose an outside contractor, approved the study design, oversaw the work, and provided peer review for the final product. The Panel's relationship with Rocketdyne and agencies such as DHS was not always free of problems; however, we believe that the Panel's independence was crucial in establishing public confidence in the results obtained.

We therefore recommend as next steps:

- The Oversight Panel continue.
- The Panel commence a review of the feasibility of various approaches for a community study. This may entail the selection and direction by the Panel of an independent contractor.
- The Panel be provided the resources necessary to continue its operations and to ensure that the feasibility study is conducted.
- The feasibility review and the actual community study, if found feasible, be performed under the Panel's direction. As in the case of the UCLA study, the community study should be performed by an outside contractor selected and overseen by the Panel.
- We particularly stress the importance of assuring that the independence, from both the operator and regulators of the SSFL facility, of this follow-up work be vigorously maintained, in order to assure public confidence.

We additionally recommend:

- The worker population should continue to be followed. Such follow-up should, like the original study, be performed independently of Rocketdyne.

- The chemical study was hampered by the loss or destruction of the pre-1985 air monitoring data and the lack of job location records for workers. It is recommended that efforts be undertaken to better assure such data are maintained in the future so as to facilitate epidemiological studies.
- In the annex to the UCLA chemical study, the researchers highlight an issue regarding a chemical called NDMA (nitrosodimethylamine), classed as a human carcinogen, that may also bear further study at the Rocketdyne site. NDMA is produced by oxidation of certain rocket fuels used at the site. The researchers note that NDMA releases have been observed at other rocket-testing sites and that they believe there was a potential for exposure to NDMA during the transfer of rocket fuel propellants and testing of rockets at SSFL. In addition, at least five groundwater wells at SSFL have reported NDMA contamination, one as recently as 1997. Further work may be useful to determine if NDMA could be involved in the increased cancer risk observed to be associated with exposure at the rocket-engine test stands, and if so, whether it represents any off-site risk associated with the rocket tests. The UCLA researchers recommend additional on-site and off-site NDMA sampling.
- The worker health study was triggered in part by the earlier finding of an apparent elevated bladder cancer rate in off-site areas near SSFL. The observation in the current study of a possible bladder cancer effect in workers exposed to chemicals associated with the rocket-engine tests thus suggests an interesting question, in light of those earlier findings. It may be useful in follow-up work to explore whether releases from the rocket-engine tests could possibly be a common link between the on- and off-site observations. The current data are insufficiently precise to draw any conclusion other than, given the particular origins of this study, it may be useful to explore the matter in subsequent work.

Concluding Observation

The SSFL worker health study, now completed, indicates that on-site radioactive materials associated with nuclear reactor development and hazardous chemicals associated with rocket-engine testing appear to have increased cancer death rates in exposed workers. Rocket testing continues at the site, and there remains radioactive and chemical contamination from past activities, the object of ongoing clean-up efforts.

This epidemiological study of the SSFL workers and any follow-up study of the neighboring community, important though they may be, can only provide information about harm that may already have occurred from past exposures. The critical lesson to be learned from such studies is the importance of taking affirmative steps, to the extent feasible, to prevent or reduce future exposures to workers or the surrounding public. The continuing operations at the site should be reviewed in light of these findings. Comprehensive and rigorous cleanup of contamination from past operations, with effective public accountability, is also extremely important. We note that the excess cancer deaths among radiation workers occurred at exposure levels far below regulatory limits, a factor we urge be considered in reviewing operational releases and cleanup goals.

Nothing can be done about the exposures that have already occurred and were the subject of this study, although their health consequences may still be unfolding. The central message of these results, however, is the importance of reducing, where possible, the potential for future radioactive and hazardous chemical exposures, both for workers and the public.