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# Fallout from Plowshare
## Peaceful Nuclear Explosions and the Environment 1956-1973

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# FALLOUT FROM PLOWSHARE

Peaceful Nuclear Explosions and the Environment

1956-1973

by

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Peaceful Nuclear Explosions and the Environment

1956-1973[1]

By the mid 1950s, constructive uses for nuclear energy had already been a lively topic for years, and not only in the United States. Scientists and engineers everywhere wondered about using nuclear or thermonuclear reactions for a variety of potentially nonmilitary ends. Although power production topped the list, also high among the prospects was substituting nuclear for conventional explosives in civil and industrial engineering applications. Immense power in small packages promised advantages so great as to offset even such drawbacks as radioactive fallout. In mid-1957 the U.S. Atomic Energy Commission, the AEC, launched a major research and development program for peaceful nuclear explosions. Scientists would beat nuclear swords into nuclear plowshares.

Project Plowshare directly sponsored 27 nuclear tests over a 12-year span, 1962 through 1973, though project planners drew freely on results from other tests for ideas or data. Over half the Plowshare-sponsored tests focused on developing suitable nuclear explosives—which

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meant chiefly finding ways to reduce fallout. The other tests explored the physical effects of nuclear explosions and how they might be applied toward practical ends. Initially, nuclear excavation—cheaply moving vast amounts of earth to help build harbors, canals, and other civil engineering projects—held the most promise. When this goal proved unattainable after 6 tests in 7 years (1962-1968), the main effort shifted to extracting oil, gas, or minerals from deep underground deposits, which also proved unworkable, this time after 3 tests spread over 7 years (1967-1973).[2]

Ultimately, Plowshare succeeded in none of its aims, a failure that owed something to technological misjudgments but more to a changing sociopolitical climate. One large factor in Plowshare's failure was the problem of radioactivity. Ostensibly a straightforward question of health risk—which could presumably be addressed with facts and figures—the underlying issues may well have had more to do with public unease about nuclear matters and growing public mistrust of government—which could not. Radiation hazards, in any event, always remained the major spur to public opposition, and this essay focuses on radiation safety aspects of the Plowshare test program.

### *Plowshare Begins: Gnome, Chariot, and the Moratorium*

Primary impetus for a U.S. program of peaceful nuclear explosions came from the nuclear weapons laboratory at Livermore, then a branch of the University of California Radiation Laboratory.[3] In late 1956 Livermore sought AEC support for a classified conference to discuss peaceful nuclear explosives, secret because peaceful differed from warlike chiefly in purpose, not technology. The conference took place in February 1957.[4]

Five months later Livermore had AEC approval for a full-fledged program. Officially, Project Plowshare began in July 1957.[5]

Early planning centered on two projects, Gnome and Chariot. Gnome fell outside Plowshare's major lines of development. Instead, it addressed two unique questions. First, could molten salt store the enormous heat of a nuclear explosion to produce electricity via steam-driven generators, a possibility suggested by results from an earlier, non-Plowshare test? And second, could potentially valuable explosion-created radionuclides be recovered for use? The answer to the latter question proved a qualified yes; repeated in several other tests, such recovery also identified new transuranic elements. Planners found an underground salt bed near Carlsbad, New Mexico, and scheduled Gnome for late 1959.[6] The second project, Chariot, had closer links to a major Plowshare goal, using the atom more cheaply than conventional explosives for massive earth-moving. Tentatively scheduled for fall 1960, it called for blasting a harbor on Alaska's Arctic coast with nuclear explosives.[7] When the moratorium on nuclear weapons testing began at the end of October 1958, however, Plowshare schedules went out the window.

For Gnome the delay proved more beneficial than not. Nuclear explosions away from the Nevada Test Site made public safety loom very large in Plowshare planning, all the more so for Gnome as the first continental test outside Nevada since 1945. Numerous studies during the moratorium-forced delay convinced the AEC that Gnome would cause no damage.[8] Reassuring people living and working near the New Mexico site that they need fear neither shock nor radiation became just as high a priority. Despite the region's sparse population (one reason it was chosen), Gnome officials worked hard to maintain good public relations.

They announced their plans early and issued frequent progress reports, taking pains to explain expected effects and safeguards.[9] Strong radiation safety (rad-safe) groups, based on the Nevada organization, backed the promise of safety: Reynolds Electrical & Engineering Co. (REECo), the AEC's prime support contractor in Nevada, for project workers; the Public Health Service for the off-site population. Exposure limits for Gnome likewise matched those that prevailed in Nevada.[10]

Project Chariot, unlike Project Gnome, failed to survive the moratorium-caused delay. Situated 300 miles above the Arctic Circle at Point Hope on Alaska's north coast, the Chariot site clearly threatened a fragile and little-studied biosphere. Opponents of the project, though relatively few in number, made themselves heard. By early 1959 their prodding had helped persuade the AEC to place contracts with University of Alaska faculty members and others for expert studies of every aspect of the project's geographical, biological, and human environment.[11] Planning for public safety had likewise begun early and work continued even when the moratorium rendered the schedule unlikely.[12] Moratorium also gave the opposition time to improve its organization, swell its ranks, and ask new questions.[13] By 1961 the Commission and its agents found themselves with no ready means to quiet growing public concerns, ill-founded though they believed such concerns to be.[14] Substantial efforts to ensure public safety and to make the facts known—the same linkage of safety and public relations that tended to characterize all AEC operations—met but modest success.[15] Although ongoing studies still returned encouraging findings, Chariot seemed less and less likely to take place.[16]

Early in 1962 the Commission tentatively decided to cancel the project when Chariot study contracts expired in September. The Alaskan test would have no place in a new five-year plan to develop nuclear excavation techniques.[17] Neither health risks ("exceedingly remote" according to all the studies) nor public outcry (deemed the work of "small but very vocal groups") played much part in the decision. The AEC had more compelling reasons to cancel Chariot: an obsolescent design, high costs and long lead times at the Alaska site, the prospect of a fight with the Department of Interior over using the land. Yet the Commission hesitated, partly because of money already spent, more because of problems cancellation might itself pose: it might imply that Chariot really had been risky; it might also suggest that the AEC had wasted $4 million and responded too timidly to criticism.[18]

Forestalling such charges demanded a well-crafted public information plan and careful timing. Enter Project Sedan, calling for the explosion of a 100-kiloton thermonuclear device buried 635 feet below ground level at the Nevada Test Site. Announcement of Chariot's demise and Sedan's promise would coincide. Explaining that Sedan would provide much of the data sought from Chariot and that other tests would pick up the slack more cheaply, the AEC could then plausibly deny any major role in the decision to doubts about safety. By adding a promise to publish the research results in due course, the issue seemed largely resolved.[19] Sedan might thus allow the Commission to salvage something from the four-year investment in Chariot. Although not part of original Plowshare plans, Sedan was nonetheless also a significant test in its own right.

### *The First Field Tests: Gnome and Sedan*

When the moratorium ended in fall 1961, Gnome was ready to go. To assuage the last nagging doubt, the test organization cut the planned yield from 10 to 5 kilotons; the actual yield proved to be 3 kilotons. The test device went into a chamber carved in bedded rock salt almost 1,200 feet below ground and 1,100 feet from the access shaft. When it exploded at noon on 10 December 1961, plans to contain the blast went awry. Unforeseen salt-bound water flashed to steam, vastly multiplying the explosive force and bursting through all seals. Radioactive steam and smoke geysered from the access shaft 300 feet into the air. High readings of external exposure rate and high tritium concentrations in air and under water in the shaft delayed recovery of experimental data for several days, and final recovery operations for several months.[20] But project workers escaped unscathed as did members of the nearby public. With little fallout from the gas cloud, radionuclides nowhere measured more than a hundredth of the published maximum concentration permitted offsite populations.[21] Disaster narrowly averted, however, scarcely boded well for Project Plowshare. Exposures both onsite and off, even if judged harmless, still caught the test organization by surprise and raised hard-to-answer questions about future Plowshare tests.

Several months later, Project Sedan raised such questions anew and Sedan, unlike Gnome, involved a major Plowshare goal: excavation. Technically, Sedan was not an atmospheric test but a so-called cratering shot. Cratering was a key earth-moving technique that required finely calculated depth of burial: the blast must break the surface, but not too much. Ejected rock falling back into the crater was supposed to trap most of the fission products underground. Radioactivity inevitably escaped from cratering shots, though only a fraction of what the nuclear explosion produced. The fraction that escape stayed relatively close to the ground and so did not travel far.[22] Although as much as 95 percent of the radioactivity would remain in the crater, even 5 percent of the debris from a 100-kiloton blast could pose problems. Naturally, the largest test device yet used in Nevada would have made public safety a prime concern anyway, all the more so because well over three years had passed since the last above-ground test in Nevada.[23] But in the event, Sedan rad-safe presented no problems: safety measures both onsite and off followed practice well-honed over more than a decade of nuclear weapons testing in Nevada.[24] Previous usage also dictated appropriate offsite exposure standards.[25]

The blast on 6 July 1962 lifted a huge dome of earth 290 feet into the air. That took the first three seconds. Incandescent gases then burst through the dome in a bright flash, the entire mixture of gas and earth shooting up to 2,000 feet. Atmospheric inversion capped the rising cloud of dust and gas 12,000 feet above the desert floor. Drifting on the wind north-northeastward, the cloud dropped ever decreasing fallout along a 150-mile path across Nevada. Heavier debris meanwhile had collapsed into the crater as planned, trapping more than 90 percent of the radioactivity but raising a base surge that spread a circular pattern of intense fallout two miles in all directions. The blast had shifted 6.5 million cubic yards of earth and rock, leaving a hole 1,200 feet across and 320 feet deep; most of the debris never left the vicinity, and the crater's lip towered as much as 100 feet into the air.[26]

Though greater than expected, onsite fallout caused little problem. No Sedan workers exceeded the 3-rem per quarter dose limit. Offsite rad-safe under Public Health Service auspices also functioned smoothly, and low levels of fallout posed no public health threat around the test site.[27] But events farther downwind did cause a stir. Levels of radioiodine-131 detected in milk samples from Salt Lake City alarmed Utah's public health director. The chief source of radioiodine in humans was drinking milk from cows grazing on plants exposed to fallout. City and state health officials urged milk producers to use dry feed for their animals. Relatively short-lived radioiodine would soon fall to minor levels in milk after the animals shifted from fresh forage.[28] AEC experts arrived in Salt Lake City to soothe ruffled feathers and persuade local health officials that no great danger attended the current situation. They largely succeeded, though some doubts remained.[29] Plowshare had nonetheless clearly gotten off to a shaky start.

### *Nuclear Excavation*

Neither contained completely underground nor purely atmospheric, cratering shots like Sedan remained something of an anomaly and might be hard to classify.[30] The AEC preferred to call them underground tests. This became a crucial issue after 5 August 1963, when the United States, the Soviet Union, and the United Kingdom signed the Limited Test Ban Treaty. Article I barred all nuclear explosions "in the atmosphere; beyond its limits, including outer space; or underwater." Underground tests remained legal only if they caused no "radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted."[31] Containment might thus involve not only safety but also international law.

The AEC quickly revised test rules to reflect the new limits. This meant chiefly test devices buried deeper. Minimum depth, the former practice for economic and technical reasons, no longer sufficed because it increased the likelihood of venting.[32] Whatever the AEC termed them, cratering shots did release fission products to the air and wind-borne debris might cross United States borders. That they also resembled weapons tests in almost every respect but purpose made distinctions between "peaceful nuclear explosions" and "military weapons tests" hard to draw. Some tests, in fact, served both purposes. The Kennedy administration's recently created Arms Control and Disarmament Agency led growing opposition to the AEC's broad interpretation of the new treaty.[33]

Confident of solving the problems with enough time and effort, the AEC nonetheless revised its Plowshare plans. It now focused on two immediate goals: developing the cleanest possible nuclear explosives and gaining a better handle on crater formation.[34] Inevitably, such a shift delayed the program. Almost two-and-a-half years passed before the next major Plowshare test. On 18 December 1964 Project Sulky, the first nuclear cratering experiment since Sedan in mid-1962, went smoothly enough.[35] Radioactivity was detected offsite, a common result of crater tests, but radiation safety presented no problems onsite or off.[36]

Well before the event, however, Sulky aroused heated debate within the AEC. Whether or not to announce the test beforehand was the issue, the test ban treaty the sticking point. Despite the AEC's promise of an open program, the Division of Peaceful Nuclear Explosives preferred to issue a public notice only after the fact. Sulky involved a very small-scale blast, equivalent to less than 100 tons of high explosive. Radioactive releases seemed likely to be minor and harmless nearby, all but undetectable farther away. Announcing the test in advance might simply allow "another nation" to deploy special gear and thus to detect an otherwise innocuous explosion.[37] The Director of Public Information objected to an action that could "open the AEC to legitimate charges of deliberately trying to mislead in a devious attempt to withhold potentially embarrassing information."[38] Nevada Operations Office agreed, but the White House and the Commissioners did not. The press release came only after 24 hours and made no mention of radioactivity.[39]

The next Plowshare test, Palanquin in April 1965, tried another approach to cleaner nuclear explosions, "debris entrapment," or, more familiarly, the "down-hole scheme." The explosion itself could propel radioactive debris downward into a special shaft below the emplaced device, the hole to closing behind it before the surface ruptured. Promising to reduce fallout from crater shots by a factor of 100, the scheme could save years of work on clean explosives.[40] Radioactive releases from Palanquin, given the nature of the test, should pose no problems, especially after Livermore redesigned the test for a 4-kiloton yield.[41] But the shot on 14 April 1965 surprised everyone. Radioactivity hurtled into the air (along with the gravel plug that was supposed to have contained it), and dust rose 8,000 feet above the unexpected crater. Although the AEC could assure the president that the mishap held no health threat, health was not the prime concern.[42]

Radioactivity in the cloud drifting northward was more than high enough to be tracked for almost a week heading toward Canada. Anxious officials waited for reports from flights along the U.S.-Canadian border. As predicted, the winds swept the cloud in a great arc from Nevada northward through Idaho, eastward through Montana, then southward toward Nebraska. Radioactivity never crossed the border, so far as anyone knew, and the test ban treaty remained inviolate.[43] Finally certain that trouble had been avoided, the AEC on 17 April released a brief statement to the wire services, though it retained tight control over further news for months.[44] Whatever the cloud's fate, Palanquin nonplussed the experts. Cratering clearly needed still cleaner test devices and better understood basic phenomena.[45]

But time was fast running out. Demonstrating nuclear methods for economically digging a sea-level canal across Central America had always been a Plowshare goal, once one among many proposed nuclear excavation projects, but by the mid-1960s the only firm prospect that remained. With Plowshare test results coming in so much more slowly than expected, however, even the canal job might be in jeopardy. By mid-1968 the Atlantic-Pacific Interoceanic Canal Study Commission was to decide if a sea-level canal were needed, where it should go, and whether building it should use conventional or nuclear explosives.[46] Unless the pace of Plowshare development accelerated, the nuclear option could lose by default.

Preparations for the next test, Cabriolet, proceeded smoothly toward an early 1966 firing date.[47] In mid-February 1966 Plowshare Director Kelly sought final approval for the test. It proved a long time coming. Once again, the Arms Control and Disarmament Agency argued vigorously that the test ban treaty precluded such tests. The Johnson administration wavered, then postponed the test until early 1967.[48] It also decided to announce Cabriolet, unlike Sulky and Palanquin, in advance.[49] But the January 1967 press release proved too hasty by far. Cabriolet was again deferred, first until spring, then fall.[50] Finally fired on 26 January 1968, it was all but trouble free. With a yield of 2.3 kilotons, the long-delayed event caused virtually no offsite fallout.[51]

Favorable Cabriolet results allowed the next 2 tests to follow quickly. Buggy was designed to show that a series of at least five charges detonated at once could produce a smooth-sided trench. This, of course, had special relevance for the canal project. Buggy used five test devices with a total yield of 5.4 kilotons; they were spaced 150 feet apart, buried 135 feet deep, and fired in sequence with slight delays between each shot. Everything went as planned on 12 March 1968.[52] Buggy produced a fairly smooth-walled trench and little offsite radioactivity.[53] The largest cratering test since Sedan took place at the end of the year. Originally planned in 1963 for a yield of 100 kilotons at a site in southwestern Idaho, Schooner was deferred when the test ban treaty went into effect.[54] The 1968 version projected a yield of 35 kilotons at the Nevada Test Site. As plans matured, the test date became 12 December.[55] Performance largely matched plans, despite a yield slightly lower than expected.[56] Schooner produced good results and no problems, with little radioactivity detected offsite.[57]

Notwithstanding the successes of 1968, Project Plowshare's future grew more doubtful. Nuclear earth-moving, despite several new schemes, retained a role in only one active program, the sea-level canal study. Congress had extended the 1968 deadline for the final report, now due December 1970, but much remained to be done. The AEC planned 4 major tests before the deadline. Unlikely though that might seem in terms of workload, schedules, and resources, especially in view of past performance, the study commission would accept nothing less.[58] But Schooner became the AEC's last cratering test, and nuclear excavation remained only a promise. Restrictions imposed by the test ban treaty were but part of the reason. Because further testing required much higher yields, questions of public safety also revived.[59] In its 1970 report the canal study commission rejected the technique: Not only was it unproved as to safety and perhaps treaty-breaking, but it might even be too costly. Conventional canal-building appeared to carry a price tag lower by $200 million than nuclear. Economy in large-scale earth-moving, a major Plowshare selling point, seemed at least questionable.[60]

***Plowshare's Fading Promise***

As earth-moving prospects dimmed, Plowshare planners began stressing underground engineering or industrial applications. All such projects were proposed or strongly supported by private industry; they centered on efforts to produce gas, oil, or minerals from deposits otherwise too costly to extract; and they would take place deep enough below ground to be fully contained. Burial depth mattered more than usual because they were not confined to the Nevada Test Site. Containment sharply reduced threats to public safety, to say nothing of the test ban treaty.[61] Feasibility studies of several projects marked the mid-1960s, though only Project Gasbuggy reached the field.[62]

In January 1967 El Paso Natural Gas Company signed a contract with the Department of the Interior and the AEC to conduct an experiment in northwestern New Mexico. Could nuclear explosives replace conventional high explosives or high-pressure fluids to fracture rock and stimulate the flow of natural gas?[63] Radiological safety raised questions early, centered during this phase of the program on normal concerns about venting. Nevada Test Site standards should serve just as well in New Mexico, the more so as the danger appeared small given the planned depth and yield.[64] The actual figures for the 10 December 1967 test were 4/5 of a mile (4,240 feet) below ground and 29 kilotons. Initial results looked good and only traces of activity reached the surface through cabling.[65]

Radioactive venting, however, had never seemed the major threat. The harder question was how badly contaminated the gas would be. Reentry drilling began just three days after the shot. Gasbuggy's final phase required tapping the chimney of fractured rock for gas samples, partly to measure increased flow, partly to learn what radionuclides might present problems. Precautions during drillback and later production tests safeguarded workers and kept the environment free of radioactivity.[66] Although Gasbuggy may have multiplied obtainable gas as much as eightfold, El Paso never sold any.[67] Even if the gas posed no health threat, as the experts believed, it remained too radioactive for the market.[68]

Encouraged by Gasbuggy's success, however limited, the AEC found another joint venture in gas stimulation, this time with Houston's Austral Oil Company footing the bill and a new Las Vegas corporation, CER Geonuclear, as hired manager. The scene shifted as well, to the Rulison field of west central Colorado, where rocks one to two miles deep tightly locked 8 trillion cubic feet of natural gas.[69] Radiation safety remained a key issue, though not for lack of progress by the Public Health Service and the AEC.[70] Despite a well-contained Gasbuggy test and a Rulison burial depth of 8,440 feet for a test device with a yield of 40 kilotons, rad-safe took a major share of Rulison planning. Environmental surveys figured largely in this effort.[71] Rulison also revealed anew the tight links between safety and public relations.[72] Reassuring local officials as well as the public became as great a part of the Public Health Service role in Colorado as it had long been in Nevada.[73]

Opposition to Rulison based largely on issues of safety nonetheless surfaced.[74] AEC attempts to argue the facts did little to appease critics, who largely rejected the Commission's basic premises.[75] For the first time, local citizens sought in court to enjoin the AEC from testing. They failed. Impressed by the government's careful precautions, the court denied the injunction on 27 August 1969. Immediately appealed, the decision was upheld on 2 September, two days before Rulison's scheduled firing date.[76] Although delayed by weather until 10 September 1969, the test otherwise went as planned.[77]

But Rulison was not yet out of the legal woods. Activists now sought a court order to enjoin the AEC from flaring gas. Once again, the government prevailed. Having already achieved some measure of success by having their case heard, this time plaintiffs did not appeal.[78] The central issue had never been the test itself. Impermeable rock over a mile-and-a-half deep seemed shield enough against radioactive contamination of land or water. Anxiety centered rather on posttest reentry drilling and production testing. With some prodding from the court, the AEC tried to assure worried citizens of its own great concern for just that work.[79] Safety planning had, in fact, focused chiefly on posttest drilling and testing, and the scheduled six-month pause before flaring would allow radioactivity to decay to safer levels.[80]

During the interim, safety remained much pondered.[81] Final plans were still being shaped when drilling began late in April 1970.[82] From a safety viewpoint, matters could scarcely have gone better.[83] But success had not come cheaply. Escalating costs—more than double the best original estimates—hit especially hard at the AEC's industrial partner in Rulison, Austral Oil. As the manager of Nevada Operations observed, "When Austral had to advance funds for preliminary safety studies to the AEC, . . . [they] realized that they would have no control . . . over any of the safety-related costs of the project."[84] And like El Paso, Austral never marketed its gas—not one of Rulison's technical goals, to be sure, but disappointing nonetheless.[85]

Plowshare's third gas stimulation experiment, Project Rio Blanco, began with a proposal from CER Geonuclear. Sited in Colorado north and west of Rulison, three test devices, each with a design yield of 30 kilotons, would explode in a single shaft more than a mile below ground to form a connected chimney of fractured rock 1,300 feet long. Accounted a partial success, Rio Blanco still fell short of expectations.[86] Environmental and safety concerns may have affected Rio Blanco even more than Rulison, less because Rio Blanco posed any new threat than because the *National Environmental Policy Act of 1969* had meanwhile become law. Preparing the first environmental impact statement for a nuclear test proved no easy task. Once more the AEC found itself in court. Despite again winning its case, the Commission could only expect worse to come. Practical ends depended on using large numbers of nuclear explosions, the same bleak prospect that blocked nuclear excavation.[87]

Technical success in a narrow sense marked all three gas stimulation tests, but in broader terms they failed. Although gas flow increased, the gas was slightly radioactive (it would have added less than 1 percent to background radiation in a normal house); none of it ever went on sale. Marketing was not one of the stated goals of any test, but failure to produce useful results still rankled. To make matters worse, the AEC found itself embroiled in litigation, a state of affairs unlikely to improve. Plowshare had reached the end of the road, less a victim of its admitted technical problems than of a drastically altered political climate. Practices that might have been accepted in the early 1960s, or at least not vigorously opposed, were more than likely to arouse active protest in the 1970s.

Technical success and practical failure likewise marked Project Plowshare as a whole. That it seemed to call for no great extension of extant scientific and technical skills made failure all the more galling. Nuclear explosives were, after all, Livermore's stock in trade, and adapting them to earth-moving or rock-fracturing hardly seemed to demand undue technological stretch. Yet technical success failed to translate into practical accomplishment; Plowshare achieved few of its larger aims. From a narrowly technical viewpoint, the program did demonstrate that nuclear explosives could move earth or fracture rock; what it could not show was how such effects could be achieved without raising hard questions about economy, treaty obligation, and public safety.

The real safety problem was not even how to avoid releasing dangerous levels of radioactivity to the atmosphere. Early program delays had the effect of shifting Plowshare decision-making into a new historical era; acceptable practice in the early 1960s was no longer so a decade later. Even if radioactivity could be controlled, that still left unsolved the problem of persuading the public of the program's safety. Ostensibly a straightforward question of health risk, it presumably could be addressed with facts and figures. But facts were not enough to allay public concerns. The underlying issues had more to do with unease about nuclear matters in general, to say nothing of growing mistrust of government, than to specific health effects. To such concerns, facts about radiation and health hardly mattered. Although not obvious at the time, Rio Blanco proved to be the last Plowshare test. Underground engineering went the way of nuclear excavation, victim of meager results and rising public opposition at least partly motivated by fear of radioactive fallout.[88]

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## ACRONYMS AND ABBREVIATIONS USED IN NOTES

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| ACE | Army Corps of Engineers |
| AGMIA | Assistant General Manager for International Activities, AEC |
| AIME | American Institute of Mining Engineers |
| ALOO | Albuquerque Operations Office, AEC |
| AEC | Atomic Energy Commission |
| *BAS* | *Bulletin of the Atomic Scientists* |
| CCEI | Colorado Committee for Environmental Information |
| CNI | Committee for Nuclear Information |
| DMA | Division/Director of Military Application, AEC |
| DNA | Defense Nuclear Agency, DOD |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOS | Division/Director of Operational Safety, AEC |
| DPI | Division/Director of Public Information, AEC |
| DPNE | Division/Director of Peaceful Nuclear Explosives, AEC |
| EIC | Eberline Instrument Corporation |
| EPA | Environmental Protection Agency |
| FRC | Federal Radiation Council |
| FY | Fiscal Year |
| GAC | General Advisory Committee, AEC |
| HASL | Health and Safety Laboratory, AEC |
| IAEA | International Atomic Energy Agency |

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|---|---|
| JCAE | Joint Committee on Atomic Energy, U.S. Congress |
| JOI | Joint Office of Information |
| JRB | JRB Associates |
| LLL | Lawrence Livermore Laboratory |
| LRL | Lawrence Radiation Laboratory |
| NASM | National Security Action Memorandum |
| NCRH | National Center for Radiological Health, PHS |
| NPT | Non-Proliferation Treaty |
| NTS | Nevada Test Site |
| NVO | Nevada Operations Office, AEC |
| OFO | Office of Field Operations, ALOO |
| OTO | Office of Test Organization, ALOO |
| PAC | Plowshare Advisory Committee |
| PGO | Project Gnome Office |
| PHS | Public Health Service |
| PNE | Peaceful Nuclear Explosions |
| P-SAC | President's Science Advisory Committee |
| REECo | Reynolds Electrical & Engineering Co. |
| SOP | Standard Operating Procedure |
| SWRHL | Southwestern Radiological Health Laboratory, PHS |
| UAPC | University of Alaska Project Chariot |
| UCRL | University of California Radiation Laboratory |
| USPHS | U.S. Public Health Service |