BIBLIOGRAPHY ON RADIATION EFFECTS AT VERY LOW DOSES AND DOSE RATES

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Induction of a bystander mutagenic effect of alpha particles in mammalian cells

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Ever since the discovery of X-rays was made by Röntgen more than a hundred years ago, it has always been accepted that the deleterious effects of ionizing radiation such as mutation and carcinogenesis are attributable mainly to direct damage to DNA. Although evidence based on microdosimetric estimation in support of a bystander effect appears to be consistent, direct proof of such extranuclear/extracellular effects are limited. Using a precision charged particle microbeam, we show here that irradiation of 20% of randomly selected A_L cells with 20 alpha particles each results in a mutant fraction that is 3-fold higher than expected, assuming no bystander modulation effect. Furthermore, analysis by multiplex PCR shows that the types of mutants induced are significantly different from those of spontaneous origin. Pretreatment of cells with the radical scavenger DMSO had no effect on the mutagenic incidence. In contrast, cells pretreated with a 40 μM dose of lindane, which inhibits cell–cell communication, significantly decreased the mutant yield. The doses of DMSO and lindane used in these experiments are nontoxic and nonmutagenic. We further examined the mutagenic yield when 5–10% of randomly selected cells were irradiated with 20 alpha particles each. Results showed, likewise, a higher mutant yield than expected assuming no bystander effects. Our studies provide clear evidence that irradiated cells can induce a bystander mutagenic response in neighboring cells not directly traversed by alpha particles and that cell–cell communication process play a critical role in mediating the bystander phenomenon.

Epidemiological studies of uranium mine workers and experimental animal studies suggest a positive correlation between exposure to alpha particles emitted from radon and its progeny and the development of lung cancer (1–4). The mechanism(s) by which alpha particles cause lung cancer has not been elucidated, although a variety of genetic lesions, including chromosomal damage, gene mutations, induction of micronuclei, and sister chromatid exchanges (SCE), have been associated with the DNA-damaging effects of alpha particles (5–9).

For over a century since the discovery of X-rays, it has always been accepted that the deleterious effects of ionizing radiation such as mutation and carcinogenesis are attributable mainly to direct damage to DNA. Although the differential biological effects of nuclear versus cytoplasmic irradiation has been of interest to biologists and geneticists for decades, not much is known about the potential interaction between the two types of cellular damages. However, there is recent evidence to suggest that extranuclear or extracellular targets may also be important in mediating the genotoxic effect of irradiation (8–13). It was found, for example, that very low doses of alpha particles induced clastogenic responses (principally SCE) in both Chinese hamster ovary (CHO) and human fibroblast cultures at levels significantly higher than expected based on microdosimetric calculation of the number of cells estimated to have been traversed by a particle (8, 9). In CHO cells irradiated with low dose of alpha particles where <1% of the cells were actually traversed by a particle, an increase in SCE was observed in >30% of the cells (8). Subsequently, based on microdosimetric analysis, it was estimated that the potential target size for this SCE-induced effect would require an area 350 times the typical size of a CHO nucleus (9). The additional responding cells that received no irradiation were "bystanders" of either directly hit cells or resulted from agents released from the irradiated medium (8, 10). Subsequent studies suggested that reactive oxygen species might contribute to the induction of SCE among the bystander cells (11). Enhanced expression of the p53 tumor suppressor gene in bystander cells has also been reported in immortalized rat lung epithelial cells and human diploid fibroblast cells irradiated with alpha particles (12, 13). Although evidence in support of a bystander effect appears to be consistent, clear and unequivocal proof of a mutagenic effect has not been available.

Using a precision charged particle microbeam, we showed recently that irradiation of cellular cytoplasm with either a single or an exact number of alpha particles resulted in mutation in the nucleus while inflicting minimal toxicity, and that free radicals mediate the mutagenic process (14). The results with the well established free radical scavenger dimethyl sulfoxide (DMSO), and the thiol depleting drug buthionine S-R-sulfoximine provide further support of the idea that reactive oxygen species, particularly hydroxyl radicals, modulate the mutagenic response of cytoplasmic irradiation. More recently, Prise *et al.* (15) reported that a single human fibroblast irradiated with five alpha particles from a microbeam induced a significant increase in micronuclei among neighboring cells, although no mechanistic explanations were provided in this study as to how a single irradiated cell mediated a bystander response. Using human–hamster hybrid A_L cells, we report here that irradiated cells can induce a bystander mutagenic response in neighboring cells not directly traversed by alpha particles, and that signal transduction pathways, other than hydroxyl radical-mediated oxidative stress, play a critical role in mediating the bystander effect.

Materials and Methods

Cell Culture. Human–hamster hybrid A_L cells that contain a standard set of Chinese hamster ovary-K1 chromosomes and a single copy of human chromosome 11 were used in the study (16). Chromosome 11 encodes a cell surface marker that renders A_L cells sensitive to killing by specific monoclonal antibody E7.1 in the presence of rabbit serum complement (Covance, Denver, PA). Monoclonal antibody specific to the *CD59* (formerly called *S1*) antigen was produced from hybridoma culture as described (16, 17). Cells were maintained in Ham's F-12 medium supplemented with 8% heat-inactivated fetal bovine serum, 25 μg/ml gentamycin, and

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Abbreviations: SCE, sister chromatid exchanges; CHO, Chinese hamster ovary.

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2× normal glycine (2×10^{-4} M) at 37°C in a humidified 5% CO_2 incubator, and were passaged as described (18–20).

Irradiation Procedure. Approximately 500 exponentially growing A_L cells were inoculated into each of a series of microbeam dishes constructed by drilling a 1/4-inch hole in the center of 60-mm diameter non-tissue-culture dishes (14, 19). A 3.8-μm-thick polypropylene film was epoxied over the bottom of the hole, creating a miniwell that was then coated with Cel-Tak to enhance cell attachment. Two days after plating, when the number of attached cells reached an average of 2,000 per dish and covered ≈80% of the growth surface, with ≈70% of the attached cells in contact with neighboring cells, the nuclei of attached cells were stained with a 50 nM solution of Hoechst 33342 dye for 30 min. An image analysis system was used to determine the centroid of each nucleus. The nucleus of a fixed proportion of A_L cells, chosen at random, was then irradiated with an exact number of alpha particles (14, 19). After irradiation, cells were maintained in the dishes for 3 days before being removed by trypsinization and replated into culture flasks. After incubation for an additional 4–5 days, the cells were trypsinized and reinoculated into plates for mutation studies as described (18–20).

Dose Response for Cytotoxicity. Irradiated and control cells in a series of miniwells were trypsinized immediately after irradiation and were replated into 100-mm diameter Petri dishes for colony formation. As described previously, we routinely recovered >98% of the attached cells from each miniwell for analysis (14, 19). Cultures were incubated for 7–12 days, at which time they were fixed with formaldehyde and were stained with Giemsa. The number of colonies was counted to determine the surviving fraction as described (18–20).

Quantification of Mutations at the *CD59* locus. To determine mutant fractions, 5×10^4 cells were plated into each of six 60-mm dishes in 2 ml of growth medium and were incubated for 2 hr for attachment, at which time 0.3% *CD59* antiserum and 1.5% (vol/vol) freshly thawed complement were added to each dish as described (21). The cultures were further incubated for 7–8 days and were fixed and stained, and the number of $CD59^-$ mutant colonies was scored. Controls included identical sets of dishes containing antiserum alone, complement alone, or neither agent. Each culture derived from each treatment dose was tested for mutant yield for two consecutive weeks to ensure full expression of mutations. The mutant fraction at each dose (MF) was calculated as the number of surviving colonies divided by the total number of cells plated after correction for any nonspecific killing on the plating efficiency due to complement alone.

PCR Analysis of Mutant Spectrum. Cloning of $CD59^-$ mutants and PCR analysis of mutant spectrum were performed as described (19–21). In brief, independently derived colonies were isolated by cloning and were expanded in cultures, and DNA was extracted by using a high salt method (22). To ensure that all mutants analyzed were independently generated, irradiated cells from each microbeam dish were processed individually. In the few cases in which clones recovered from each dish were fewer than expected, cells from 2–3 dishes were pooled and processed together for mutation assay as individual flasks. Irradiated A_L cells recovered from each microbeam dish were plated out for mutagenesis studies as described above. In most cases, only one and at times no more than two $CD59^-$ mutants were isolated from each irradiated population for mutant spectrum analysis. Five DNA marker genes on chromosome 11 (Wilms' tumor, Parathyroid Hormone, Catalase, RAS, and Apolipoprotein A-1) were chosen for multiplex PCR analysis because of their mapping positions relative to the *CD59* gene, which encodes the *CD59* antigen (16, 17, 23), and the availability of PCR primers for the coding regions of these genes (24–26). PCR amplifications were performed for 30 cycles by using a DNA thermal cycler model 480 (Perkin–Elmer/Cetus) in 20-μl reaction mixtures containing 0.2 μg of the *Eco*RI-digested DNA sample in 1× Stoffel fragment buffer, all four dNTPs (each at 0.2 mM), 3 mM $MgCl_2$, 0.2 mM each primer, and 2 units of Stoffel fragment enzyme (19, 21). Each PCR cycle consisted of denaturation at 94°C for 1 min, annealing at 55°C for 1 min, and extension at 72°C for 1 min. After the last cycle, the samples were incubated at 72°C for an additional 20 min, were electrophoresed on 3% agarose gels, and were stained with ethidium bromide.

Prediction of the Expected Yield of Mutants. To predict mutant yields in experiments in which a fixed fraction of the cells were irradiated with an exact number of alpha particles through the nuclei, we use a mathematical analysis to a combination of results from experiments in which cells were irradiated and assayed in homogenous groups, assuming no bystander effect. We define: N is the number of cells in the irradiated dish; S is the number of clonogenic cells after irradiation; P is the number of progeny at the time when mutation is assayed; M is the number of mutants counted; K is the number of alpha particles delivered to the nuclear centroids; f is the fraction of cells that are irradiated; and F is the fraction of cells that are progeny of irradiated cells at the time of assay.

The present experiment is described as

$$N_K = f \times N \quad [1]$$

$$N_0 = (1 - f) \times N, \quad [2]$$

where the subscripts show the number of alpha particles delivered. After irradiation, the number of unirradiated survivors is expected to be

$$S_0 = N_0 \times \mathrm{PE} \quad [3]$$

The plating efficiency (PE) is derived from sham-irradiated control. The number of irradiated survivors is expected to be

$$S_K = N_K \times \mathrm{PE} \times \mathrm{SF}_K \quad [4]$$

where the survival fraction (SF) is derived from an experiment in which 100% of the cells were irradiated with k alpha particles. The fraction of cells that are progeny of the irradiated cells in the culture after the expression period is assumed to be the same as the fraction that survived initially, so

$$F = S_K/(S_K + S_0) \quad [5]$$

Aliquots of 5×10^4 cells are assayed for mutation as described. The number of progeny of irradiated and unirradiated cells in each aliquots is

$$P_K = F \times 5 \times 10^4 \quad [6]$$

$$P_0 = (1 - F) \times 5 \times 10^4 \quad [7]$$

Assuming no bystander effects, the number of mutants in each aliquot arising from irradiated and unirradiated cells is expected to be

$$M_K = P_K \times \mathrm{MF}_K \quad [8]$$

$$M_0 = P_0 \times \mathrm{MF}_0 \quad [9]$$

where the mutant fractions (MF) are derived from experiments in which 100% of the cells were irradiated through the nucleus or sham irradiated respectively. The predicted mutant fraction in the present experiment, assuming no bystander effect, is therefore

$$\mathrm{MF} = (M_0 + M_K)/5 \times 10^4 \quad [10]$$

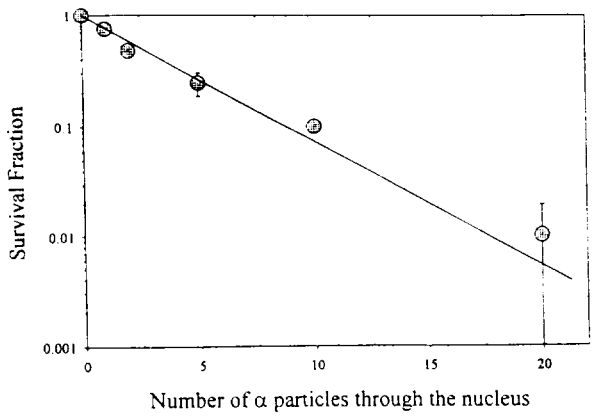

Fig. 1. Survival of A_L cells irradiated with an exact number of alpha particles in the nucleus. Data were pooled from three to four independent experiments. Error bars represent ± SEM.

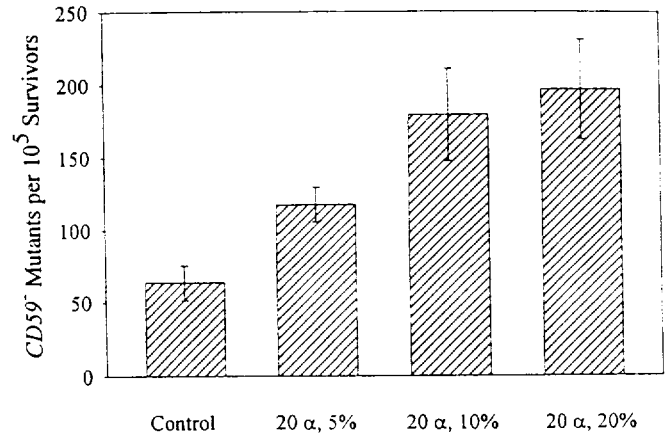

Fig. 2. Mutant fraction obtained from populations of A_L cells in which 0, 5, 10, or 20% of whose nuclei were traversed by 20 alpha particles. Data were pooled from three to eight independent experiments. Error bars represent ± SEM.

Treatment with DMSO. To examine the role of reactive oxygen species in mediating bystander mutagenesis, cells were treated with 8% DMSO 10 min before and 10 min after the irradiation or with 0.2% DMSO for 24 hr before irradiation, continued through the 7-day expression period. DMSO at the doses used in these experiments was nontoxic and nonmutagenic but had been shown to be an effective free radical scavenger (14, 27, 28). After treatment, cultures were washed, trypsinized, and replated for determination of survival and mutation as described.

Treatment with Lindane. The role of cell–cell communication in the bystander genotoxicity of alpha irradiation was investigated by treating A_L cells with a 40 μM dose of lindane for 2 hr before and 3 days after the irradiation. Lindane, a γ-isomer of hexachlorocyclohexane, has been shown to be an effective inhibitor of cell–cell communication (29). After treatment, cultures were washed, trypsinized, and replated for analysis of survival and mutagenesis as described above.

Statistical Analysis. All data for cell killing and mutation were calculated as means and standard errors of the mean. Determinations of the statistical significance of survival fractions and induced mutant fractions between treated groups and controls were made by Student's t test. Differences in the mutation spectra for $CD59^-$ mutants between treated group and control were analyzed by χ^2 analysis. A P value of 0.05 or less between groups was considered to be significant.

Results

Lethality of Alpha Particles Traversal through the nucleus of A_L Cells. Fig. 1 shows the dose-response for clonogenic survival of A_L cells irradiated through the nucleus with an exact number of alpha particles. The average plating efficiency of non-irradiated A_L cells grown on polypropylene under the experimental conditions used here was ≈10%. The survival data were fit by a log-linear curve with no shoulder. The mean lethal dose D_0, defined as the dose that reduced survival to 0.37 ($1/e$) in the log-linear portion of the curve, was ≈3.6 particles. It is clear from these data that most of the cells survived to form colonies after exposure of their nuclei to a single particle. This result is consistent with our previous finding (19). The surviving fraction after irradiation with 20 alpha particles was 0.01 ± 0.01. In the mutation experiment, 20% of the 2,000 cells in each microbeam dish were irradiated with 20 alpha particles. From Eqs. **2** and **3**, we expect the number of non-irradiated survivors to be $S_0 = (1 - 0.2) \times 2{,}000 \times 0.1$ or 160 ± 16. Similarly, the number of irradiated survivors from Eqs. **1** and **4** is predicted to be $S_{20} = 0.2 \times 2{,}000 \times 0.1 \times 0.01$ or 0.4 ± 0.4 cells per dish. The fraction of irradiated survivors in the culture from Eq. **5** is, therefore, $F = 0.4/(0.4 + 160)$ or $(2 \pm 2) \times 10^{-3}$. This means that 99.8% of the progeny are from unirradiated cells. The uncertainty is dominated by the uncertainty in the surviving fraction following 20 alpha particles.

Mutagenicity of Alpha Particle Traversals Through the Nucleus. We have reported the mutagenic effects of exact numbers of alpha particles up to eight particles per nucleus in the A_L cell assay (19). Using the same procedures, the mutant fraction, when 20 alpha particles traversed the nucleus, was 130 ± 38 per 10^5 survivors. The error was the SEM of three independent experiments. Although this yield is less than that from eight alpha particles, it is consistent with broad beam irradiation at high doses (21). The background mutant fraction of the A_L cell population used in the present experiments was 64 ± 15 per 10^5 survivors.

Bystander Mutagenesis in A_L Cells in Which a Fixed Proportion of Randomly Selected Cells Each Received 20 Alpha Particles Through Their Nucleus. The relatively high mutagenic sensitivity of the A_L cell system made it possible to assess the bystander mutagenic potential of alpha particles. Using a precision charged particle microbeam and image analysis system, we irradiated 20% of randomly selected A_L cells with 20 alpha particles each, such that the clonogenic survival fraction was reduced to <0.01. Under the experimental conditions, ≈70% of the cells were in direct contact with an irradiated cells. The results for mutation after irradiation with 20 alpha particles, along with the survival results can be combined to predict the number of mutants expected in the present experiments, assuming no bystander effect. The number of mutants in an aliquot of 5×10^4 cells resulting from unirradiated cells predicted from Eqs. **7** and **9** is $M_0 = (1 - 0.2 \times 0.01) \times 5 \times 10^4 \times (64 \pm 15) \times 10^{-5}$ or 32 ± 8. Similarly, using Eqs. **6** and **8**, we predict that the number of mutants resulting from the progeny of the cells irradiated with 20 alpha particles to be $M_{20} = (2 \pm 2) \times 10^{-3} \times 5 \times 10^4 \times (130 \pm 38) \times 10^{-5}$ or 0.13 ± 0.14. The predicted result is that 99.6% of the mutants found in the absence of bystander effects are from spontaneous mutagenic events among the unirradiated cells. The predicted mutant fraction is MF = 64 ± 15 per 10^5 progeny in the absence of a bystander effect. As shown in Fig. 2, the measured mutant fraction when 20% of cells were irradiated with 20 alpha particles each was 196 ± 34 per 10^5 progeny, a 3-fold higher than expected yield assuming no bystander effect. The results suggest that

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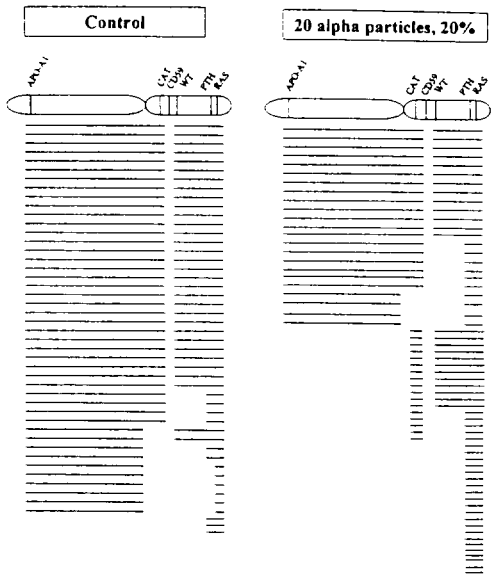

Fig. 3. Mutational spectra of *CD59*⁻ mutants isolated from unirradiated populations or from populations in which 20% of the cells had been irradiated with 20 alpha particles through their nuclei. Each line depicts a single mutant. Blank spaces depict missing markers on chromosome 11 as determined by multiplex PCR.

unirradiated cells acquire the mutations indirectly. In other words, irradiated cells clearly induce a bystander mutagenic response in neighboring cells not directly traversed by alpha particles.

If irradiated cells generate substances that induce mutation in neighboring, non-irradiated cells, then mutant yields in the latter would be expected to decrease when fewer cells were irradiated. To test this prediction, 5 and 10% of the cells were randomly irradiated through their nuclei with 20 alpha particles each. The expected yield as calculated above, assuming no bystander effect, should be almost the same as the background mutation yield. As shown in Fig. 2, the actual mutant fraction obtained when 5% of cells were irradiated with 20 alpha particles each was 118 ± 12 per 10^5 progeny, a value significantly higher than the expected value of 64 mutants per 10^5 survivors assuming no bystander effect ($P < 0.05$). A similar finding was also observed when 10% of the population was randomly irradiated to result in a measured mutant fraction of 179 ± 32 per 10^5 progeny ($P < 0.05$). The difference in bystander mutant fractions between 10 and 20% of cells traversed through their nuclei by 20 alpha particles each was not statistically different.

Analysis of Mutant Spectrum. To determine the types of mutation associated with the *CD59*⁻ phenotype in bystander A_L cells, we isolated individual independent clones and applied multiplex PCR to determine the presence or absence of five chromosome 11 markers located on either side of the *CD59* gene. The primers and PCR conditions were selected to amplify only the human genes and not their CHO cognates (19, 21, 30). Previous studies have shown that a small segment of the human chromosome 11 near the RAS gene is required for survival of *CD59*⁻ mutants. The obligate presence of this region identified here by the presence of RAS probe in all of the mutants provides a convenient internal PCR control (29). A total of 108 mutants, including 47 spontaneous ones, were analyzed. As shown in Fig. 3, 30 of 47 or 63% of spontaneous *CD59*⁻ mutants had retained all of the markers. In contrast, 82% of the mutants from populations in which 20% of the cells were irradiated with 20 alpha particles each had lost at least one additional marker, which included 28% complex mutations. The difference in spectrum between the two types of mutants was highly significant ($P < 0.01$). Furthermore, the spectrum of mutants generated in the present study was significantly different from that induced by cytoplasmic irradiation, which consisted mainly of small alterations involving only the *CD59* gene (14). The difference in spectrum suggests that different mutagenic mechanisms are involved in the two processes.

Table 1. Effects of the free radical scavenger DMSO on mutant yield in A_L cells in which 20% of them were irradiated with 20 alpha particles each through their nuclei

Irradiation	DMSO, %	Mutant fraction per 10^5 survivors
0	0	63 ± 20
0	0.2	41 ± 12
0	8	61 ± 10
20 α, 20%	0	210 ± 30
20 α, 20%	0.2	203 ± 27
20 α, 20%	8	224 ± 39

DMSO when used at 0.2% was added to the cells 24 hr before irradiation and was removed after 7 days of incubation. DMSO, 8%, was present for 20 min, 10 min before and 10 min after irradiation (14). Data were pooled from three independent experiments

Bystander Mutagenicity of Alpha Particles Is Not Affected by DMSO. Reactive oxygen species such as superoxide anion, hydroxyl radicals, and hydrogen peroxides are the intermediates formed during oxidative metabolism. The antioxidant DMSO has been shown to be an effective radical scavenger, particularly of hydroxyl radicals, and it can protect mammalian cells against the toxic and genotoxic effects of variety of agents such as ionizing radiation, asbestos fibers, and arsenic in which oxyradicals are known to mediate their biological effects (31, 32, 33). Table 1 shows that, in cells pretreated with 0.2% DMSO 24 hr before irradiation and maintained in it throughout the expression period, the bystander mutation frequency was like that in cells without DMSO treatment. Similarly, treatment with 8% DMSO 10 min before and 10 min after irradiation, which reduced the mutagenic response caused by cytoplasmic irradiation (14), did not affect the bystander mutation fraction in the present experiments (Table 1). DMSO treatment by itself was nontoxic and nonmutagenic to A_L cells under the experimental condition used in the present study.

Is the Bystander Mutagenicity of Alpha Particles Mediated by Cell–Cell Communication? To explore the possible mechanisms involved in bystander mutagenic effects, experiments were performed to investigate the contribution of cell–cell communication between irradiated and non-irradiated cells using lindane as described (13, 29). Lindane by itself at the dose used was neither toxic nor mutagenic to A_L cells (data not shown). As shown in Fig. 4, in cells pretreated with a 40 μM dose of lindane 2 hr before irradiation and maintained in it for 3 days after irradiation, the mutant fraction was decreased significantly to 97 ± 16 per 10^5 progeny ($P < 0.05$), but at a level slightly higher then that of lindane control (64 ± 15).

Discussion

Most of the genetic effects induced in mammalian cells by ionizing radiation have been shown to result from direct damage to nuclear DNA or via "quasi-direct" effects mediated by water molecules associated with it (34–37). Thus, when a proportion of cells is exposed to alpha-particle irradiation, biological effects would be expected only in those cells whose nuclei are physically traversed by alpha particles. Presumably, no effects are to be

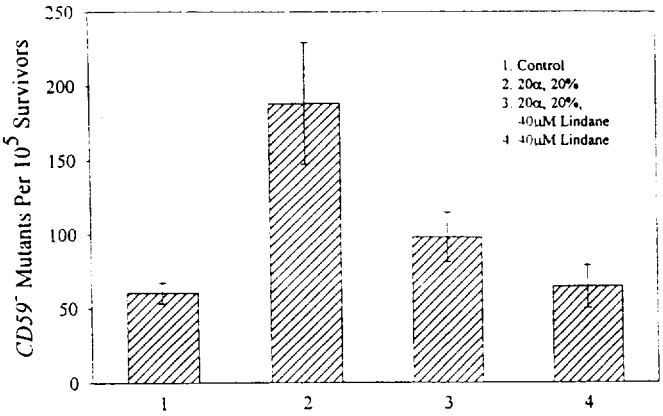

Fig. 4. Effect of lindane treatment (40 μM, 2 hr before and 3 days after irradiation) on mutant yields in A_L cells 20% of which had been irradiated with 20 alpha particles through their nuclei. Data were pooled from three independent experiments. Error bar represents ± SEM.

expected in the unirradiated cells in the population. However, there is also evidence, much of it based on statistical considerations, that indicates that irradiated mammalian cells can produce and release substances that cause genetic damage in co-cultivated but unirradiated cells. Early evidence for this bystander effect came from studies in which the frequency of SCE in populations of cells exposed to low fluences of alpha particles was significantly higher than expected from target theory calculations of the number of cells that had actually received an alpha particle (8, 9, 38). There is recent evidence that this bystander effect may also be extended to include mutation in CHO cells (39). In addition, medium from cultures of cells irradiated with γ rays can kill unirradiated cells (10) and cells in contact with cells internally irradiated by short-range ^{3}H-β particles have a reduced clonal survival (40). Using a precision charged particle microbeam, we recently reported that irradiation of cellular cytoplasm with either a single or an exact number of alpha particles results in mutation in the nucleus while causing little toxicity, and that free radicals mediate the process (14). The study provided a clue that cytoplasmic targets may contribute to the bystander phenomenon. To extend these observations, we present in the present study clear evidence, not based on target theory Poisson calculations, that mutations are induced in cells not traversed by an alpha particle. We further show that mutagenesis depends on cell–cell communication and that the spectrum of mutations induced is unlike that found spontaneously.

Using the nuclear cross sectional area of 108 μm^2 measured for A_L cells, we calculated that a dose of $\approx$12 cGy of 90 keV/μm alpha particles from track segment irradiation where attached cells are exposed to a board beam of monoenergetic particles would be required to deliver an average of one particle traversal per nucleus based on random, Poisson distribution (19). Our direct measurement showed that $\approx$20% of the irradiated cells were killed by a single alpha particle traversal through the nuclei, and >99% of the cells grown on the microwell dishes were killed by 20 alpha particles through the nucleus. These data are consistent with our previous findings (19).

Interaction between irradiated and non-irradiated cells has been of interest to biologists and geneticists for decades. Lorimore *et al.* (41) reported recently that alpha particle irradiation induced chromosome instability in the descendants of unirradiated stem cells and suggested that instability could be attributed to interactions between the irradiated and non-irradiated cells. There is evidence that culture medium exposed to alpha particles can produce a SCE-inducing factor(s) and that exposure of unirradiated cells to factor(s) present in the residual medium can induced the production of SCE in these cells (38). These findings are reminiscent of the earlier report of Stone *et al.* that demonstrated that irradiation of bacterial culture broth by UV light for a period of 3 hr significantly enhanced the mutational phenotype of penicillin-resistance in *Staphylococcus aureus* (42). However, in the present study using the microbeam, there was <3 μl of medium present per microbeam dish during irradiation. It is, therefore, unlikely that medium would play a significant role in mediating the bystander mutagenic effect. Because DMSO is highly effective in scavenging hydroxyl radicals, our data would seem to rule out the role of this radical species, although other long-lived radicals not scavenged by DMSO could be involved (31).

It is of interest to note that the bystander mutagenic effect induced among unirradiated A_L cells in which either 10 or 20% of the cell population were irradiated with 20 alpha particles each are not much different (Fig. 2). This finding is consistent with our previous report on mutagenicity induced by cytoplasmic irradiation with alpha particles (14). The decrease in bystander mutant yield could reflect that the production of mediators of mutation was saturated because the number of unirradiated cells in direct contact with an irradiated cell between the 10 and 20% population was not much different (data not shown).

Our present finding with lindane is consistent with that of Azzam *et al.* (13), who reported that expression levels of p53, p21, CDC2, Cyclin B1, and RAD51 were significantly modulated in confluent, density-inhibited human diploid cell populations exposed to doses in which only a small fraction of nuclei were expected to be traversed by an alpha particle track. The extent of modulation of p53, p21 was found to be significantly reduced in the presence of lindane, which suggested that cell–cell communication was involved in the bystander effect (13). Extracellular communication from one cell to another over extracellular space triggers various kinds of intracellular signal transduction processes in the receiving cell. Modulation of the intracellular physiology of the target cell can affect the up- or down-regulation of intercellular communication, which is essential in tissue homeostasis (43). However, the nature of the signaling molecule(s) involved in the communication between alpha particle-traversed and -non-traversed cells remains to be established. It is likely that multiple pathways are involved in mediating the bystander effect. Our present finding with DMSO is consistent with data obtained in our preliminary dilution experiment in which cells irradiated with 20 alpha particles are mixed with a fixed proportion of control cultures (80 and 90%) to achieve either 10 or 20% irradiated population. No enhancement in bystander mutagenic effect was detected in these mixing studies, suggesting that cell–cell contact was required and that labile mediator(s) appeared unlikely to be involved in the response. Our studies provide clear proof that irradiated cells may induce bystander mutagenic response in neighboring cells not directly traversed by alpha particles and suggest that signal transduction pathway other than hydroxyl radical-mediated oxidative stress may play a critical role in mediating the bystander phenomenon.

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Cell Biology

Targeted cytoplasmic irradiation with alpha particles induces mutations in mammalian cells

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ABSTRACT **Ever since x-rays were shown to induce mutation in *Drosophila* more than 70 years ago, prevailing dogma considered the genotoxic effects of ionizing radiation, such as mutations and carcinogenesis, as being due mostly to direct damage to the nucleus. Although there was indication that alpha particle traversal through cellular cytoplasm was innocuous, the full impact remained unknown. The availability of the microbeam at the Radiological Research Accelerator Facility of Columbia University made it possible to target and irradiate the cytoplasm of individual cells in a highly localized spatial region. By using dual fluorochrome dyes (Hoechst and Nile Red) to locate nucleus and cellular cytoplasm, respectively, thereby avoiding inadvertent traversal of nuclei, we show here that cytoplasmic irradiation is mutagenic at the CD59 (S1) locus of human–hamster hybrid (A_L) cells, while inflicting minimal cytotoxicity. The principal class of mutations induced are similar to those of spontaneous origin and are entirely different from those of nuclear irradiation. Furthermore, experiments with radical scavenger and inhibitor of intracellular glutathione indicated that the mutagenicity of cytoplasmic irradiation depends on generation of reactive oxygen species. These findings suggest that cytoplasm is an important target for genotoxic effects of ionizing radiation, particularly radon, the second leading cause of lung cancer in the United States. In addition, cytoplasmic traversal by alpha particles may be more dangerous than nuclear traversal, because the mutagenicity is accomplished by little or no killing of the target cells.**

Radon is ubiquitous in indoor environments and is recognized as a causal factor for lung cancer, which the U.S. Environmental Protection Agency has estimated accounts for as many as 21,600 cases per year (1). It is a secondary decay product of ^{238}uranium and is a colorless, odorless gas, which decays with a half-life of 3.82 days into a series of short-lived radionuclides that emit high linear energy transfer α-particles (2). To develop a better quantitative assessment of lung cancer risk associated with residential radon exposure, it is essential to derive an understanding of the effects of low dose exposure. Furthermore, understanding radiation carcinogenesis requires information on mechanisms underlying the genotoxic effects of radiation. We showed previously that a single α-particle traversal through the nucleus of the human–hamster hybrid (A_L) cells induced a mutant yield that was more than 2-fold above the background level (3). Furthermore, the proportion of mutants with multilocus deletions increased with the number of particle traversals. With improvement in the image analysis system, which permits selective targeting and irradiation of cellular cytoplasm in a way similar to the nuclear irradiation, we are able to test the dogmatic theme that DNA is the quintessential genetic target by examining the genotoxicity of cytoplasmic irradiation in mammalian cells.

Ever since x-rays were shown to induce mutation in *Drosophila* more than 70 years ago, it has always been assumed that the deleterious effects of ionizing radiation, such as mutation and carcinogenesis, are due mainly to direct damage to DNA. Although evidence suggesting that extracellular/extranuclear targets may play a role in such damage has surfaced recently, direct proof of this has not been available. It was found, for example, that very low doses of α-particles induced clastogenic responses (principally sister chromatid exchanges) in both Chinese hamster ovary (CHO) and human fibroblast cultures at levels significantly higher than expected, based on the number of cells that had been traversed by a particle (4, 5). The additional responding cells, which received no radiation exposure, were "bystanders" of either directly hit cells or resulted from agents released from the irradiated medium (5). Subsequent studies suggested that reactive oxygen species may contribute to the induction of SCE among the bystander cells (6). Enhanced expression of the p53 tumor suppressor gene in bystander cells has also been reported in immortalized rat lung epithelial cells irradiated with α-particles (7). The biological consequences of irradiating cytoplasm are largely unknown. To address this issue, we used a charged particle microbeam (3), where cytoplasm of individual A_L human–hamster hybrid cells could be targeted and irradiated with high precision to quantify clonogenic survival and mutations induced by defined numbers of α-particle traversals at 90 keV/μm. Our data demonstrate that irradiation of cytoplasm produces gene mutations in the nucleus and that free radicals mediate the process.

MATERIALS AND METHODS

Cell Culture. The A_L hybrid cells that contain a standard set of CHO-K1 chromosomes and a single copy of human chromosome 11 were used (8). Chromosome 11 contains the *CD59* gene (formerly known as *M1C1*) at 11p13.5, which encodes the CD59 cell surface antigen (also known as the S1 antigen) that renders A_L cells sensitive to killing by a specific mAb, E7.1, in the presence of rabbit serum complement (HPR, Denver, PA). Antibody E7.1 was produced from hybridoma culture as described (9, 10). Cells were maintained in Ham F-12 medium

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Abbreviations: CHO, Chinese hamster ovary; DMSO, dimethyl sulfoxide; ROS, reactive oxygen species; BSO, buthionine-*S*-*R*-sulfoximine; 8-OHdG, 8-hydroxy-deoxyguanosine.

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supplemented with 8% heat-inactivated fetal bovine serum, 25 μg/ml gentamycin, and 2× normal glycine (2×10^{-4}M) at 37°C in a humidified 5% CO_2 incubator, and passaged as described (11, 12).

Irradiation Protocols. The layout and methods for nuclear irradiation using the microbeam have been described (3). For cytoplasmic irradiation, Hoechst 33342 and cytoplasmic Nile Red (13) fluorochromes were used to stain the nucleus and cytoplasm, respectively. An image analysis system with a computer controlled stage was used to position cells with an accuracy of ±1 μm over the collimated particle beam. The filter cube (Omega Optical XF06), which had a 366 nm band-pass illumination, was chosen to maximize contrast and to minimize UV exposure. Cells were viewed with a channel-plate image intensifier and an integrating CDD camera, which provided excellent low light sensitivity, thus allowing low intensity illumination and very low concentrations of fluorochromes. Approximately 300 A_L cells were seeded overnight into specially constructed microbeam dishes in medium containing 1 mM dibutyryl cAMP to enhance cell spreading (14). Cells were stained for 30 min with a 50 nM solution of Hoechst 33342, washed with medium, and then stained for 10 min with a 100 ng/ml solution of Nile Red. Two images of the cells were captured. The location of individual nuclei in each cell was determined by optical imaging of the fluorescent staining pattern at 366 nm. The cytoplasmic stain was then visualized by using green light excitation and red emission. The images from the film grabber were superimposed into a 24-bit color image using the "merge channel" capacity of Image Pro Plus. The pixel location of the chosen irradiation points and the microscope stage were combined by the computer to calculate the coordinates necessary to position each of these points over the microbeam for irradiation. We found that the cytoplasm had a strong tendency to be stretched out along the same axis as the nucleus. The aiming points in these cytoplasmic irradiations were chosen to be 8 μm from the ends of the major axis of each nucleus (see Fig. 1). Thus, the cytoplasm of each cell was irradiated at each of these two sites depicted by the small numbered circles next to the nuclei. The control program included provisions to mask out the nuclear regions and thus prevent irradiation when the aiming point from one cell was within a neighboring nucleus. For irradiation, the culture medium from the microbeam dish was removed and the chosen targets of each cell were automatically positioned over the microbeam collimator. An electrostatic shutter on the accelerator was opened and a precise number of α-particles, determined by the detector mounted on the microscope lens, was delivered. The precision of the targeting was determined by Monte Carlo modeling of 4,279 particles through the collimator system, which showed that when four particles were delivered to the cytoplasm (two particles at each end), the probability that the nucleus was accidentally struck by a scattered particle was 0.4%. It took on average 6 sec to locate and irradiate a cell. Four ~6,000 irradiated cells were used per group for each experiment. After every cell on a plate had been irradiated, the cells were removed by trypsinization and replated to measure both survival and mutation. More than 98% of the irradiated cells were recovered from each dish. Neither dAMP, Hoechst 33342, or Nile Red, either alone or in combination, affected the survival, mutagenesis, or radiosensitivity of the cells when used under the conditions described in this study (data not shown).

Mutagenesis Assay and Mutant Spectrum Analysis. Mutation was measured as described (3, 11, 12, 15). Briefly, cells were plated into 60 mm dishes with a total of 2 ml of F12 medium. After 2 hr of incubation to allow for cell attachment, 0.2% CD59 antiserum and 1.5% freshly thawed complement (vol/vol), were added to each dish. The cultures were incubated for 7–8 days, at which time they were fixed, stained, and the number of $CD59^-$ mutants scored. Controls included identical sets of dishes containing antiserum alone, complement alone, or neither agent. The mutant fraction at each dose (M_F) was calculated as the number of surviving colonies divided by the total number of cells plated after correction for any nonspecific killing due to complement alone.

$CD59^-$ mutants were isolated by cloning and expanded in cultures as described (3, 12). Mutational spectra were assessed by using multiplex PCR and primer sequences for five marker genes located on either the short arm (*WT, PTH, CAT, RAS*) or the long arm (*APO-A1*) of human chromosome 11. PCR amplifications were performed for 30 cycles as described (3, 12, 15). After the last cycle, the samples were incubated at 72°C for an additional 20 min, electrophoresed on 2% agarose gels, and stained with ethidium bromide.

Treatment with Dimethyl Sulfoxide (DMSO). To examine the role of reactive oxygen species (ROS) in mediating the mutagenic response to cytoplasmic irradiation, A_L cells were treated with 8% DMSO 10 min before and 10 min after irradiation with four α-particle traversals through the cytoplasm. This dose is nontoxic and nonmutagenic under the conditions used in our study and as shown by others (16). After treatment, cells were trypsinized and replated to determine both the survival and mutagenesis as described.

Nonprotein Sulfhydryl Depletion by Buthionine-*S-R*-Sulfoximine (BSO). A_L cells in microbeam dishes were treated with a 10 μM, nontoxic and nonmutagenic, dose of BSO (Chemalog) for 18 hr, which reduced the nonprotein sulfhydryl level to less than 5% of the control level based on Tietze's assay (17, 18). Cells were then irradiated with four α-particles through the cytoplasm. After radiation, cultures were trypsinized and replated for both survival and mutagenesis as described above.

Immunoperoxidase Staining for 8-Hydroxy-Deoxyguanosine (8-OHdG). 8-OHdG is recognized as a reliable marker for oxidative DNA damage in mammalian cells (19, 20). Induction of 8-OHdG in the nucleus of A_L cells irradiated with eight α-particles through the cytoplasm was quantified by using the mAb IF7 specific for 8-OHdG coupled with immunoperoxidase staining and an image analysis software as described (20). Briefly, irradiated cells on polypropylene dishes were fixed with cold 5% acid alcohol. Cells were treated with RNase (100 μg/ml) in Tris buffer followed by a 5 min treatment with proteinase K (10 μg/ml) at room temperature. After DNA was denatured using 4N HCl for 5 min at room temperature, cells were treated with 10% normal goat serum in Tris buffer to block nonspecific binding. Cells were stained with the primary antibody (IF7) at 1:30 dilution in 2% BSA overnight at 4°C. After washing, mouse ABC reagent (Vector Laboratories), avidin conjugated to horseradish peroxidase, was added for 20 min followed by treatment with 2-aminobenzidine to visualize the reaction as described (20, 21). A Cell Analysis System 200 microscope (Becton Dickinson) and a cell measurement software package were used to quantify the relative staining intensity from 50 randomly selected cells per dish. A total of 150–200 cells were measured from either the control or the irradiated group.

RESULTS

Cytoplasmic Targeting with the Microbeam. In determining the biological effects of cytoplasmic irradiation, it is critically important to avoid hitting the nucleus. Fig. 1 shows the fluorescent image of a representative population of A_L cells stained with Hoechst 33342 (nucleus) and Nile Red (cytoplasm) as seen by the image analysis system under a 40× objective lens. The aiming points in cytoplasmic irradiation were chosen to be 8 μm from the ends of the long axis of each nucleus (Fig. 1). The cytoplasm of each cell was then irradiated at two separate sites with one-half of the number of particles delivered to each end of the cell. The efficiency of targeting

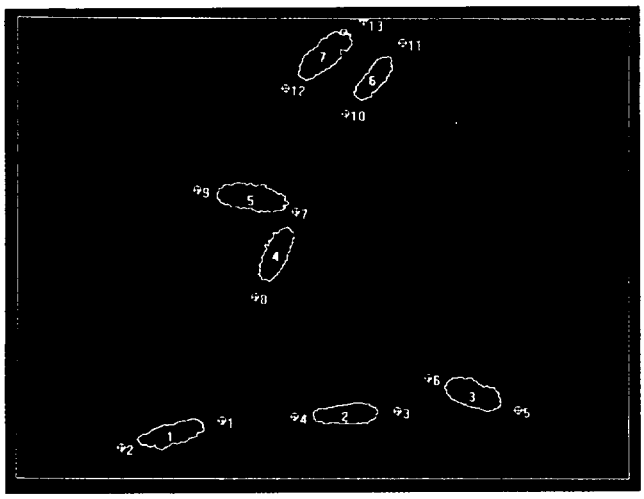

FIG. 1. Dual fluorescent imaging of A_L cells stained with Hoechst 33342 (nucleus) and Nile Red (cytoplasm) by the image analysis system under a 40× objective lens. The nucleus of each cell is outlined in white. The image analysis system determines the length of the major axis of each nucleus to calculate the irradiation positions that are chosen to be 8 μm from each end of the nucleus, as shown by the small, numbered circles.

and particle delivery was assessed by viewing each of 250 A_L cells with two α-particles (one particle in each end of the cell) and determine the actual placement of particle hits. We found that 75% of the cells had a hit in both selected sites, 15% at one end, and 10.3% of the cells had been missed. In no case was the target within the nuclei of any cells (Fig. 1). A_L cells stained with both fluorochromes and mock irradiated had a plating efficiency and background mutant yield comparable to controls.

Lethality and Mutagenicity of Cytoplasmic Irradiation. Cytoplasmic irradiation induces minimal toxicity in A_L cells, as shown in Fig. 2, such that traversal of cells by four particles results in a surviving fraction of ≈0.9, and more than 70% of the cells survive to form colonies when traversed by 32 α-particles. By comparison, survival after an equivalent number of nuclear traversals was 0.35 and <0.01, respectively (3). By using anti-CD59 antibody that kills wild-type cells in the presence of complement, mutations at the *CD59* locus can be quantified. The preexisting level of $CD59^-$ mutations was 43 ± 15 mutants per 10^5 survivors among the A_L cell population used in the present studies. Mutant fraction (M_F) initially increased with the number of particle traversals, reaching a peak of 125 ± 58 at eight particles, an increase of ≈3-fold over background (Fig. 3). These data indicate that targeted cytoplasm damage can cause mutations in the nucleus. There was, however, no further increase in mutant fraction with particle traversals higher than eight.

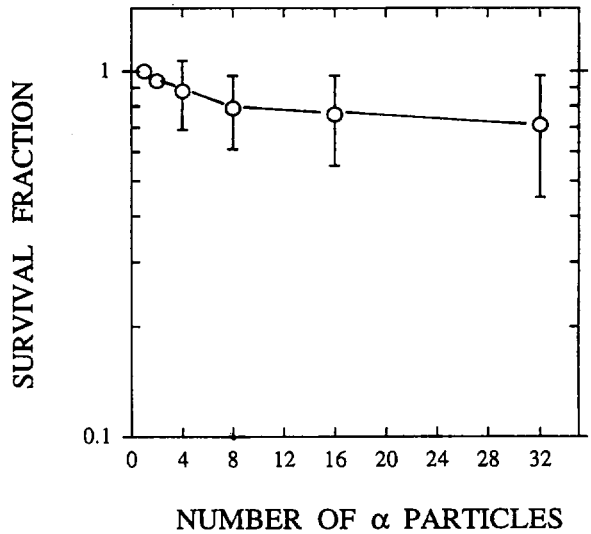

FIG. 2. Survival of A_L cells irradiated with a single or an exact number of 90 keV/μm α-particles targeted to areas of the cytoplasm. Each data point was obtained from three to seven independent experiments. (Bars represent ± SEM.)

Analysis of Mutant Spectra. To determine the types and sizes of mutations that caused the $CD59^-$ phenotype among A_L cell irradiation with α-particles through the cytoplasm, we used multiplex PCR and primer sequences for five marker genes located on either the short arm (Wilm's tumor, parathyroid hormone, catalase, *RAS*) or the long arm (apolipoprotein A-1) of human chromosome 11 as described previously (3, 12, 15, 22). These primers and PCR conditions were selected so as to amplify only the human genes and not their CHO cognates (22). Because A_L cells have only one chromosome 11, the presence or absence of the corresponding PCR products shows that a particular segment of DNA containing these genes is present or missing, respectively (12, 22). Previous studies have shown that a small region of the distal end of human chromosome 11 at 11p15.5 is required for survival of the A_L cells (3, 12, 15, 22). The obligate presence of this region, identified here by the *RAS* probe in all mutants, provides a convenient internal PCR control. As shown in Fig. 4, most of the mutants induced by eight α-particles through the cytoplasm (four through each end of the cells) had deletion patterns similar to spontaneous mutants that consisted of small alterations involving only the *CD59* gene (26/28 or 93% compared with 82/92 or 89% among spontaneous). In contrast, 19/24 or 80% of the mutants induced by an equivalent number of eight particles through nuclei were multilocus deletions (Fig. 4, lower right). The difference in mutant spectra induced by nuclear versus cytoplasmic irradiation suggests that different mutagenic mechanisms are involved.

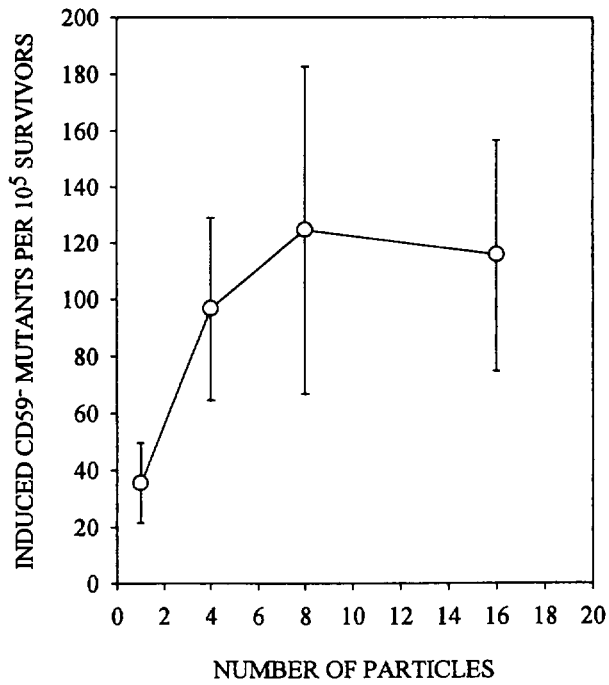

FIG. 3. Induced $CD59^-$ mutant fractions per 10^5 survivors in A_L cells irradiated with exact numbers of α-particle traversals through the cytoplasm. Induced mutant frequency equals total mutant yield minus background incidence. Data are pooled from 11 experiments. Induced mutant yield at 32 particles was the same as at eight particles and showed no further increase (data not shown). (Bars represent ± SEM.)

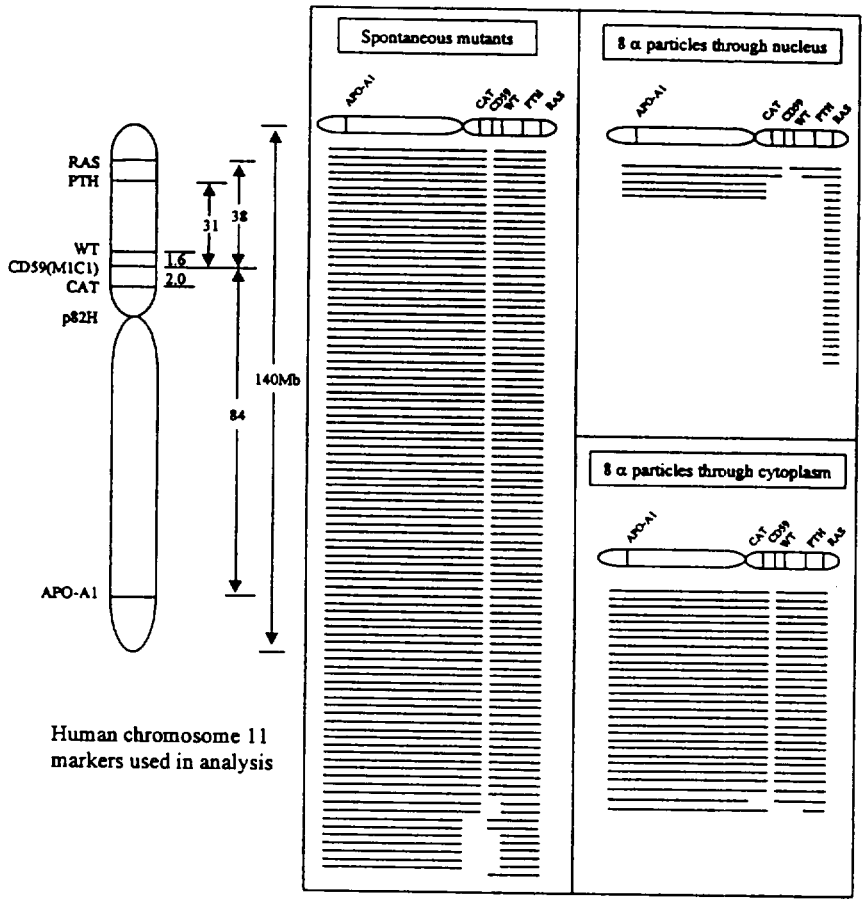

FIG. 4. Mutational spectra of CD59⁻ mutants either of spontaneous origin or from cells exposed to eight α-particles delivered either to the cytoplasm or the nucleus. Each line represents the spectrum for a single, independent mutant. Blank spaces depict missing markers. The absence or presence of marker genes in each mutant was determined by multiplex PCR. Nuclear irradiation with eight α-particles resulted in 384.6 ± 116 mutants per 10^5 survivors at a surviving fraction of 12% (3).

Mutagenicity of Cytoplasmic Irradiation Is Mediated by ROS. The possible role of ROS in mediating the mutagenesis induced by cytoplasmic irradiation was investigated with two complementary approaches: (*i*) using the antioxidant DMSO to reduce ROS and (*ii*) using the thiol-depleting drug BSO to reduce intracellular glutathione. DMSO has been shown to protect against the lethal (23) and genotoxic effects (24, 25) of ionizing radiation in mammalian cells. As shown in Fig. 5, treatment of A_L cells with 8% DMSO for 10 min before and 10 min after irradiation with four α-particles significantly suppressed mutation induction by 4- to 5-fold to near background levels. In contrast, pretreatment of A_L cells with a 10 μM dose of BSO for 18 hr, which reduced the intracellular glutathione content to <5% of control levels (data not shown), increased the mutagenicity of cytoplasmic irradiation (four α-particles) by 4- to 5-fold. The doses of both the DMSO and BSO used here have been shown to be nontoxic and nonmutagenic in mammalian cells (15–17). These results strongly implicate reactive oxygen species as being the mediator of the mutagenic response of cytoplasmic irradiation. On the other hand, we found that DMSO treatment had no effect on the mutagenic yield in A_L cells traversed by four α-particles through nuclei (data not shown).

Detection of 8-OHdG in Nuclei of Cytoplasmic Irradiated Cells. Fig. 6 shows the relative staining intensity of 8-OHdG in control A_L cells and those irradiated with eight α-particles targeted to the cytoplasm. The mean background intensity among control cells was 0.051 ± 0.01, whereas the irradiated cells showed a staining intensity of 0.096 ± 0.012, or 1.9-fold higher. The peak expression level of 8-OHdG among irradiated cells was obtained when cells were fixed at 5 min after irradiation. Thereafter, the level decreased rapidly and by 45 min after irradiation, the 8-OHdG level was down to control level (data not shown). These data indicate that cytoplasmic irradiation generates oxidative DNA damages in the nuclei of the target cells.

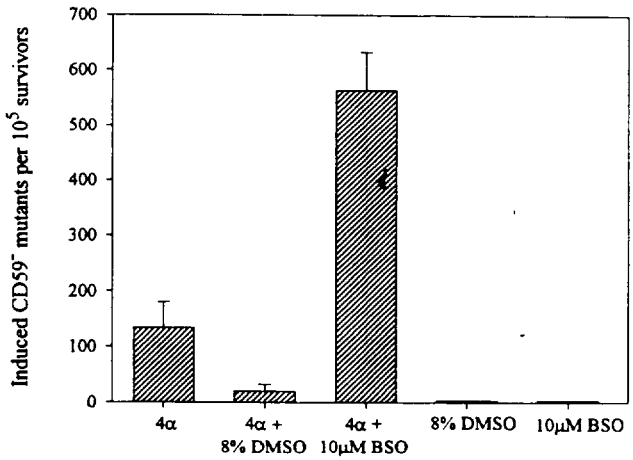

FIG. 5. Effects of the free radical scavenger DMSO and the thiol-depleting drug BSO on induced mutant yield in A_L cells irradiated with four α-particles through the cytoplasm. Cells were treated with 8% DMSO for 10 min before and 10 min after irradiation or with 10 μm BSO for at least 18 hr before irradiation. Data were pooled from three to six experiments. Neither DMSO nor BSO was mutagenic alone. (Bars represent ± SEM.)

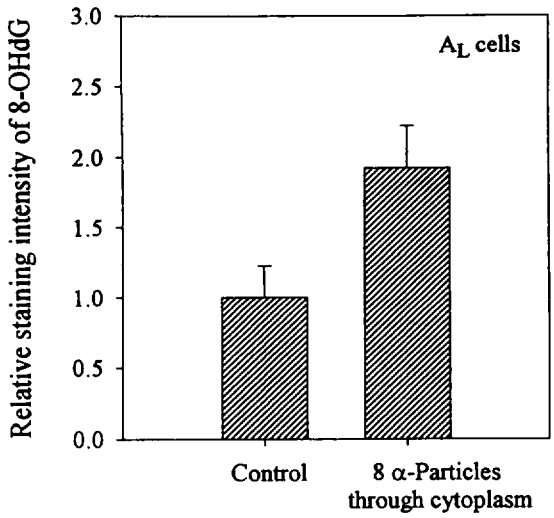

FIG. 6. Relative immunoperoxidase staining intensity for 8-OHdG in control and A_L cells irradiated with eight α-particles through the cytoplasm. Data are averaged from three independent experiments with 60–90 nuclei each. (Bars represent ± SEM.)

DISCUSSION

The differential biological effects of nuclear versus cytoplasmic irradiation has been of interest to biologists and geneticists for decades. Earlier studies using polonium-tipped microneedles to deliver α-particles largely to either the nucleus or cytoplasm of CHO cells showed that the nucleus was the determining site for cellular survival (26), as well as induction of mitotic delay (27). Although these earlier studies were not very precise and used the distance between the needle tip and cell surface to estimate the particle fluency and, derivatively, the dose, nevertheless, they demonstrated that irradiation of cytoplasm was largely innocuous (26) and strongly indicated that DNA was the target for the radiobiological effects of ionizing radiation (28). Recent circumstantial evidence, however, suggests that extranuclear or extracellular targets may also be important in mediating these effects (4–7). In CHO cells irradiated with low doses of α-particles, where <1% of the cells were actually traversed by a particle, an increase in sister chromatid exchanges was observed in more than 30% of the cells (4). Subsequently, based on microdosimetric analysis, it was estimated that the potential target size for this SCE-inducing effect would require an area 350 times the typical size of a CHO nucleus (5). In another words, given the relatively small cytoplasmic area of CHO cells, it is likely that an extracellular component may modulate the observed genotoxic response (5). However, direct proof of such extranuclear/extracellular effects is not available. By using a precision charged particle microbeam, we show here that irradiation of cellular cytoplasm with either a single or an exact number of α-particles results in gene mutation in the nucleus while inflicting minimal toxicity.

Our finding that cytoplasmic irradiation is largely nonlethal is consistent with the earlier reports of Munro (26) and Puck (28). Our observation that the surviving and mutant fractions level off at eight or more particle traversals (Figs. 2 and 3) may reflect that the production of the mediators of mutation was saturated, because only two areas of the cytoplasm were irradiated in each cell. A recent report by Narayanan *et al.* (6) provides support for this assumption by showing that the intracellular production of O_2^- in normal human skin fibroblasts irradiated with α-particles was not a function of dose. Alternatively, our results may indicate the induction of a cellular repair process that acts to limit killing and mutations (29). A similar saturating effect has been reported with SCE induction by low doses of alpha particles in CHO cells (5).

It is likely that mutation induced by nuclear traversal is principally a consequence of direct DNA interaction with α-particles, whereas the biological effects of nonnuclear traversals are by indirect action possibly mediated by ROS. This conclusion is supported by the mutant spectra data shown in Fig. 4, where we analyzed the types and size of the $CD59^-$ mutants generated by an equivalent number of α-particles targeted either at the nuclear or cytoplasm of the cells. The spectra for cytoplasmic irradiation resemble that found spontaneously, which are often thought to arise as a result of DNA damage from endogenous ROS (30). The clear difference in mutant spectra suggested that different mechanisms are involved in the induction of the mutants at the two target sites.

Our results with the thiol-depleting drug BSO provide further support of the idea that ROS modulate the mutagenic response of cytoplasmic irradiation. BSO, a competitive inhibitor of the enzyme γ-glutamyl cysteine synthetase functions to deplete the intracellular level of nonprotein sulfhydryls, which consist mainly of glutathione (≈95%) and other low molecular weight aminothiols such as cysteine and cysteamine (31). These sulfhydryls have been shown to have significant free radical scavenging abilities that contribute to the maintenance of genomic integrity. Although a decrease in the level of the cellular glutathione is not lethal, it has been shown to enhance the cytotoxicity of a variety of agents, including ionizing radiation and heavy metals (32). Our findings that A_L cells in which the level of intracellular nonprotein sulfhydryls has been greatly reduced by BSO treatment showed a 4- to 5-fold increase in mutagenic response to cytoplasmic irradiation compared with similarly irradiated control cultures supports the role of ROS in mediating mutagenicity of cytoplasmic damage. Furthermore, the induction of 8-OHdG in irradiated cells is consistent with a role of oxidative DNA damage.

It is of interest to consider the nature of the events initiated by cytoplasmic irradiation as to what types of oxyradicals are involved and how the signal(s) is transposed from the cytoplasmic target sites to the nucleus where mutagenesis occurs. Because DMSO is a well-established free radical scavenger, particularly of hydroxyl radicals (33), one would expect OH· to be an integral part of the initiating signal. However, OH· is short-lived and can only diffuse ≈4 nm (34), whereas our irradiation sites were ≈8 μm from the nucleus. One possible scenario is that free radicals generated by cytoplasmic irradiation may perpetuate in a cascading event involving lipid peroxidation. Alternatively, organic radicals such as peroxynitrite anions generated as a result of mitochondrial damage could also be involved (35, 36). There is evidence that mitochondrial DNA damage may also modulate DNA damage, although the exact mechanism of how mitochondrial DNA escapes into the nuclear compartment is not known (37).

Finally, although nuclear irradiation induced 3- to 4-fold more $CD59^-$ mutants than cytoplasmic irradiation at equivalent particle traversals, the latter is more important to carcinogenesis because it induces mutants with little or no killing. For example, at an equitoxic dose level (e.g., 90% survival), cytoplasmic irradiation induced 7-fold more mutants than nuclear irradiation (3). Therefore, cytoplasmic irradiation should be considered a major concern to human health in terms of risk of exposure for cancer and birth defects, as well as having a profound impact on our understanding of the relationship between radiation exposure and disease.

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Cell Biology

Mutagenic effects of a single and an exact number of α particles in mammalian cells

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ABSTRACT **One of the main uncertainties in risk estimation for environmental radon exposure using lung cancer data from underground miners is the extrapolation from high- to low-dose exposure where multiple traversal is extremely rare. The biological effects of a single α particle are currently unknown. Using the recently available microbeam source at the Radiological Research Accelerator Facility at Columbia University, we examined the frequencies and molecular spectrum of S1⁻ mutants induced in human–hamster hybrid (A_L) cells by either a single or an exact number of α particles. Exponentially growing cells were stained briefly with a nontoxic concentration of Hoechst dye for image analysis, and the location of individual cells was computer-monitored. The nucleus of each cell was irradiated with either 1, 2, 4, or 8 α particles at a linear energy transfer of 90 keV/μm consistent with the energy spectrum of domestic radon exposure. Although single-particle traversal was only slightly cytotoxic to A_L cells (survival fraction ≈ 0.82), it was highly mutagenic, and the induced mutant fraction averaged 110 mutants per 10^5 survivors. In addition, both toxicity and mutant induction were dose-dependent. Multiplex PCR analysis of mutant DNA showed that the proportion of mutants with multilocus deletions increased with the number of particle traversals. These data provide direct evidence that a single α particle traversing a nucleus will have a high probability of resulting in a mutation and highlight the need for radiation protection at low doses.**

Accurate risk assessment of human exposure to ionizing radiations traditionally has been compromised, in that reliable data are available only for relatively high doses, so that extrapolations must be made down to the relevant, low-dose region of interest in radiation protection. However, this approach in risk assessment is often complicated by concurrent exposure to other chemical and physical environmental contaminants. Data indicate that exposure of the lung to α-emitting radon progeny is the largest component of background radiation received by the general public in the United States (1). Epidemiological studies have shown that uranium miners exposed to high levels of radon progeny have the largest incidence of radiation-induced lung cancers of any exposed population (2, 3). However, studies designed to identify a link between lung cancer and the low levels of radon commonly found in the home have been inconclusive because of confounding factors. The recent estimate by the Environmental Protection Agency of 21,600 deaths per year (confidence limits between 7,000 and 30,000) illustrates the uncertainties inherent in environmental risk assessment using epidemiological data (see ref. 4 for review).

Radon, a secondary decay product of uranium-238, is a colorless, odorless gas that decays with a half-life of 3.82 days into a series of solid, short-lived radionucleotides, including polonium-218 and polonium-214 that emit α particles during decay. Radon is ubiquitous in indoor environments, including homes and schools, and, in general, at concentrations hundreds of fold lower than in underground mines.

To have a better quantitative assessment of lung cancer risk associated with residential radon exposure, it is essential to have a better database for low-dose exposure. It has been estimated that 96% of the target bronchial cells of an average uranium miner will be traversed by more than one α particle each year. In contrast, only 1 in 10^7 bronchial cells will be hit by multiple particles from an average household exposure (4). The biological effects of a single α-particle traversal are unknown. Several relevant questions arise: Is a single traversal by these high linear energy transfer (LET) particles lethal to a cell? If not, will the surviving cells have a higher propensity to undergo chromosomal aberrations, mutations, and neoplastic transformation than nonirradiated cells? How does the number of particle traversals affect the kinds of mutations induced? The availability of a microbeam irradiation facility at the Radiological Research Accelerator Facility at Columbia University, where individual cells can be irradiated with either a single or an exact number of α particles, provides a unique opportunity to address these questions.

Since individual cells are irradiated one at a time so as to limit the number of cells available for analysis, a sensitive mutagenic assay system is essential to give meaningful data. The A_L cells developed by Waldren and Puck (5) fulfill this requirement. These cells contain a standard set of hamster chromosomes, but only one human chromosome (chromosome 11), which carries specific cell-surface antigenic markers. By the use of appropriate antibodies, mutations in the human chromosome can be quantified. Because only a small segment of this human chromosome (11p15.5) is needed for viability of the hybrid cell, this mutation system is particularly sensitive to agents such as ionizing radiations and asbestos fibers that induce multilocus deletions (6, 7). The A_L surface antigens (S1, S2) are effective genetic markers, because their presence or absence can be easily measured, and their distribution on opposite arms of chromosome 11 permits identification of lesions involving the long, short, or both chromosome arms. In the present studies, we have determined the dose response with regard to toxicity, mutant induction, and the kinds of mutations at the S1 locus found in cells whose nuclei were exposed to either a single or an exact number of α particles. Our data provide the first demonstration that a single α

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Abbreviation: LET, linear energy transfer.

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particle hit in the nucleus, which kills only 20% of the cells, is indeed mutagenic.

MATERIALS AND METHODS

Cell Culture. The A_L hybrid cells that contain a standard set of Chinese hamster ovary-K1 chromosomes and a single copy of human chromosome 11 were used. Chromosome 11 encodes cells surface markers that render A_L cells sensitive to killing by specific monoclonal antibodies in the presence of complement. Rabbit serum complement was from HPR (Denver, PA). Antibody specific to the S_1 antigen was produced from hybridoma culture as described (5, 8, 9). Cells were maintained in Ham F-12 medium supplemented with 8% heat-inactivated fetal bovine serum, 25 μg/ml gentamycin, and 2× normal glycine (2×10^{-4}M) at 37°C in a humidified 5% CO_2 incubator, and passaged as described (6, 7).

Irradiation Procedure. The layout and irradiation procedure using the microbeam facility at the Radiological Research Accelerator Facility have been described (10). Approximately 500 exponentially growing A_L cells were inoculated into each of a series of microbeam dishes constructed by drilling a ¼-inch hole in the center of 60-mm-diameter non-tissue-culture dishes. A 3.8-μm-thick polypropylene film was epoxied over the bottom of the hole, creating a miniwell that was then coated with Cel-Tak to enhance cell attachment. The DNA of attached cells was stained with a 50 nM solution of Hoechst 33342 dye for 30 min, and the location of individual nuclei was determined by optical imaging of the fluorescent staining pattern at 366 nm. The image analysis system then located the centroid of each nucleus, which were irradiated one at a time with an exact number of α particles. On average, it took 2 sec to locate and irradiate a cell so that up to 10,000 cells could be irradiated per day. We used 15,000–20,000 irradiated cells per group per experiment in the present study. The overall spatial precision of the beam, including positioning and beam spread, is about ±4 μm. Because the average cross-sectional area of the nucleus of live, attached A_L cells was determined to be 108 μm^2, we estimated by Monte Carlo modeling of the collimators that the particle beam would hit the targeted nucleus 98.4% of the time. Due to the lag time of shutter closure, about 4 per 1,000 nuclei would have received one extra α particle. After every cell on a plate had been irradiated, the dish was removed from the stage, and the cells were trypsinized and replated to measure both survival and mutation as described (6, 11, 12). The percent recovery of irradiated cells from the polypropylene dishes was >98% as determined by cell count of representative dishes.

Dose Response for Cytotoxicity. Irradiated and control cells recovered from each miniwell were trypsinized and replated into 100-mm-diameter Petri dishes for colony formation. Cultures were incubated for 7–12 days, at which time they were fixed with formaldehyde and stained with Giemsa. The number of colonies was counted to determine the surviving fraction as described (11, 12).

Quantification of Mutations at the S1 Locus. Irradiated and control cultures from each miniwell were replated into 25-cm^2-area tissue-culture flasks and cultured for 7 days. This expression period is needed to permit surviving cells to recover from the temporary growth lag caused by irradiation and to multiply such that the progeny of the mutated cells no longer express lethal amounts of the S1 surface antigen. To determine mutant fractions, 5×10^4 cells were plated into each of six 60-mm dishes in a total of 2.5 ml of growth medium as described (6, 7, 11). The cultures were incubated for 2 h to allow for cell attachment, after which 0.2% S1 antiserum and 1.5% freshly thawed complement (vol/vol) were added to each dish. After overnight incubation, the medium in each dish was changed to remove the antiserum and complement. The cultures were further incubated for 7 to 8 days, at which time they were fixed, stained, and the number of S1 mutants scored. Controls included identical sets of dishes containing antiserum alone, complement alone, or neither agent. The cultures derived from each well were tested for mutant yield for 2 consecutive weeks to ensure full expression of the mutations. Mutant fractions were calculated as the number of surviving colonies divided by the total number of cells plated after correction for any nonspecific killing due to complement alone.

Analysis of Mutant Spectrum by Multiplex PCR. S1 mutants were isolated by cloning and expanded in cultures as described (6, 7, 11). We isolated no more than two well-separated colonies per culture dish to ensure their clonal origin. A minimum of 25 mutants from each irradiated group and over 50 spontaneous mutants were analyzed. DNA was extracted by a simple salting-out procedure as described (11, 13).

Five DNA markers on chromosome 11 (Wilms tumor, parathyroid hormone, catalase, RAS, and apolipoprotein A-1) were chosen for multiplex PCR analysis because of their map positions relative to the MIC1 gene, which codes for the S1 antigen (14), and the availability of PCR primers for the coding regions of these genes (15–17). PCR amplifications were performed for 30 cycles using a DNA Thermal Cycler 480 (Perkin–Elmer Cetus) in 20-μl reaction mixtures containing 1 μg of the *Eco*RI-digested DNA sample in 1× Stoffel fragment buffer, 0.2 mM dNTP, 3 mM $MgCl_2$, 0.2 mM each primer, and 2 units of Stoffel fragment enzyme. Each PCR cycle consisted of denaturation at 94°C for 1 min, annealing at 55°C for 1 min, and extension at 72°C for 1 min. After the last cycle, the samples were incubated at 72°C for an additional 20 min, electrophoresed on 2% agarose gels, and stained with ethidium bromide.

RESULTS

Irradiation of Cell Nuclei with the Microbeam. Fig. 1 shows the fluorescent image of a representative population of A_L cells as seen by the image analysis system under a 40× objective lens. Each nucleus was outlined by the image analysis program, and the precise center of each nucleus was located and placed over the exit aperture of the beam. Selected numbers of α particles then were automatically delivered within the 5 μm diameter of the beam line. These areas are shown by the small circles in the center of each nucleus (Fig. 1). Because the

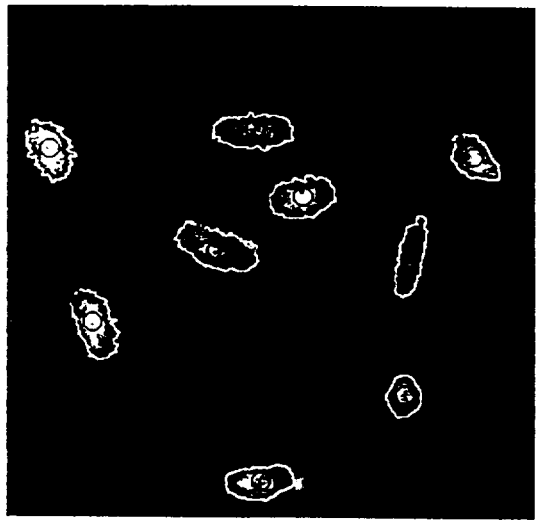

FIG. 1. Fluorescent imaging of A_L cells stained with Hoechst dye viewed by the image analysis system under a 40× objective lens. The nucleus of each cell is outlined in white, and the circles indicate the area where the particle is delivered.

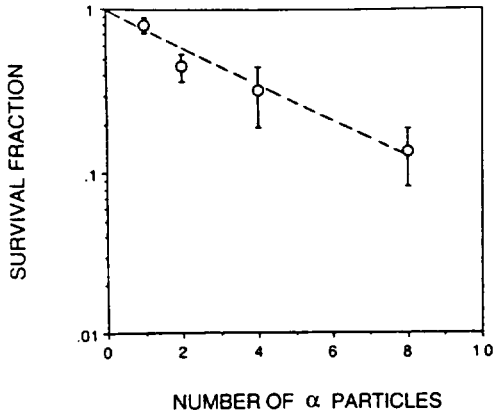

FIG. 2. Survival of A_L cells irradiated in the nucleus with either a single or an exact number of α particles. Data were pooled from 3–4 independent experiments. Bar represents ± SEM.

particle detector was positioned behind the monolayer of cells, every α particle registered would have traversed the nucleus. Given the track length of ≈40 μm for the 5.5-MV α particles used here when they entered attached mammalian cells, and the thickness of the A_L cell nucleus measured to be less than 4 μm, it was unlikely that any α particle would be stopped within the nucleus. The pixel position of irradiated nuclei was recorded to prevent multiple exposure of the same cell. It should be noted that the 50 nM dose of Hoechst dye used in the imaging step had been determined to be nontoxic and nonmutagenic under the conditions used in these studies[§] and verified here.

Lethality of a Single-Particle Traversal. There is considerable interest in the carcinogenic effects of low doses of high LET radiations, such as α particles. It has been estimated for attached mammalian cells, for example, that the mean number of α-particle traversals required for cell killing ranges from 2 to 6 (18). Direct measurement of the lethality of a single α particle was, until recently, not possible. Fig. 2 shows the dose–response clonogenic survival of A_L cells irradiated with defined numbers of α traversals through the nucleus. The curve was best fitted by a linear quadratic model with $\alpha = 0.285 \pm 0.01$ and $\beta = 0$, yielding a mean lethal dose of ≈3.7 particles. It is clear from these data that most of the cells (≈80%) survived to form colonies after exposure of their nuclei to a single particle. In fact, more than 10% of the cells survived after nuclear traversal by eight particles.

Mutagenicity of a Single α Particle. The relatively high mutagenic sensitivity of the A_L cell system made it possible to assess the mutagenic potential of a single α particle from relatively few irradiated cells. Mutation data were analyzed using the least-square method with the following parameters: $y = 108x - 7.7x^2$ where y was the number of induced mutants and x represented the number of particle traversals. Fig. 3 shows the number of induced mutant (background subtracted) per 10^5 clonogenic survivors at the S1 locus in A_L cells irradiated with either a single or an exact number of α particles. The fraction of preexisting $S1^-$ mutants in the A_L cell population used in these experiments averaged 45 per 10^5 survivors. The induced mutant yield by a single α particle was 2-fold of this background level and increased to 8-fold for eight particles. The dose–response curve yielded an initial slope of ≈100 mutants/10^5 cells per particle.

Analysis of Mutant Spectrum. The S1 surface antigenic marker is encoded by the MIC1 gene mapped to chromosome

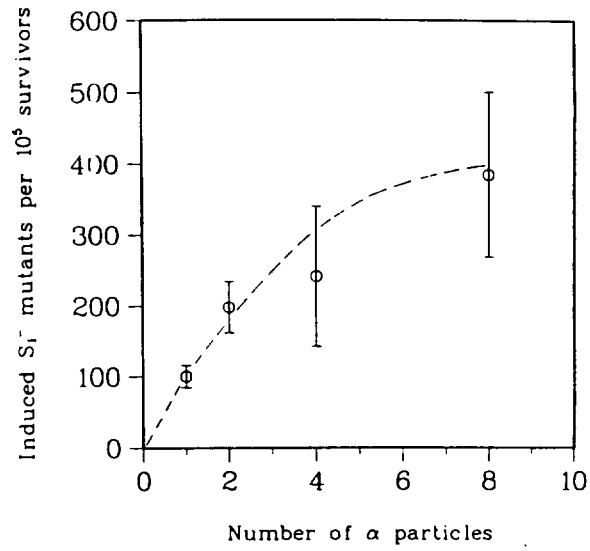

FIG. 3. Induced mutants per 10^5 survivors at the S1 locus in A_L cells irradiated with an exact number of α-particle traversals at 90 keV/μm. Induced mutant yield = total mutant yield minus background incidence. The background mutant fraction in A_L cells used in these experiments averaged 45 per 10^5 survivors. Data were pooled from three experiments, and the curves fitted using the least-square method. (Bars represent ± SEM.)

11p13. With the mapping of over 200 genes on both the short and long arm of chromosome 11, together with the availability of primer sequences for some of these genes, it is relatively easy to determine the spectrum of $S1^-$ mutants induced. A total of 167 mutants, including 57 spontaneous ones, were analyzed. Fig. 4 shows a representative gel of PCR products using DNA from $S1^-$ mutants as template and primers synthesized for specific regions of marker genes located on either the long arm (Apo-A1) or short arm (CAT, WT, PTH, and RAS) of the human chromosome 11. The presence or absence of the corresponding PCR products indicates that the particular segments of DNA containing these genes are present or missing, respectively. Fig. 5 shows the cumulative deletion maps of these $S1^-$ mutants. Previous studies have shown that a small segment of the human chromosome 11 near the RAS gene is required for survival of the $S1^-$ mutants (11, 19). The obligate presence of this region identified here by the RAS probe in all the mutants provides a convenient internal PCR control. Fig. 4 shows that the majority of spontaneous $S1^-$ mutants (50 of 57 or 88%) had retained all of the markers analyzed. Likewise, the majority of mutants induced by a single α particle resulted from mutations involving the loss of S1 marker only (24 of 32 or 75%), whereas the remaining 25% of the mutants had lost at least one additional marker. In contrast, the proportion of mutants suffering loss of additional chromosomal markers increased with increasing number of particle traversals such that 19 of 24 (79%) of the mutants induced by eight particles had lost all four markers examined, which spanned both arms of the human chromosome 11. These mutants were further characterized by Southern blotting using the centromeric probe p82H (20). Approximately 50% of the mutants had lost the centromere, indicating a loss of the entire human chromosome 11 except for the 11p15.5 fragment that had translocated to a hamster chromosome (data not shown).

DISCUSSION

It is of societal importance to provide realistic risk estimate for the carcinogenic effects of domestic radon exposure, currently estimated at 15,000 lung cancer deaths per year. This number is based largely on extrapolation from the high-dose exposure

[§]Hei, T. K., Wu, L.-J., Liu, S.-X., Vannais, D., Waldren, C. & Randers-Pehrson, G. Proceedings of the Annual Radiation Research Society Meeting, April 14–17, 1996, Chicago, IL.

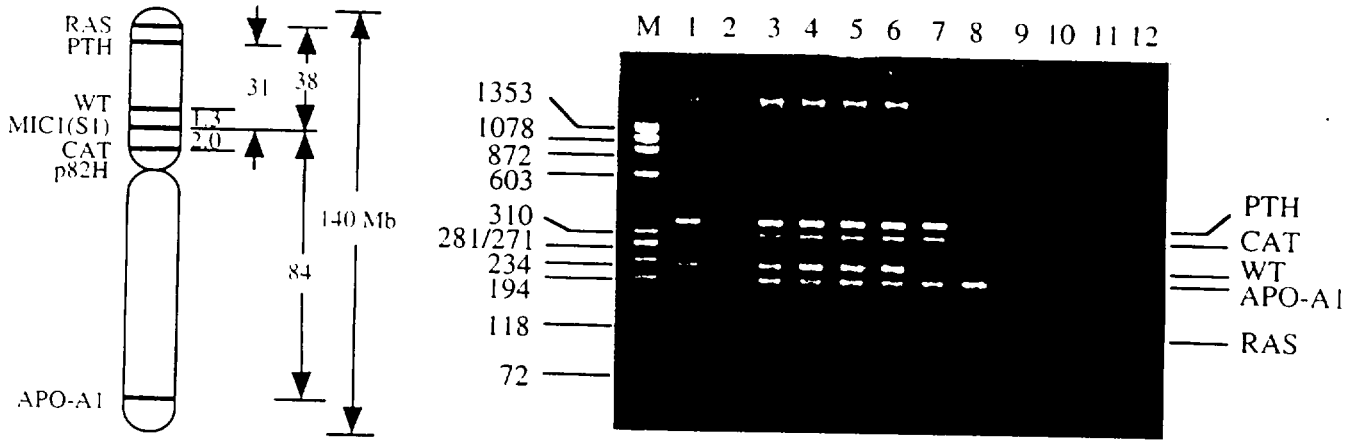

FIG. 4. (*Right*) Gel electrophoresis of multiplex PCR products using DNA from S1⁻ mutants as templates and primers for parathyroid hormone (PTH), Wilms tumor (WT), catalase (CAT), apolipoprotein A1 (APO-A1), and RAS. *Hae*III-digested ϕX174 DNA provided the size markers (lane M). Lane 1, wild-type A_L cells with all of the markers present. Lane 2, a positive control showing the loss of all the markers examined except RAS. Lanes 3 and 4, spontaneous mutants showing no marker loss. Lanes 5 and 6, mutants induced by a single α particle where none of these markers was lost. Lanes 7–12, mutants induced by eight α particles showing mostly deletions of various sizes. (*Left*) The relative location of the marker genes on human chromosome 11 used in the multiplex PCR and their relative distance from the M1C1 gene.

data for underground miners where the majority of the target bronchial epithelial cells received multiple α-particle traversals (4). However, environmental radon exposure levels are such that multiple traversals are extremely rare, so that the effects of a single α-particle hit are the most relevant to environmental risk analysis (21). Our data provide a direct measurement of the genotoxicity of a single α particle.

The question of whether traversal of a single α particle through the nucleus is lethal has been debated for more than three decades. Earlier studies by Barendsen (22) suggested that traversal of the nucleus by a single α particle would be lethal. Moreover, studies based on measurement of induced DNA double-strand breaks in C3H10T½ cells indicated that virtually 100% of the cells traversed by a single α particle would be

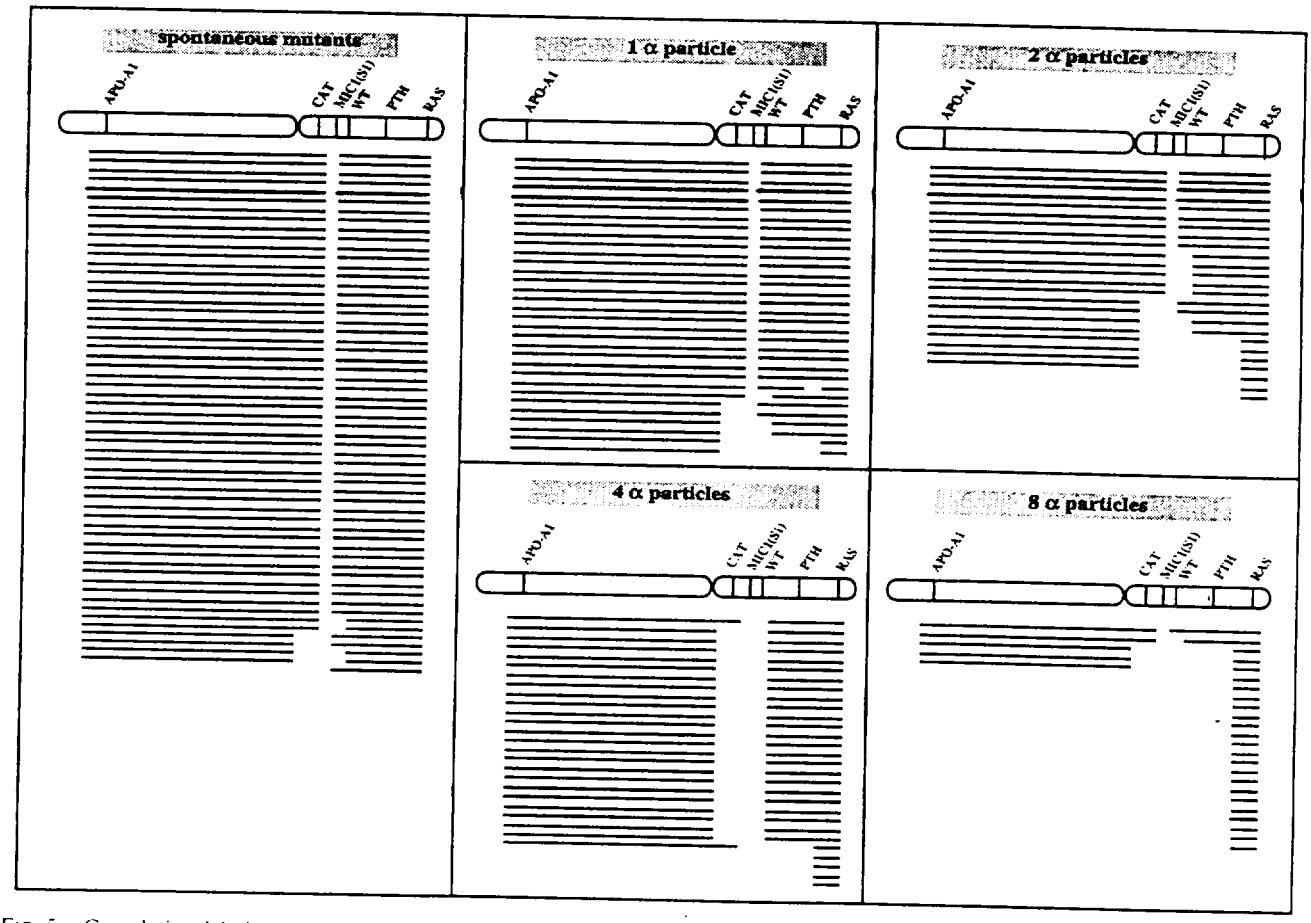

FIG. 5. Cumulative deletion spectra of S1⁻ mutants either of spontaneous origin or from cells exposed to either a single or an exact number of α-particle traversals through the nucleus. Each line depicts the spectrum from a single, independent mutant. The absence or presence of marker genes among the mutants was determined by multiplex PCR. Blank spaces depict missing markers.

killed by direct action (23). On the other hand, microdosimetric studies based on particle track structure suggested that the probability of an α-particle traversal resulting in lethal damage was only 17% in rodent fibroblasts, i.e. it takes six hits to kill a cell (24). Our direct measurement of a single particle survival is consistent with an estimate of a low probability of cell inactivation: only 20% of the irradiated cells were killed. It is amazing that roughly 10% of cells irradiated with eight α particles were still viable enough to form colonies even though they carried a much higher mutagenic potential.

Using the nuclear crosssectional area of 108 μm^2 measured for A_L cells, we calculated that a dose of $\approx$12 cGy of 90 keV/μm α particles from track segment irradiation where attached cells are exposed to a broad beam of monoenergetic particles would be required to deliver an average of one particle traversal per nucleus based on random, Poisson distribution. At this dose, about one-third of the nuclei would not be hit, another third would sustain one α-particle hit, and the remaining third would receive multiple hits. The dose response for survival of A_L cells irradiated with an exact number of α particles was not significantly different from recent data obtained using average particle traversals (11, 12). These results suggest that, at least for cell lethality, the Poisson estimation gives a fairly accurate projection of the biological effects of either a single or an exact number of α particles.

The numbers and kinds of mutants induced by α particles at several gene loci, including thymidine kinase and hypoxanthine-guanine phosphoribosyltransferase, have been reviewed recently (25, 26). High LET radiation, such as α particles, induced more mutant per mean lethal dose (D_0) than low LET radiation such as x- and γ-rays ($\approx$280 $S1^-$ mutants/D_0 for 90 keV/μm α particles versus 150 mutants/D_0 for γ-rays; refs. 11, 12). The number of induced mutants is both dose- and LET-dependent. Our present data provide the first demonstration that a single α particle induces mutations in mammalian cells. Using the highly sensitive A_L assay system, we were able to show that a single-particle traversal induced a mutant fraction 2 times greater than the background value. This mutant yield was comparable to the frequency induced by an equivalent mean of one particle traversal based on a Poisson distribution (11). Our results are consistent with those of Nelson *et al.* (27) who demonstrated a linear dose response with regard to the induction of micronuclei among Chinese hamster ovary cells irradiated with up to five α particles using a 3.2-MV microbeam. However, at a dose of eight particle traversals per nucleus, where we found the induced frequency was 8 times background level, the incidence was significantly higher than the yield obtained with a mean of eight particles as determined by the Poisson distribution (data not shown). It is possible that many cells in the latter group may received either very few particle traversals and subsequently fewer mutations, or many more than eight particles that are lethal to the cells. Thus, it is likely that this difference is due to distortion of the cell population at the time of the assay in the track segment experiment (Poisson distributed) because of differences in radiation-induced division delay. The cells that received a small number of traversals would be expected to expand more rapidly during the expression period than those that received a large number of particle hits. Thus, there is a closed correlation between the effects of exactly one and a mean of one particle, the single cell irradiation allows a more accurate extrapolation from high to low doses.

While the majority of radiation-induced mutants showed deletions of varying sizes (11, 28, 29), there is recent evidence to indicate that the percentage of multilocus deletions is dose- and LET- dependent as well (11, 12). As shown in Fig. 4, the majority of spontaneous S1 mutants (88%) have lost only the S1 marker, presumably as a result of either a point mutation or a small deletion involving the MIC1 gene. These findings are consistent with our previous studies when only a limited number of marker genes were used (7, 11). However, due to the distance of the two nearest marker gene (WT and CAT) from the MIC1 gene, mutants that are classified as $S1^-$ only have the potential of losing up to a 3.3-Mb region of the human chromosome 11. As the number of particle traversals increase, the relative proportion of mutants losing only the S1 marker decreased from 75% among mutants induced by a single particle to 4% among those induced by eight α particles. Because the mutant fraction induced by a single α particle was two times higher than the spontaneous background, it is likely that one out of three mutants analyzed could be of spontaneous origin. Nevertheless, the mutant spectrum from the single-particle group was not significantly different from that of spontaneous. This data suggest that most mutants induced by a single particle harbored deletions that were smaller than those traversed by multiple particles. These results further confirmed our previous finding that the relative proportion of mutants with large gene/chromosomal deletions is dose-dependent (11, 12).

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MUTATION RESEARCH

Fundamental and Molecular Mechanisms of Mutagenesis

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Radon, tobacco-specific nitrosamine and mutagenesis in mammalian cells

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Fundamental and Molecular Mechanisms of Mutagenesis

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Radon, tobacco-specific nitrosamine and mutagenesis in mammalian cells

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Abstract

The mutagenicity of 4-methylnitrosamine-1-3-pyridyl-1-butanone (NNK), either alone or in combination with low dose alpha particle irradiation, was examined using the human–hamster hybrid (A_L) cell assay. NNK induced a dose-dependent toxicity in A_L cells. In combination with a 25 cGy dose of alpha particles, the induced survival fraction fell within the statistical range of the calculated values assuming an additive interaction of the two agents. In addition, NNK is mutagenic in A_L cells at the *CD59* locus. Furthermore, a low dose of NNK, when combined with radon alpha particles, resulted in a combined mutagenic effect in A_L cells that was consistent with an additive model but less than additive at higher NNK concentrations. The majority of NNK induced *CD59*$^-$ mutants (77.6%) lost at least one additional marker in addition to the *CD59* which encodes the cell surface antigen. When combined with alpha particles, the proportion of mutants with additional marker loss increased with increasing dose of NNK. Our study further confirms that NNK is mutagenic in mammalian cells, induces mostly deletions, and provides an in vitro assessment of the combined genotoxic effects of NNK and alpha particles at low environmentally relevant doses. This finding should be helpful in understanding the molecular mechanism of the mutagenic process as a result of multi-agent interaction. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: NNK; Alpha particle; A_L cell; *CD59*; PCR

1. Introduction

It has been recognized for more than four decades that tobacco smoking is causally associated with several types of human cancer such as lung, oral cavity, and esophageal cancer. Cigarette smoke is a mixture of about 3800 chemical substances containing at least 40 known human carcinogens [1]. Studies have indicated that 4-methylnitrosamine-1-3-pyridyl-1-butanone (NNK) is the most carcinogenic among tobacco-specific nitrosamines, and there is approximately 80–770 ng NNK per cigarette, depending on the type of tobacco [2]. Although previous studies have shown that NNK is carcinogenic in mice, rats, and hamsters [3], little information is available re-

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garding the clastogenic effects of tobacco-specific nitrosamines in mammalian cell cultures.

Radon, a secondary decay product of uranium-238, is a colorless, odorless gas that decays with a half-life of 3.82 days into a series of solid, short-lived radionucleosides, including polonium-218 and polonium-214 that emit alpha particles during decay. Radon is ubiquitous in indoor environments, including homes and schools and, in general, at concentrations hundreds of fold lower than in underground mines. Residential exposure to radioactive radon and its decay products has been estimated to account for 10%–12% of all lung cancer deaths in the United States [4]. Epidemiological studies have shown that uranium miners exposed to high levels of radon progeny have the largest incidence of radiation-induced lung cancers of any exposed population [5].

Assessment of the carcinogenic and mutagenic effects of two or more environmental agents in combination is an important health issue, as the risk from joint exposure may be substantially higher than predicted from the sum of the individual agents. While tobacco smoke remains the single most important compounding factor in lung cancer incidence among uranium miners, analysis of the current epidemiological data cannot formulate a definitive interaction model between smoking and radon exposure.

Mutation may play a causal role in cancer induction either by activating silent oncogene(s) or by eliminating the activity of tumor suppressor gene(s). While the first process can be mediated by point mutations, the latter can also be brought about by multilocus deletions. In order to understand the underlying mechanisms of mutagenesis, it is necessary to analyze the molecular pattern of mutations. In this paper, we report our findings on mutagenesis in human–hamster hybrid (A_L) cells treated with graded doses of NNK either alone or in combination with a single 25 cGy dose of alpha particles. We further examine the molecular pattern using multiplex PCR. Our data indicate that NNK induces mostly deletion mutations at moderately high doses in mammalian cells. In combination with a 25 cGy dose of alpha particles, NNK at low non-cytotoxic doses induces a mutagenic yield that is consistent with an additive interaction. However, at a higher dose of NNK, the combined mutagenic yield is less than additive.

2. Materials and methods

2.1. Cell culture

The A_L hybrid cells that contain a standard set of Chinese hamster ovary-K1 chromosomes and a single copy of human chromosome-11 were used. Chromosome-11 encodes cells surface markers that render A_L cells sensitive to killing by a special monoclonal antibody in the presence of complement. Rabbit serum complement was from HPR (Denver, PA). Antibody specific to the *CD59* (*S1*) antigen was produced from hybridoma culture as described [6,7]. Cells were maintained in Ham's F-12 medium supplemented with 8% heat-inactivated fetal bovine serum, 25 μg/ml gentamycin, and 2 × normal glycine (2×10^{-4} M) at 37°C, in a humidified 5% CO_2 incubator, and were passaged as described [8–10].

2.2. Toxicity studies with NNK and alpha particles

A stock solution of NNK (Midwest Research Institute, Kansas City, MO) at 100 mg/ml was prepared in dimethyl sulfoxide (DMSO). Working concentrations were prepared by diluting the stock with complete F-12 medium. Exponentially growing cultures of A_L cells were treated with NNK in the presence of S9 (ICN Biomedicals, Lisle, IL) for either 1 day or 7 days followed by irradiation with a 25 cGy dose of ^{4}He ions (150 keV/μm). These high energy particles have a LET value comparable to the alpha particles emitted by radon progenies. The ^{4}He ions were accelerated using a 4 MeV van de Graff Accelerator at the Radiological Research Accelerator Facility as described previously [11,12]. A single 25 cGy dose of ^{4}He ions was chosen for the study since it corresponded to an average of one particle traversal per nucleus based on microdosimetric analysis [13]. The dose of S9 used in this study (184 μg/ml) was non-lethal, non-mutagenic, and capable of metabolically activating benzo(*a*)pyrene in A_L cells based on our preliminary experiments (data not shown). After treatment, cultures were washed twice with balanced salt solution, trypsinized to remove them from the culture flasks or mylar dishes, and replated into 100-mm diameter petri dishes for colony formation. Cultures were incubated for 7–8 days, at

which time they were fixed with formaldehyde and stained with Giemsa. The number of colonies was counted to determine the surviving fraction as described [8,10].

2.3. Quantification of mutations at the CD59 (S1) locus

After treatment, cultures were replated into T75 flasks and cultured for 7 days. This expression period was needed to permit surviving cells to recover from the temporary growth lag caused by NNK with or without alpha particles and to multiply sufficiently so that the progeny of the mutated cells were no longer expressing lethal amounts of the *CD59* surfaced antigen. To determine mutant fractions, aliquots containing 5×10^4 cells per dish were plated into six 60-mm dishes in a total of 2 ml of growth medium as described [8–10]. The cultures were incubated for 2 h to allow for cell attachment, after which 0.3% *CD59* antiserum and 1.5% (vol/vol) freshly thawed complement were added to each dish. After overnight incubation, this medium was removed, and the cultures were further incubated in standard growth medium for 7–8 days. At this time, the cells were fixed and stained, and the number of *CD59*$^-$ mutant colonies was scored. Controls included identical sets of dishes containing antiserum alone, complement alone, or neither agent. The cultures derived from each treatment dose were tested for mutant yield for two consecutive weeks to ensure full expression of the mutations. The mutant fraction at each dose (Mf) was calculated as the number of surviving colonies divided by the total number of cells plated after correction for any non-specific killing due to complement alone. The mutant yield (My) is the slope of the dose–response curve and is independent of the background mutant level.

2.4. Analysis of mutant spectrum by multiplex PCR

Cloning of *CD59*$^-$ mutants and PCR analysis were performed as described previously [9,10]. Briefly, independently derived colonies from each treatment groups including controls from each experiment were isolated by cloning and expanded in cultures, and DNA was extracted using a salt-out method described by Miller et al. [14]. To ensure their clonal origin, either a single colony or, at times, two well-separated colonies per culture dish were isolated.

For *CD59*$^-$ mutant analysis, five DNA marker genes on chromosome-11 (Wilms' tumor, parathyroid hormone, catalase, *RAS*, and apolipoprotein A-1) were chosen for multiplex PCR analysis because of their mapping positions relative to the *CD59* gene, which encodes the *CD59* antigen (Refs. [6,7,15], Fig. 1), and the availability of PCR primers for the coding regions of these genes [16–18]. PCR amplifications were performed for 30 cycles using a DNA thermal cycler model 480 (Perkin-Elmer/Cetus) in

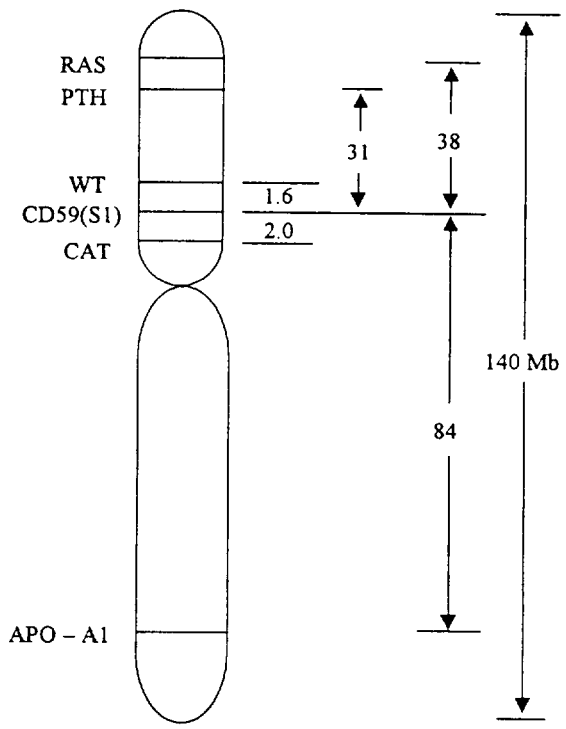

Fig. 1. Diagram of human chromosome-11 showing the *CD59* gene used in defining the *CD59*$^-$ phenotype and the relative positions of other markers used in the multiplex PCR analysis to determine the extent of the *CD59* mutations. The *CD59* gene maps to 11p13.5. The two nearest markers flanking *CD59*, *CAT* and *WT* are separated by approximately 3.6 megabase pairs (Mbp) so that the *CD59*$^-$ mutants that retained these neighboring markers could result from a base change to deletions as large as 3.6 Mbp.

20 μl reaction mixtures containing 0.2 μg of the *Eco*RI-digested DNA sample in 1 × Stoffel fragment buffer, all four dNTPs (each at 0.2 mM), 3 mM $MgCl_2$, 0.2 mM each primer, and 2 units of Stoffel fragment enzyme [8,12]. Each PCR cycle consisted of denaturation at 94°C for 1 min, annealing at 55°C for 1 min, and extension at 72°C for 1 min. After the last cycle, the samples were incubated at 72°C for an additional 20 min, electrophoresed on 3% agarose gels, and stained with ethidium bromide.

2.5. Statistical analysis

The survival and mutagenic data for either alpha particles or NNK alone were compared with those obtained using the two carcinogens concomitantly. The mode of interaction, either additive, super-additive, or antagonistic, was assessed as a function of effect level at a confidence level of ±1 SD as described previously [13,19].

All numerical data were calculated as mean and SD, comparisons of survival fractions and induced mutation frequencies between treated groups and controls were made by Student's *t*-test. A *p*-value of 0.05 or less between groups was considered to be significance of the differences.

3. Results

3.1. Toxicity of NNK and alpha particles in A_L cells

NNK induced a dose-dependent toxicity in A_L cells, as shown in Fig. 2, where the survival fractions after either a 1- or 7-day continuous exposure in the presence of microsomal S9 fraction are plotted against drug concentration, the survival data fit well to a log–linear curve. NNK treatment of A_L cells for a 24-h period was largely non-toxic as shown in Fig. 2. In cultures treated with NNK continuously for 7 days and in which fresh S9 was added every other day, the toxicity was significantly increased with a mean lethal dose (D_0) of about 500 μg/ml. After a single dose of 25 cGy alpha particle irradiation, the surviving fraction was about 0.70. When cells were pretreated with NNK for 7 days followed by exposure to a 25 cGy dose of alpha particles, the resultant survival fraction fell within the statistical range of the calculated values assuming an additive interaction of the two agents (Fig. 3).

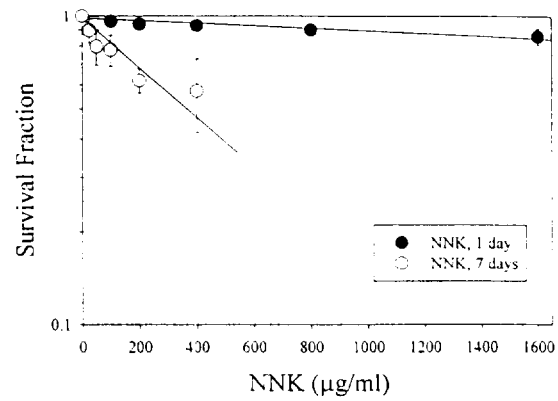

Fig. 2. Survival response of A_L cells treated with graded doses of NNK plus S9 (184 μg/ml) exposed for either 1 or 7 days. Data are pooled from four to six experiments. Error bars show means ± S.E.M.

3.2. Mutagenicity of NNK and alpha particles

Since the majority of the chromosome-11 is not required for survival of A_L cells, the entire gene except for a required small segment near the *RAS* gene (11p15.5) can serve as a target for mutagens. As such, the A_L cell assay is highly sensitive to agents that induce predominately multilocus deletions, as demonstrated previously [10,12]. In addition,, the *CD59* surface antigen is an effective genetic marker since its presence or absence can readily measured in a complement-mediated cytotoxicity assay.

Induction of $CD59^-$ mutants by NNK either alone or in combination with alpha particles is shown in Fig. 4. The induced mutant frequency for cells treated with S9 alone for 7 days was similar to the control. The average background mutant frequency in these experiments was approximately 50 per 10^5 survivors. NNK induced a dose-dependent increase in mutant yield over the range of doses examined. The single 25 cGy dose of alpha particles induced a net mutant fraction (total mutant yield minus background) averaging 74.5 ± 5.8 per 10^5 survivors. In cultures pretreated with either a 25 or 100 μg/ml

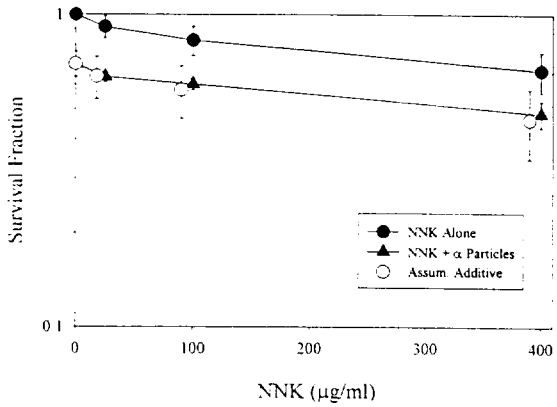

Fig. 3. Survival fraction of A_L cells treated with graded doses of NNK plus S9 (184 μg/ml) for 7 days followed by a 25cGy dose of alpha particle irradiation. Survival fraction of a single 25cGy dose was 0.70. Data are pooled from three to four experiments. Error bars show means ± S.E.M.

dose of NNK, concurrent treatment with alpha particles induced a combined mutant frequency that was consistent with an additive effect, i.e., the combined treatment resulted in a mutant yield which fell within the statistical range assuming an additive interaction between the two mutagens. However, with a 400 μg/ml dose of NNK, the combined mutant yield in A_L cells exposed to concurrent alpha radiation was significantly less than an additive interaction ($p < 0.01$). One plausible explanation is that the treatment induced mostly multilocus deletions that are incompatible with cell survival. In other words, it is possible that many types of mutations induced by 400 μg/ml NNK combined with alpha particles were poorly recovered in these assays because they were lethal. To assess this possibility, we examined the spectrum of mutants induced by the various treatments.

3.3. Analysis of mutant spectra

The *CD59* surface antigenic marker is encoded by the *CD59* gene mapped to chromosome 11p13. A total of 192 mutants, including 35 spontaneous ones, were analyzed. Fig. 5 shows the cumulative deletion maps of these $CD59^-$ mutants. Previous studies have shown that a small segment of the human chromosome-11 near the *RAS* gene is required for survival of the $CD59^-$ mutant [20]. The obligate presence of this region identified here by the *RAS* probe in all the mutants provides a convenient internal PCR control. Consistent with previous studies, the majority of spontaneous $CD59^-$ mutants showed no detectable changes in any of the marker genes examined; 69% of these spontaneous $CD59^-$ mutants had retained all of the markers analyzed. In contrast, only 35% of mutants from alpha particle irradiation retained all of the marker genes examined, i.e., 65% of them lost at least one additional marker gene. The proportion of mutants suffering loss of additional chromosomal markers increased with increasing concentration of NNK. Eighty-eight percent (23/26) of the mutants induced by a 400 μg/ml NNK lost at least one additional marker and of which 19% (5/26) lost all four markers examined which spanned both the short and long arms of the human chromosome-11. In combination with alpha particle irradiation, the proportion of NNK-induced mutants suffering loss of additional markers increased such that for mutants induced by a 400 μg/ml dose of NNK in combination with alpha particles, 97% (33/34) of the mutants lost at least one additional marker as compared with 88% (23/26) with NNK alone. Furthermore, 24% (8/34) of these mutants induced by the combined treatments

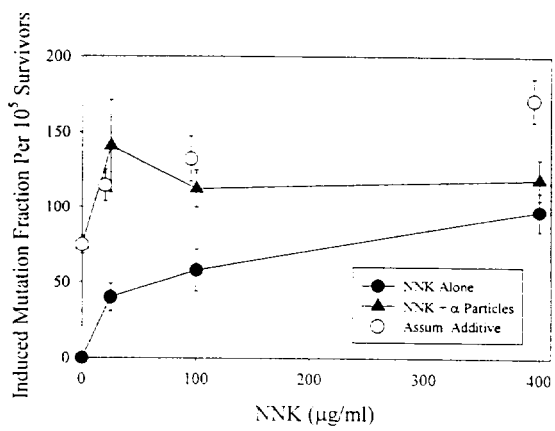

Fig. 4. Induction of $CD59^-$ mutants in A_L cells treated with graded dose of NNK plus S9 (184 μg/ml) for 7 days followed by a single 25cGy dose of alpha particle irradiation. Induced mutation frequency = total mutant yield minus background. Average spontaneous mutation frequencies from these three to five experiments averaged 50 per 10^5 survivors. Error bars show means ± S.E.M.

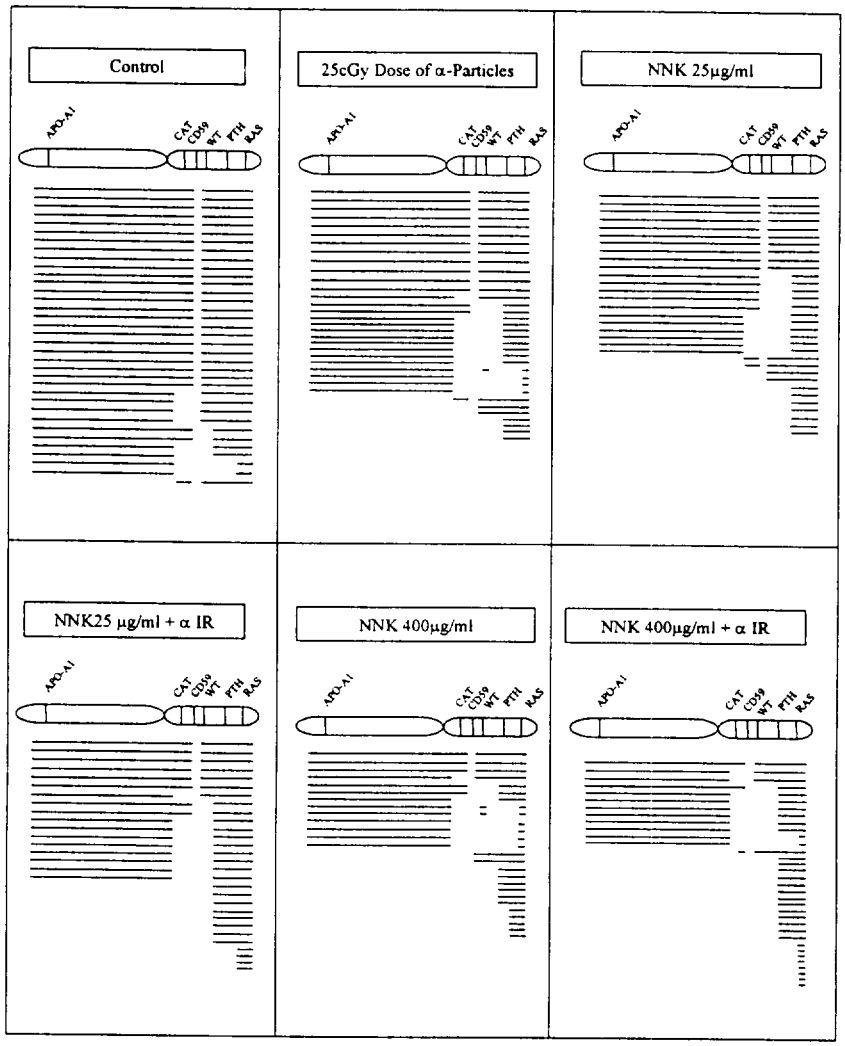

Fig. 5. Cumulative deletion spectra of *CD59*⁻ mutants either of spontaneous origin or from cells treated with graded dose of NNK plus S9 for 7 days alone or followed by a single 25cGy dose of alpha particle irradiation.

lost all four markers compared with 19% (5/26) induced by NNK alone.

4. Discussion

Tobacco products are responsible for a significant proportion of human cancers. A recent estimate indicates that cigarette smoking causes approximately 80%–90% of lung cancers, 60%–90% of oral cancers, 70%–80% of esophageal cancers, 80%–90% of larynx cancers, 30% of pancreatic cancers, 40%–50% of bladder cancers, 10%–50% of kidney cancers, and 30% of cervical cancers in the United States [21]. As one of the strongest carcinogens found in tobacco smoking, NNK has been shown to induce tumors in mice, rats, and hamsters. However, the carcinogenic and mutagenic mechanism(s) of NNK are still unclear. It has been shown that the amount of NNK in tobacco smoke are high enough that the total estimated doses to smokers and long term snuff-dippers

are similar in magnitude to the total doses required to produce cancer in laboratory animals. These exposures thus represent a realistic risk to cigarette smokers and non-smokers exposed for years to environmental tobacco smoke. Recent studies have shown that the proportion of smokers affected in the U.S. population is highest among African Americans (35%) and Hispanics (20%), and they also have the highest mortality rate for smoking-related cancers [22]. The fact that cigarette smoke can interact with other environmental pollutant such as asbestos in a synergistic fashion in cancer induction highlight the complexity in risk assessment and emphasizes the urgent need for basic research on the fundamental mechanisms involved.

Tobacco smoke has been shown to be a compounding factor in the induction of lung cancers among underground miners exposed to high doses of radon alpha particles. Radon is ubiquitous in indoor environments. It is estimated that residential exposure to radon and its progenies may account for 10%–12% of all lung cancer deaths in the U.S. [4]. Epidemiological studies based on cohorts of underground miners have been performed in an attempt to determine the mode of interaction between smoking and radon exposure. However, the variance of the interaction estimate was an order of magnitude greater than the statistical variance of the individual agents under a no-interaction model [23,24]. Therefore, it was difficult to formulate a definitive interaction model between smoking and radon exposure. Animal studies have also shown that exposure to high levels of cigarette smoke decreased the risk of radon induced lung cancer in dogs [25], but a synergistic effect of smoking and radon was found in rats [26]. In contrast to occupational exposure where the majority of the target lung epithelial cells were likely to be traversed by multiple alpha particles [27], the overwhelming majority of lung cells will never be exposed to more than a single particle over a lifetime in domestic exposure [28].

The single 25 cGy dose of an average of ^{4}He ions chosen in the present study corresponds to a single alpha traversal per nucleus based on the measured cross-section area of 108 μm^2 for the A_L hybrid cells [9]. Our current finding of an additive interaction in mutagenic yield in A_L cells exposed to a low dose of NNK and alpha particles is consistent with our previous oncogenic transformation studies in 10T1/2 cells between alpha particles and cigarette smoke condensate [13].

Individual difference in susceptibility to cancer causing agents is one of the most important determining factors in human risk estimation related to environmental carcinogenesis. There is evidence based on both rodent and human studies that NNK can be activated into a DNA reactive metabolite by α-hydroxylation of its methylene and methyl group to yield various DNA methylating and pyridyloxobuylating species [29]. Studies with NNK induced lung tumors among A/J mice indicated that the methylating moieties induce primarily G–A transition whereas pyridylozobuylating agents induce mainly G–T transvertion in codon 12 of the K-*ras* oncogene. However, report on the genotoxity of NNK in mammalian cells is rather limited. NNK has been shown to be largely non-toxic, non-mutagenic at the *hprt* locus in human lymphoblastoid cells [30] and in splenic lymphocytes from rats exposed in vivo to NNK [31]. The negative findings have been largely attributed to the inability of the lymphoid tissue to metabolize NNK since cells transfected with human cytochrome *P*450 cDNA demonstrated high *hprt* mutant yields [30].

In the present study, we treated A_L cells with graded doses of NNK in the presence of S9 rat liver microsomal fraction. In our preliminary studies, we had shown that S9 at the dose used was non-toxic, non-mutagenic, and effective in metabolizing the polycyclic aromatic hydrocarbon, benzo(*a*)pyrene in A_L cultures. We show here that NNK is mutagenic in A_L cells at the *CD59* locus. Furthermore, a low dose of NNK, when combined with radon alpha particles results in a combined effect in A_L cells that is consistent with an additive model, but a less than additive response was observed at a higher NNK concentration. The majority of NNK induced *CD59*$^-$ mutants (77.6%) lost at least one additional marker examined. When combined with alpha particles, the proportion of mutants with additional marker loss increased with increasing dose of NNK. Our study further confirms that NNK is mutagenic in mammalian cells and induces mostly deletions. The data are comparable to the *hprt* mutant spectra induced by equivalent doses of NNK (data not shown). The mutant spectra for *CD59* mutants induced by the

single 25 cGy dose of alpha particles are consistent with previous reports that high linear energy transfer radiation induces predominately multilocus deletions in mammalian cells at the various genetic loci examined [9,12,32]. While mutations at codon 249 of exon 7 in the *p53* gene had previously been suggested to be a hotspot mutation in lung cancers among Colorado uranium miners [33], there is recent evidence that such point mutations may not be common among other miner cohorts studied [34,35]. Consequently, if loss of the *p53* tumor suppressor function is a target for radon alpha particles, it is likely to occur by chromosomal loss via intrachromosomal deletions [35,36].

Since the majority of the chromosome-11 is not required for the survival of A_L cells, the entire gene except for a required small segment near the *RAS* gene (11p15.5) can serve as a target for mutagens [9,12,20]. As such, the A_L cell assay is highly sensitive to agents that induce predominately multilocus deletions, as demonstrated previously [10,12]. In this regard, our finding is consistent with the recent report that NNK induced a significant increase in exon loss of the *hprt* gene among NNK induced mutants in a metabolically competent human lymphoblastoid MCL-5 cells [37]. Our in vitro finding provides the first report on the combined genotoxic effects of NNK and alpha particles and should be helpful in understanding the interactive mechanism of diverse environmental carcinogens at low doses.

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LPDR CUMULATIVE ACCESSION LIST		
Page 1	8101210369	Teton Exploration Drilling Co., Inc.: Oct - Dec 1980
	8605150476	Request for all records re: Molycorp for 1965-1985
	8101080188	GW Dawes has been selected as radiation officer.
	8406150130	Items of interest - discuss options for final disposition of wastes containing thorium or U.
Page 2	8604020386	License SMB-1393, authorizing possession of up to 88,000 lbs. natural thorium in slags at any one time for storage only in Washington, PA.
	8701270212	Definition of by-product material, including application of definition to Kerv McGee wastes. Each application available in PDR.
Page 3	8701270414	Discusses Molycorp comments on proposed rule 10CFR20.
	9501300020	Forwards "Site Characterization Report for license termination of Washington, PA. Vols. 1-3 and App. G.
Page 4	9503290025	Forwards "Plan for Closure of Eight Surface Impoundments + latest set of comments + questions.
	950329033	Response to NRC comments on surface impoundment closure plan acceptable.
	9503290037	Groundwater Monitoring Plan Holding Pond Area.
	9503290041	Comments on plan for closure and decommissioning of (8) holding ponds.
Page 5	9611050086	Submits "Final Design Rep. + Temporary Thorium Storage"
	9611050355	Final Design oversize drawings.
	9701230095	Provides results of additional air modeling work + radiological dose calculations conducted for York.
Page 6	811060382	Forwards IE Inspection Rept. 40-8778/81-ol on 810916 + 0501 + notice of violation.
	8110060389	Violation from insp. On 810416 + 0501 summary of 810429 meeting/recent inspection results enclosed.
*Page 7	8110060496	IE Insp. Rept. 40-8778/8101 on 810416 + 0501. Noncompliance noted: licensable quantities + concentrations of source material found at unauthorized location + one third of storage pile fence missing.

	8112230478	Responds to IE Insp. Rept/discusses past disposal of residues from York Chemical Plant.
	8112230490	Outline of storage + handling plans for licensable thorium in surplus cerium-fluoride by-product + discussion of ground accumulation of low-level radioactive soils at plant.
	8111230388	Responds to NRC 810915 Hr re: violations noted in IE inspection. Corrective actions: monthly gamma surveys initiated + written radiologic monitoring.
Page 8	8407110407	Regarding visits to Amax, Inc., B&W, + Whittaker Corp. Meetings in Canonsburg, PA w/Molycorp + renewal of GE + Rockwell International licenses.
	8502270055	Radiological Survey Plan, Molybdenum Corp. of America, Washington, PA.
Page 8	8506240453	Advises that request for extension of submittal data for corrective action to permit bulk of property to be released for unrestricted use granted, per 850605 telcon.
	8511110363	Requests that all future correspondence be addressed to listed name + address
Page 9	8510220025	Rept. Does not adequately address extent of clean up required. Requests 90-day extension.
	8604020247	FOIA request for records re: Molycorp. 1965-1985.
	8601030339	Firm schedule of completion approved. Feb. or March 1986. Action plan may require amend to license.
	8601030340	90-day extension to define order of magnitude of clean up required + formulate plan of action. Pits will be dug in next 6 weeks.
	8601030341	Responds to 851120 letter regarding necessity of amend to license SMB-1408 in order to convert drummed residue to thorium free rare earth product + forwards "Radiological Measurements..." + "Aerial Radiological..." Amend not required.
Page 10	8601030342	Unassailable Th-u concentrate and less than 0.04 requests amend to license Th-u. Procedures for disposal of thorium residue also requested.
	8602210046	Provides results of survey of underground tanks at licensed facilities.
	8610090014	On-site disposal request for approval/NRC option L/.
Page 11	8610090017	"Health Physics Evaluation of Molycorp, Washington site.
	8612170186	Requests review of encl. TR Fabian 790102 + 0226 letters regarding environment concerns brought to authors attention by E. Greger. Greger expressed concerns over Falleged Disposal of RADWASTE by Molycorp., Inc.
	8612170200	Forwards Senators Schweiker letter requesting NRC findings + views on Fabian, Dept. of

		Environ. Resources, ltrs + E. Greger of Washington, PA letters regarding disposal of radioactive waste by Molycorp.
	8612170208	Partially withheld summary of letter from T. Fabian to Schweiker regarding disposal of radioactive waste still under license control + subject to periodic inspection.
Page 12	8612240057	Informing NRC of steps taken to correct violations noted in inspection of license SMB-1393.
	8706030308	Application for amend to license SMB-1408, permitting rare earth products SNM containing, more than 0.25 thorium production & storage at facility to be blended w/soda ash.
	8811300275	Response to 881117 telcon regarding results of radiation survey of TEST borings + portions of facility including where borings were taken.
	8812140009	Requests proposal determining procedures to be used for decontamination of _____.
Page 13	8901090225	Requests that Molycorp be provided w/name or names of possible disposal sites for contaminated soil. Vendor cannot proceed w/closure of hazardous waste storage ponds unless disposal site located.
	9010100165	Forwards guarantee from Union Oil for financial assurance for facilities in Washington + York.
	9010100173	"Unocal Corp Annual Report 1989"
	9109170289	Forwards irrevocable standby letter of credit 233-796 from San Pablo Bank issued to NRC at request and for account of Molycorp, Inc. Letter of Credit _____ parent company.
Page 14	9205060058	Forwards Press Release 92-52, NRC Approves Action Plan to assure timely cleanup of sites contamination w/relocation.
	920020248	Advise that NRC intends to initiate site - specific steps to implement action plan to accelerate cleanup of sites listed in site decommissioning management plan.
	9206120307	Responds to 92507 letter transmitting questions. Five criteria for inclusion in plan listed.
Page 15	9206240255	Brief history of Molycorp site overview + alternative remediation approaches.
	9207290275	Forwards newsclippings received from NRC press release York + Washington.
Page 16	9208210001	1972 reaching study + proposed rule on import + export of RAD waste.
	9306110240	Appeals 1992 annual renewal fee license covers storage only does not permit processing.
	9306110243	Requests that corrected invoice be issued.
	9306110247	Requests to maintain current license which authorizes only permanent storage/possession of source material.
Page 17	9209100212	Forwards plan for closure + decommissioning of eight holding ponds.
	9209180349	Forwards second irrevocable standby letter of

		credit P077008 from Chase Manhattan Bank. Should replace original letter of credit issued from San Pablo Bank.
	9209210145	Required Financial Assurance for decommissioning No Detailed Affiliation Given.
	9210010121	Request scheduled exception from decommissioning funding plan outlined 10 10CFR40.36 (c) (2) to permit time to conduct site characterization.
Page 18	9210070056	Excavate + package low-level radioactive lantlanide material on site + return material to Mt. Pass, CA facility for processing.
	9210130265	Requests that Molycorp submit amended letter of credit incorporating clause on standby trust fund + agreement demonstrating compliance w/financial assurance requirements.
Page 19	9210300123	Amend 1 to license SMB-1393 for Molycorp, Inc. new street address, new expiration date for license, change in form of natural thorium, increase in possession limit, change in authorized use/decommissioning schedule.
	9211030054	Forwards comments on report entitled "Sub-Surface Survey for Thorium Content at Molycorp plant site".
	9306110234	Accepts invitation to participate in panel presentation; will be advised if PA Dept. will be submitting comments on pond closing.
Page 20	9410130182	Submits standby trust agreement from Chase Manhattan Bank also from Chase Manhattan Bank invoked to pay for decommissioning.
	9211200313	Forwards comments on plan for closure + decommissioning of eight holding ponds - Additional clarification needed on decommissioning of ponds for radioactivity.
	9212240005	Submits results of review of site closure project involving thorium - concerns raised regarding potential chemical groundwater contamination which may have occurred + which will not be addressed in subsurface survey.
	9301070067	Forwards final report entitled "Justification of Caliber Factor Used for Bore-holes Measurements of Underground Radiation Exposure Rates + Average Th - 232 Concentrations + Response to NRC comments d + d 921029."
Page 21	9301070072	Same as above.
	9302020030	Comments on 921113 financial assurance submittal for two Molycorp plants. Should be amended to incorporate first paragraph on page 4-34 in Reg. Guide 3.66.
	9303040074	Discusses comments on plan for site characterization in support of decommissioning.
	9303040080	Forwards comments for consideration, ESSAP reviewed justification of calibration factor used for bore-hole measurements of underground

		radiation exposure rates + average thorium concentration + response to NRC comments.
Page 22	9304290214	Submits results of review of 930312 letter regarding amended letter of credit 1877008 + revisions to standby trust agreement. Amended letter of credit + revised standby trust agreement satisfy NRC.
Page 23	9304290223	Responds to 930406 telcon regarding transfer of small quantity of source _____ corporate lab in California.
	9309280388	Package consisting of national license program coder + listing of termination actions pending.
	9308110364	Revised "sub-surface survey" for thorium content of Molycorp plant site into two oversize enclosures.
Page 24	9709100140	Application for renewal of license.
	9709110217	Radiation, Protection Programs Plan.
	9310060308	FR notice for Molycorp info discussing NRC 930726 _____ Need record keeping documentation.
	9401050410	Requests NRC approval to demolish.
	9404140352	Response to NRC carpeted on surface impoundment closure play plan originally submitted to PA dept of Environment.
	9405020239	Response requests 120-day extension in submitting site characterization report.
Page 25	9406200156	Forwards request to adjust elements of three tasks in site characterization under way at plant.
	9407080059	Responds to 940610 telcon regarding releases to sanitary sewer system.
	9407080075	Responds to 940526 HR modify three tasks to eliminate redundant + costly tasks regarding site characterization plan.
Page 26	9408040325	Responds to 940607 concerns about radiation levels along Chartiers Creek + decommission.
	9409120065	Forwards documentation from Molycorp parent company Union Oil Co. of California, demonstrating financial responsibility for decommissioning activities at Washington, PA site.
	9409120077	Provides NRC w/guarantee, App A of 10 CFR30 of liability, coverage for decommissioning activities.
	9410260401	Informs that forced main sewer line will not be excavated.
	9411210391	Informs that local publicly owned treatment works will not excavate forced main sewer line to determine location as written confirmation of telcon early this summer.
Page 27	9411210394	Requests NRC review radiological survey of Bldg. 38.
	9704140186	NRC attend public meeting in Canton Township.
Page 28	9501250149	Requests NRC approval to demolish bldg. at Washington facility.

	9501250156	Survey report for R&D Bldg. located at Molycorp.
	9502010180	Responds to NRC review Molycorp. Guarantees to demonstrate.
	9502010184	Certifies that Union Oil co. of California currently going concern possesses positive tangible net worth in stated amount as of 931231, in support of _____ in support of _____.
Page 29	9502010186	Guarantees that Union Oil Co. of California, through parent company.
Page 30	9504200088	Forwards work plan to remove off-site contamination from property immediately north of Molycorp, Washington facility. Contamination reported in site Characterization Report submitted by licensee.
	9504200092	Project Work Plan to remove off-site contamination.
	9507070014	Expresses gratitude for informing NRC of actions taken in 950526 letter regarding posting of contaminated are at Washington.
	9507070018	Informs that Molycorp posted areas in question immediately after 950425 site visit, all access gates to impoundment are + all traffic access roads to are have been posted w/caution signs in response to 950510 Hr.
*Page 31	957270362	Tri report of 950428 visit to Molycorp site in Washington first-hand review of licensee site environmental characteristics + examination of physical details on ongoing site characterization activities. List of attendee's encl.
	9508030117	Forwards Decommissioning Plan for Washington, Revised Cost Estimate for decommissioning facility according to plan outline in site decommissioning plan.
Page 32	9508040275	Revised cost estimate for decommissioning (SDP).
	9503010149	Forwards Decommissioning Plan for York, Revised Cost Estimate for decommissioning facility.
	9508110121	Letter from F. Wheeler Environ Corp., discussing criteria selected for release of residue from licensee surface impoundments.
Page 33	9510130241	FOIA requests for decommissioning plan for Molycorp + Characterization Report in support of decommissioning plan Division of Freedom of Information + Publications Services (Post 940714).
	9602230380	Forwards disk containing bore-hole gamma readings in excel spreadsheet.
	9602230384	Forwards responses to comments on Molycorp, Washington, PA site characterization report. Comments prepared w/assistance of consultant.
Page 34	9602230396	Forwards info to support request for license amendment for interim storage of radioactive material in response to NRCIN 90-009

		"Extended Interim Storage of LLW by Fuel Cycle + Materials Licensees.
	9603220345	FOIA request for documents cost estimate + site characterization for York, PA.
	9605090107	Forwards add hydrogeology report submitted on 960422. w/o enclosure.
	9607180036	Forwards 30% conceptual design for storage of thorium from York.
Page 35	9605220184	Offers no objective to Apr. 1995 Plan to Remove Off-Site Contamination" from Findlay property northern border.
Page 36	9611290375	Accepts certifications owner/operator for impoundment of Canton Twp. Cannot approve 960105 request for bond reduction due to 1 yr. Bond liability.
Page 37	9612170340	Concludes that facility design to resist flooding + erosion for interim storage period of 10 years.
	9701170441	Forwards comments on "Final Radiological Status Report for Removal Action conducted Along Northern Boundary of Molycorp"
*	9702180077	Submits concerns regarding Molycorp radiation clean up in Washington Public Health statement enclosed.
	9702130190	Findlay clean up complete.
Page _____ all mixed up and missing		
Page 23	97/03/27	
	9703260265	Responds to 970211 letter to President Clinton, expressing concerns regarding actions proposed by Molycorp Office of Nuclear Material Safety & Safeguards.
	9703260317	Responds to recent letter to (1) person expressing concerns.
Page 15	9705050199	"Environmental Report" Washington, Pa site.
*	9705050203	Rev O to Environmental Report: Vol. 1 + 2 w/six oversized drawings.
Page 18	9706130254	Acknowledge receipt of 970417 Date of surface water + ground water tests conducted in vicinity show no evidence of radioactive contamination.
Page 18	9801290186	Telcon on monitoring of temporary storage of York material.
Page 16	9806050382	Correspondence to licensee d + d 980504 reacceptance review.
Page 22	9806080025	Confirms 980427 telcon w/M. Jardine regarding Molycorp's Washington, PA project. Copies of NRC correspondence + listed info, requested, as J.T. Olshock is Solicitor for Canton Township.
Page 20	9812040197	Forwards response to NRC recent comments + questions on decommissioning estimate for Molycorp Washington facility. Parent company guarantee will follow under separate cover.
Page 17	9810090156	Questions & comments on staff review - estimated cost of third party completion work.

Page 26	9810230040	Alternatives + list of alternatives recommended for future consideration.
Page 23	9903010012	Fin L-2094 "RESRAD Assessment of dose Inadvertent Intruder."
*	9903010015	"RESRAD Assessment of _____ to Inadvertent Intruder."
	9903090232	Comments on Summary report "Solubility + _____controls on Radionuclides in _____ Wastes.
Page 15 (5 - 97)	9905130012	Discussed info _____ with Commonwealth of PA.
Page 20 (4 - 99)	9904070265	Forwards signed original of US NRC notice of public meeting on Molycorp amendment request to build interim storage structure.
Page 22	9904070220	Requested meeting on 990415 in Washington confirmed.
	9902040281	Canton Township's Board of Supervisors has agreed that 990415 is an acceptable date for Town Meeting.
Page 23	9904280237	Photograph of Catfish Creek flooding beside Molycorp plant on Caldwell. Potential for disaster seems very real.
Page 17	9906240312	Supply Report of Shallow Groundwater _____ at Molycorp, York, PA facility.
Page 20 (7 - 99)	9907090252	Forwards part (1) Decommission Plan. Soils will be covered in part (2).
Page 22	9906110214	Forwards info DEP developed during Oil & Gas Management Review of Molycorp site.
	9906110174	Positives regarding applicability of Ground-fathering provisions to 950814 Decommissioning Plans.
Page 21	9907160017	Hearing requests submitted by city of Washington & Canton Township. Requests for hearing.
Page 15	9908200053	Requester Canton Township, PA re/vote to strike _____ Molycorp. Petitioner/requester request that Molycorp, Inc. request for hearing be stricken as untimely.

Inspection and Testing - Element 4.10

General- 4.10.1

The supplier shall establish and maintain documented procedures for inspection and testing activities in order to verify that the specified requirements for the product are met. The required inspection and testing, and the records to be established, shall be detailed in the quality plan or documented procedures.

Acceptance Criteria for Attribute Characteristics - 4.10.1.1
Acceptance criteria for attribute data sampling plans shall be zero defects. Appropriate acceptance criteria for all other situations (e.g. visual standards) shall be documented by the supplier and approved by the customer.

Receiving Inspection and Testing- 4.10.2

4.10.2.1 The supplier shall ensure that incoming product is not used or processed (except in the circumstances described in 4.10.2.3) until it has been inspected or otherwise verified as conforming to specified requirements. Verification of conformance to the specified requirements shall be in accordance with the quality plan (Control Plan) *and/or documented procedures*

4.10.2.2 In determining the amount and nature of receiving inspection, consideration shall be given to the amount of control exercised at the subcontractor's premises and the recorded evidence of conformance provided.

4.10.2.3 Where incoming product is released for urgent production purposes prior to verification, it shall be positively identified and recorded (see 4.16) in order to permit immediate recall and replacement in the event of nonconformity to specified requirements.

Incoming Product Quality - 4.10.2.4
The supplier's incoming quality system shall use one or more of the following methods:

- Receipt and evaluation of statistical data by the supplier
- Receiving inspection and/or testing (e.g., sampling based on performance)
- Second or third party assessments or audits of subcontractor sites, when coupled with records of acceptable quality performance
- Part evaluation by accredited laboratories

In-process Inspection and Testing- 4.10.3

The supplier shall:

a) *inspect and test the product as required by the quality plan* (Control Plan) *and/or documented procedures;*

b) *hold product until the required inspection and tests have been completed or necessary reports have been received and verified, except when product is released under positive-recall procedures (see 4.10.2.3). Release under positive-recall procedures shall not preclude the activities outlined in 4.10.3a).*

c) direct process activities toward defect prevention methods, such as statistical process control, mistake proofing, visual controls, rather than defect detection.

Final Inspection and Testing- 4.10.4

The supplier shall carry out all final inspection and testing in accordance with the quality plan (Control Plan) *and/or documented procedures to complete the evidence of conformance of the finished product to the specified requirements.*

The quality plan (Control Plan) *and/or documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either on receipt of product or in-process, have been carried out and that the results meet specified requirements.*

No product shall be dispatched until all the activities specified in the quality plan (Control Plan) *and/or documented procedures have been satisfactorily completed and the associated data and documentation are available and authorized.*

Layout Inspection and Functional Testing - 4.10.4.1
A layout inspection and a functional verification (to applicable customer engineering material and performance standards) shall be performed for all products at a frequency established by the customer (see Section II). Results shall be available for customer review.

Final Product Audit - 4.10.4.2
The supplier shall conduct audits of packaged final product to verify conformance to all specified requirements (e.g. product, packaging, labeling) at an appropriate frequency.

NOTE: This activity, also known as a "dock audit", is based upon sampling and is generally performed after final inspection but prior to shipment. Where customer PPM requirements are met, the frequency of Final Product Audits may be reduced.

Inspection and Test Records- 4.10.5

The supplier shall establish and maintain records which provide evidence that the product has been inspected and/or tested. These records shall show clearly whether the product has passed or failed the inspections and/or tests according to defined acceptance criteria. Where the product fails to pass any inspection and/or test, the procedures for the control of nonconforming product shall apply (see 4.13).

Records shall identify the inspection authority responsible for the release of the product (see 4.16).

Supplier Laboratory Requirements- 4.10.6

NOTE: Element 4.10.6 applies to supplier in-house laboratory facilities, not inspection or testing performed outside of a laboratory facility.

Laboratory Quality Systems - 4.10.6.1
The laboratory (supplier's testing facility - chemical, metallurgical, reliability, test validation, e.g. fastener labs) shall have a laboratory scope (see Glossary). The laboratory shall document all its policies, systems, programs, procedures, instructions and findings which enable the laboratory to assure the quality of the tests or calibration results it generates within the scope (see 4.2.1).

NOTE: Accreditation of supplier facilities to ISO/IEC Guide 25 or national equivalent is not required by, nor does it satisfy, all **QS-9000** requirements for a laboratory. Therefore, the laboratory should be included in the on-site audits.

Laboratory Personnel - 4.10.6.2
The personnel making professional judgment with reference to testing and/or calibration shall have appropriate background and experience (see 4.1.2.2).

NOTE: Such background should include both theoretical and recent practical experience.

Laboratory Product Identification and Testing - 4.10.6.3
The laboratory shall have procedures for the receipt, identification, handling, protection and retention or disposal of test samples and/or

calibration equipment items, including all provisions necessary to protect the integrity of the items (see 4.15). The items shall be retained until final data is complete throughout the life of the item in the laboratory, enabling traceability from final data to raw data (see Glossary and 4.10.1).

Laboratory Process Control - 4.10.6.4
The laboratory shall monitor, control and record (see 4.16) environmental conditions as required by relevant specifications or where they may influence the quality of results. Requirements for environmental conditions (e.g. biological sterility, dust, electromagnetic interference, radiation, humidity, electrical supply, temperature, and sound and vibration levels) shall be established and maintained as appropriate to the technical activities concerned.

Laboratory Testing and Calibration Methods - 4.10.6.5
The laboratory shall use test and/or calibration methods, including those for sampling, which meet the needs of the customer and are appropriate for the tests and/or calibrations it undertakes, preferably the current issue of those published as international, regional, or national standards (see 4.11). The laboratory shall verify its capability to perform to the standard specifications before carrying out such work. When it is necessary to employ methods not covered by standard specifications, these shall be subject to agreement with the customer.

Laboratory Statistical Methods - 4.10.6.6
Appropriate statistical techniques should be applied to verification activities whose deliverables are data (see. 4.20).

Accredited Laboratories- 4.10.7

Commercial/independent laboratory facilities used by the supplier shall be accredited laboratory (see Glossary) facilities. Reference the customer-specific pages of this document and the Glossary.

NOTE: Commercial/independent laboratories cannot be registered to **QS-9000**.

NOTE: For further guidance on Element 4.10.7, see ISO/IEC Guide 25 or national equivalent.

Control of Inspection, Measuring and Test Equipment - Element 4.11

General- 4.11.1

The supplier shall establish and maintain documented procedures to control, calibrate and maintain inspection, measuring and test equipment (including test software) used by the supplier to demonstrate the conformance of product to the specified requirements. Inspection, measuring and test equipment shall be used in a manner which ensures that the measurement uncertainty is known and is consistent with the required measurement capability.

> **NOTE:** Additional guidance on measurement uncertainty may be found in ISO 10012-1:1992 (E). The choice of the specific method to be used should be based upon sound technical knowledge of the complete measurement system, the conditions under which it will operate, and the uses for which the data are being produced.

Where test software or comparative references such as test hardware are used as suitable forms of inspection, they shall be checked to prove that they are capable of verifying the acceptability of product, prior to release for use during production, installation, or servicing, and shall be rechecked at prescribed intervals. The supplier shall establish the extent and frequency of such checks and shall maintain records as evidence of control (see 4.16).

Where the availability of technical data pertaining to the inspection, measuring, and test equipment is a specified requirement, such data shall be made available, when required by the customer or customer's representative, for verification that the inspection, measuring, and test equipment is functionally adequate.

> *NOTE 17: For the purposes of this International Standard, the term "measuring equipment" includes measurement devices.*

Control Procedure- 4.11.2

The supplier shall:

a) determine the measurements to be made and the accuracy required, and select the appropriate inspection, measuring and test equipment that is capable of the necessary accuracy and precision;

b) *identify all inspection, measuring and test equipment that can affect product quality, and calibrate and adjust them at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to internationally or nationally recognized standards. Where no such standards exist, the basis used for calibration shall be documented;*

> **NOTE:** "inspection, measuring and test equipment" includes equipment in tooling departments used to qualify or maintain production tools regardless of ownership.

Calibration Services - 4.11.2.b.1
Calibration of inspection, measuring or test equipment shall be conducted by a qualified in-house laboratory (see 4.10.6), a qualified commercial/independent laboratory (see 4.10.7), or a customer-recognized government agency. The laboratory scope shall include the calibration of such equipment.

Commercial/ independent calibration facilities shall be accredited to ISO/IEC Guide 25 or national equivalent or have evidence, e.g. assessment by an OEM customer or an OEM customer-approved second party, that they meet the intent of ISO/IEC Guide 25 or national equivalent.

> **NOTE:** Where a qualified laboratory does not exist for a given piece of equipment, calibration services may be performed by the original equipment manufacturer.

c) *define the process employed for the calibration of inspection, measuring and test equipment, including details of equipment type, unique identification, location, frequency of checks, check method, acceptance criteria and the action to be taken when results are unsatisfactory;*

d) *identify inspection, measuring and test equipment with a suitable indicator or approved identification record to show the calibration status;*

> **NOTE:** A serial number traceable to the device calibration record meets the intent of this requirement.

e) *maintain calibration records for inspection, measuring and test equipment (see 4.16);*

f) assess and document the validity of previous inspection and test results when inspection, measuring or test equipment is found to be out of calibration;

g) ensure that the environmental conditions are suitable for the calibrations, inspections, measurements and tests being carried out;

h) ensure that the handling, preservation and storage of inspection, measuring and test equipment is such that the accuracy and fitness for use is maintained;

i) safeguard inspection, measuring and test facilities, including both test hardware and test software, from adjustments which would invalidate the calibration setting.

NOTE: Inspection, measuring and test facilities is generally understood to mean inspection, measuring and test equipment where test results can be invalidated by inappropriate adjustment at the audited site.

NOTE 18: *The metrological confirmation system for measuring equipment given in ISO 10012 may be used for guidance.*

Inspection, Measuring, and Test Equipment Records- 4.11.3

Records of the calibration (see Glossary) activity for all gages, measuring, and test equipment, including those owned by employees, shall include:

- Revisions following engineering changes (if appropriate);
- Any out of specification readings as received for calibration;
- Statements of conformance to specification after calibration;
- Notification to the customer if suspect material or product (see Glossary) may have been shipped.

Measuring System Analysis- 4.11.4

Appropriate statistical studies shall be conducted to analyze the variation present in the results of each type of measuring and test equipment system. This requirement shall apply to measurement systems referenced in the Control Plan (see 4.2.3.7). The analytical methods and acceptance criteria used should conform to those in the **Measurement Systems Analysis** reference manual (e.g. bias, linearity, stability, repeatability and reproducibility studies). Other analytical methods and acceptance criteria may be used if approved by the customer.

the basis of appropriate education, training and/or experience.

4.4.3 Communication

With regard to its environmental aspects and environmental management system, the organization shall establish and maintain procedures for

a) internal communication between the various levels and functions of the organization;

b) receiving, documenting and responding to relevant communication from external interested parties.

The organization shall consider processes for external communication on its significant environmental aspects and record its decision.

4.4.4 Environmental management system documentation

The organization shall establish and maintain information, in paper or electronic form, to

a) describe the core elements of the management system and their interaction;

b) provide direction to related documentation.

4.4.5 Document control

The organization shall establish and maintain procedures for controlling all documents required by this International Standard to ensure that

a) they can be located;

b) they are periodically reviewed, revised as necessary and approved for adequacy by authorized personnel;

c) the current versions of relevant documents are available at all locations where operations essential to the effective functioning of the environmental management system are performed;

d) obsolete documents are promptly removed from all points of issue and points of use, or otherwise assured against unintended use;

e) any obsolete documents retained for legal and/or knowledge preservation purposes are suitably identified.

Documentation shall be legible, dated (with dates of revision) and readily identifiable, maintained in an orderly manner and retained for a specified period. Procedures and responsibilities shall be established and maintained concerning the creation and modification of the various types of document.

4.4.6 Operational control

The organization shall identify those operations and activities that are associated with the identified significant environmental aspects in line with its policy, objectives and targets. The organization shall plan these activities, including maintenance, in order to ensure that they are carried out under specified conditions by

a) establishing and maintaining documented procedures to cover situations where their absence could lead to deviations from the environmental policy and the objectives and targets;

b) stipulating operating criteria in the procedures;

c) establishing and maintaining procedures related to the identifiable significant environmental aspects of goods and services used by the organization and communicating relevant procedures and requirements to suppliers and contractors.

4.4.7 Emergency preparedness and response

The organization shall establish and maintain procedures to identify potential for and respond to accidents and emergency situations, and for preventing and mitigating the environmental impacts that may be associated with them.

The organization shall review and revise, where necessary, its emergency preparedness and response procedures, in particular, after the occurrence of accidents or emergency situations.

The organization shall also periodically test such procedures where practicable.

4.5 Checking and corrective action

4.5.1 Monitoring and measurement

The organization shall establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of its operations and activities that can have a significant impact on the environment. This shall include the recording of information to track performance, relevant operational controls and conformance with the organization's environmental objectives and targets.

Monitoring equipment shall be calibrated and maintained and records of this process shall be retained according to the organization's procedures.

The organization shall establish and maintain a documented procedure for periodically evaluating compliance with relevant environmental legislation and regulations.

Title: Executive Order #12866: Regulatory Planning and Review
Author: The White House
Date: June, 1994

THE WHITE HOUSE

Office of the Press Secretary

September 30, 1993

EXECUTIVE ORDER #12866

REGULATORY PLANNING AND REVIEW

The American people deserve a regulatory system that works for them, not against them: a regulatory system that protects and improves their health, safety, environment, and well-being and improves the performance of the economy without imposing unacceptable or unreasonable costs on society; regulatory policies that recognize that the private sector and private markets are the best engine for economic growth; regulatory approaches that respect the role of State, local, and tribal governments; and regulations that are effective, consistent, sensible, and understandable. We do not have such a regulatory system today.

With this Executive order, the Federal Government begins a program to reform and make more efficient the regulatory process. The objectives of this Executive order are to enhance planning and coordination with respect to both new and existing regulations; to reaffirm the primacy of Federal agencies in the regulatory decision-making process; to restore the integrity and legitimacy of regulatory review and oversight; and to make the process more accessible and open to the public. In pursuing these objectives, the regulatory process shall be conducted so as to meet applicable statutory requirements and with due regard to the discretion that has been entrusted to the Federal agencies.

Accordingly, by the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Statement of Regulatory Philosophy and Principles.

a. The Regulatory Philosophy. Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people. In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that

maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

b. The Principles of Regulation. To ensure that the agencies' regulatory programs are consistent with the philosophy set forth above, agencies should adhere to the following principles, to the extent permitted by law and where applicable:
    1. Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem.
    2. Each agency shall examine whether existing regulations (or other law) have created, or contributed to, the problem that a new regulation is intended to correct and whether those regulations (or other law) should be modified to achieve the intended goal of regulation more effectively.
    3. Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.
    4. In setting regulatory priorities, each agency shall consider, to the extent reasonable, the degree and nature of the risks posed by various substances or activities within its jurisdiction.
    5. When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective. In doing so, each agency shall consider incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity.
    6. Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.
    7. Each agency shall base its decisions on the best reasonably obtainable scientific, technical, economic, and other information concerning the need for, and consequences of, the intended regulation.
    8.) Each agency shall identify and assess alternative forms of regulation and shall, to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt.
    9. Wherever feasible, agencies shall seek views of appropriate State, local, and tribal officials before imposing regulatory requirements that might significantly or uniquely affect those governmental entities. Each agency shall assess the effects of Federal regulations on State, local, and tribal governments, including specifically the availability of resources to carry out those mandates, and seek to minimize those burdens that uniquely or significantly affect such governmental entities, consistent with achieving regulatory objectives. In addition, as appropriate, agencies shall seek to harmonize Federal regulatory actions with related State, local, and tribal regulatory and other governmental functions.
    10. Each agency shall avoid regulations that are inconsistent, incompatible, or duplicative with its other regulations or those of other Federal agencies.
    11. Each agency shall tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes, and other entities (including small communities and governmental entities), consistent with obtaining the regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations.
    12. Each agency shall draft its regulations to be simple and easy to understand, with the goal of

minimizing the potential for uncertainty and litigation arising from such uncertainty.

Sec. 2. Organization.

An efficient regulatory planning and review process is vital to ensure that the Federal Government's regulatory system best serves the American people.

a. The Agencies. Because Federal agencies are the repositories of significant substantive expertise and experience, they are responsible for developing regulations and assuring that the regulations are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order.
b. The Office of Management and Budget. Coordinated review of agency rulemaking is necessary to ensure that regulations are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order, and that decisions made by one agency do not conflict with the policies or actions taken or planned by another agency. The Office of Management and Budget (OMB) shall carry out that review function. Within OMB, the Office of Information and Regulatory Affairs (OIRA) is the repository of expertise concerning regulatory issues, including methodologies and procedures that affect more than one agency, this Executive order, and the President's regulatory policies. To the extent permitted by law, OMB shall provide guidance to agencies and assist the President, the Vice President, and other regulatory policy advisors to the President in regulatory planning and shall be the entity that reviews individual regulations, as provided by this Executive order.
c. The Vice President. The Vice President is the principal advisor to the President on, and shall coordinate the development and presentation of recommendations concerning, regulatory policy, planning, and review, as set forth in this Executive order. In fulfilling their responsibilities under this Executive order, the President and the Vice President shall be assisted by the regulatory policy advisors within the Executive Office of the President and by such agency officials and personnel as the President and the Vice President may, from time to time, consult.

Sec. 3. Definitions.

For purposes of this Executive order:

a. "Advisors" refers to such regulatory policy advisors to the President as the President and Vice President may from time to time consult, including, among others: (1) the Director of OMB; (2) the Chair (or another member) of the Council of Economic Advisers; (3) the Assistant to the President for Economic Policy; (4) the Assistant to the President for Domestic Policy; (5) the Assistant to the President for National Security Affairs; (6) the Assistant to the President for Science and Technology; (7) the Assistant to the President for Intergovernmental Affairs; (8) the Assistant to the President and Staff Secretary; (9) the Assistant to the President and Chief of Staff to the Vice President; (10) the Assistant to the President and Counsel to the President; (11) the Deputy Assistant to the President and Director of the White House Office on Environmental Policy; and (12) the Administrator of OIRA, who also shall coordinate communications relating to this Executive order among the agencies, OMB, the other Advisors, and the Office of the Vice President.
b. "Agency," unless otherwise indicated, means any authority of the United States that is an "agency" under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10).
c. "Director" means the Director of OMB. (

d. "Regulation" or "rule" means an agency statement of general applicability and future effect, which the agency intends to have the force and effect of law, that is designed to implement, interpret, or prescribe law or policy or to describe the procedure or practice requirements of an agency. It does not, however, include:
    1. Regulations or rules issued in accordance with the formal rulemaking provisions of 5 U.S.C. 556, 557;
    2. Regulations or rules that pertain to a military or foreign affairs function of the United States, other than procurement regulations and regulations involving the import or export of non-defense articles and services;
    3. Regulations or rules that are limited to agency organization, management, or personnel matters; or
    4. Any other category of regulations exempted by the Administrator of OIRA.
e. "Regulatory action" means any substantive action by an agency (normally published in the Federal Register) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking.
f. "Significant regulatory action" means any regulatory action that is likely to result in a rule that may:
    1. Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
    2. Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
    3. Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
    4. Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive order.

Sec. 4. Planning Mechanism.

In order to have an effective regulatory program, to provide for coordination of regulations, to maximize consultation and the resolution of potential conflicts at an early stage, to involve the public and its State, local, and tribal officials in regulatory planning, and to ensure that new or revised regulations promote the President's priorities and the principles set forth in this Executive order, these procedures shall be followed, to the extent permitted by law:

a. Agencies' Policy Meeting. Early in each year's planning cycle, the Vice President shall convene a meeting of the Advisors and the heads of agencies to seek a common understanding of priorities and to coordinate regulatory efforts to be accomplished in the upcoming year.
b. Unified Regulatory Agenda. For purposes of this subsection, the term "agency" or "agencies" shall also include those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10). Each agency shall prepare an agenda of all regulations under development or review, at a time and in a manner specified by the Administrator of OIRA. The description of each regulatory action shall contain, at a minimum, a regulation identifier number, a brief summary of the action, the legal authority for the action, any legal deadline for the action, and the name and telephone number of a knowledgeable agency official. Agencies may incorporate the information required under 5 U.S.C. 602 and 41 U.S.C. 402 into these agendas.
c. The Regulatory Plan. For purposes of this subsection, the term "agency" or "agencies" shall also include those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(10).
    1. As part of the Unified Regulatory Agenda, beginning in 1994, each agency shall prepare a

Regulatory Plan (Plan) of the most important significant regulatory actions that the agency reasonably expects to issue in proposed or final form in that fiscal year or thereafter. The Plan shall be approved personally by the agency head and shall contain at a minimum:

A. A statement of the agency's regulatory objectives and priorities and how they relate to the President's priorities;
B. A summary of each planned significant regulatory action including, to the extent possible, alternatives to be considered and preliminary estimates of the anticipated costs and benefits;
C. A summary of the legal basis for each such action, including whether any aspect of the action is required by statute or court order;
D. A statement of the need for each such action and, if applicable, how the action will reduce risks to public health, safety, or the environment, as well as how the magnitude of the risk addressed by the action relates to other risks within the jurisdiction of the agency;
E. The agency's schedule for action, including a statement of any applicable statutory or judicial deadlines; and
F. The name, address, and telephone number of a person the public may contact for additional information about the planned regulatory action.

2. Each agency shall forward its Plan to OIRA by June 1st of each year.
3. Within 10 calendar days after OIRA has received an agency's Plan, OIRA shall circulate it to other affected agencies, the Advisors, and the Vice President.
4. An agency head who believes that a planned regulatory action of another agency may conflict with its own policy or action taken or planned shall promptly notify, in writing, the Administrator of OIRA, who shall forward that communication to the issuing agency, the Advisors, and the Vice President.
5. If the Administrator of OIRA believes that a planned regulatory action of an agency may be inconsistent with the President's priorities or the principles set forth in this Executive order or may be in conflict with any policy or action taken or planned by another agency, the Administrator of OIRA shall promptly notify, in writing, the affected agencies, the Advisors, and the Vice President.
6. The Vice President, with the Advisors' assistance, may consult with the heads of agencies with respect to their Plans and, in appropriate instances, request further consideration or inter-agency coordination.
7. The Plans developed by the issuing agency shall be published annually in the October publication of the Unified Regulatory Agenda. This publication shall be made available to the Congress; State, local, and tribal governments; and the public. Any views on any aspect of any agency Plan, including whether any planned regulatory action might conflict with any other planned or existing regulation, impose any unintended consequences on the public, or confer any unclaimed benefits on the public, should be directed to the issuing agency, with a copy to OIRA.

d. Regulatory Working Group. Within 30 days of the date of this Executive order, the Administrator of OIRA shall convene a Regulatory Working Group ("Working Group"), which shall consist of representatives of the heads of each agency that the Administrator determines to have significant domestic regulatory responsibility, the Advisors, and the Vice President. The Administrator of OIRA shall chair the Working Group and shall periodically advise the Vice President on the activities of the Working Group. The Working Group shall serve as a forum to assist agencies in identifying and analyzing important regulatory issues (including, among others (1) the development of innovative regulatory techniques, (2) the methods, efficacy, and utility of comparative risk assessment in regulatory decision-making, and (3) the development of short forms and other

streamlined regulatory approaches for small businesses and other entities). The Working Group shall meet at least quarterly and may meet as a whole or in subgroups of agencies with an interest in particular issues or subject areas. To inform its discussions, the Working Group may commission analytical studies and reports by OIRA, the Administrative Conference of the United States, or any other agency.

e. Conferences. The Administrator of OIRA shall meet quarterly with representatives of State, local, and tribal governments to identify both existing and proposed regulations that may uniquely or significantly affect those governmental entities. The Administrator of OIRA shall also convene, from time to time, conferences with representatives of businesses, nongovernmental organizations, and the public to discuss regulatory issues of common concern.

Sec. 5. Existing Regulations.

In order to reduce the regulatory burden on the American people, their families, their communities, their State, local, and tribal governments, and their industries; to determine whether regulations promulgated by the executive branch of the Federal Government have become unjustified or unnecessary as a result of changed circumstances; to confirm that regulations are both compatible with each other and not duplicative or inappropriately burdensome in the aggregate; to ensure that all regulations are consistent with the President's priorities and the principles set forth in this Executive order, within applicable law; and to otherwise improve the effectiveness of existing regulations:

a. Within 90 days of the date of this Executive order, each agency shall submit to OIRA a program, consistent with its resources and regulatory priorities, under which the agency will periodically review its existing significant regulations to determine whether any such regulations should be modified or eliminated so as to make the agency's regulatory program more effective in achieving the regulatory objectives, less burdensome, or in greater alignment with the President's priorities and the principles set forth in this Executive order. Any significant regulations selected for review shall be included in the agency's annual Plan. The agency shall also identify any legislative mandates that require the agency to promulgate or continue to impose regulations that the agency believes are unnecessary or outdated by reason of changed circumstances.
b. The Administrator of OIRA shall work with the Regulatory Working Group and other interested entities to pursue the objectives of this section. State, local, and tribal governments are specifically encouraged to assist in the identification of regulations that impose significant or unique burdens on those governmental entities and that appear to have outlived their justification or be otherwise inconsistent with the public interest.
c. The Vice President, in consultation with the Advisors, may identify for review by the appropriate agency or agencies other existing regulations of an agency or groups of regulations of more than one agency that affect a particular group, industry, or sector of the economy, or may identify legislative mandates that may be appropriate for reconsideration by the Congress.

Sec. 6. Centralized Review of Regulations.

The guidelines set forth below shall apply to all regulatory actions, for both new and existing regulations, by agencies other than those agencies specifically exempted by the Administrator of OIRA:

a. Agency Responsibilities.
    1. Each agency shall (consistent with its own rules, regulations, or procedures) provide the public with meaningful participation in the regulatory process. In particular, before issuing a notice of proposed rulemaking, each agency should, where appropriate, seek the involvement

of those who are intended to benefit from and those expected to be burdened by any regulation (including, specifically, State, local, and tribal officials). In addition, each agency should afford the public a meaningful opportunity to comment on any proposed regulation, which in most cases should include a comment period of not less than 60 days. Each agency also is directed to explore and, where appropriate, use consensual mechanisms for developing regulations, including negotiated rulemaking.

2. Within 60 days of the date of this Executive order, each agency head shall designate a Regulatory Policy Officer who shall report to the agency head. The Regulatory Policy Officer shall be involved at each stage of the regulatory process to foster the development of effective, innovative, and least burdensome regulations and to further the principles set forth in this Executive order.
3. In addition to adhering to its own rules and procedures and to the requirements of the Administrative Procedure Act, the Regulatory Flexibility Act, the Paperwork Reduction Act, and other applicable law, each agency shall develop its regulatory actions in a timely fashion and adhere to the following procedures with respect to a regulatory action:
   A. Each agency shall provide OIRA, at such times and in the manner specified by the Administrator of OIRA, with a list of its planned regulatory actions, indicating those which the agency believes are significant regulatory actions within the meaning of this Executive order. Absent a material change in the development of the planned regulatory action, those not designated as significant will not be subject to review under this section unless, within 10 working days of receipt of the list, the Administrator of OIRA notifies the agency that OIRA has determined that a planned regulation is a significant regulatory action within the meaning of this Executive order. The Administrator of OIRA may waive review of any planned regulatory action designated by the agency as significant, in which case the agency need not further comply with subsection (a)(3)(B) or subsection (a)(3)(C) of this section.
   B. For each matter identified as, or determined by the Administrator of OIRA to be, a significant regulatory action, the issuing agency shall provide to OIRA:
      i. The text of the draft regulatory action, together with a reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need; and
      ii. An assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate and, to the extent permitted by law, promotes the President's priorities and avoids undue interference with State, local, and tribal governments in the exercise of their governmental functions.
   C. For those matters identified as, or determined by the Administrator of OIRA to be, a significant regulatory action within the scope of section 3(f)(1), the agency shall also provide to OIRA the following additional information developed as part of the agency's decision-making process (unless prohibited by law):
      i. An assessment, including the underlying analysis, of benefits anticipated from the regulatory action (such as, but not limited to, the promotion of the efficient functioning of the economy and private markets, the enhancement of health and safety, the protection of the natural environment, and the elimination or reduction of discrimination or bias) together with, to the extent feasible, a quantification of those benefits;
      ii. An assessment, including the underlying analysis, of costs anticipated from the regulatory action (such as, but not limited to, the direct cost both to the government in administering the regulation and to businesses and others in

complying with the regulation, and any adverse effects on the efficient functioning of the economy, private markets (including productivity, employment, and competitiveness), health, safety, and the natural environment), together with, to the extent feasible, a quantification of those costs; and

iii. An assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, identified by the agencies or the public (including improving the current regulation and reasonably viable nonregulatory actions), and an explanation why the planned regulatory action is preferable to the identified potential alternatives.

D. In emergency situations or when an agency is obligated by law to act more quickly than normal review procedures allow, the agency shall notify OIRA as soon as possible and, to the extent practicable, comply with subsections (a)(3)(B) and (C) of this section. For those regulatory actions that are governed by a statutory or court-imposed deadline, the agency shall, to the extent practicable, schedule rulemaking proceedings so as to permit sufficient time for OIRA to conduct its review, as set forth below in subsection (b)(2) through (4) of this section.

E. After the regulatory action has been published in the Federal Register or otherwise issued to the public, the agency shall:

i. Make available to the public the information set forth in subsections (a)(3)(B) and (C);

ii. Identify for the public, in a complete, clear, and simple manner, the substantive changes between the draft submitted to OIRA for review and the action subsequently announced; and

iii. Identify for the public those changes in the regulatory action that were made at the suggestion or recommendation of OIRA.

F. All information provided to the public by the agency shall be in plain, understandable language.

4. **OIRA Responsibilities. The Administrator of OIRA shall provide meaningful guidance and** oversight so that each agency's regulatory actions are consistent with applicable law, the President's priorities, and the principles set forth in this Executive order and do not conflict with the policies or actions of another agency. OIRA shall, to the extent permitted by law, adhere to the following guidelines:

1. OIRA may review only actions identified by the agency or by OIRA as significant regulatory actions under subsection (a)(3)(A) of this section.

2. OIRA shall waive review or notify the agency in writing of the results of its review within the following time periods:

A. For any notices of inquiry, advance notices of proposed rulemaking, or other preliminary regulatory actions prior to a Notice of Proposed Rulemaking, within 10 working days after the date of submission of the draft action to OIRA;

B. For all other regulatory actions, within 90 calendar days after the date of submission of the information set forth in subsections (a)(3)(B) and (C) of this section, unless OIRA has previously reviewed this information and, since that review, there has been no material change in the facts and circumstances upon which the regulatory action is based, in which case, OIRA shall complete its review within 45 days; and

C. The review process may be extended

1. once by no more than 30 calendar days upon the written approval of the Director and

2. at the request of the agency head.
3. For each regulatory action that the Administrator of OIRA returns to an agency for further consideration of some or all of its provisions, the Administrator of OIRA shall provide the issuing agency a written explanation for such return, setting forth the pertinent provision of this Executive order on which OIRA is relying. If the agency head disagrees with some or all of the bases for the return, the agency head shall so inform the Administrator of OIRA in writing.
4. Except as otherwise provided by law or required by a Court, in order to ensure greater openness, accessibility, and accountability in the regulatory review process, OIRA shall be governed by the following disclosure requirements:
   A. Only the Administrator of OIRA (or a particular designee) shall receive oral communications initiated by persons not employed by the executive branch of the Federal Government regarding the substance of a regulatory action under OIRA review;
   B. All substantive communications between OIRA personnel and persons not employed by the executive branch of the Federal Government regarding a regulatory action under review shall be governed by the following guidelines:
      i. A representative from the issuing agency shall be invited to any meeting between OIRA personnel and such person(s);
      ii. OIRA shall forward to the issuing agency, within 10 working days of receipt of the communication(s), all written communications, regardless of format, between OIRA personnel and any person who is not employed by the executive branch of the Federal Government, and the dates and names of individuals involved in all substantive oral communications (including meetings to which an agency representative was invited, but did not attend, and telephone conversations between OIRA personnel and any such persons); and
      iii. OIRA shall publicly disclose relevant information about such communication(s), as set forth below in subsection (b)(4)(C) of this section.
   C. OIRA shall maintain a publicly available log that shall contain, at a minimum, the following information pertinent to regulatory actions under review:
      i. The status of all regulatory actions, including if (and if so, when and by whom) Vice Presidential and Presidential consideration was requested;
      ii. A notation of all written communications forwarded to an issuing agency under subsection (b)(4)(B)(ii) of this section; and
      iii. The dates and names of individuals involved in all substantive oral communications, including meetings and telephone conversations, between OIRA personnel and any person not employed by the executive branch of the Federal Government, and the subject matter discussed during such

communications.

D. After the regulatory action has been published in the Federal Register or otherwise issued to the public, or after the agency has announced its decision not to publish or issue the regulatory action, OIRA shall make available to the public all documents exchanged between OIRA and the agency during the review by OIRA under this section.

5. All information provided to the public by OIRA shall be in plain, understandable language.

Sec. 7. Resolution of Conflicts.

To the extent permitted by law, disagreements or conflicts between or among agency heads or between OMB and any agency that cannot be resolved by the Administrator of OIRA shall be resolved by the President, or by the Vice President acting at the request of the President, with the relevant agency head (and, as appropriate, other interested government officials). Vice Presidential and Presidential consideration of such disagreements may be initiated only by the Director, by the head of the issuing agency, or by the head of an agency that has a significant interest in the regulatory action at issue. Such review will not be undertaken at the request of other persons, entities, or their agents.

Resolution of such conflicts shall be informed by recommendations developed by the Vice President, after consultation with the Advisors (and other executive branch officials or personnel whose responsibilities to the President include the subject matter at issue). The development of these recommendations shall be concluded within 60 days after review has been requested.

During the Vice Presidential and Presidential review period, communications with any person not employed by the Federal Government relating to the substance of the regulatory action under review and directed to the Advisors or their staffs or to the staff of the Vice President shall be in writing and shall be forwarded by the recipient to the affected agency(ies) for inclusion in the public docket(s). When the communication is not in writing, such Advisors or staff members shall inform the outside party that the matter is under review and that any comments should be submitted in writing.

At the end of this review process, the President, or the Vice President acting at the request of the President, shall notify the affected agency and the Administrator of OIRA of the President's decision with respect to the matter.

Sec. 8. Publication.

Except to the extent required by law, an agency shall not publish in the Federal Register or otherwise issue to the public any regulatory action that is subject to review under section 6 of this Executive order until (1) the Administrator of OIRA notifies the agency that OIRA has waived its review of the action or has completed its review without any requests for further consideration, or (2) the applicable time period in section 6(b)(2) expires without OIRA having notified the agency that it is returning the regulatory action for further consideration under section 6(b)(3), whichever occurs first. If the terms of the preceding sentence have not been satisfied and an agency wants to publish or otherwise issue a regulatory action, the head of that agency may request Presidential consideration through the Vice President, as provided under section 7 of this order. Upon receipt of this request, the Vice President shall notify OIRA and the Advisors. The guidelines and time period set forth in section 7 shall apply to the publication of regulatory actions for which Presidential consideration has been sought.

Sec. 9. Agency Authority.

Nothing in this order shall be construed as displacing the agencies' authority or responsibilities, as authorized by law.

Sec. 10. Judicial Review.

Nothing in this Executive order shall affect any otherwise available judicial review of agency action. This Executive order is intended only to improve the internal management of the Federal Government and does not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

Sec. 11. Revocations.

Executive Orders Nos. 12291 and 12498; all amendments to those Executive orders; all guidelines issued under those orders; and any exemptions from those orders heretofore granted for any category of rule are revoked.

WILLIAM J. CLINTON

THE WHITE HOUSE,
September 30, 1993.

federal register

Thursday
May 28, 1998

Part III

The President

Executive Order 13085—Establishment of the Enrichment Oversight Committee

Federal Register
Vol. 63, No. 102
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Presidential Documents

Title 3—

The President

Executive Order 13085 of May 26, 1998

Establishment of the Enrichment Oversight Committee

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to further the national security and other interests of the United States with regard to uranium enrichment and related businesses after the privatization of the United States Enrichment Corporation (USEC), it is ordered as follows:

Section 1. *Establishment.* There is hereby established an Enrichment Oversight Committee (EOC).

Sec. 2. *Objectives.* The EOC shall monitor and coordinate United States Government efforts with respect to the privatized USEC and any successor entities involved in uranium enrichment and related businesses in furtherance of the following objectives:

(a) The full implementation of the Agreement Between the Government of the United States of America and the Government of the Russian Federation Concerning the Disposition of Highly Enriched Uranium (HEU) Extracted from Nuclear Weapons, dated February 18, 1993 ("HEU Agreement"), and related contracts and agreements by the USEC as executive agent or by any other executive agents;

(b) The application of statutory, regulatory, and contractual restrictions on foreign ownership, control, or influence in the USEC, any successor entities, and any other executive agents;

(c) The development and implementation of United States Government policy regarding uranium enrichment and related technologies, processes, and data; and

(d) The collection and dissemination of information relevant to any of the foregoing on an ongoing basis, including from the Central Intelligence Agency and the Federal Bureau of Investigation.

Sec. 3. *Organization.* (a) The EOC shall be Chaired by a senior official from the National Security Council (NSC). The Chair shall coordinate the carrying out of the purposes and policy objectives of this order. The EOC shall meet as often as appropriate, but at least quarterly, and shall submit reports to the Assistant to the President for National Security Affairs semiannually, or more frequently as appropriate. The EOC shall prepare annually the report for the President's transmittal to the Congress pursuant to section 3112 of the USEC Privatization Act, Public Law 104–134, title III, 3112(b)(10), 110 Stat. 1321–344, 1321–346 (1996).

(b) The EOC shall consist of representatives from the Departments of State, the Treasury, Defense, Justice, Commerce, Energy, and the Office of Management and Budget, the NSC, the National Economic Council, the Council of Economic Advisers, and the Intelligence Community. The EOC shall formulate internal guidelines for its operations, including guidelines for convening meetings.

(c) The EOC shall coordinate sharing of information and provide direction, while operational responsibilities resulting from the EOC's oversight activities will rest with EOC member agencies.

(d) At the request of the EOC, appropriate agencies, including the Department of Energy, shall provide day-to-day support for the EOC.

Sec. 4. *HEU Agreement Oversight.* The EOC shall form an HEU Agreement Oversight Subcommittee (the "Subcommittee") in order to continue coordination of the implementation of the HEU Agreement and related contracts and agreements, monitor actions taken by the executive agent, and make recommendations regarding steps designed to facilitate full implementation of the HEU Agreement, including changes with respect to the executive agent. The Subcommittee shall be chaired by a senior official from the NSC and shall include representatives of the Departments of State, Defense, Justice, Commerce, and Energy, and the Office of Management and Budget, the National Economic Council, the Intelligence Community, and, as appropriate, the United States Trade Representative, and the Council of Economic Advisers. The Subcommittee shall meet as appropriate to review the implementation of the HEU Agreement and consider steps to facilitate full implementation of that Agreement. In particular, the Subcommittee shall:

(a) have access to all information concerning implementation of the HEU Agreement and related contracts and agreements;

(b) monitor negotiations between the executive agent or agents and Russian authorities on implementation of the HEU Agreement, including the proposals of both sides on delivery schedules and on price;

(c) monitor sales of the natural uranium component of low-enriched uranium derived from Russian HEU pursuant to applicable law;

(d) establish procedures for designating alternative executive agents to implement the HEU Agreement;

(e) coordinate policies and procedures regarding the full implementation of the HEU purchase agreement and related contracts and agreements, consistent with applicable law; and

(f) coordinate the position of the United States Government on any issues that arise in the implementation of the Memorandum of Agreement with the USEC for the USEC to serve as the United States Government Executive Agent under the HEU Agreement.

Sec. 5. *Foreign Ownership, Control, or Influence (FOCI).* The EOC shall collect information and monitor issues relating to foreign ownership, control, or influence of the USEC or any successor entities. Specifically, the EOC shall:

(a) monitor the application and enforcement of the FOCI requirements of the National Industrial Security Program established by Executive Order 12829 with respect to the USEC and any successor entities (*see* National Industrial Security Program Operating Manual, Department of Defense 2–3 (Oct. 1994));

(b) monitor and review reports and submissions relating to FOCI issues made by the USEC or any successor entity to the Nuclear Regulatory Commission (NRC) under the Atomic Energy Act of 1954, 42 U.S.C. 2011 *et seq.* (1994), and the USEC Privatization Act, Public Law 104–134, title III, 110 Stat. 1321–335 *et seq.* (1996);

(c) ensure coordination with the Intelligence Community of the collection and analysis of intelligence and ensure coordination of intelligence with other information related to FOCI issues; and

(d) ensure coordination with the Committee on Foreign Investment in the United States.

Sec. 6. *Domestic Enrichment Services.* The EOC shall collect and analyze information related to the maintenance of domestic uranium mining, enrichment, and conversion industries, provided that such activities shall be undertaken in a manner that provides appropriate protection for such information. In particular, the EOC shall:

(a) collect and review all public filings made by or with respect to the USEC or any successor entities with the Securities and Exchange Commission;

(b) collect information from all available sources necessary for the preparation of the annual report to the Congress required by section 3112 of the USEC Privatization Act, as noted in section 3(a) of this order, including information relating to plans by the USEC or any successor entities to expand or contract materially the enrichment of uranium-using gaseous diffusion technology;

(c) collect information relating to the development and implementation of atomic vapor laser isotope separation technology;

(d) to the extent permitted by law, and as necessary to fulfill the EOC's oversight functions, collect proprietary information from the USEC, or any successor entities, provided that the collection of such information shall be undertaken so as to minimize disruption to the normal functioning of the private corporation. For example, such information would include the USEC's financial statements prepared in accordance with standards applicable to public registrants and the executive summary of the USEC's strategic plan as shared with its Board of Directors, as well as timely information on its unit production costs, capacity utilization rates, average pricing and sales for the current year and for new contracts, employment levels, overseas activities, and research and development initiatives. Such information shall be collected on an annual basis, with quarterly updates as appropriate; and

(e) coordinate with relevant agencies in monitoring the levels of natural and enriched uranium and enrichment services imported into the United States.

Sec. 7. *Coordination with the Nuclear Regulatory Commission.* Upon notification by the NRC that it seeks the views of other agencies of the executive branch regarding determinations necessary for the issuance, reissuance, or renewal of a certificate of compliance or license to the privatized USEC, the EOC shall convey the relevant views of these other agencies of the executive branch, including whether the applicant's performance as the United States agent for the HEU Agreement is acceptable, on a schedule consistent with the NRC's need for timely action on such regulatory decisions.

THE WHITE HOUSE,
May 26, 1998.

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Tuesday, August 10, 1999

Presidential Documents

Title 3—

The President

Executive Order 13132 of August 4, 1999

Federalism

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to guarantee the division of governmental responsibilities between the national government and the States that was intended by the Framers of the Constitution, to ensure that the principles of federalism established by the Framers guide the executive departments and agencies in the formulation and implementation of policies, and to further the policies of the Unfunded Mandates Reform Act, it is hereby ordered as follows:

Section 1. *Definitions.* For purposes of this order:

(a) "Policies that have federalism implications" refers to regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.

(b) "State" or "States" refer to the States of the United States of America, individually or collectively, and, where relevant, to State governments, including units of local government and other political subdivisions established by the States.

(c) "Agency" means any authority of the United States that is an "agency" under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(5).

(d) "State and local officials" means elected officials of State and local governments or their representative national organizations.

Sec. 2. *Fundamental Federalism Principles.* In formulating and implementing policies that have federalism implications, agencies shall be guided by the following fundamental federalism principles:

(a) Federalism is rooted in the belief that issues that are not national in scope or significance are most appropriately addressed by the level of government closest to the people.

(b) The people of the States created the national government and delegated to it enumerated governmental powers. All other sovereign powers, save those expressly prohibited the States by the Constitution, are reserved to the States or to the people.

(c) The constitutional relationship among sovereign governments, State and national, is inherent in the very structure of the Constitution and is formalized in and protected by the Tenth Amendment to the Constitution.

(d) The people of the States are free, subject only to restrictions in the Constitution itself or in constitutionally authorized Acts of Congress, to define the moral, political, and legal character of their lives.

(e) The Framers recognized that the States possess unique authorities, qualities, and abilities to meet the needs of the people and should function as laboratories of democracy.

(f) The nature of our constitutional system encourages a healthy diversity in the public policies adopted by the people of the several States according to their own conditions, needs, and desires. In the search for enlightened public policy, individual States and communities are free to experiment with a variety of approaches to public issues. One-size-fits-all approaches to public policy problems can inhibit the creation of effective solutions to those problems.

(g) Acts of the national government—whether legislative, executive, or judicial in nature—that exceed the enumerated powers of that government under the Constitution violate the principle of federalism established by the Framers.

(h) Policies of the national government should recognize the responsibility of—and should encourage opportunities for—individuals, families, neighborhoods, local governments, and private associations to achieve their personal, social, and economic objectives through cooperative effort.

(i) The national government should be deferential to the States when taking action that affects the policymaking discretion of the States and should act only with the greatest caution where State or local governments have identified uncertainties regarding the constitutional or statutory authority of the national government.

Sec. 3. *Federalism Policymaking Criteria.* In addition to adhering to the fundamental federalism principles set forth in section 2, agencies shall adhere, to the extent permitted by law, to the following criteria when formulating and implementing policies that have federalism implications:

(a) There shall be strict adherence to constitutional principles. Agencies shall closely examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and shall carefully assess the necessity for such action. To the extent practicable, State and local officials shall be consulted before any such action is implemented. Executive Order 12372 of July 14, 1982 ("Intergovernmental Review of Federal Programs") remains in effect for the programs and activities to which it is applicable.

(b) National action limiting the policymaking discretion of the States shall be taken only where there is constitutional and statutory authority for the action and the national activity is appropriate in light of the presence of a problem of national significance. Where there are significant uncertainties as to whether national action is authorized or appropriate, agencies shall consult with appropriate State and local officials to determine whether Federal objectives can be attained by other means.

(c) With respect to Federal statutes and regulations administered by the States, the national government shall grant the States the maximum administrative discretion possible. Intrusive Federal oversight of State administration is neither necessary nor desirable.

(d) When undertaking to formulate and implement policies that have federalism implications, agencies shall:

(1) encourage States to develop their own policies to achieve program objectives and to work with appropriate officials in other States;

(2) where possible, defer to the States to establish standards;

(3) in determining whether to establish uniform national standards, consult with appropriate State and local officials as to the need for national standards and any alternatives that would limit the scope of national standards or otherwise preserve State prerogatives and authority; and

(4) where national standards are required by Federal statutes, consult with appropriate State and local officials in developing those standards.

Sec. 4. *Special Requirements for Preemption.* Agencies, in taking action that preempts State law, shall act in strict accordance with governing law.

(a) Agencies shall construe, in regulations and otherwise, a Federal statute to preempt State law only where the statute contains an express preemption provision or there is some other clear evidence that the Congress intended preemption of State law, or where the exercise of State authority conflicts with the exercise of Federal authority under the Federal statute.

(b) Where a Federal statute does not preempt State law (as addressed in subsection (a) of this section), agencies shall construe any authorization in the statute for the issuance of regulations as authorizing preemption of State law by rulemaking only when the exercise of State authority directly conflicts with the exercise of Federal authority under the Federal statute or there is clear evidence to conclude that the Congress intended the agency to have the authority to preempt State law.

(c) Any regulatory preemption of State law shall be restricted to the minimum level necessary to achieve the objectives of the statute pursuant to which the regulations are promulgated.

(d) When an agency foresees the possibility of a conflict between State law and Federally protected interests within its area of regulatory responsibility, the agency shall consult, to the extent practicable, with appropriate State and local officials in an effort to avoid such a conflict.

(e) When an agency proposes to act through adjudication or rulemaking to preempt State law, the agency shall provide all affected State and local officials notice and an opportunity for appropriate participation in the proceedings.

Sec. 5. *Special Requirements for Legislative Proposals.* Agencies shall not submit to the Congress legislation that would:

(a) directly regulate the States in ways that would either interfere with functions essential to the States' separate and independent existence or be inconsistent with the fundamental federalism principles in section 2;

(b) attach to Federal grants conditions that are not reasonably related to the purpose of the grant; or

(c) preempt State law, unless preemption is consistent with the fundamental federalism principles set forth in section 2, and unless a clearly legitimate national purpose, consistent with the federalism policymaking criteria set forth in section 3, cannot otherwise be met.

Sec. 6. *Consultation.*

(a) Each agency shall have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. Within 90 days after the effective date of this order, the head of each agency shall designate an official with principal responsibility for the agency's implementation of this order and that designated official shall submit to the Office of Management and Budget a description of the agency's consultation process.

(b) To the extent practicable and permitted by law, no agency shall promulgate any regulation that has federalism implications, that imposes substantial direct compliance costs on State and local governments, and that is not required by statute, unless:

(1) funds necessary to pay the direct costs incurred by the State and local governments in complying with the regulation are provided by the Federal Government; or

(2) the agency, prior to the formal promulgation of the regulation,

(A) consulted with State and local officials early in the process of developing the proposed regulation;

(B) in a separately identified portion of the preamble to the regulation as it is to be issued in the **Federal Register**, provides to the Director of the Office of Management and Budget a federalism summary impact statement, which consists of a description of the extent of the agency's prior consultation with State and local officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of State and local officials have been met; and

(C) makes available to the Director of the Office of Management and Budget any written communications submitted to the agency by State and local officials.

(c) To the extent practicable and permitted by law, no agency shall promulgate any regulation that has federalism implications and that preempts State law, unless the agency, prior to the formal promulgation of the regulation,

(1) consulted with State and local officials early in the process of developing the proposed regulation;

(2) in a separately identified portion of the preamble to the regulation as it is to be issued in the **Federal Register**, provides to the Director of the Office of Management and Budget a federalism summary impact statement, which consists of a description of the extent of the agency's prior consultation with State and local officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of State and local officials have been met; and

(3) makes available to the Director of the Office of Management and Budget any written communications submitted to the agency by State and local officials.

Sec. 7. *Increasing Flexibility for State and Local Waivers.*

(a) Agencies shall review the processes under which State and local governments apply for waivers of statutory and regulatory requirements and take appropriate steps to streamline those processes.

(b) Each agency shall, to the extent practicable and permitted by law, consider any application by a State for a waiver of statutory or regulatory requirements in connection with any program administered by that agency with a general view toward increasing opportunities for utilizing flexible policy approaches at the State or local level in cases in which the proposed waiver is consistent with applicable Federal policy objectives and is otherwise appropriate.

(c) Each agency shall, to the extent practicable and permitted by law, render a decision upon a complete application for a waiver within 120 days of receipt of such application by the agency. If the application for a waiver is not granted, the agency shall provide the applicant with timely written notice of the decision and the reasons therefor.

(d) This section applies only to statutory or regulatory requirements that are discretionary and subject to waiver by the agency.

Sec. 8. *Accountability.*

(a) In transmitting any draft final regulation that has federalism implications to the Office of Management and Budget pursuant to Executive Order 12866 of September 30, 1993, each agency shall include a certification from the official designated to ensure compliance with this order stating that the requirements of this order have been met in a meaningful and timely manner.

(b) In transmitting proposed legislation that has federalism implications to the Office of Management and Budget, each agency shall include a certification from the official designated to ensure compliance with this order that all relevant requirements of this order have been met.

(c) Within 180 days after the effective date of this order, the Director of the Office of Management and Budget and the Assistant to the President for Intergovernmental Affairs shall confer with State and local officials to ensure that this order is being properly and effectively implemented.

Sec. 9. *Independent Agencies.* Independent regulatory agencies are encouraged to comply with the provisions of this order.

Sec. 10. *General Provisions.*

(a) This order shall supplement but not supersede the requirements contained in Executive Order 12372 ("Intergovernmental Review of Federal Programs"), Executive Order 12866 ("Regulatory Planning and Review"), Executive Order 12988 ("Civil Justice Reform"), and OMB Circular A–19.

(b) Executive Order 12612 ("Federalism"), Executive Order 12875 ("Enhancing the Intergovernmental Partnership"), Executive Order 13083 ("Federalism"), and Executive Order 13095 ("Suspension of Executive Order 13083") are revoked.

(c) This order shall be effective 90 days after the date of this order.

Sec. 11. *Judicial Review.* This order is intended only to improve the internal management of the executive branch, and is not intended to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its agencies, its officers, or any person.

William J. Clinton

THE WHITE HOUSE,
August 4, 1999.

[FR Doc. 99–20729
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Local News : Sunday, June 11, 2000

Salting away Hanford's nuclear waste

by Craig Welch
Seattle Times staff reporter

CARLSBAD, New Mexico - The contents sound innocuous: a pair of scissors, rubber gloves, cloth rags, paper floor mats.

Housed in barrels in simple sheet-metal potato sheds at the Hanford **nuclear** reservation, it's the debris of workers who assembled an arsenal, everyday Cold War stuff now spotted with plutonium.

Later this month, the first shipments of this contaminated trash will leave the Tri-Cities bound for permanent burial in the same southwestern mesquite, sage and oak desert that gave birth to the Atomic Age.

It will be the first **nuclear waste** to leave Hanford since a cleanup agreement was reached 10 years ago.

The 80,000 barrels of **waste** to be trucked across the West over the next 35 years is **Hanford's** least hazardous - mostly irradiated clothing and equipment. Corroding **nuclear** fuel rods still rest near the Columbia River, waiting to be moved. A 50-year project to turn the deadly **nuclear** soup in the reservation's 177 underground tanks, one-third of which leak, into glass is over-budget and facing potential delays.

Still, the shipments will be a small but perceptible sign of cleanup at a place where progress is slow and bean counters estimate a quarter of each dollar is wasted.

"Unless you work at Hanford, it's just out there. It's hard to tell what's getting done," said State Rep. Jerome Delvin, D-Richland. "Now people will start seeing these shipments go by and know they're making progress."

On June 19th, 33 ordinary 55-gallon drums will be loaded into three gargantuan stainless steel Thermoses - 6-ton containers that can't be burned, frozen, gored or shattered.

Under police escort, they'll be hauled by flatbed truck to an underground grave in a 225-million-year-old salt seam - a spot chosen by government scientists so mindful of security they initially pondered whether it could survive asteroids and, if need be, space aliens.

There, a half-mile into the earth, the salt will creep, a few inches each year, a foot or two each decade. A sort-of natural trash compactor, it will slowly crush the drums like beer cans, isolating radiation until it eventually decays, 250,000 years from now.

That, at least, is the plan.

The science is 50 years in the making, but the nature of the material leaves little room for error. The mathematical modeling used to predict the future is only reliable to 10,000 years.

And in its first year, the world's only permanent Cold War **nuclear** dump, New Mexico's **Waste** Isolation Pilot Plant (WIPP), has had its public-relations gaffes.

Shipments from one lab veered off course in New Mexico through sacred tribal lands. And a package from Colorado arrived with a spot of radiation outside a container - a blob **WIPP general manager Joe Epstein insists didn't come from the waste**. The cause was never pinpointed, and Epstein said it was naturally occurring.

For the Department of Energy and Westinghouse, the private contractor in charge of the facility, **Hanford's** shipments are another chance to convince a skeptical public that hauling and burying radioactive substances is safe.

"It's better to be transported and deposited a half-mile down . . . than to be sitting where it can be hit by earthquakes, hurricanes, tornadoes and fire," Epstein said.

A region wedded to the atom

Northeast of the 8,000-foot Guadalupe Mountains and the caves of Carlsbad Caverns, in the corner of New Mexico that cuts sharply into Texas, the Chihuahuan desert flattens to a desolate moonscape of brush. Temperatures can hit 120 degrees, and yearly rainfall is less than Seattle gets in a month.

It was not far from here that Pat Garrett killed Billy the Kid. Closer still, a wealthy land barren named Charles Eddy founded a cowtown he named for himself, until citizens later found underwater springs, and renamed the town after mineral-springs-rich Karlsbad, Czechoslovakia.

The region subsisted on ranching and tourism, as visitors came to nearby national parks. Residents also mined potash, potassium salts used for fertilizer, until the market bottomed out in the late 1960s and early 1970s.

In 1974, seeking a place to discard its least-hazardous **nuclear** detritus, the Atomic Energy Commission came calling. Carlsbad residents were eager rather than fearful. They'd grown up with the **nuclear** industry and were in need of jobs.

They had seen light from the 1945 Trinity test, the world's first atomic-bomb explosion, 200 miles away. Others recall seeing the dust dance off the earth during Gnome, an underground explosion outside town in 1961.

Scientists were convinced the region was ideal for storage. Tests 1,000 feet below revealed a salt bed devoid of moisture. They chose a 16-square-mile tract 26 miles east of town, 10 miles from the nearest home, and began carving a system of tunnels in the earth. By the time WIPP began receiving **waste** in 1999, it employed more than 1,000. Carlsbad residents and workers are fiercely loyal.

"I have family in Lubbock who say, `You should change the name of your town to Carlsglow,' " said WIPP miner Armando Rodriguez, who feels perfectly safe in the caverns. "They just don't understand."

Worst waste won't come here

The garbage brought here is primarily low-level alpha- and beta-emitting **waste**. Alpha and beta rays are considered highly carcinogenic but easy to shield with paper or glass, dangerous only when inhaled or ingested. But small amounts of the **waste** are loaded with deadly pure energy known as gamma rays, typically containable by lead - and salt.

Eventually, 6.2 million cubic feet of **waste** will travel here from 10 Energy Department sites, transported on 18-wheelers by specially trained drivers.

The truckers will use high-tech satellite devices to monitor weather patterns, while state, federal and tribal officials will keep tabs on the semis with tracking devices. Safety rules

governing drivers are strict.

"If one of them gets a speeding ticket on his way to church Sunday, he might as well not show up for work Monday," said Donovan Mager, spokesman for WIPP contractor Westinghouse.

The radioactive materials will be packed in $330,000 vacuum-packed stainless steel cocoons. In tests, the containers have survived being frozen, burned in jet fuel, dumped three stories onto battleship armor and slammed onto upturned steel spikes. The containers are so impregnable, drivers are told to abandon them at signs of trouble from protesters.

Not that officials expect any. Early shipments had opponents, including a physicist and anti-nuke protester who had fasted 82 days. But the only attempt to interrupt a trip came when an activist blocked a road with his Volkswagen.

The first Hanford shipment will contain material generated during cleanup. Plastic sheeting and tape helped contain radioactive dust and debris, while cloth rags were used to wipe plutonium off other materials. Paper pads were once used to scrape radiation off shoes.

Inside the atomic tomb

From the outside, WIPP looks like a power station: stark cream-white buildings and pipes surrounded by fences. Only on the inside are there reminders of the dangerous material stored here.

Visitors pass through a radiation detector and run their palms over an electronic counter, which prompts guards to randomly search every 11th person.

To enter the "**waste**-handling room," a mammoth warehouse where trucks unload, workers pass through airlocks, which can be slammed shut in emergencies. Radiation-blocking "monkey suits" aren't necessary, but eating or drinking is prohibited. In a release, radiation could settle on food and be ingested.

Inside the warehouse, **waste** is removed from the cocoons and carted to a dual-chambered mining elevator - one chamber for people, the other for toxic **waste** - which drops 2,150 feet below the surface.

Underground, WIPP seems busy as a city. Salt dust swirls like snow, gathering on clothing and hair. Workers travel on golf-cart-like people-movers. Tunnels are wide as a street and a

dozen feet tall. Mining machines chew through the crystalline salt building an ever-expanding maze.

Garage doors separate intersecting corridors and are opened with cords hanging from the ceiling. Several lead to dead ends, where drums of **waste** have already been gathered, stacked in honeycomb patterns.

Experts insist that this method of storage is safe. The **waste** contains little moisture so is unlikely to leach into a water supply. Because salt acts as a shock absorber, even the rare earthquakes this region experiences shouldn't disturb it.

If barrels were dropped or damaged down here, an alpha or beta release would not likely harm workers, Energy Department administrators say. A more harmful gamma release couldn't reach the surface.

Scientists fear only that future miners searching for oil, basalt or hydrogen could accidentally bore into WIPP and smash a **waste** container. Even so, from these depths, radiation would be unlikely to reach any humans, Epstein said.

While WIPP is restricted by law to handling primarily low-level **waste**, administrators and politicians maintain it could safely handle more hazardous **waste**, such as spent fuel rods.

But Hanford chief Keith Klein and WIPP manager Epstein are quick to downplay the idea.

"Years from now, when we have conducted thousands of shipments and nothing has ever happened, then, maybe," Epstein said.

Either way, the long-term future is scripted.

After WIPP reaches its storage capacity sometime near mid-century, the underground shafts will be sealed. Buildings will be torn down. WIPP will become a time capsule experts hope won't be opened. To be certain, university specialists debated how best to erect a warning that would last thousands of years and be comprehensible in any language.

Thirteen anthropologists, astronomers, architects and linguists considered hundreds of ideas: a cemetery of bizarrely angled spikes bursting through the ground; a black slab of rock that would absorb so much sun it would be too hot to approach; a giant map of the Earth showing all the **nuclear waste** sites; a series of obelisks; a collection of rubble and blocks.

Eventually they settled on this: Granite structures, extending 22 feet below ground and 25 feet above, surrounded by a 33-foot-high earthen berm, with radar reflectors buried inside. The monument will be inscribed, in seven languages, with warnings about contents and location of the materials below.

"This place is a message, and part of a system of messages," it will read in part. "Pay attention to it."

Craig Welch's phone message number is 206-464-2093.

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Firefighters halt spread of blaze near Washington nuclear site

Thousands evacuate; government says no radiation released

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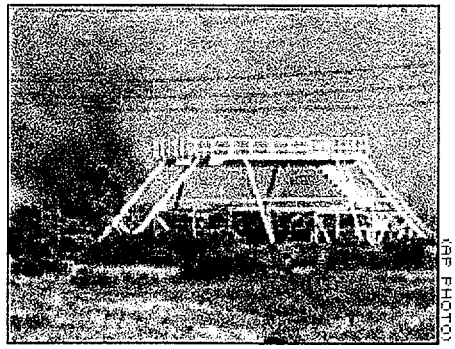

AP PHOTO

A ball of fire and smoke rises from a remote location on the Hanford nuclear reservation on Thursday

HANFORD, Washington (CNN) -- Authorities fighting a fast-moving brush fire said Thursday they have halted the spread of the blaze that has burned more than 150,000 acres (234 square miles) in just a day and a half and forced more than 10,500 people from their homes.

"Things are going well," said Dale Warriner of the state's Department of Natural Resources. He said the real test for firefighters would come when the winds, which had reached gusts of 20 mph Thursday morning, picked up later in the day. As of midday, Warriner said, there was "no increased fire activity."

The blaze forced thousands of evacuations near the former weapons production facility in southeastern Washington state. A man was critically burned and two people were treated for smoke inhalation.

The U.S. Department of Energy said that no radiation was released from the nuclear reservation by the blaze -- which tripled in size since Wednesday, when it covered 50,000 acres.

"There has been no sign of radioactive or hazardous materials being dispersed," department spokeswoman Jackie Hanson told CNN. She said

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Hanford: Ground zero for plutonium in U.S.

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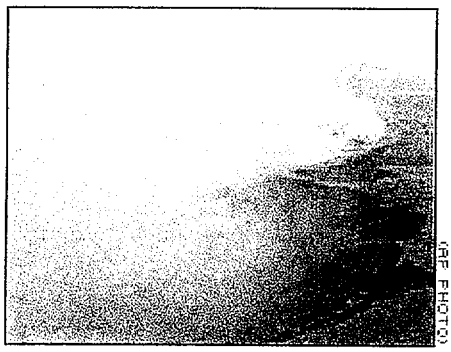
the fire is "burning away from the tanks" where nuclear waste is stored.

"The tanks are in absolutely no danger at this time," Hanson said. "The winds are blowing the fire away from the tanks."

Winds were calm Thursday morning, but officials feared a possible shift in wind direction could heighten the danger.

While the size of the blaze had increased dramatically, it remained west of anything potentially sensitive, said Don Aunspaugh, a spokesman for the Department of Energy Hanford Joint Information Center.

Even so, Hanford ordered nonessential personnel not to report to work Thursday because of the fire, which had scorched about one-third of the 560-acre reservation. Most of that land is sagebrush.


AP PHOTO

The wildfire on and near the Hanford nuclear reservation grew to around 150,000 acres in size by Thursday morning

Injuries, evacuations

At least three people have been hurt in the fire.

One man, 49-year-old Robert Pierce, was reported in critical condition on Thursday with burns on his back and arms, said Larry Zalin, a spokesman for Seattle's Harborview Medical Center.

Also, Michael Turner, a spokesman for reservation contractor Fluor Hanford, said two workers were treated for smoke inhalation on Wednesday.

The fire forced the evacuation Wednesday of some 2,500 residents in the town of Benton City about 15 miles south of the Hanford site.

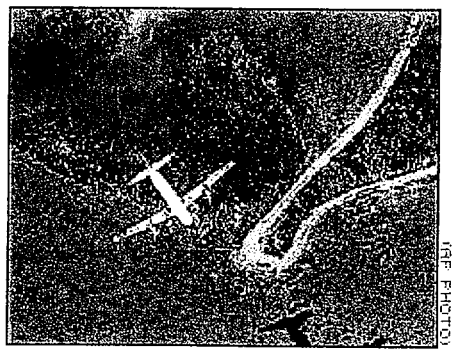
Some of the 8,000 residents of nearby West Richland also were evacuated on Wednesday but were later allowed to return to their homes.

The Red Cross set up shelters in nearby Kennewick, Washington, and Gov. Gary Locke declared a state of emergency in Benton County, activating the National Guard to assist in the evacuations.

Radiation monitoring urged

The flames, fueled Wednesday by 100-degree temperatures and 30 mph wind gusts, overwhelmed firefighters. The number of firefighters grew to 750 on Thursday and more were on the way.

As of Thursday morning, the 15-mile fire line was two to three miles from highly radioactive contamination in an area that once handled spent nuclear fuel, said John Britton, a spokesman at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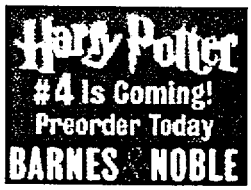
A plane flies low over the fire on the Arid Lands Ecology Reserve, in Richland, Washington, on Wednesday



Benton County's operations center.

The worst of the radioactive waste at Hanford is encased and buried underground, but anti-nuclear activists warned that the fire could burn radioactive soils and spew contaminated particles into the air.

"We urge state officials to independently monitor to protect the public and firefighters from the hazards of airborne radioactive contaminated particles," said Gerald Pollet, director of Heart of America Northwest.

Earlier this month, the federal government warned that radioactive-contaminated soil from the Los Alamos National Laboratory could flush into the Rio Grande River because of the fire there.

Workers are digging up truckloads of dirt along Los Alamos Canyon and shipping it to a waste storage site on the federal laboratory's property.

The fire began Tuesday in dry grass along the shoulder near the west gate to Hanford, when a car left the road, veered back onto the pavement and slammed head-on into a tractor-trailer rig.

The car driver, 67-year-old Phyllis Arnold, died and the truck driver was injured.

The Associated Press and Reuters contributed to this report.

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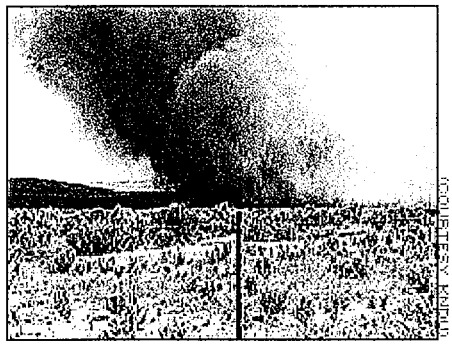

Authorities said they have halted the spread of the blaze

RICHLAND, Washington (CNN) -- The spread of a brush fire on and near the Hanford nuclear reservation in rural Washington that has forced more than 10,500 people from their homes has been stopped, authorities say.

"Things are going well," said Dale Warriner of the Washington Department of Natural Resources on Thursday. Warriner said the real test for firefighters would come when the winds, which had reached gusts of 20 mph Thursday morning, picked up later in the day.

As of midday, Warriner said, there was "no increased fire activity."

The huge, fast-moving fire was fueled by dry sagebrush.

The U.S. Department of Energy said no radiation was released from the nuclear site by the blaze -- which tripled in size since Wednesday, when it covered 50,000 acres.

BACKGROUND
Hanford: Ground zero for plutonium in U.S.

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Nature's wrath

"There has been no sign of radioactive or hazardous materials being dispersed," department spokeswoman Jackie Hanson told CNN. She said the fire was "burning away from the tanks" where nuclear waste is stored.

"The tanks are in absolutely no danger at this time," Hanson said.

Even so, Hanford ordered nonessential personnel not to report to work

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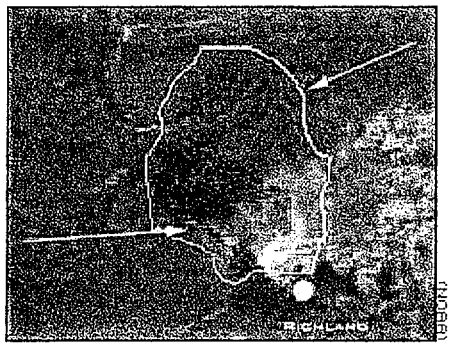
Even so, Hanford ordered nonessential personnel not to report to work Thursday because of the fire, which had scorched about one-third of the 560-acre reservation. Most of that land is sagebrush.

Injuries, evacuations

All 2,500 residents of Benton City, about 15 miles south of the Hanford site, were evacuated, said Benton County Emergency Management spokeswoman Deanna Westover.



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Click and see a June 29 satellite image of the fires buring in Washington state

Evacuation recommendations remained for about 8,000 people in West Richland and for residents of Horn Rapids, a small golfing community near Richland, where as many as 300 homes had also been evacuated.

The fire began Tuesday in dry grass along the shoulder near the west gate to Hanford, when a car left the road, veered back onto the pavement and slammed head-on into a tractor-trailer rig.

The driver of the car, 67-year-old Phyllis Arnold, died and the truck driver was injured.

At least three people have been hurt in the fire.

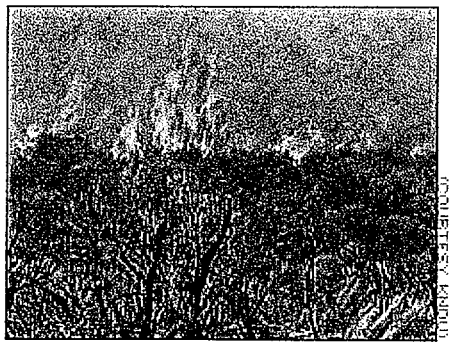
One man, 49-year-old Robert Pierce, was reported in critical condition on Thursday with burns on his back and arms, said Larry Zalin, a spokesman for Seattle's Harborview Medical Center.

Also, Michael Turner, a spokesman for reservation contractor Fluor Hanford, said two workers were treated for smoke inhalation on Wednesday.

The Red Cross set up shelters in nearby Kennewick, Washington, and Gov. Gary Locke declared a state of emergency in Benton County, activating the National Guard to assist in the evacuations.

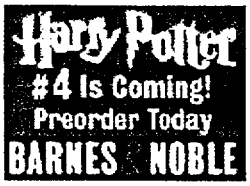
Classified material secured

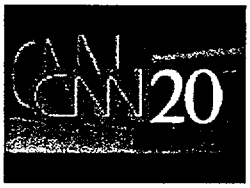
About 1,700 workers at the Hanford Site were evacuated Wednesday as the flames approached. Between 60 and 100 essential personnel, or those required for routine shift work or recovery from power outages, were instructed to report to work.



Since Tuesday, at least 25 homes have been destroyed by the fire

"My primary concern throughout this event has been for the safety of our workers and their families, our neighbors in the local communities, and Hanford Site facilities," said Keith





Hanford site facilities," said Keith Klein, manager of the DOE Richland Operations Office. "We are watching the fire and weather conditions very closely."

Erickson added that all classified information had been secured, a concern raised after the loss of top-secret files from the Los Alamos National Laboratory in the wake of last month's wildfires in New Mexico.

The fire was declared an "alert level emergency," the lowest of three DOE emergency categories. Erickson said the status could change if conditions worsen.

"That's always a possibility," she said. "Right now our efforts are focused on trying to prevent that."

Radiation monitoring urged

The flames, fueled Wednesday by 100-degree temperatures and 30 mph wind gusts, overwhelmed firefighters. The number of firefighters grew to 750 on Thursday, and more were on the way.

As of Thursday morning, the 15-mile fire line was two to three miles from highly radioactive contamination in an area that once handled spent nuclear fuel, said John Britton, a spokesman at Benton County's operations center.

The worst of the radioactive waste at Hanford is encased and buried underground, but anti-nuclear activists warned that the fire could burn radioactive soil and spew contaminated particles into the air.

"We urge state officials to independently monitor to protect the public and firefighters from the hazards of airborne radioactive contaminated particles," said Gerald Pollet, director of Heart of America Northwest.

Earlier this month, the federal government said rains could possibly flush low-level radioactive-contaminated soil from the Los Alamos National Laboratory into the Rio Grande River because of the fire there.

Workers are digging up truckloads of dirt along Los Alamos Canyon and shipping it to a waste storage site on the federal laboratory's property.

The Associated Press and Reuters contributed to this report.

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U.S. energy secretary to tour fire-scarred Hanford nuclear waste reservation; evacuees return to homes

June 30, 2000
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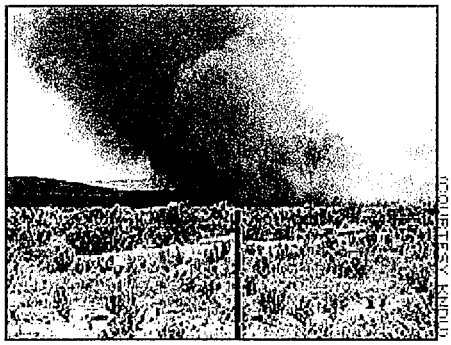

Authorities said they have halted the spread of the blaze

From staff and wire reports

RICHLAND, Washington -- U.S. Energy Secretary Bill Richardson is expected to survey the fire damage Friday at the Hanford nuclear complex in rural southeastern Washington state and make a public statement.

Meanwhile, thousands of people who left their neighborhoods in fear of the fire burning at and near the Hanford Site Reservation returned to their homes Thursday, as authorities put the breaks on the fast-moving brush fire.

Hanford was established in 1943 as part of the Manhattan Project to build the atomic bomb. Plutonium was produced at the site until 1986.

The Hanford nuclear reservation contains the nation's largest volume of radioactive waste from nuclear weapons.

Air quality tested

"It was just a fireball two or three times taller than our house," said Marty Peck, 43, who watched the flames approach his house in Benton City from a mountain about two miles away.

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Hanford: Ground zero for plutonium in U.S.

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All of Benton City's 2,500 people were evacuated, along with a portion of West Richland, a city of 8,000 people. The evacuees were allowed back home after fire officials stopped the spread of the blaze and health officers tested the air

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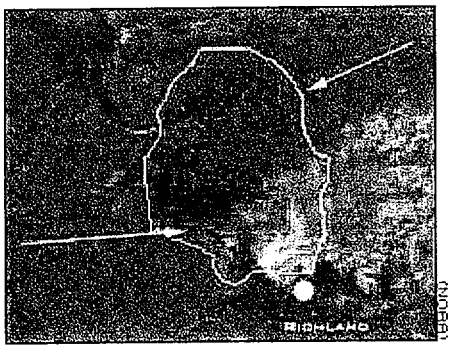
"The flames were about three miles away. I could see them from my living room. They were coming fast. That's when we split," said 50-year-old Richard Newby of Benton City, who spent Thursday at an emergency shelter.

Radiation exposure was a concern, but the Washington State Department of Health released a report Thursday evening saying air samples so far showed no increases in radiation.



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Click and see a June 29 satellite image of the fires buring in Washington state

An anti-nuclear group said the fire could burn radioactive soil and spew contaminated particles into the air. "We urge state officials to independently monitor to protect the public and firefighters from the hazards of airborne radioactive contaminated particles," said Gerald Pollet, director of Heart of America Northwest.

Al Conklin, head of the state Health Department's division of radiological protection, said the state is using monitoring devices, and "we're not going let the Department of Energy get away with anything if we find anything positive.

The blaze, dubbed the Two Fork fire, had driven 7,000 people from their homes and devoured approximately 192,000 acres in just two days, but it now is largely under control, authorities said.

In the tri-city area, which includes Richland, Pasco and Kennewick, area hospitals report treating 15 people since the fire began. Thirteen were treated and released for smoke inhalation.

One firefighter was treated for a minor leg injury, and on Wednesday, Benton City resident Robert Pierce, 49, was airlifted to Seattle's Harborview Trauma Center with second degree burns to his back and arms. He was in stable condition Thursday.

As of 10 p.m. EDT on Thursday, the fire was about 40 percent contained, according to the Hanford Joint Information Center monitoring the blaze. "There has been no increased fire, and the winds are calm," said Dale Warriner, a spokesman with the Washington State Integrated Management Team.

At its height, the fire marched through the Hanford Site and spread across a former radioactive waste disposal area known as the B-C crib, where radioactive liquid is stored underground. But the Department of Energy said there never was a danger of fire reaching the underground crib tanks.

Even though the fire is still burning at Hanford, structures on the Hanford Site were free from danger late Thursday, the Department of Energy said. Officials have taken precautions by building obstructions and removing dangerous materials from the 560-square-mile reservation.

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DOE spokeswoman Julie Erickson said gravel areas surrounding many of the buildings would help to keep the flames at bay.

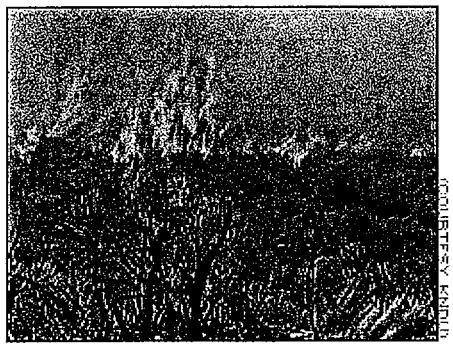
"The fire has not threatened any structures on the Hanford site," Erickson said. "We have removed combustible materials. We've evacuated people."

About 1,700 workers at the Hanford Site were evacuated Wednesday as the flames approached. Nonessential personnel have been told to stay home on Friday.

Classified material secured

Erickson added that all classified information had been secured, a concern raised after the loss of top-secret files from the Los Alamos National Laboratory in the wake of last month's wildfires in New Mexico.

The Washington brush fire began Tuesday afternoon when a car traveling on Highway 24 crashed head-on into a semi truck, setting both vehicles ablaze and igniting the surrounding brush and grassland.


COURTESY KNDU

Since Tuesday, at least 25 homes have been destroyed by the fire

Benton County Emergency Management spokeswoman Deanna Westover said 73 structures have burned, including 20 residential structures and 53 out-buildings.

As many as 1,000 firefighters from local and outside agencies were called to the fire lines. Nine air tankers and seven helicopters were being used along with bulldozers and other firefighting equipment.

In all, more than a third of the Hanford Site had burned, but none of the structures -- which include various nuclear plants and a 1,200 megawatt electrical power station -- was in danger.

"My primary concern throughout this event has been for the safety of our workers and their families, our neighbors in the local communities, and Hanford Site facilities," said Keith Klein, manager of the DOE Richland Operations Office. "We are watching the fire and weather conditions very closely."

Washington Gov. Gary Locke proclaimed a state of emergency in Benton County and activated the National Guard to assist local officials with crowd control and evacuations.

The Two Fork fire is the second blaze in two months to threaten a U.S. nuclear weapons installation. In May, a blaze that was set to clear brush near the Los Alamos nuclear weapons laboratory in New Mexico raged out of control, forcing more than 25,000 people to evacuate and destroying more than 200 homes.

Officials said nuclear material was safely protected in bunkers at Los Alamos, though there now are concerns that low-level radioactive material in the soil

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The Associated Press contributed to this report.

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Three towns evacuated as fires rage through Los Alamos; blaze reaches laboratory campus

May 11, 2000
Web posted at: 9:25 a.m. EDT (1325 GMT)

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A firefighter watches a house go up in flames as wildfires rapidly spread across Los Alamos, New Mexico

LOS ALAMOS, New Mexico (CNN) -- Nearly 22,000 residents of three New Mexico towns were being evacuated Thursday morning after a wildfire descended on Los Alamos, moving onto the acreage of the Los Alamos National Laboratory.

Grass and brushfires were burning in the southwest quadrant of the Los Alamos laboratories. Federal officials said that nuclear materials at the lab were safely stored, and protected from the fire.

The fire caused evacuations in Los Alamos, Espanola and White Rock -- and prompted re-evacuation of the emergency command post from White Rock to Los Alamos.

Hundreds of homes were destroyed and many more damaged by early Thursday, officials said. According to some reports, up to 25 percent of Los Alamos buildings have been engulfed by the flames.

On Wednesday night, firefighters tried to save

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residential areas before they were forced to withdraw because of the intensity of the heat and flames, which were fanned by high winds. Officials predicted that conditions would worsen, raising the possibility of further outbreaks of fire on Thursday.

Los Alamos's 14,000 residents were evacuated, and residents on the west side of Espanola, northeast of Los Alamos, were later asked to evacuate after a fresh blaze broke out.

At 1:10 a.m. local time (3:10 a.m. EDT) officials said that up to 14,000 residents would be evacuated from White Rock, to the southeast of Los Alamos, including those who had already been evacuated from Los Alamos, as the fire continued to spread.

Richardson: 'We don't see any problem' with nuclear security

Flames burned early Thursday on the land of the 43-square-mile Los Alamos laboratory, which closed three days ago as a precaution, though critical operations were maintained. A weapons research building briefly caught fire, sustaining minor damage, a spokesman for the laboratory said..

Fire fighters battle the wildfires that rage in and around Los Alamos as homes go up in flames

Officials at the nation's most famous nuclear laboratory said explosives and radioactive material stored there were protected in fireproof facilities away from the fire lines.

Energy Secretary Bill Richardson said late Wednesday night that he would accompany Federal Emergency Management director James Lee Witt on Thursday to review the scene in Los Alamos.

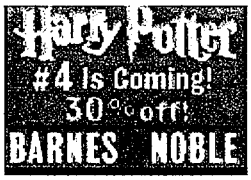
"Our critical security systems are operational. All our Energy Department nuclear materials are secure," Richardson said early Thursday morning. "Some of the high explosives are kept in concrete bunkers surrounded by earth and we don't see any problem."

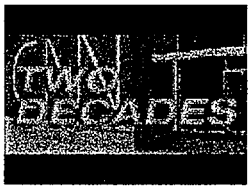
Wind gusts of at least 60 miles per hour forecast for the area Thursday, making firefighting conditions difficult. National guardsmen were aiding in evacuations, which include the Los Alamos Medical Center. Patients were taken to medical cetners in nearby communities.

"People in Los Alamos are terrified," said resident Sarah Meyer, who came to a fire information center in nearby White Rock in search of information about her house.

"This is probably the biggest thing that's happened to this town since the bomb," said one fleeing motorist on Wednesday.

Gusting winds feeding flames, spreading fire





More than 800 firefighters were battling the flames and water-dropping helicopters and airplanes dropping pink fire retardant were bombarding the blaze. The intense heat forced firefighters to pull back from whole neighborhoods.

Los Alamos County spokesman Bill Lehman said, "We are in a retreat situation," adding that the blaze had spread into two west-side subdivisions and crews were running out of water.

"When you have to evacuate an entire town, it's got to be one of the worst fires in New Mexico (history)," Lehman said.

The water shortage was caused by a power outage, said Jim Paxon, a fire department spokesman. "Generators were brought in, and power was restored, so that fire crews could have water again."

"The fire is three times the size it was at noon on Wednesday," Paxon said. "We are not going to get in front of the fire and attack it. This fire will go where it will."

Slurry, a fire retardant, is dropped from a plane, top, while wind is pushing the fires toward the Los Alamos Canyon in northern New Mexico

Efforts Wednesday were hampered by winds blowing embers and firebrands and starting spot fires. Most of the emergency crews were moved to safe areas as high winds made it difficult to fight the fires during Wednesday night.

Homes in western and northern parts of the city began burning late Wednesday afternoon. The extent of the damage was not immediately known. Even the fire command post was forced to evacuate and re-establish itself farther away from the fire.

"We have reports from the fire chief that an unknown number of structures has caught on fire," said Jim Danneskiold, a spokesman with the region's fire information center. "The town is pretty well evacuated," he added.

Asked how authorities would stop the encroaching blaze, he said, "I don't have a good answer to that."

'Jumping out of their seats and leaving'

Thick clouds of smoke blanketed the town and could be seen from miles away as winds gusted up to 45 mph on Wednesday. Police, sheriff's and fire department officials went door to door, urging people to pack up and leave as quickly as possible.

"This is the first time I felt fear," said Jaret McDonald, 28, who had been evacuated three times before for fires. "When you're against Mother Nature, you

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can't contain it. You'll lose every time."

Many customers at Katherine's Restaurant in Los Alamos' White Rock area were alerted to the evacuation by calls on their cell phones at lunch.

"They're just jumping out of their seats and leaving," said waitress Chris Vaughn.

Others had only to look outside for a reason to leave.

"It's very windy, very smoky. There's ash blowing around," said Era Jones, a receptionist at Trinity Realty.

Original fire deliberately set last week

New Mexico Gov. Gary Johnson, who expressed increasing concern Wednesday night over the situation, had declared a state of emergency on Monday as a precaution.

Johnson then activated the National Guard when officials ordered Wednesday's evacuation, Danneskiold said.

President Clinton declared three counties -- Los Alamos, Sandoval and Santa Fe -- disaster areas, allowing FEMA to move in and coordinate disaster relief measures. The declaration also frees up federal aid for FEMA to do its job in mobilizing personnel, equipment and other resources in the affected areas.

Danneskiold said a center has been set up for fleeing residents in Pojoaque, a village about 15 miles due east of Los Alamos, where the Red Cross is helping coordinate housing and temporary shelter for people.

The fire, which began last week, spread into Los Alamos Canyon earlier on Wednesday, threatening the town and forcing the evacuation.

Winds of more than 35 mph, low humidity and hot temperatures were all feeding the blaze. "All those contribute to erratic fire behavior," said Rita Skinner, a spokeswoman with the U.S. Forest Service.

"We don't want people to panic," Skinner said. "We are evacuating and we are moving into another phase of this."

The fire soon burned out of control after the National Park Service set it last Thursday to clear brush at the nearby Bandelier National Monument, which is just south of the town.

An estimated 500 homes were evacuated Sunday night, and 3,700 acres had burned by Wednesday morning.

Los Alamos, 70 miles north of Albuquerque, is essentially a company town for the federal laboratory. It sprang up in the 1940s as the base of operations for the Manhattan Project, which built the atomic bomb. There are still military barracks and military-style housing in Los Alamos, along with relatively upscale, newer developments.

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Meanwhile, authorities evacuated and closed part of the Grand Canyon National Park on Wednesday as high winds drove a fire out of control.

The fire was one of two set deliberately on April 25 to improve ecology. Firefighters said flames were relatively low and didn't threaten the park's developed area.

All visitors and non-essential personnel were evacuated from the North Rim on Wednesday afternoon. The main visitor entrance and development on the South Rim and the park's eastern entrance are unaffected, park officials said.

Members of Albuquerque Animal Services went to Los Alamos to rescue large animals that residents were forced to leave behind. They managed to rescue some horses at a stable, before being ordered to leave by sheriffs because of worsening conditions.

The Associated Press and Reuters contributed to this report.

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Flames roll across Los Alamos

Richardson: 'We don't think there is any danger of contamination'

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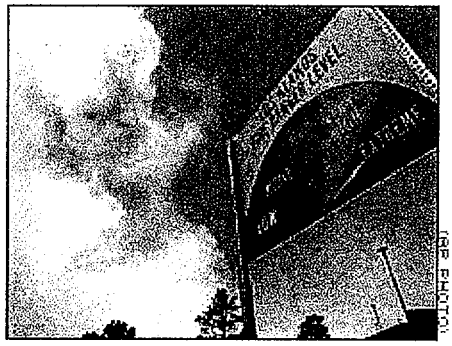

A sign is posted in Los Alamos, New Mexico, warning residents that the fire danger level is extreme

LOS ALAMOS, New Mexico (CNN) -- As federal officials continue to assure the public that the nuclear laboratory at the heart of town is safe, firefighters say Friday's calmer winds could help them gain control of the inferno which has burned 20,000 acres, forced nearly 20,000 people to evacuate, and torched land that lies only a few hundred yards from a plutonium storage facility.

A spokesman for the Emergency Operation Center in Santa Fe says Friday is a key day in fighting the fire. Winds will not be as strong as Thursday, and they are expected to change direction -- in effect, pushing the fire back on itself. Temperatures are expected to be somewhat lower, and humidity slightly higher.

Helicopters continue to drop water on the blaze, while fire retardant is dropped from planes. Bulldozers are clearing vegetation and cutting firebreaks, as firefighters even do battle with hand tools, trying to save homes, and stop the

VIDEO
CNN's Charles Zewe reports that the National Parks superintendent who

hand tools, trying to save homes, and stop the spread of flames.

No major lab structures affected

John Gustafson, a spokesman for the Los Alamos National Laboratories said lab officials "took preliminary measurements ... and all those numbers showed results consistent with background readings from natural sources of radioactivity."

Gustafson said of the fire damage to the lab, "We've lost a number of transportables. No major structures have been affected and certainly none of them lost."

Energy Secretary Bill Richardson, a former New Mexico congressman, said on Thursday night, "We don't think there is any danger of contamination" from the wildfire. "The danger has passed."

Richardson said five air monitors in the area recorded no releases of contaminants. They will continue to monitor the situation, he added.

Richardson confirmed that all laboratory staff except emergency personnel had been evacuated and the electricity had been shut off. He said he did not think that it would take long to get the facility operating again once the fires were out, "but we are not going to start again before we are sure everything is okay."

Congress demands inquiry

Nearly 20,000 people fled in front of the wind-driven firestorm as 1,000 firefighters battled the flames around the town where the atomic bomb was built. In the wake of massive fire, whole neighborhoods in Los Alamos have been reduced to ashes.

"Everything is being done that can be done. And yet, we may just be seeing the beginning of what is a real catastrophe," said New Mexico Gov. Gary Johnson.

The man some have blamed for putting the catastrophe in motion was suspended with pay Thursday by the National Park Service, pending an investigation. Congress is also demanding an inquiry.

Park Superintendent Roy Weaver has taken responsibility for the fire, which began near Bandelier National Monument on May 4 as a controlled burn, aimed

authorized the controlled burn in the forests near Los Alamos has been suspended, while the fire has destroyed nearly 400 homes.

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GALLERY

Fires blaze through Los Alamos, New Mexico

AUDIO

New Mexico Gov. Gary Johnson says the state has everything it needs to fight the fire

405k/19 sec.
AIFF or WAV sound

Chris Judson, of the National Park Service, says the federal laboratory in Los Alamos is safe

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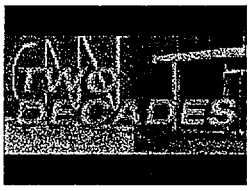
began near Bandelier National Monument on May 4 as a controlled burn, aimed at ridding the area of brush in order to prevent other fires.

The burn was conducted despite a severe drought and a special forecast that the National Weather Service said it faxed to Bandelier shortly before the fire was started.



Forecast before fire: Rising winds and temperatures, lower humidity

The forecast told park officials that there was maximum potential for fire growth: winds and temperatures were about to increase and there was a diminishing chance for the usual rise in nighttime humidity.

"This action is administrative in nature and in no way reflects on Superintendent Roy Weaver's decisions regarding the fire," said Karen Wade, director of the inter-mountain regional office of the Park Service.

Weaver has not been available for comment about whether he saw the weather service's fax. He is believed to have been evacuated and his office phone is out of service because of the fire.

In an interview with The New York Times before he was put on leave, Weaver said: "The data and the spot weather forecasts met the fire prescription. It's not like someone was just picking things out of the air."

He said the winds whipped up unexpectedly and the flames spread towards Los Alamos, the newspaper reported on its Web site.*

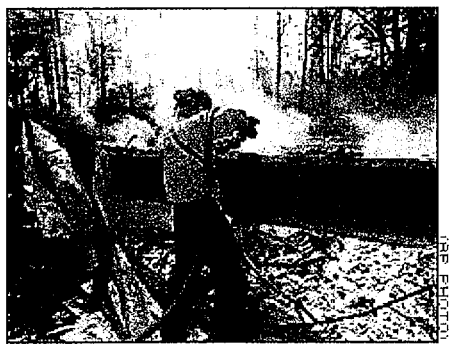
"I couldn't believe they were out there starting these controlled burns," said resident Roger Shurter, who has had to move his family twice to stay ahead of the advancing flames.

Iris Kegel, who was evacuated from her home in Espanola, said: "I'd hate to be the people who made the decision. I feel sorry for them."

Many homes gone

The governor said no deaths or injuries have been reported. Officials have not given a damage estimate, but some destroyed homes had an estimated value of $250,000.

Winds of up to 60 mph pushed the fire Thursday from block to block in the deserted town. Firefighters battled house to house, but within hours, some neighborhoods were reduced to rows of lonely chimneys poking up from piles of cinders.


AP PHOTO

A fireman with the Chamita Fire Department hoses down some hot spots on one of the homes destroyed during the fire

"I can't believe how many homes are gone," said Don Shainin, a fire battalion commander from Albuquerque who came to Los Alamos to help.

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homes destroyed during the fire

Fire crews used hand tools and
bulldozers to clear away vegetation and cut firebreaks to try in vain to stop the fire's march.

"There really isn't anything ground crews can do," said U.S. Fire Service Chief Mike Dombeck. "And there are even challenges with aircrafts -- so we're sort of at the mercy of the weather right now."

The weather is not expected to show any mercy until the weekend, when winds are expected to drop to 10-20 mph.

An estimated 400 homes have burned, when blowtorch-like winds caused the wildfire to expand dramatically from 3,700 acres to 18,000 acres in just five hours Thursday.

Flames within 300 yards of plutonium

Those flames also came within 300 yards of a plutonium storage facility at the Los Alamos National Laboratories, the nation's leading nuclear laboratory. But lab officials insisted that dangerous materials were protected in fireproof facilities strong enough to withstand a crash of a 747 jetliner.

"We can assure the country and New Mexico that our nuclear materials are safe," said Richardson.

Water-bombing helicopters and planes dropping fire retardant on the relentless blaze sent plumes of smoke so high into the sky they could be easily seen from space.

"It's like a giant refinery fire," CNN Producer Eric Fiegel said from Los Alamos. "The entire horizon from where I'm looking is nothing but smoke."

'This community helped us win the Cold War'

Los Alamos and surrounding communities, including Espanola and White Rock, became virtual ghost towns after authorities ordered the evacuation of at least 18,000 people, most of whom headed for the bigger cities of Santa Fe and Albuquerque, 60-90 miles away.

"I've driven through White Rock three times and there's not a soul to be seen there except for Guardsmen and police," Fiegel said. "No people. But you should see the smoke now. It's really carrying."

Los Alamos, 70 miles north of Albuquerque, is essentially a company town for the weapons laboratory, which employs 7,000 people at buildings scattered throughout the city. The town is on a mesa at an altitude 7,600 feet.

About 150 National Guardsmen were called in to keep people out of the evacuated zones and prevent looting.

"We will recover," Richardson said. "This has been a tragedy for this community, but this community helped us win the Cold War, and we're going to stand very much behind them."

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Lawmakers and lawsuits

Sen. Peter Domenici, R-New Mexico, promised to find out more about why the fire was set. "It's quite obvious that it was very risky," he said at the fire scene.

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The red and blue areas in this infrared image of the area around Los Alamos on Tuesday show the extent of the ongoing Cerro Grande fire

larger

Smoke from the Cerro Grande fire is evident in a satellite image of the area around Los Alamos on Tuesday

Domenici and Rep. Tom Udall, whose district includes Los Alamos, are already blaming the Park Service.

"They obviously made the wrong decision based on the weather," Udall said. "This just isn't the time to have any fire burning when you have such extreme winds and no humidity."

Udall suggested government compensation for Los Alamos residents might prevent a long court battle over damage claims.

"The issue is to what extent this was a negligent decision and if it was, I don't think we want to be forcing people into court to litigate those kind of things," he said. "I think if it was, we should step up and try to remedy the losses."

There is precedent for such a decision. A prescribed fire set by the federal Bureau of Land Management in Northern California last July raged out of control and destroyed 23 homes, causing $1.7 million in damage.

A federal report blamed the BLM for several lapses, including setting the blaze despite gusty winds and failing to notify or properly protect homeowners.

The BLM accepted responsibility and agreed to compensate homeowners.

Federal courts might also compensate those who lost property.

Under the federal Tort Claims Act, the government is generally liable for negligent acts by its agencies and employees, said Turner Branch, an Albuquerque lawyer who met Thursday with potential clients from Los Alamos.

He said a lawsuit also might focus on whether the Forest Service responded quickly enough to fight the fire.

Two more wildfires ravage state

Two other wildfires were burning elsewhere in New Mexico on Thursday night. A fire sparked by the crash of a private plane scorched 350 acres of a forest near Las Vegas, New Mexico, 65 miles east of Los Alamos.

Residents from the small communities of Manuelitas and Canoncito were evacuated to Las Vegas' Highland University, where a shelter was set up, said

Terri Wildermuth, the fire information officer for the New Mexico Forestry division.

In the Lincoln National Forest, 200 miles south of Santa Fe, residents of Weed and Sacramento were evacuated after a fast-moving fire consumed 3,000 acres in less than six hours.

Gwen Shaffer, of the Forest Service Despatch Center, said no injuries had been reported in that blaze and crews were mobilizing as fast as possible to get an indirect started on the flames.

Fire Information Officer Rick Hartigan told CNN that earlier air support units had been grounded, because winds were too strong and erratic for aircraft to fly in.

The fire danger remains extreme in the area, he said.

Correspondents Tony Clark and Charles Zewe and The Associated Press contributed to this report.

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In body and spirit, fire consumes Los Alamos

May 12, 2000
Web posted at: 1:21 AM EDT (0521 GMT)

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A house burns in Los Alamos

LOS ALAMOS, New Mexico (AP) -- A black kettle resting on a fireplace was all that remained of one home. Down the road, a basketball hoop stood intact in a driveway, its net still hanging but singed. The house it once flanked lay behind it in a smoldering mess.

With daybreak Thursday came the harsh realization: A chunk of Los Alamos was gone, gobbled up by a wind-whipped forest fire that damaged up to 400 homes and the spirit of this town built around a storied nuclear weapons facility.

"We've lost quite a bit," said Brian Deschamp, manager at the Best Western Hilltop House hotel, the only business open in this city of 11,000 people. "I don't even want to go out there."

As residents were kept from their homes for a second day, 1,000 firefighters continued battling blazes that scorched 20,000 acres of land and threatened to consume still more houses and businesses.

From any vantage point in town, plumes of white smoke could be seen billowing across an otherwise blue sky, as the horizon took on a tangerine tint. At one point flames flickered a few hundred yards from the police department, although downtown remained mostly unscathed.

It was a different story all along the city's perimeter, where scars from the blaze were visible from the scorched grasses of Los Alamos nuclear laboratory to the charred homes on the city's west and north sides.

On Ridgeway Street on the western edge of town, home after home was burned to the ground on a mesa overlooking Los Alamos Canyon. The canyon's towering ponderosa pines, once viewed from the back porches of homes valued at more than a quarter-million dollars, can now be seen through scorched shells.

At 4222 Ridgeway, a lone firefighter stood alongside what had been a garage, dousing the collapsed structure to prevent any remaining hot spots from igniting the house next door, which stood unscathed. A few doors down, firefighters

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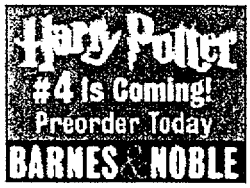

fought back flames at two more homes that initially had been considered out of danger.

"Last night, these two houses were saved," said Don Shainin, a battalion commander with the Albuquerque Fire Department. "You can see what they look like now."

The neighborhood, one of the oldest in town, is part of Los Alamos Police Sgt. John Chicoine's neighborhood watch route. It's home to a melting pot of families, retirees and lab workers. Chicoine knows one retired police dispatcher who lives in the area, but his home was spared -- for now.

"The fire just comes out of that canyon and grabs a house, while another might not be touched," he said.

On the south side of town, at the laboratory complex, fire swept across 1,000 acres of land -- blowing by concrete bunkers that store explosives and coming within 30 yards of a plutonium storage facility. Energy Secretary Bill Richardson, in town Thursday to view the damage, reassured both the public and the lab's 7,000 employees that the facility was safe.

"We will recover," he said. "This has been a tragedy for this community, but this community helped us win the Cold War, and we're going to stand very much behind them."

Los Alamos, a canyon-studded city 70 miles north of Albuquerque, arose from the top-secret Manhattan Project that built the world's first atomic bomb during World War II. After several years of functioning as a sort of federal government reservation, residents petitioned the U.S. and New Mexico governments for county status. A measure creating Los Alamos was signed into law in 1949.

Deschamp, a resident here for 20 years, described the community as "tight. It's like a little Mayberry."

"As long as the town doesn't burn, we'll be fine," he said.

Others were less sure about the road to recovery.

"Our task right now is to try to get everybody back in the town, and get about the business of trying to rebuild our lives," said Benny Roybal, a Los Alamos police officer for 10 years. "It's going to be a long time before that happens."

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Fire cleanup crews at Los Alamos worry about contamination

LOS ALAMOS, New Mexico -- About 100 firefighters have begged off from cleanup work at Los Alamos for fear of radioactive contamination from the nuclear lab.

Lab officials say no toxic substances were released during the wild fire, bu some firefighters are unconvinced.

After air monitors registered faint traces of two radioactive elements during fire, jokes about people "glowing" began doing the rounds, an official said.

The lab has offered to put radiation monitors on firefighters' bodies when they're working.

About 750 firefighters from across the country have been camping out not from a waste dump containing toxic chemicals. The dump burned undergrc for nearly a month, until the fire was finally put out on Tuesday.

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First fire, now flooding: Los Alamos braces for another disaster

June 3, 2000
Web posted at: 4:31 PM EDT (2031 GMT)

LOS ALAMOS, New Mexico (AP) -- Shawn Mills looked at the blackened hills across from her two-story home, shook her head, and cast her eyes to the ground.

"That mountain is going to come down, I know it," she said. "It's going to be like a California mudslide when the monsoon season comes."

Los Alamos, in the forested mountains of central New Mexico, was attacked last month by one of the largest wildfires in New Mexico history. Now it is threatened by what could be some of the state's worst flooding when the region's rainy season begins in July.

The wildfire that raged through the part of the city destroyed more than 200 homes and turned the once-green hills a stone's throw from Mills' neighborhood into an ashen wasteland. The mountain slopes are bare, and the grasses and shrubs that residents once relied on to help control water runoff have been reduced to ash.

"A fire that burns like this causes hydrophobic conditions ... water repellant soil," said Wayne Patton, a fire rehabilitation expert with the U.S. Forest Service. "The water beads up on soil like on a car that's been waxed and just rolls away."

So, homes like Mills' that survived the fire in Los Alamos and nearby White Rock are now open to flooding and mudslides. The threat is so serious that the Federal Emergency Management Agency is urging homeowners to purchase national flood insurance.

"We're concerned," FEMA spokesman Brad Craine said.

The Los Alamos area averages about 8.8 inches of rain from July through September -- nearly half its annual precipitation, according to the National Weather Service.

Fire crews are frantically trying to replant the slopes surrounding Los Alamos before the rains come. They also are conducting aerial seed drops onto the watershed to quicken the grass-growing.

But it takes the fastest-growing seeds at least two weeks to begin sprouting after the first good rain -- if they are not washed away first. Straw is used to absorb moisture and keep seeds from being washed down the steep slopes.

Patton said computer models have predicted the possibility of extensive flooding in the area, especially for neighborhoods in the hills and in the canyons below. He said fire officials are working with local authorities to set up an early warning system.

"It's like a toss of the dice," Patton said. "Some of these areas are going to be at risk. It's a 50 percent chance of happening."

In the meantime, dozens of fire crews armed with chainsaws, pick axes and hoes have been felling burned trees inside the forest in an effort to divert the expected water flows.

Doug DeMoss, a tree cutter with the U.S. Forest Service, had just felled a giant pine that was charred from top to bottom.

As soon as the tree hit the ground, firefighters chopped it into smaller pieces and buried the trunk lengthwise to serve as a sluice.

"We try to pick spots where we think the water will run down," DeMoss said. "We try to log in spots where it can stop erosion and stop up big gullies."

The ash-covered forest floor also is littered with car-sized boulders and downed trees as long as utility poles. If there are mudslides, the trees and boulders could be hurled down the hills.

In southern New Mexico, recent thunderstorms caused heavy flooding and mudslides on charred hillsides of the Sacramento Mountains. With much of the vegetation burned away from a 16,000-acre fire there, the water moved quickly downhill, taking mud and ash with it. The resulting mudslides left debris that caused the temporary closure of several highways.

Mills isn't taking any chances. Her family has bought sand bags and hay bales to protect their home from a possible deluge.

The fire burned down the house next door, and the heat was so intense, it bubbled the paint on her house and melted some of her outside fixtures.

"A lot of people don't believe a flood is going to happen," Mills said. "They're totally in denial. They didn't believe a fire would hit, either."

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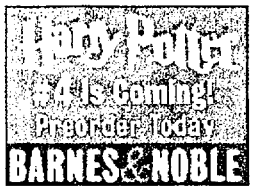

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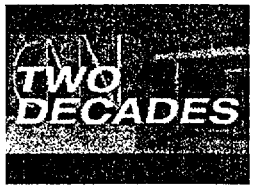

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The serpentine mineral group includes chrysotile, which is the best known, most abundant and the one we use the most. The structure of chrysotile consists of alternate strata of magnesia and silica, and in nature, are coiled into tubes called fibrils, that look like rolled newspapers. The amphibole mineral group contains the actinolite-tremolite series, anthophyllite, crocidolite and the cummingonite-grunerite series. The serpentine group contains elements such as aluminum, iron, magnesium and sodium. In various forms products made from these groups are used for heat resistance, roof coatings, siding, shingles, gaskets, and brake linings. We know them all as asbestos.

From the mine to construction, unless protection is utilized, the fibers that comprise these minerals can be inhaled; causing a disease called asbestosis. Families of people that mine or manufacture products associated these groups of minerals, and are not properly protected, are susceptible as well. It is customarily transmitted as dust on clothing and its transmission is similar in nature to what we are now familiar with, second hand smoke. Living near a plant that uses the fibers is also perilous, as the wind can easily transport the fibers and they readily become lodged in the unknowing victim's lungs. Other diseases that these fibers produce are lung cancer and mesothelioma, which is a rare form of chest or abdomen cancer.

In spite of both the Egyptians and Romans utilized asbestos, its deadly nature was not disclosed until 1931, when Britain began regulating its exposure. Studies done by the English doctors, along with those of American insurance companies, unequivocally revealed its harmful effects. Within a short time certain

insurance companies began excluding coverage for workers whose occupation was allied with asbestos related industries, but whenever the boat became severely rocked, workers claims against the producers were quietly paid. The amount of money being paid out remained negligible for many years and the producers considered this a paltry price to pay in an industry that was returning stratospheric profit margins.

IS THIS WHAT ADAM SMITH HAD IN MIND?

Workers' compensation was expanded to cover lung diseases and thus became a joint government and industry problem, but the total reimbursement continued to be minimal and was considered part of the cost of doing business. Early on, the manufacturers, long after producers became aware of asbestosis' danger, but still being unwilling to forgo the extravagant profitability of the product line, developed certain ploys to mask its side effects. For example, It became de rigiour for managements in the industry to disparage those complaining of lung disease as shirkers and laggards, rather than address the medical issues that they had been aware of for several decades. Additionally, corporate liability was extremely limited by virtue of legal nuances that set extremely short time frames for the inflicted to bring action.

THEY KNEW WHAT IN 1964?

In 1964, a team at Mount Sinai Hospital in New York issued a report, irrefutable in nature, meticulously documented in character, loudly trumpeted in the press, laying out both chapter and verse as related to the medical horrors of asbestos. It was issued with such notoriety that after that date, no one could dare feign ignorance of the real facts. That, coupled with the discovery of studies commissioned by asbestos manufacturers analyzing the effect asbestos on laboratory animals, which were completed in the 30s and 40s, showing that in some cases all of the animals exposed to the material developed fatal diseases. This, as well it should, became the end of the asbestos era.

In spite of superb evidence was available regarding the adverse elements of asbestos, the United States did not begin to address the subject until 1972, long after the damage had been done. Estimates of the damage caused by the unfettered use of the substance for so many years are hard to come by on a global basis, but in the United States, it has been estimated that 21 million people come in contact with it on a regular basis, and the Environmental Protection Agency (EPA) has stated that, as an insulator, its in about 700,000 building and 31,000 schools nationwide ( ). It is believed that 8,000 to 10,000 Americans will continue to die each year, for the foreseeable future, from this cause.

The sale of asbestos products remained an extremely profitable business throughout the world until the deadly effects of the product became known. Now that there is a global push to eliminate, or encapsulate asbestos, it has been estimated that this cost will be over a hundred times more expensive than the original installation. Both the original profits, and the ultimate losses, were born by a select group of companies in the United States, led by the biggest user of asbestos in the world, Johns-Manville Corporation.

THE WEB WE WEAVE WHEN WE PRACTICE TO DECEIVE

Seeing that the game was over, 100 year old Manville twisted, turned and filed bankruptcy, having been overrun with 17,000 lawsuits. Remarkably, a company that had $2.2 billion in sales and had made $60 million the previous year, performed this act. One of the most devastating issues facing Manville was their own employees pension fund was the largest shareholder of the company, thus the bankruptcy, in one fell swoop, eliminated whatever savings the company's employees had in the fund. Not a very good start.

The next problem, or benefit, depending on which side of the fence you are sitting, was the staying of all

lawsuits or claims against Manville by people injured from asbestos. Lastly, the bankruptcy proceeding caused massive layoffs of the employees, pending a reorganization. The litigants were placed in limbo and new cases were estopped, the employee's pensions were wiped out, and their jobs decimated, in a majestic swipe of the legal pen.

The most unusual aspect of the bankruptcy, was Manville had substantially more assets than liabilities at the time of the filing. As the years progressed, Manville's stash increased, having avoided the payment of dividends on their stock, all bills due and owing, before the filling of the bankruptcy. Loans that had come due and judgements that were owed interest on their money, along with profitability from non-asbestos subsidiaries, continued to flow into the till. Senior corporate officers continued to be paid handsomely, directors fees continued, lawyers were cleaning up and not one cent was going to the people that had been maimed by Manville's cover-up.

A YOU ARE STANDING THERE AND SAYING, NO ONE WENT TO JAIL FOR THIS

A personal-injury trust was set up to deal with the afflicted and their litigation. A fund of money was left in the trust to be distributed among the legitimate claimants. To date, 94,600 people have collected approximately $10,000 each, after payment of legal fees. Considering the life that awaits these recipients, it is hardly a princely sum.

As for management, they had another trick up their sleeve; when they formed the trust, they also formed another company to go about doing business as usual. The name has been changed to Schuller, so that no one will know the nefarious background of the principals and guess what! They are now in the non-asbestos building materials business, which is doing quite well, thank you.

Hard working people who diligently performed their duties working for Manville and companies like it, were lied to and mislead. , when the day of reckoning came, a small amount was set aside to cover pain and suffering, and management went on to bigger and better things. Claimants were expected to live out their lives in pain and suffering for an unconscionable act, not just by Manville, but by an entire industry of asbestos producers who put the almighty dollar in front of the lives of their employees. Managements of all these companies were aware that health risks existed for their employees, and yet moved not a finger to prevent it or aid them. Tribunals should be set up to try those who take others' lives, either through sins of omission, or those of commission. These people are no more conscionable than the dictator dealing in genocide, and management of these companies has shown about as much remorse for what they have done, as did Hitler's henchmen at Nuremberg.

Last changed: March 17, 2000

MANVILLE PERSONAL INJURY SETTLEMENT TRUST: HISTORY

- Background and Mission
- Start up Operations of the Trust
- Settlement vs. Litigation
- Bankruptcy Court Intervention
- New Operational Mandates -- the TDP

Background and Mission

In August 1982, Johns-Manville Corporation filed a petition for reorganization under Chapter 11 of the Bankruptcy Code which automatically suspended all personal injury lawsuits and allowed Manville Corporation ("Manville") to reorganize, thus preserving its financial viability to compensate asbestos claimants.

In December 1986, the United States Bankruptcy Court for the Southern District of New York approved Manville's Plan of Reorganization (the "Plan"). A cornerstone of the Plan was the creation of the Manville Personal Injury Settlement Trust (the "Trust") to compensate individuals suffering personal injury from exposure to asbestos or asbestos-containing products manufactured or sold by Manville. Following several appeals, the U.S. Court of Appeals for the Second Circuit confirmed the Plan on October 28, 1988. The Trust became operational thirty days later on November 28, 1988.

The Trust was created as an independent organization to distribute funds as equitably as possible while balancing the rights of current claimants against those of future, unknown claimants. The Trust's mission is to "enhance and preserve the Trust estate" in order to "deliver fair, adequate and equitable compensation to (claimants), whether known or unknown." The Trust was established as a negotiation based settlement organization pursuant to Plan provisions which made it clear that claimants did not need to litigate or threaten to litigate in order to negotiate a fair settlement.

Start up Operations of the Trust

Although not confirmed until October 1988, the Trust began operating in January of 1987, following the bankruptcy court's appointment of trustees. During the first seven months of 1987, several consulting organizations assisted the trustees in handling a range of complex issues and developing a strategy for responding to the impending deluge of claims. In October 1987, the trustees hired an executive director, and within six months, the Trust had hired and trained nearly ninety-five employees and was prepared to settle claims.

In May 1988, the Trust began to negotiate settlements of the cases filed against Manville before August 1982, all of which had been stayed by the bankruptcy proceeding. Upon consummation of the Plan on November 28, 1988, the Trust was authorized to begin paying these pre-bankruptcy claims, subject to certain conditions, including the receipt of an individual proof of claim form and a signed release from each claimant. As of December 31, 1988, the Trust had settled over 12,600 claims for almost $500 million and had paid 1,200 claimants over $50 million. Claims were paid 100% of settlement value in first-in, first-out (FIFO) order. By mid-1989, an additional 48,500 post-bankruptcy claim forms had been received. By January 1992 more than 190,000 claimants were seeking compensation from theTrust.

Settlement vs. Litigation

Although some litigation against the Trust was contemplated by the crafters of the Plan, it was recognized that substantial litigation against the Trust would be operationally unmanageable and financially detrimental. The Plan authors wanted the Trust to be a negotiation-based settlement organization. However, three factors led to the Trust's inundation with active litigation. The first was purely operational: the Plan permitted claimants to sue the Trust 120 days after filing their claims if they had not received a settlement offer. Because the Trust had received such an enormous volume of claims and was unable to make offers on all of them within 120 days, many claimants exercised their right to sue in order to improve their position in the FIFO queue.

The second factor influencing the volume of litigation was an acceleration in the volume of cases tried in the courts compared to the relative handful of asbestos cases that came to trial during the mid-1980s. On the 240th day after Consummation, July 28, 1989, co-defendants in the asbestos litigation were permitted to implead the Trust as a third party in the ongoing litigation. By December 1989 the Trust had been impleaded in and was forced to defend 89,000 cases nationwide. This unprecedented volume had not been anticipated, and the Plan did not allow modification of the Trust's operations to accommodate the problem.

Finally, as the Trust's initial cash funding dwindled and it became readily apparent that its assets were insufficient to pay its liabilities, the "race to the courthouse" became a stampede.

Bankruptcy Court Intervention

In July 1990, the Honorable Jack B. Weinstein, U.S. District Judge for the Eastern District of New York, was granted jurisdiction over the Trust. Judge Weinstein issued a stay on all Trust payments except exigent health and financial hardship settlements. During the next five months Manville Corporation, court-appointed representatives of current and future claimants, and the Trust, negotiated a restructured financial agreement and claims settlement process.

In November 1990, the Trust was judicially determined to be a "limited fund" and a class action designed to reorganize the Trust claims settlement and payment process was filed in the Eastern and Southern Districts of New York. A settlement of the class action was approved by Judge Weinstein in June 1991 (Findley v. Blinken, 129 B.R. 710 (E. & S.D.N.Y. 1991). In December 1992, the Second Circuit Court of Appeals vacated and remanded the case to Judge Weinstein for further negotiations (Findley v. Blinken, 928 F.2d 721; modified, 993 F.2d 7 (2nd Cir. 1993).

New Operational Mandates -- the TDP

Following remand, negotiations continued through 1993 and the first half of 1994 (the case name changed to Findley v. Falise), and in July 1994, a new settlement was reached. Fairness hearings were held during November. On January 19, 1995, Judge Weinstein approved the class action settlement which altered the Trust's claim settlement and distribution process. In re Johns-Manville Corporation, 878 F.Supp. 473 (E. & S.D.N.Y. 1995). The settlement, which included a revised Trust Distribution Process (the "TDP"), requires that the Trust's assets be distributed to qualifying claimants on a pro rata share basis computed to equalize payments to present and future claimants at an initial level of 10% of total liquidated claim value. Claims are paid on a scheduled basis in accordance with seven disease categories, but claimants can refuse the Trust's schedule-based offer and request individual evaluation and eventually ADR.

The settlement provided that the TDP would go into effect on February 21, 1995 unless the order was stayed. Though appeals were filed, no stay was granted and the Trust implemented the TDP procedures effective February 21, 1995. The Trust is still waiting for the Second Circuit to rule on the outstanding appeals, but strongly believes the settlement plan will ultimately be approved.

As of December 31, 1995, approximately 10 months following District Court approval of the class action settlement, the Trust had made offers or sent deficiency notices to 103,551 claimants, and had settled and paid over 55,000 claimants in excess of $270 million.

(As of December 31, 1995, the Trust had received over 280,000 claims. The Plan predicted the Trust would receive between 83,000 and 100,000 claims during the life of the Trust.)

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A STATE'S RIGHT TO RECOVER PUNITIVE DAMAGES IN A PUBLIC NUISANCE ACTION: The *Love Canal* Case Study

*by Robert Emmet Hernan**

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The subject of punitive damages has received broad and intense scrutiny over the past ten years, as has the leading environmental case, Love Canal. In this article, those two subjects meet, head-on, in Robert Emmet Hernan's analysis of a state's right to recover punitive damages in a public nuisance case, using Love Canal as a case study. The case provides a unique opportunity for examining the roots of punitive damages in the border between civil and criminal law, as well as the position of the state in that border region.

First, Hernan addresses, the issue of whether, under the common law, a state is empowered to recover punitive damages in a civil action for public nuisance. Hernan argues that punitive damages function as a punishment against a defendant for past recklessness and as a deterrence against the particular defendant, and others, from acting recklessly in the future. Because of this function, the analysis as to whether punitive damages are appropriate, or legally supportable, does and should focus on the defendant's conduct, not on who the plaintiff is. Moreover, Hernan submits that this analysis is not affected by the commonality of purposes behind criminal prosecution and civil punitive damages proceedings; it is not affected by the existence of criminal penalties for the same reckless conduct that can result in punitive damages; and, that the status of plaintiff as "state" does not convert the claim into a criminal matter subject to the special protection accorded criminal proceedings.

Hernan further argues that once it is determined that the common law presents no barrier to a state's right to recover punitive damages, it is then necessary to determine if the Constitution presents any barriers. It is argued that the standard for determining the basis for liability, as well as the more contentious issue of the standard for assessing the amount of any punitive damages, and the standard for the burden of proof are constitutionally sufficient, or not, irrespective of the status of the plaintiff as "state." In his analysis of the constitutional implications presented by the Love Canal case, Hernan reviews the recent caselaw developments following certain noted United States Supreme Court decisions on punitive damages.

THE CONTEXT

Recent Interest in Punitive Damages

For some, "punitive damages" are "damages awarded in excess of compensatory damages or nominal damages to punish a defendant for a gross wrong - called exemplary damages." Fn1 Most would add deterrence as an equally important purpose. Fn2

For others, punitive damages are a modern-day plague which has spread rapidly and with increasing fever throughout the body politic. Fn3 These critics see radical surgery as the only cure. Their hopes were raised for just such a cure when the Supreme Court decided to offer a diagnosis. However, instead of surgery, the patient only got one of those prescriptions the pharmacist is able to read, but which the patient finds unreadable. Fn4

If that result were not upsetting enough for the critics, a new strain of the disease was spotted in a federal court in Buffalo, New York. Fn5 There, the Honorable John C. Curtin, in denying a defendant's Motion to Dismiss, declared that the State of New York was entitled to seek punitive damages in a public nuisance action from the chemical company responsible for the creation of the Love Canal disaster. Fn6

This article will attempt to calm the nerves of the critics by showing that the result in the *Love Canal* litigation is not an aberrant strain of a disease, but a natural, organic growth, deserving of nurturing.

Procedural Background of the Love Canal Litigation

The *Love Canal* action was commenced by the filing of the Complaint of the United States of America on December 20, 1979. Fn7 The defendants included the Occidental Chemical Corporation (OCC) Fn8 and several affiliates. The City of Niagara Falls (the "City"), the Board of Education of the City of Niagara Falls (the "School Board") and the Niagara County Health Department (the "County" or NCDH) were also named as defendants by the United States solely for the purposes of ensuring complete relief, since the City and School Board own part of the Love Canal property and the NCDH could implement remedial measures.

On April 28, 1980, the State of New York and UDC-Love Canal, Inc., Fn9 filed claims against OCC in state supreme court. On June 11, 1980, upon OCC's motion, the State and UDC-Love Canal, Inc., were ordered joined as parties in the federal action; on August 8, 1980, the New York State Supreme Court granted OCC's Motion to Stay the proceedings commenced in state court.

The State and UDC-Love Canal, Inc., (the "State") were realigned as plaintiffs in the federal proceeding on September 11, 1980, and they filed a complaint in the federal court on September 18, 1980 against OCC, based on public and private nuisance, and restitution. The State did not raise any substantive claims against defendants City, Board or County.

In 1980, OCC answered the governments' Complaints and filed counterclaims against the United States of America and the State of New York.

In January 1984, after extensive discovery, the implementation of some remedial measures, and the passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Fn10 the State filed an Amended Complaint adding claims for relief under CERCLA. OCC filed answers, with cross-claims against the City, School Board and County, as well as counterclaims against the United States and the State. Fn11

Discovery was started in the early 1980s. The case was bifurcated into Phase I, which is to determine which parties are liable under the various claims, and Phase II, which will determine what amounts of damages will be imposed on which liable parties.

On February 23, 1988, Motions for Partial Summary Judgment by the State and the United States against OCC under Section 107 of CERCLA were granted. Fn12 The State's Motion for Partial Summary Judgment against OCC under the common law of public nuisance was also granted, on August 25, 1989. Fn13

OCC also had filed Cross-Motions for Partial Summary Judgment against the plaintiffs, the City and the Board. The decision on these motions were reserved, and carried to trial. Fn14

The County's Motion for Dismissal of OCC's crossclaim against it was granted on June 6, 1990. Fn15

What remained for disposition in Phase I, through a trial, was the State's claim for punitive damages, derived from its common law public nuisance claim, and OCC's cross and counterclaims against the City, School Board, State and United States.

The bench trial of the State's punitive damages claim, and OCC's claims against all other parties, was held in federal court in Buffalo from October 1990 through June 1991. Following extensive post-trial briefing

and oral arguments, the court issued its decision on the State's punitive damages claim on March 17, 1994. Fn16 The court found, on the facts, that the chemical company's conduct was negligent and, indeed, inexcusable at times, especially with regard to incidents when children were exposed to chemicals at Love Canal. Fn17 But considering all the circumstances, the court held that the company's conduct was not so outrageous as to warrant punitive damages. Fn18

In June 1994, the State and OCC settled their claims. OCC has agreed to pay the State $98 million, and to assume the continuing operation and maintenance of the Remedial and Monitoring facilities at Love Canal. The court has not yet ruled on OCC's cross or counterclaims against other parties.

Background of Facts Giving Rise to State's Claim for Punitive Damages

Before discussing the various legal issues on which the State's claim for punitive damages was grounded, it is critical that there be an understanding of the factual predicates for that claim. Fn19 All too often, critics of punitive damage awards discuss the size and legal implications of the award without also discussing the facts that the judge and/or jury had before it when deciding whether to award punitive damages, and in what amount. An understanding of these facts is especially important when the case involves a hazardous waste site which was created in the 1940s and 1950s and which leads some people to question, without knowing more, the appropriateness of seeking punitive damages for "ancient history," when, perhaps, companies "did not know any better" than to pollute. Fn20 As we shall see, the facts are not so forgiving.

The canal had been dug in the 1890s by a William Love, as part of a proposed water power scheme in the Niagara Falls area. The project failed and the portion of the unfinished canal which had been dug nearby the Niagara River, in an area known as LaSalle, remained open and unused, until Hooker started to use it for the disposal of chemical wastes from its manufacturing operations at its Niagara Falls plant.

Hooker first leased, then purchased, the Love Canal site in the 1940s. The canal was 3,000 feet long, running north, and filled with water. Dumping occurred in the Northern Section, from 1942 to 1946, then in the Southern Section from 1946 to 1954, with some dumping in the Central Section at the end of the period. The toxic chemicals Fn21 were dumped, usually, in metal drums, which were often old and rusted, or in fiber drums, which were used for filter cake residues. The drums sometimes broke apart as they were being dumped and sometimes chemical wastes were dumped directly into the canal. Dams were constructed across the canal. Also, pits, approximately 25 feet wide and 25 feet deep, were dug outside the canal for disposal. Drums and waste filled the canal to within a few feet of the ground surface, and then were covered with dirt or ash. Throughout the trial, OCC characterized this as the "dig, bury and cover" method of disposal. Fn22

On several occasions during the dumping period, employees of Hooker visited the site and reported to management that the water throughout the canal was contaminated and children were swimming in the sections which were not being used for disposal. Despite strong recommendations by its own General Counsel and other managers that a fence be constructed to prevent injuries to the children, Hooker did not fence in the canal. Also during this time, Hooker knew that, as a result of the way the drums and wastes were dumped in the canal and pits, the drums were deteriorating, and would continue to deteriorate, and the subsurface would shift, causing subsidence to the ground surface. Hooker also knew that when the surface subsided, the drums and wastes would become exposed, further endangering children and others. Finally, fires and explosions occurred in the canal, shooting flames as high as the homes which were built adjacent to the canal. Throughout the post-war period, more and more residences were being built in the

area.

In 1952, Hooker was approached by the School Board which wanted to buy a part of the Love Canal property (the Central Section where no dumping had occurred, as yet) in order to build a new grade school. At first Hooker declined, because it was concerned about liability for the wastes, but within a month it reconsidered and agreed to donate the property, for $1. Fn23 The conditions on the donation were that the School Board take the entire property, indemnify Hooker for any claims, and continue to allow dumping until the school was built. Hooker advised the School Board that Love Canal was used "for plant refuse containing some chemicals," that the Central Section of the property was appropriate for a school, and that the rest of the property was appropriate for playgrounds. Actually, Hooker knew that approximately 22,000 tons of toxic chemical wastes were dumped at Love Canal. Hooker never warned the School Board of the dangers from subsidence of the ground.

No sooner had Hooker conveyed the property than the dangers surfaced. The location of the school had to be moved within the Central Section because contractors discovered two pits filled with chemicals that Hooker dumped in that section. From 1954 through the mid-1970s, there were a series of incidents where the ground subsided, drums and toxic wastes rose to the surface, endangering and even burning children playing on the school grounds. Fn24 Hooker was usually called to the site, and the company would respond by stating that it would not do anything unless specifically asked by the School Board, that it had transferred Love Canal and was no longer responsible.

Toward the late 1970s, in addition to the surface exposures, the wastes had migrated through the subsurface and were entering the basements of the people who lived adjacent to the canal. Complaints to local health authorities accelerated by 1976, and the state and federal authorities became aware of the site and of the problems. Studies were undertaken in 1977 and 1978 to determine the nature and extent of the dangers, and some possible ways to remedy the dangers. Conditions continued to deteriorate, and in August 1978 the State and then President Carter declared an emergency at Love Canal. Over two hundred families were relocated and their homes were bought by the governments. Based on further studies and uncertainties about the nature and extent of the risks at Love Canal, approximately five hundred additional families were relocated in 1980, and their homes were bought by the State. Remedial measures to cleanup Love Canal were begun in late 1978, and are nearly completed, at a total cost to the governments of over $150 million.

Fight Over Punitive Damages Claim

As noted above, in August 1989, the State was granted summary judgment against OCC on the State's claim under the common law of public nuisance. Amongst other relief pursuant to this claim, the State had requested that the court find OCC liable for punitive damages. In its First Amended and Supplemental Complaint, the State had requested punitive damages in the amount of $250 million.

Also in August 1989, OCC moved to dismiss the State's punitive damages claim or, in the alternative, for partial summary judgment denying that claim. Fn25

In October 1990, the court issued its Supplemental Order No. 52, denying OCC's Motion to Dismiss the State's claim for punitive damages or, in the alternative, for Partial Summary Judgment on the State's claim. Fn26 On the issue of a State's right to recover punitive damages under the common law, the court held, first, that a New York Penal Law provision on public nuisance did not bar the State's right to recover punitive damages in a civil action for public nuisance. Fn27 Second, the court held that the case law of New York provided support for a State's right to recover punitive damages. Fn28 Third, defendant argued that awarding the State punitive damages in this environmental, hazardous waste case was unnecessary to

further the punishment and deterrence purposes served by punitive damages, since the area was already so heavily regulated. Fn29 The court rejected this "policy" argument. Fn30

With regard to several constitutional arguments, the court rejected the argument that the New York common-law standard for assessing the amount of punitive damages was constitutionally vague. Fn31 Second, the court rejected the argument that the State was required to establish its punitive damages claim with proof beyond a reasonable doubt. Fn32 Third, and finally, the defendant presented an Eighth Amendment argument that any award of punitive damages in excess of the maximum criminal fine of $2,000 would violate the Excessive Fines Clause of the Eighth Amendment. Fn33 The court found that this issue was not ripe for adjudication since neither liability nor any amount of punitive damages had yet been awarded. Fn34

This view of the court's holding is only skeleton in form, but it will serve as the framework for an analysis of the issues and arguments presented to and decided by Judge Curtin. The issues, as summarized above, revolve around two major questions. First: Is a state empowered to recover punitive damages in a civil action for public nuisance? This question invokes state common law issues, centering around the nexus between criminal and civil law. Second: If a state is entitled to recover punitive damages in a civil action, are there any federal Fn35 constitutional provisions which either bar or restrict that right? Here, several constitutional arguments present themselves: Fourteenth Amendment due process protections on the standard of proof and standard for assessing the amount of punitive damages and Eighth Amendment Excessive Fines provisions.

THE STATE'S RIGHT TO RECOVER PUNITIVE DAMAGES

Defendant's Central Thesis: The Nexus Between Criminal and Civil Actions When the State Sues for Public Nuisance

The central thesis of defendant's argument was that a state's claim for punitive damages in a public nuisance action was, by its nature, a criminal prosecution. Presumably, a state could sue for compensatory damages in public nuisance; a private plaintiff could sue for punitive damages in public nuisance; and, perhaps, a state could sue for punitive damages in a civil action other than public nuisance. According to defendant, however, when you bring together a state as a plaintiff suing for punitive damages in public nuisance, a different legal chemistry is created, the three react adversely, and an explosion occurs.

The argument was premised on a fundamental assumption that punitive damages in a public nuisance suit brought by a state are analogous to a criminal prosecution because: (1) public nuisance began as a crime and is still subject to criminal sanctions; (2) punitive damages are intended to punish and deter, which are also purposes behind criminal sanctions; and, (3) when a state seeks punitive damages, all the dangers of "unconstrained official coercion and government oppression" are implicated. Opponents of punitive damages, like defendant, make the further leap in logic that the analogies are so close between criminal prosecutions and a state seeking punitive damages in a public nuisance action, that the two situations should be treated the same. Fn36

These arguments have some superficial appeal because of the historic origins of public nuisance in criminal law, and some overlap in the purposes behind punitive damages and criminal sanctions. Yet, the appeal of the argument is only skin deep.

First, it is accurate that public nuisance began as a crime, and it still exists as a crime. That is, public nuisance traces its origins to criminal law. Fn37 However, since the sixteenth century, public nuisance has also existed in the common law as a civil action. Fn38 While this historic origin of public nuisance as a crime is interesting, it has no current legal implication. Today, in New York, public nuisance is a civil action under the common law. Fn39

It also was argued that punitive damages and criminal sanctions share the common purposes of punishment and deterrence and, therefore, criminal prosecution considerations apply to a state's claim for punitive damages in a public nuisance action. Just as the earlier point on the origins of public nuisance was historically interesting, this point was philosophically interesting. But it provided no legal impediment to recovering punitive damages in civil actions.

Punitive damages in a civil action do not constitute criminal "punishment." The obvious, and critical, difference between criminal punishment and punitive damages is that the former can punish primarily through loss of liberty or life, while the latter can punish only through loss of money. In addition, while convicted felons may lose certain civil rights, someone assessed with punitive damages does not lose such rights. Fn40

A claim for punitive damages in a civil suit based on public nuisance, whether by a state or a private party, is *not* a criminal prosecution and it cannot be treated as if it were, as even its critics acknowledge. Professor Jeffries and George Clemon Freeman set out Fn41 the argument, outlined above, that punitive damages can be equated with criminal liability, and then they state: Fn42

That none of these propositions based upon equating punitive damages with criminal liability has been clearly accepted in the courts is evidence of a continued judicial reluctance to accept that starting premise. No matter how elegantly one may argue that punitive damages are "like" criminal fines, the common understanding persists in regarding them as civil sanctions. Nor is this position entirely without foundation. Punitive damages do not partake of the distinctive style and vocabulary of the criminal law. Nor do they entail the condemnation and stigma of criminal conviction. And for individuals, there is the all-important difference between pecuniary liability and incarceration. Fn43

This same article acknowledged that the well-established, settled law on punitive damages was contrary to its espoused position: the challenge to large punitive damage awards "has been hampered by a lack of relevant precedent"; Fn44 the article presents "a specific agenda for defense counsel in punitive damages cases"; Fn45 and, "our goal has been to alert defense counsel to *plausible* constitutional attacks on *traditional* punitive damages practice . . . ." Fn46 Moreover, Professor Jeffries recognized that the specific arguments advanced against punitive damages have no support in the case law: "punishment by punitive damages differs from punishment by criminal conviction in arguably non-trivial ways"; Fn47 as to the void-for-vagueness attack, "[t]he difficulty lies in casting this concern as a constitutional objection"; Fn48 "[t]he chief difficulty in extending the vagueness doctrine to the standards for imposing punitive damages is the traditional view that vagueness review is limited to criminal statutes." Fn49

In his opinion denying defendant OCC's Motion to Dismiss the punitive damages claim, Judge Curtin addressed defendant's central thesis and concluded that there are crucial distinctions between a criminal prosecution and a civil action seeking punitive damages, including what interest is at stake (loss of liberty or life against loss of money), what collateral consequences follow each, and the heavy societal stigma attached to the former. Fn50 Moreover, the court concluded that just because there are similar purposes served by the two remedies does not equate the two, as it has been commonly understood that civil proceedings may advance punitive goals, and that criminal proceedings may advance remedial goals. Fn51

Does New York Penal Law Bar the State's Claim for Punitive Damages?

Defendant argued that a provision of New York's Penal Law, Fn52 was the exclusive criminal remedy for public nuisance, that the statute precluded non-statutory criminal prosecution, and that the statute barred any other form of non-statutory punishment by the State. The State argued that the existence of a statute in New York which declares certain conduct to constitute a criminal nuisance is no legal impediment to the State's civil action for public nuisance.

It is clear in New York that criminal statutes prohibiting certain acts or conduct as nuisances do not supersede the common law civil action for public nuisance. Chapter 1030 of the Laws 1965 (Penal Law) provides that, "This chapter does not bar, suspend, or otherwise affect any right or liability to damages, penalty, forfeiture or other remedy authorized by law to be recovered or enforced in a civil action, regardless of whether the conduct involved in such civil action constitutes an offense defined in this chapter." Fn53 This provision of the Penal Law derives from Sections 720, 722, and 723, of the Penal Code of 1881. Fn54 Thus, the savings provision of the Penal Law preserves a right to recover damages in a civil action (for public nuisance) when the conduct also constitutes a crime. Of course, this begs the question of whether a state has the right to punitive damages. But it does indicate that the Penal Law is irrelevant to that analysis.

In *New York v. Alhambra Theatre Co.*, Fn55 it was held that the provision that offenses specified in the Penal Law should be punished according to the provisions made therein, and not otherwise, did not prevent the recovery of a civil penalty for the violation of a municipal ordinance even though the violation of the ordinance was also punishable as a crime. The court further held that a civil penalty is not "punishment" within the purview of the Penal Law. Fn56

Defendant relied on the case of *People ex rel. Lemon v. Elmore*, Fn57 where an action was brought against the owners of a house of prostitution pursuant to the Public Health Law. The Public Health Law authorized a District Attorney to bring an action to enjoin the maintenance of a house of prostitution and to impose a penalty tax on persons responsible for maintaining a nuisance. The lower court entered a judgment enjoining defendants from using the house for prostitution and imposing a $300 penalty tax. The Appellate Division upheld the injunction but modified the judgment by eliminating the imposition of the tax, on the ground that the tax was a penalty and defendants were wrongly denied a jury trial. The *Elmore* case did not support the proposition that punishment for public nuisance must be by criminal prosecution. The case only stands for the proposition that a jury may be required in a penalty tax case.

Furthermore, punitive damages specifically have been held to be recoverable in a civil action based on conduct which is also criminal. In *Cook v. Ellis*, Fn58 the court followed the generally accepted rule that the potential or actual criminal punishment of the defendant for the same action which also resulted in a civil suit will not bar the imposition of punitive damages in the civil action. Fn59 The *Cook* case involved a civil action for trespass, civil assault and battery, including a claim for punitive damages resulting from defendant's attack on plaintiff with intent to have "carnal connection" with her. The defendant had been indicted for the same assault and battery, tried, convicted, and fined $250, which was paid. Defendant in the civil action claimed that the criminal fine and payment barred all claim for punitive damages in the civil action. Fn60 The court held, *per curiam*:

[J]urors are always authorized to give exemplary damages where the injury is attended with circumstance of aggravation; and the rule is laid down without the qualification that we are to regard either the possible

or the actual punishment of the defendant by indictment and conviction at the suit of the people. That the criminal suit is not a bar to the civil . . . is entirely settled. Fn61

In *United States v. Hooker Chems. & Plastics Corp.*, Fn62 Judge Curtin traced the history of the New York Penal Law Section 240.45, and concluded that the civil action of public nuisance coexisted with the crime of public nuisance and was not supplanted by the penal laws. Moreover, the court reasoned that "the more logical reading of the statutory scheme . . . is that it was intended to preserve the State's right to bring civil actions, including those sounding in public nuisance, seeking whatever remedies would be available to a private litigant." Fn63

Does the Case Law Support the State's Right to Recover Punitive Damages in Public Nuisance?

An argument was made that there was no New York case which had upheld the State's right to recover punitive damages in a public nuisance action and that such a right was unprecedented. While not extensive, the case law of New York and elsewhere has nevertheless upheld the right of a state or political subdivision to recover punitive damages in a public nuisance or other civil action.

In *State v. Schenectady Chems., Inc.*, Fn64 the State sued for punitive damages and other relief in public nuisance. The defendant moved to dismiss the complaint but the court ruled that "punitive damages would lie." Fn65 In the *Love Canal* case, the defendant attempted to distinguish *Schenectady Chemicals* on the grounds that when the court stated that punitive damages would lie in a public nuisance action by the State, the court was speaking *in dicta*. Fn66 Yet, in *Schenectady Chemicals* the defendant filed an Affidavit in Support of the Motion to Dismiss wherein defendant argued, "[t]hat the damages complained of by the plaintiff herein, are not real, but are speculative." It is this specific argument, in support of the Motion to Dismiss, that the court in *Schenectady Chemicals* addressed in its opinion, "Defendant's next contention is that the complaint must be dismissed since the requested relief is speculative and to some degree not authorized or appropriate." Fn67 As to this contention, on what kinds of damages are recoverable by the State in a public nuisance action, the court expressly held:

A complaint will not be dismissed due to a prayer for inappropriate relief so long as some right to recover is demonstrated [citation omitted]. Here, that demonstration is made as an 'action lies by the people through the attorney general to abate a public nuisance, and to restrain its continuance, and for damages' [citation omitted]. Furthermore, *punitive damages would lie* [citation omitted]. The court will dismiss the demand for attorneys' fees since that relief is not available in the absence of a statute or contract authorizing same [citation omitted]. Fn68

Thus, the court specifically addressed each component of the State's demand for damages in light of defendant's Motion to Dismiss those damages and upheld all (including punitive damages) except the demand for attorneys' fees. Therefore, the court held that the State was entitled to recover punitive damages in a public nuisance action.

Indeed, the *Schenectady Chemicals* case has been cited as support for the proposition that punitive damages are recoverable by a governmental entity in a public nuisance civil action. In *City of New York v. Taliaferrow*, Fn69 the City brought an action for permanent injunctive relief, imposition of civil penalties, and compensatory and punitive damages against defendants because of the creation and continuance of a statutory and common law public nuisance. The premises in question were being used for purposes of prostitution. After a trial before the judge, the court permanently enjoined the continuance of the public nuisance, assessed civil penalties of $68,700, awarded compensatory damages of $1, and punitive

damages of $100,000 under the common law public nuisance claim. The punitive damages were imposed in order to punish the defendant for his notorious and willful wrongdoing and also to deter others who might otherwise be tempted from indulging in similar conduct in the future. On appeal, the court affirmed stating: "[T]he [trial] court had the right to award punitive damages pursuant to the common-law theory of a public nuisance. This conclusion is not altered by the fact that the plaintiffs are governmental entities." Fn70

While the issue has not been litigated extensively in other jurisdictions, those courts that have addressed it uniformly have upheld the right of a state or political subdivision to recover punitive damages in a civil action. Fn71

The argument that a state cannot be permitted to recover exemplary damages in a civil suit, especially for conduct which is also considered a crime, was addressed fully in a well-reasoned opinion of the Minnesota Supreme Court. In *State v. Shevlin-Carpenter Company*, Fn72 the defendant was sued by the State in a civil action for willful trespass upon lands owned by the State and for cutting and removing timber from those lands. The State sought to recover treble damages under a statute which provided for treble damages as a result of willful conduct, and double damages for casual and involuntary conduct. The same section of the statute declared that violation of the statute (i.e., cutting or removing timber from state lands) was a felony.

Defendant filed a demurrer to the complaint which was overruled by the trial court. The Minnesota Supreme Court affirmed the order overruling the demurrer. In its demurrer, defendant argued that the damages provided by the statute were in the nature of a penalty and could be recovered by a state only by way of indictment and criminal prosecution. Fn73 While the State, in *Shevlin-Carpenter*, was proceeding under a statute for exemplary damages and in the *Love Canal* case the State was proceeding under the common law for exemplary damages, the reasoning of the Minnesota Supreme Court is instructive and applicable to both situations. Fn74 First, the court held:

That the awarding of exemplary damages in an action for a tort, although punishable as a criminal offense, is not a violation of the constitutional provision that no person shall be twice put in jeopardy for the same offense, is affirmed by the great majority of the courts. [citations omitted]. Nor does it deprive the citizen of his property without due process of law. [citation omitted]. The provisions of the constitution referred to apply to criminal prosecutions only. [citation omitted]. Fn75

Next, the court rejected defendant's argument that this rule should not be applied in an action brought by the State. The court reasoned:

Whatever, in legal contemplation, exemplary damages may be, whether properly termed aggravated relief or a penalty pure and simple, they are *not imposed in the sense of or as a substitute for criminal punishment*, but rather as enlarged damages for a civil wrong. No sound reason occurs to us why the state in preservation of the property entrusted to it for the use and benefit of the people, should not be granted all remedies that are afforded and extended individuals in the protection of their property and property rights. Fn76

Finally, the court dismissed out of hand the defendant's assertion that the State can recover penalties only by way of indictment and criminal prosecution: "Respecting the right of the State to maintain a civil action to recover exemplary damages, we entertain no serious doubt . . . the State occupies the same position in the courts as private suitors" [citation omitted]. Fn77

Likewise, *Unified School District No. 490, Butler County v. Celotex Corp.*, Fn78 was a products liability

case brought by a school district in which punitive damages were awarded. The defendant argued that a public entity should not be entitled to recover punitive damages. The court found no difficulty in dismissing this argument since, "[t]he general rule is that ordinarily a political corporation can avail itself of any legal remedy or any form of action that would be open to a private suitor under similar circumstances." Fn79 The court held that since the purpose of assessing punitive damages is unrelated to the status of the plaintiff, the defendant's argument was without merit.

In *State ex rel. Pollution Control Coordinating Bd. v. Kerr-McGee Corp.*, Fn80 the State sued to recover punitive damages under a common law claim that defendants had polluted a creek and caused a fishkill. The State's suit was based on a state pollution statute and the common law of negligence. The jury returned a verdict for the State of $49,617.11 in actual damages and $127,100 in punitive damages. On appeal, defendants claimed that the State had no standing to sue for actual and punitive damages. Along with the State's statutory right of recovery, the court found that, "In addition, there is a common-law right of the State that stems *not from any proprietary interest in the fish* but from the legitimate state concerns for conservation and protection of wild animals." Fn81 Moreover, the court held that, "the State's common-law right to sue for wrongful destruction of wildlife is not dependent on ownership but rather on the sovereign power to regulate, preserve and protect wild animals and fish for the common enjoyment of its citizenry." Fn82

In the *Shevlin-Carpenter Co.* Fn83 case, the court found that the State had the right to recover exemplary damages under a statute as a result of defendant's entering land owned by the State and wrongfully cutting trees. Under the facts of that case, the court held that, "in matters involving its proprietary or business function, the State occupies the same position in the courts as a private suitor" with respect to its right to recover exemplary damages. Fn84

Thus, under *Kerr-McGee* the State has a right to recover punitive damages for pollution when it seeks, as sovereign, to protect the environment. Under *Shevlin-Carpenter*, the State has a right to recover exemplary damages for injury to property it owns. However, neither the *Kerr-McGee* nor *Shevlin-Carpenter Co.*, nor any of the other cases depend for their results on the distinction between a government acting as a sovereign or in furtherance of its proprietary interests. The reason is that such a distinction affects the rights of a party to bring an action *against a state*. Thus, for example, "[u]nder the common law the State and municipal corporation were subject to liability when exercising corporate or proprietary functions, but immune from liability when exercising governmental functions." Fn85 The distinction is not determinative of the State's right to recover punitive damages in an action *instituted by the State*.

Finally, in *Village of Peck v. Denison*, Fn86 the court found that defendants were wrongfully interfering with waters which were deemed to be public and which had been duly appropriated to the beneficial use of the Village. Further, the court held that defendants' threats to disrupt the Village's water supply, and other misconduct, "created serious dangers to the health and safety of some two hundred people in the Village," and properly subjected defendants to punitive damages.

In light of his review of the case law, Judge Curtin found that the trial and appellate courts in the New York trilogy of *Schenectady*, *Caso* and *Taliaferrow* had not faced the precise arguments advanced by OCC. Nevertheless, on the punitive damages claim, "it is clear that neither court saw any need to question the State's authority in that regard." Fn87 In addition, while these cases were lower court rulings, Judge Curtin found that, "OCC has not convinced the court that the New York Court of Appeals would find that the lower-court cases cited above have led the court astray from the proper interpretation of state law." Fn88

Would an Award of Punitive Damages Promote Policy Objectives?

As an independent ground for its motion, defendant argued that punitive damages would serve no legitimate purpose in the case since the deterrent to be served by an award of punitive damages was outweighed by the deterrent effect of the "whole panoply" of environmental statutes and regulations.

Yet, whatever deterrent effect is served by statutes and regulations, an award of punitive damages serves a beneficial, additive effect to deterrence. In *Doralee Estates, Inc. v. Cities Service Oil Co.*, Fn89 plaintiff sought to recover for damages to a bungalow colony allegedly caused by an oil spill originating on premises leased by one defendant to another defendant. The jury awarded $60,000 in compensatory damages and $200,000 in punitive damages. On appeal, the court affirmed the awards and characterized the modern form of environmental nuisance as a "fair field for punitive damages." Fn90 The amount of punitive damages supports the purposes behind punitive damages: to punish the offender, to deter the offender from engaging in similar conduct, to deter others from engaging in similar conduct, and generally, "to inject an additional factor into the cost-benefit calculations of companies who might otherwise find it fiscally prudent to disregard the threat of liability." Fn91

Recognizing the legitimate and important deterrence goals of punitive damages, Judge Curtin reasoned that, "it makes no sense to weigh the potential deterrent effect of a punitive damages award *against* that of environmental laws . . . ." Fn92 While making it clear that he was not commenting on the specifics of the *Love Canal* case itself, Judge Curtin found that, "[i]t is hardly revelatory to state that willful and reckless contamination of the environment with hazardous substances and the resulting threat to public health are scourges that remain with us today and that are not likely to disappear tomorrow." Fn93

The Common Law Argument in Summation

Punitive damages function as a punishment and deterrent against a defendant for past recklessness and as a deterrent against others from acting recklessly in the future thereby protecting the public from reckless conduct. Because of this function, the analysis as to whether punitive damages are appropriate, or legally supportable, does and should focus on the defendant's conduct, not on who the plaintiff is. Plaintiff's status as an individual, corporation or government is irrelevant. Moreover, this analysis *is not* affected by the commonality of purposes behind criminal prosecution and civil punitive damages proceedings. It *is not* affected by the existence of criminal penalties for the same reckless conduct that can result in punitive damages. Above all, it is certainly *not* affected by the existence of environmental regulations however burdensome or insufficient they may be. At least this is the result in the *Love Canal* case.

Yet the fight over punitive damages has been fought less in the common law field than in the field of constitutional law. It is to that field that we now turn.

CONSTITUTIONAL IMPLICATIONS OF A STATE'S RIGHT TO RECOVER PUNITIVE DAMAGES

Does the State Law Standard for Awarding Punitive Damages

Violate Federal Constitutional Due Process Protections?

In the *Love Canal* case, the defendant did not contest the legal standard in New York *defining the kind of conduct* which subjects a defendant to punitive damages. However, defendant maintained that New York common law is standardless, and therefore unconstitutionally vague, in regard to the discretion accorded the trier of fact Fn94 in *assessing the amount* of punitive damages. Fn95 Specifically, defendant argued that New York's common law standard for assessing the amount of punitive damages in a civil action was unconstitutionally vague under the Due Process Clause of the Fourteenth Amendment to the United States Constitution, or under Article I, Section 6 of the New York Constitution. Fn96

Before addressing any constitutional dimension to the standard, it is necessary to describe the standard, under New York common law, for assessing the amount of punitive damages. Fn97

First, the amount of punitive damages is, in part, based on the degree of reckless or wanton conduct which subjects the defendant to punitive damages. Fn98 In this way the amount of punitive damages supports the purposes behind punitive damages, i.e., to punish the offender, to deter the offender from engaging in similar conduct, to deter others from engaging in similar conduct and, generally, "to inject an additional factor into the cost-benefit calculations of companies who might otherwise find it fiscally prudent to disregard the threat of liability." Fn99 Further, the amount is specifically based on the gravity of the defendant's conduct. Second, the amount of punitive damages need not be proportionally related to the amount of compensatory damages. Fn100 However, the amount should bear some reasonable relationship to the *mala fides* of the defendant. Fn101 Finally, the financial status of the defendant is a factor to be considered in assessing the amount. Fn102

Thus, while the trier of fact has discretion in assessing the amount of punitive damages, that discretion is firmly grounded on the specific factors that have developed into the common law standard of New York. These factors are no more, and no less than those adopted in the Restatement (Second) Torts § 908(2): "In assessing punitive damages, the trier of fact can properly consider the character of the defendant's act, the nature and extent of the harm to the plaintiff that the defendant caused or intended to cause and the wealth of the defendant." Most states have adopted these same factors for the assessment of the amount of punitive damages by the trier of fact. Fn103

In addition, when a standard of conduct has evolved over time, and withstood the aging process, as with common law standards, then it is generally conceded to satisfy substantive due process requirements: "[a] statute is sufficiently certain if it employs words of long usage or *with a common law meaning*, 'notwithstanding an element of degree in the definition as to which estimates might differ'." Fn104 And in *People v. Mancuso*, Fn105 the court, per Chief Judge Cardozo, was faced with a void-for-vagueness attack on a criminal statute. In upholding the constitutionality of the statute, the court reasoned that, "[t]he test established by the statute, the diligence that is expected of agents in receipt of compensation for their services, is a legislative recognition of a standard of diligence long known to the common law." Fn106 As pointedly noted, previously, "[t]he use of common law terms tends to eliminate the vagueness problem." Fn107

In analyzing the due process attack, Judge Curtin found that once liability for punitive damages was determined, then under New York law, there are sufficient limits on the amount that a trier of fact can award. Fn108 New York law provides that there is no fixed, rigid formula for assessing the amount; it is not necessary that there be a ratio between punitive damages and compensatory damages; it is necessary that the amount bear some reasonable relation to the harm done, and to the flagrancy of the conduct causing it; the amount should be within reasonable bounds considering the purposes to be served, as well as the *mala fides* of defendant in the particular case; and, New York Appellate Courts are empowered to

overturn excessive punitive damages awards and order a new trial or remittitur. Fn109 As Judge Curtin noted, Fn110 the Second Circuit only recently upheld New York's punitive damages due process protections in *Racich v. Celotex Corp.* Fn111 Thus, Judge Curtin concluded that, "the court finds the criteria set forth above sufficient to survive OCC's constitutional challenge." Fn112

The court's decision in the *Love Canal* case was issued in 1990, after the Supreme Court decision of *Browning-Ferris Indus. v. Kelco Disposal*, Fn113 but prior to the long-awaited Supreme Court consideration of a due process challenge to punitive damages awards. In *Aetna Life Insurance Co. v. La Voie*, Fn114 and in *Bankers' Life and Casualty v. Crenshaw*, Fn115 the Supreme Court literally invited a Due Process Clause attack on the size of punitive damages awards, implying that the Court would listen attentively, perhaps even kindly.

An Alabama case obliged, presenting squarely to the Court, in *Pacific Mutual Life Insurance Co. v. Haslip*, Fn116 the Due Process protection argument. A sign of the anticipation attending this case is the fact that thirty-one briefs of *amici curiae* were filed in the Supreme Court. Fn117 Moreover, early in its opinion, the Court referred to the case as "yet another" case presenting a challenge to punitive damages, and that it granted certiorari in light of the "long-enduring debate" about punitive damages. Fn118 Indeed, an entire section of the majority's opinion is devoted to a review of the recent concerns of that Court about punitive damages. Fn119

Haslip, and others, had claimed fraud against an insurer for failing to provide insurance when premiums were paid to the insurer. The insurer's agent had misappropriated the premiums. The jury returned a general verdict for each of the plaintiffs, including Haslip. Haslip was awarded $1,040,000; the other three respondents/plaintiffs each received between $10,000 and $15,000. While a general verdict returns only a single award, without differentiating between compensatory and punitive damages, and while concededly there was uncertainty about the matter, the Supreme Court assumed that the punitive damages component was not less than $840,000, or four times the compensatory component. Fn120 The Supreme Court concluded that the punitive damages assessed by the jury against Pacific Mutual were not violative of the Due Process Clause. Fn121

As with the *Love Canal* case, it is instructive to recite the predicate facts. Haslip, and other plaintiffs, were workers for Roosevelt City in Alabama. Lemmie Ruffin, Jr., was a licensed agent for Pacific Mutual Life Insurance Co. (Pacific), as well as for Union Fidelity Life Insurance Company (Union); Pacific wrote individual life policies, while Union wrote group health policies. Ruffin approached the City, representing himself as an agent of Pacific, and eventually sold the City, for its employees, group health polices with Union and individual life policies with Pacific.

Premium payments were deducted from the workers' payrolls; the City issued a check for these premiums; and the check was delivered to Ruffin. The initial premium payments were delivered to Ruffin, who submitted them to the two insurers with the applications. However, thereafter, Ruffin misappropriated most of the premiums. When Union did not receive payments, it canceled the health coverage and sent notices of the lapsed coverage to the workers in care of Ruffin and Pacific. The workers never received notice of the cancellation.

Haslip was hospitalized and incurred hospital and physician charges. When it was discovered that she had no coverage, the hospital required her to pay on the bill. The physician turned her bill over to a collection agency, when it was not paid, and the agency obtained a judgment against Haslip, adversely affecting her credit.

Significantly, the Court found that, "[b]efore the frauds in this case were effectuated, Pacific Mutual had

received notice that its agent Ruffin was engaged in a pattern of fraud identical to those perpetrated against respondents." Fn122 Moreover, since Ruffin was acting as Pacific's agent, Pacific was liable for both the compensatory and punitive damages arising out of the fraud of its employee acting within the scope of his employment. Fn123

The Supreme Court first found that, "every state and federal court that has considered the question has ruled that the common-law method for assessing punitive damages does not in itself violate due process." Fn124 Having found the common law method not to be *per se* unconstitutional, the Court proceeded to determine whether, as applied in this case, the award was constitutionally unacceptable. That determination turned on an analysis of the jury instructions and the post-trial procedures for reviewing punitive awards.

On the jury instructions, the Court found that the jury properly was informed that the purpose of punitive damages was not to compensate plaintiff but to punish defendant and protect the public by deterring others from such conduct. Fn125 The jury was also instructed to take into consideration the character and degree of the wrong, and, as required under Alabama law, Fn126 evidence of defendant's wealth was excluded. While such instructions accorded the jury "significant discretion," the Court found that the instructions satisfied due process principles, noting that the discretion here was no greater than in many familiar areas of law, involving, for example, determination of "the best interests of the child," or "reasonable care," or "due diligence." Fn127

Next, the Court turned to the post-trial procedures for "scrutinizing" punitive awards which had been adopted by the Alabama Supreme Court in *Hammond v. Gadsden*. Fn128 First, the Court found that the procedures for the trial court's review of jury verdicts were satisfactory. Fn129 It required the trial court to reflect, on the record, the reasons for upholding or interfering with the jury verdict on punitive damages, taking into account such factors as the culpability of defendant's conduct, the desirability of discouraging others from similar conduct, the impact upon the parties, as well as other factors. Fn130 Second, the Court found Fn131 that the Alabama Supreme Court also subjected the jury verdict and judgment to a further review, applying standards it had developed in *Green Oil Co. v. Hornsby*, Fn132 and *Central Alabama Electric Cooperative v. Tapley*. Fn133 Those standards, in assessing whether a punitive award was excessive or inadequate, Fn134 were:

(a) whether there is a reasonable relationship between the punitive damages award and the harm likely to result from the defendant's conduct as well as the harm that actually has occurred; (b) the degree of reprehensibility of the defendant's conduct, the duration of that conduct, the defendant's awareness, any concealment, and the existence and frequency of similar past conduct; (c) the profitability to the defendant of the wrongful conduct and the desirability of removing that profit and of having the defendant also sustain a loss; (d) the 'financial position' of the defendant; (e) all the costs of litigation; (f) the imposition of criminal sanctions on the defendant for its conduct, these to be taken in mitigation; and (g) the existence of other civil awards against the defendant for the same conduct, these also to be taken in mitigation. Fn135

The Court concluded that such standards "provide for a rational relationship in determining whether a particular award is greater than reasonably necessary to punish and deter." Fn136 And while the Court acknowledged that the punitive award was four times the amount of compensatory damages, and more than two hundred times the out-of-pocket expenses of Haslip, Fn137 "[w]e conclude, after careful consideration, that in this case it does not cross the line into the area of constitutional impropriety." Fn138 The "line" to which the Court referred was found in its articulation of the standard to be applied in reviewing punitive damages awards:

We need not, and indeed we cannot, draw a mathematical bright line between the constitutionally acceptable and the constitutionally unacceptable that would fit every case. We can say, however, that general concerns of reasonableness and adequate guidance from the court when the case is tried to a jury properly enter into the constitutional calculus. Fn139

Justice Kennedy's concurring opinion is of interest for two reasons. First, he devotes his short, concurring opinion to a defense of the jury system, arguing persuasively that inconsistencies in jury results are inherent in the nature of the task which juries are given: to uphold widely-applicable, abstract rules of conduct by fashioning them to concrete, particular flesh-and-bones. As Justice Kennedy notes: "nonuniformity cannot be equated with constitutional infirmity." Fn140 Based on this respect for juries, Justice Kennedy would avoid the majority's analysis of a particularized, fact-specific result, such as in *Haslip*, and instead return to traditional principles of reviewing jury verdicts, in non-punitive contexts: A verdict returned by a biased or prejudiced jury can violate due process, and the disproportionality between an actual and punitive award may be evidence of bias or prejudice. Fn141

Justice Kennedy then concluded, based on these principles, that the issue of punitive damages is a matter of common law, that the federal courts are not the appropriate forum for resolving whatever tensions exist with regard to such damages, as state court judges and legislatures have the authority to address changes in the common law. Fn142 Justice Scalia's concurring opinion in *Haslip* articulates some parallel arguments. Fn143 As we shall see, this perspective is brought to the foreground in the plurality opinion of Justice Blackmun in upholding the $10 million punitive damages award in *TXO Production Corp. v. Alliance Resources Corp.*, Fn144 where compensatory damages of only $19,000 were awarded.

Given the diverging analysis in the four separate opinions in *Haslip*, and the absence of a "bright line" to follow, there was much anticipation as to whether *Haslip* would effect a cure for punitive damages awards, or would turn out to be a placebo. Perhaps neither extreme has resulted, as a review of several post-*Haslip* Circuit Court decisions will reflect.

In *Vasbinder v. Scott*, Fn145 a jury awarded punitive damages of $150,000 against each of two individuals who had wrongfully punished plaintiff for his whistle-blowing activities, in violation of plaintiff's First Amendment rights. The trial court upheld the amount of the punitive damages award. The circuit court ordered a remittitur of the punitive damages, to $20,000 against one individual, and $30,000 against the other. Fn146 In reaching its remittitur, the court found that the general rule was that an award for punitive damages was reversible only if it was so high as to shock judicial conscience. Fn147 Moreover, the court found that the function of appellate review is to ensure that the punitive damages award is reasonable in its amount, and rational in light of the purposes of punishment and deterrence, citing *Haslip*. Fn148 This rule includes an analysis of whether the award is so high as to financially ruin the defendant, or so high as to constitute a windfall for an individual litigant. Applying this analysis to the case, the court found that defendant Scott had a total net worth Fn149 of about $270,000, that $150,000 or 50% of that net worth was too high an award, and that $20,000 would more appropriately satisfy the purposes of punitive damages; for defendant Switzer, who had a net worth closer to $450,000, that $150,000 or 30% of net worth was too high, and that $30,000 would suffice. Fn150

In *Mattison v. Dallas Carrier Corp.*, Fn151 plaintiffs were husband and wife who collided into the rear end of defendant company's truck, which had pulled over in the right travel lane, in the middle of a rain storm. The jury awarded the husband $100,000 and the wife $25,000 in compensatory damages, and each also was awarded $50,000 in punitive damages. The net worth of the defendant company at the time of the award was $6,428. Fn152 The company appealed, claiming the applicable South Carolina law for awarding punitive damages violated due process and equal protection provisions of the federal constitution.

The circuit court distinguished *Haslip* on the ground that in *Haslip* the case was before the Supreme Court from the state courts of Alabama, whereas here, in *Mattison*, the case was tried before a jury in federal court. The court reasoned that in a federal court action, the district court applies the substantive law of the state when instructing the jury on punitive damages, under the principles laid down in *Erie Railroad v. Tompkins;* Fn153 the district court then reviews the jury verdict under standards established by Federal Rules of Civil Procedure 50 and 59, counterbalanced by 7th Amendment constraints guaranteeing the right to jury trial and restricting judicial interference with that jury province. Fn154 The court relied on *BFI* for its reasoning, finding *Haslip* of limited assistance because of its origin in state court proceedings. Fn155

Proceeding to apply its reasoning, the Court found that South Carolina provided no constraints on jury discretion, except to instruct the jury on the purposes to be served by punitive damages, and that the reviewing court only overturned awards if they were so shockingly excessive to reflect caprice, passion or prejudice. Fn156 The Court found a federal court review under Federal Rules of Civil Procedure 50 and 59 did not differ substantially from South Carolina's less-than-satisfactory procedure. Fn157 In particular, in *Mattison*, the Court found no instruction on the notion of proportionality. Thus, it was not surprising to the Court that the jury awarded $100,000 in punitive damages which was fifteen times defendant's net worth. Fn158 The Court found that such a scheme violated due process. Fn159

Subsequent to the jury determination in *Mattison*, the South Carolina Supreme Court had adopted new rules for post-verdict trial court review of punitive damages awards, along the lines of the factors adopted in Alabama, and approved in *Haslip*. But the Circuit Court in *Mattison* held that since a new trial was being granted in federal court, the new state procedural rules were not applicable. Fn160 Rather the district court review, after a new verdict was entered, would proceed under Federal Rules of Civil Procedure 50 and 59, and 7th Amendment protections would not permit the court to consider any facts that were not before the jury. To provide some specific guidance to the district court, and to avoid any 7th Amendment constrictions on the trial and appellate courts review, the Court directed that South Carolina's new standards for post-trial review would be incorporated into the jury instructions given by the district court, if it was found that plaintiffs were entitled to punitive damages. Fn161 Those factors, in summary form, are: (1) relationship to harm caused; (2) other civil and criminal penalties imposed for same conduct; (3) improper profits and plaintiff's costs; and, (4) defendant's ability to pay. Fn162

In *Glasscock v. Armstrong Cork Co.*, Fn163 eighteen plaintiffs were injured by exposure to asbestos-containing products. A jury awarded $2,590,000 in compensatory damages against all defendants (all but one had settled), with $317,625 of that attributed to the remaining defendant, Celotex. The jury also awarded eleven of the plaintiffs a total of $6,100,000 in punitive damages against Celotex, a 20:1 ratio.

Noting that the ratio was 20:1, the court found that proportionality between the actual and punitive damages awards was helpful in determining whether the punitive award was the product of a jury's passion rather than reason, but no specific ratio was necessary to make the award reasonable. Fn164 Moreover, the Texas courts required the application of five factors in analyzing the appropriateness of an award: the nature of the wrong; character of the conduct involved; degree of culpability of wrongdoer; situation and sensibilities of parties concerned; and extent which defendant's conduct offends public sense of justice and propriety. Fn165

During the pendency of the appeal, the *Haslip* case was decided. After further briefing, the Fifth Circuit found that Texas procedures, outlined above, satisfied the due process requirements. Fn166 In so holding, the Fifth Circuit rejected Celotex's argument that a "passion and prejudice" standard of review can never

withstand constitutional scrutiny after *Haslip*, although the court did find that Texas' five factors added sufficient protection to satisfy the due process concerns. Fn167

In another Fifth Circuit Court case, *Eichenseer v. Reserve Life Insurance Co.*, Fn168 an insured under a health policy brought an action alleging wrongful denial of claim. After a bench trial, the court awarded $1,000 in compensatory damages, and $500,000 in punitive damages, a ratio of 500:1. Fn169 The appeal court affirmed; certiorari was granted, and the Supreme Court remanded, Fn170 in the wake of *Haslip*. On remand, the Fifth Circuit found that the award did not violate due process protections. Fn171

Interpreting *Haslip*, the circuit court found that an award passes constitutional muster, first, if the circumstances of the case indicate the award is reasonable, and second, if procedures in assessing and reviewing awards provide sufficiently definite and meaningful constraints on the fact finder. Fn172 Importantly, the reviewing court is not to substitute its own views for that of the fact finder which is closer to the evidence. On the first factor, the court further reasoned, "[i]f there are *any* circumstances of probative force that support the amount of the award, then the award meets the 'reasonableness' prong of the due process test in *Haslip*." Fn173 Under the facts, where defendant had a net worth of $157 million, the court found that a "proportionate" award, i.e., where the ratio was lower than 500:1 in relation to the small actual damages, would have had little deterrent effect stating, "While the Due Process Clause requires that punitive damages not be grossly excessive, it does not require that punitive damages be ineffectual and impotent." Fn174

On the second factor, the procedural protections, the court reasoned that, "[a]s long as there is some meaningful procedural assurance that the amount of the award is not an impulsive reaction to the wrongful conduct of the defendant, the award survives the procedural protection aspect of the due process analysis in *Haslip*." Fn175 Applied to the case, the court found that Mississippi law required the application of three factors in reviewing the award: an amount necessary to punish and deter the defendant; an amount necessary to deter others; and the pecuniary ability or financial worth of the defendant. Fn176 Also under Mississippi law, the court should consider the degree of the offense, the presence or absence of malice or other motives, the injury intended and the public sense of justice and propriety. Fn177 These factors were carefully considered by the district court, and that court provided an explanation and justification for the award, providing further protection under due process provisions. Fn178

In *Mason v. Texaco, Inc.*, Fn179 a products liability case, the jury awarded plaintiffs $9 million in actual damages and $25 million in punitive damages. The district court found the $25 million award to be a "staggering sum," but not so excessive as to shock the court's judicial conscience or to indicate that the award was motivated by passion, prejudice, or bias. Fn180 That court had analyzed the award according to factors identified by the Kansas Supreme Court for reviewing punitive damages awards: the actual damages sustained, the actual damage award, the circumstances of the case (the nature, extent, and enormity of the wrong), the intent of the party committing it, the relative positions of the plaintiff and the defendant, the defendant's financial worth, and the plaintiff's probable litigation expenses. Fn181 The circuit court agreed that there was no indication that the award was motivated by passion, prejudice, or bias, but it did find the award shockingly excessive. Fn182 The circuit court entered a remittitur for $12.5 million on the grounds, apparently in Solomon-like fashion, that in an initial trial plaintiffs were denied punitive damages by the jury, and after an appeal by Texaco on other grounds, the plaintiffs received a punitive award of $25 million. Fn183

In *Latham Seed v. Nickerson American Plant Breeders*, Fn184 a seed stock company committed fraud on its distributors by making false representations and wrongfully competing with its distributors. A jury awarded separate compensatory damages to ten distributors, ranging from about $11,000 to about $475,000; the jury also awarded each distributor $1 million in punitive damages. Fn185 Defendant

appealed, and the case was remanded on constitutional challenge after *Haslip*.

On remand, the district court found the jury instructions similar to those given in *Haslip* and satisfactory. Fn186 The district court then reviewed the punitive damages award, applying the seven *Hammond* factors used in Alabama and approved by *Haslip*, although such factors were not required under the applicable state laws in the Eighth Circuit. Fn187 Under its analysis, the district court found the award properly made. Fn188

On appeal, defendant argued that despite the district court's application of the *Hammond* factors, the applicable state laws were less stringent than Alabama's and therefore unconstitutional under *Haslip*. Fn189 Moreover, defendant argued that a "passion and prejudice" standard of review cannot satisfy constitutional due process requirements after *Haslip*. Fn190 The Eighth Circuit rejected this argument and found that while the applicable state law procedures for reviewing punitive damages awards were less stringent than Alabama's, that difference did not result in a due process violation. Fn191

If the critics of punitive damages were not mollified by the outcomes or analyses in the post-*Haslip* life of the circuit courts, their hopes rose again when *TXO Production Corp. v. Alliance Resources Corp.* Fn192 came along. For here was a case where the compensatory damages were $19,000 (primarily consisting of attorneys fees), and the punitive damages award was $10 million, an award 526 times greater than the compensatory award. Surely, Justice O'Connor would be given the task, the pleasure, of writing a majority opinion curing permanently the fever of punitive damages. Such was not the case.

Once again, it is important to recite the facts that served as the basis for the punitive damages award. TXO, a subsidiary of USX, entered into an agreement with Alliance to acquire Alliance's rights to develop oil and gas resources on a tract of land known as the Blevins Tract. TXO had initiated the deal and it was very favorable to Alliance, although it was conditioned on there being no problems with Alliance's title to the oil and gas. As part of its title search, TXO found a 1958 deed conveying away certain mineral rights in the tract. Although the earlier deed was found to be less than crystal clear, it was clear enough, and all the parties to the deed agreed, that the deed had conveyed only the right to mine coal and did not cover any interest in oil or gas development rights. Nonetheless, the jury and lower courts found, TXO embarked on a course of conduct to cut Alliance out of its favorable benefits by pretending that the earlier deed was a cloud on Alliance's title, and that, therefore, Alliance would have to give up its oil and gas rights or accept substantially reduced benefits. This course of conduct included an unsuccessful attempt to induce the former lessor, who had executed the 1958 deed and knew it did not cover oil and gas, to sign a false affidavit to the effect that the 1958 deed *had* included oil and gas rights. And, TXO obtained a quitclaim deed from one of the parties to the 1958 deed, and recorded that deed without ever informing Alliance of the alleged problem with the title. Finally, when Alliance refused to renegotiate its deal, TXO brought a declaratory judgment action, to quiet title, knowing, as the court found, that it was frivolous. Alliance counterclaimed for slander of title, seeking compensatory and punitive damages.

During discovery, TXO refused to disclose any financial records to show its wealth; Alliance introduced expert witness evidence as to the worth of TXO, and USX, and introduced evidence of similar courses of conduct elsewhere by TXO in negotiating oil and gas rights.

The state trial court found against TXO on its declaratory judgment action, and a jury then returned a verdict in favor of Alliance on its counterclaim for slander of title, awarding Alliance $19,000 in compensatory damages (costs of defending the declaratory judgment action), and $10 million in punitive damages. Fn193

Amongst other issues on appeal, TXO argued that the punitive damages award was violative of the Due

Process Clause under *Haslip*. Fn194 The West Virginia Supreme Court upheld the $10 million punitive damages award. Fn195 In a delightful and thoughtful, if provocative, opinion the court proceeded to analyze the post-*Haslip* cases, to discern any pattern in applying the holding of *Haslip*, and reasoned that the cases could be divided into those where the losing defendant was "really stupid" or "really mean." Fn196

In the United States Supreme Court, a majority of the Court upheld the $10 million award as not being violative of the Fourteenth Amendment Due Process protections. Fn197 A plurality relied on the test adopted in *Haslip*, stressing again that there is no "mathematical bright line between the constitutionally acceptable and the constitutionally unacceptable that would fit every case," and that general concerns of reasonableness properly enter into the constitutional calculus. Fn198 The plurality then concluded, based on the record, that:

The punitive damages award in this case is certainly large, but in light of the amount of money potentially at stake, the bad faith of petitioner [TXO], the fact that scheme employed in this case was part of a larger pattern of fraud, trickery and deceit, and petitioner's wealth, we are not persuaded that the award was so 'grossly excessive' as to be beyond the power of the State to allow. Fn199

One interesting aspect to the plurality opinion, alluded to above, is that the plurality opinion seems to go out of its way to pay tribute to the value and integrity of the jury system, especially its impartiality and its assessment, which is the "product of collective deliberation based on evidence and the arguments of adversaries . . . ." Fn200 Indeed, the plurality opinion of Justice Blackmun acknowledges the contribution to this perspective from the concurring opinions of Justices Kennedy and Scalia in *Haslip*. Fn201

Justice O'Connor, in dissent in *TXO*, accepts that "[o]ur system of justice entrusts jurors - ordinary citizens who need not have any training in the law Fn202 - with profoundly important determinations." Fn203 The compliment, thin and brief, is quickly followed with this statement, "But jurors are not infallible guardians of the public good," and, "[a]rbitrariness, caprice, passion, bias, and even malice can replace reasoned judgment and law as the basis for jury decisionmaking." Fn204

Justice O'Connor views the result in *TXO* as arising out of just such passion and bias against a large, wealthy, out-of-state defendant, TXO and its parent USX. Yet it is noteworthy that Justice O'Connor accepts many of the same factors relied on by the plurality in its analysis: no federally-imposed multi-part test for assessing punitive damages is appropriate; Fn205 the potential, but unrealized harm to the victim can be a factor; Fn206 the defendant's anticipated gain can be a factor; Fn207 and, permitting juries to consider defendant's wealth is not impermissible. Fn208 Rather Justice O'Connor examines sharply the closing arguments of plaintiff's counsel to demonstrate, persuasively, that the image of the rich, out-of-state, corporate defendant, deserving of punishment, was hammered home. Fn209 However, it does not appear that defendant objected to such argument, thus waiving any use of it to attack the award on appeal. Moreover, if that truly is the basis for Justice O'Connor's dissent, then it seems that the solution is closer trial supervision of closing argument, not a fundamental, federal overhaul of punitive damages.

Since *TXO* was decided only in June 1993, there has been little time to measure the fallout. However, the Third Circuit has recently addressed the punitive damages award issue, in the context of multiple awards in asbestos litigation.

In *Dunn v. HOVIC*, Fn210 a jury awarded compensatory damages of $1.3 million, and punitive damages of $25 million against an asbestos manufacturer. The district court entered a remittitur of compensatory damages of $500,000 and punitive damages of $2 million. Fn211 A panel of the circuit affirmed the district court's award for compensatory damages but entered a further remittitur of the punitive damages

award for $1 million. Fn212 A rehearing *en banc* was granted limited to the punitive damages issue and defendant's argument that multiple awards of punitive damages in asbestos-related injury cases violated federal due process protections.

The circuit court *en banc* found that, under the principles set forth in *Haslip*, the jury instructions were appropriate and the post-trial procedures also satisfied due process requirements. Fn213 In particular, the reviewing court appropriately considered the percentage of defendant's wealth impacted by the award, the comparability of this award to other awards, and the defendant's ability to pay, as well as other factors. Moreover, these were factors to be considered by the federal court under its review pursuant to Federal Rules of Civil Procedure 50 and 59, not any particular state law factors. Thus, the Third Circuit Court disagreed with the Fourth Circuit Court in *Glasscock* Fn214 with regard to the nature of an appellate review of punitive damages awarded in a federal court. The Third Circuit has held that there is no requirement for a set of criteria to be applied by a jury. Fn215 Rather, federal trial court review under Rules 50 and 59, along with appellate review of jury awards, provides sufficient constraint on a jury's discretion to satisfy due process requirements. When the trial court and appellate court articulate the grounds for upholding or interfering with an award, and the grounds are specific factors for assessing the amount of punitive damages derived from the applicable state law, then due process protections are satisfied.

In looking back to *Haslip*, through *TXO*, critics of punitive damages see a field still cluttered, not cleared. The substantive standards for assessing punitive damages by the trier of fact, and the attendant jury instructions, by and large have survived unscathed. Very large punitive damages awards have been upheld, even embraced (over 500:1 in *TXO*). And, in several instances, the traditional analysis of reviewing an award for signs of bias or prejudice, with the proportionality of the award being one sign, has survived *Haslip*.

Do the Procedural Due Process Provisions of the Fourteenth Amendment Require That the State Prove Its Entitlement to Punitive Damages by Proof Beyond a Reasonable Doubt?

The general rule under New York common law is that in civil actions, such as a claim for public nuisance, a plaintiff's burden is to prove its claim by a preponderance of the evidence. Fn216 Moreover, under New York law, in an action to recover statutory penalties, the State is required to prove its claim only by a preponderance of the evidence. Fn217

In the *Love Canal* case, the defendant argued that the State was required to prove its claim for punitive damages with proof beyond a reasonable doubt. Fn218 However, there are limited circumstances under which the Supreme Court has found that the Constitution, under procedural due process principles, mandates a burden of proof higher than a preponderance of the evidence in a civil action. Fn219 No decision of the Supreme Court, or of any other court, has held that proof beyond a reasonable doubt is *constitutionally mandated* in a punitive damages claim. Fn220 Nor has a standard of proof other than "by a preponderance of the evidence" been found to be *constitutionally mandated* in a punitive damages claim. Indeed, a standard of proof higher than "by a preponderance of the evidence," has been constitutionally mandated only in cases where the defendant's liberty interest or some other non-economic fundamental right is at stake. Fn221 Further, in *United States v. Regan*, Fn222 the Court held that in an action by the government to recover a penalty for violations of the Alien Immigration Act of 1907, the government was required to prove its claim only by a preponderance of the evidence and that the Constitution required no higher burden of proof. *Regan* is directly analogous to the *Love Canal* case because only the defendant's economic interest was at stake.

Labelling an action as "civil," however, is not dispositive of whether the action, in substance, is civil. The Supreme Court set forth seven factors in *Kennedy v. Mendoza-Martinez*, Fn223 for determining whether a particular proceeding is, in substance, civil or criminal. Fn224 Further, these factors were intended to determine if a statute, and particularly an Act of Congress, was penal or civil. Fn225 Assuming, *arguendo*, that the *Kennedy* factors apply to a constitutional attack on a rule of common law, it must be remembered that the test enunciated in *Kennedy* is a two-part test. First, the court determines whether Congress intended the sanction to be civil or criminal. Second, if the intent was to provide a civil remedy, then the court determines whether the statutory scheme is so penal, in purpose or effect, as to negate the intention that the sanction be civil.

In *United States v. Ward*, Fn226 the Supreme Court upheld the imposition of a civil penalty under the Federal Water Pollution Control Act against an attack that the assessment of a civil penalty under the Act was a "criminal" case entitling the defendant to Fifth Amendment protections against compulsory self-incrimination. Defendant had reported an oil spill, and was assessed a civil penalty. In analyzing whether the imposition of the civil penalty should be considered a civil or criminal proceeding, the Court adopted the *Kennedy* two-part test. The Court held that Congress clearly intended that the penalty be civil, as it labelled the sanction as a "civil penalty" and set it apart from criminal penalties also provided for in the Act. Fn227 Next, the Court found that analysis of the penalty in question could be guided by the factors outlined in *Kennedy v. Mendoza-Martinez*. The Court noted especially that even though the conduct which gave rise to the penalty also constituted a crime, this did not convert this civil action into a criminal one because, "Congress may impose both a criminal and a civil sanction in respect to the same act or omission." Fn228

As applied to the *Love Canal* case, the issue was whether the common law "intended" punitive damages to be civil or penal. To pose the question is to provide the answer. For hundreds of years, courts have held punitive damages to be a civil remedy under the common law.

Applying the second part of the *Kennedy* test-*the seven factors*-leads to the same answer: punitive damages are civil in nature. Punitive damages do not involve an affirmative disability or restraint, as accepted even by defendant; punitive damages have historically been regarded as serving the purpose of punishment, but they have also served other purposes as well; punitive damages do promote the traditional aims of punishment, retribution and deterrence, but they promote these aims in ways different from criminal punishment, e.g., primarily through loss of money, never through loss of liberty; the behavior to which punitive damages apply is already a crime, but the behavior - creating a public nuisance - is also a civil wrong and has been so for hundreds of years; punitive damages, in the *Love Canal* case, further the public policy of ensuring that the State's environment is protected; and the appropriateness or excessiveness of the punitive damages cannot be evaluated in a vacuum where no assessment has been made. Fn229

In *Hooker*, Judge Curtin held that under New York law, as discussed above, punitive damages were not considered to be criminal punishment. Fn230 And, as for the second prong of the analysis adopted from *Kennedy-Mendoza*, Judge Curtin found that the various factors support a finding that the award of punitive damages to the State would not be so punitive as to transform what was clearly intended as a civil remedy into a criminal penalty. Fn231

Judge Curtin also noted that in *Simpson v. Pittsburgh Corning Corp.*, Fn232 a case involving private parties, the Second Circuit held that due process does not require an award of punitive damages to be supported by clear and convincing evidence. Fn233

Also, in *Haslip*, the Court noted that while it had been urged by Pacific Mutual and *amici* to adopt a standard of proof higher than "preponderance of the evidence" for punitive damages claims, the Court found that the Due Process Clause does not require such a standard of proof. Fn234

Finally, there is another tactical weakness to the argument that a higher burden of proof is required in punitive damages claims. Critics of punitive damages are mostly concerned with the potential size of punitive damages awards. The problem with the due process burden of proof attack is that the mortar strikes over too large a target area, injuring innocent bystanders. Imposing a higher burden of proof has the danger of excluding some plaintiffs who are entitled to punitive damages, because of a defendant's outrageous conduct, and who would recover punitive damages under a lesser, preponderance of the evidence standard. And those defendants who are assessed punitive damages even under a higher standard of proof still are subject to what they presumably would believe to be excessive awards. Thus, imposing a higher standard of proof cuts too sharply against plaintiffs, and does not address the central concern over the size of the award.

Punitive damages developed under the common law as a form of punishment for outrageous, willful, and reckless conduct in civil actions. They have been accepted and applied as civil damages for hundreds of years, and they remain civil, in substance and in effect.

Was Defendant's Eighth Amendment Challenge Ripe for Decision, and Is the State Limited in Its Punitive Damages Claim to a Statutory Criminal Penalty?

Defendant maintained that the Excessive Fines Clause of the Eighth Amendment was applicable to an award of punitive damages in the case, and, to avoid being considered "excessive," the State was limited in any punitive damages award to an amount ($2,000) equal to the criminal penalty for the crime of public nuisance. Such an argument was not yet ripe for consideration by the court, as acknowledged by defendant: "Of course, the question of excessiveness ordinarily would arise later in the litigation-if and when punitive liability were established. In a sense therefore, the issue of excessiveness may not yet seem ripe for final adjudication . . . ." Fn235

Not surprisingly, Judge Curtin agreed that the issue was not ripe since neither judgment on liability nor any award yet had been entered. Fn236 Nonetheless, a discussion of the Eighth Amendment implications may be useful for the time when the issue does ripen.

In the first of the punitive damages trilogy, *Browning-Ferris Indus. v. Kelco Disposal*, Fn237 Browning-Ferris Industries (BFI) appealed from a jury award of $6 million in punitive damages. The jury had also awarded compensatory damages in the amount of $51,146, on Kelco's claims of antitrust violations and tortuous interference by BFI with Kelco's contractual relations. On the appeal to the Supreme Court, BFI argued that the size of the punitive damages award was impermissibly excessive under the Fourteenth Amendment Due Process Clause and, alternatively, that the award violated the Excessive Fines Clause of the Eighth Amendment. The Court held that the due process argument had not been preserved by BFI, and would not be considered; and, that the Eighth Amendment Excessive Fines Clause did not apply to punitive damages awards in cases between private parties. Fn238

Before addressing the legal issues presented by *Browning-Ferris*, it is again important to recite the predicate facts for the jury's finding that BFI was liable for punitive damages. Fn239 BFI operates a nationwide commercial waste-collection and disposal business, and it entered the waste collection business in Burlington, Vermont in 1976. By 1980, BFI controlled 100% of the market in Burlington.

Also in 1980, Joseph Kelley left BFI's employment, where he had been district manager for the region since 1973; he started his own waste disposal company, Kelco, and began to compete with BFI in Burlington. In just one year, Kelley captured about 37% of the market, and by 1982 he had 42% of the market. It was then that BFI's management instructed its employees in Burlington to "[p]ut [Kelley] out of business. Do whatever it takes. Squish him like a bug." Fn240 BFI proceeded to cut their prices by 40%, in an attempt to drive Kelley out of the market. Fn241

The jury found BFI liable for punitive damages in the amount of $6 million.

The Second Circuit found that, under Vermont law, the punitive damages award was not "manifestly and grossly excessive." Fn242 The Circuit Court held that, "[f]aced with evidence that defendants willfully and deliberately attempted to drive Kelco out of the market, the jury imposed punitive damages amounting to less than 0.5% of BFI's revenues, 0.6% of its net worth, and less than 5% of its net income, for fiscal year 1986." The court also found that such an amount was "not inconsistent with punitive damages levied in other jurisdictions against large corporations." Fn243

With regard to BFI's Eighth Amendment argument characterized as a "notion" by the court, the court dismissed it summarily, "[e]ven if the Eighth Amendment does apply to this nominally civil case . . . [citations omitted] . . . we do not think the damages here were so disproportionate as to be cruel, unusual, or constitutionally excessive." Fn244

The Eighth Amendment issue received more than cursory treatment in the Supreme Court, where several opinions explored in depth the history, and meaning, of that amendment.

The majority held that the Eighth Amendment, with its concerns for bails, fines and punishments, was understood "to apply primarily, and perhaps exclusively, to criminal prosecutions and punishments." Fn245 While the Court held that the amendment did not apply to private parties, the Court was careful, and explicit, that it was *not* deciding whether the amendment applied only to criminal cases, and that it was deciding only that, "it does not constrain an award of money damages in a civil suit when the government neither has prosecuted the action nor has any right to receive a share of the damages awarded." Fn246

The Court in *BFI* also noted that in *United States v. Halper*, Fn247 it was held that the Double Jeopardy Clause of the Fifth Amendment does place limits on the amount of penalties the federal government may recover in a civil action, after the defendant had been punished in a criminal proceeding by the federal government. Fn248 Although not applicable in the *BFI* case, nevertheless, the Court further noted that the analysis in *Halper* implied that punitive damages awarded to the federal government in a civil action might raise Eighth Amendment concerns. Fn249 But before critics leap to such *dictum* as comfort for any grievance at the thought of a government recovering punitive damages, it should be freshly recalled that much was made of the *dictum* in the *Crenshaw* and *BFI* cases, with regard to the due process concerns. Furthermore, the critics were convinced that in *TXO* the Court would, finally, hammer shut the coffin on punitive damages. As we have seen, the early reports of the death of punitive damages were greatly exaggerated.

Moreover, it is submitted that little comfort will be found in *Halper*.

In *United States v. Halper*, Fn250 the defendant was convicted in a criminal proceeding of submitting sixty-five false claims for government reimbursement, under the federal Medicare program, in violation of the federal False Claims statute, and for sixteen counts of mail fraud. Defendant was sentenced to imprisonment for two years and fined $5,000. The government then brought a civil action against Halper

under the civil False Claims Act. The district court granted summary judgment for the government on the issue of liability, and addressed the issue of the damages. Fn251

Under the civil False Claims Act, the defendant was liable to the government for a civil penalty of $2,000 per offense, plus an amount equal to two times the government's damages, plus costs of the civil action. Of importance was the fact that as a result of the sixty-five violations, the government had overpaid on the false claims a *total* of $585. The district court found that since Halper had violated the Act sixty-five separate times, he was subject to liability for a statutory penalty of $2,000 per offense, or a total of $130,000, as well as for double damages and costs. Fn252 The district court concluded, however, that "in light of Halper's previous criminal punishment, an additional penalty *this large* would violate the Double Jeopardy Clause." Fn253 Therefore, "[b]ecause it considered the Act unconstitutional *as applied to* Halper," the district court limited the government's recovery to double damages of $1,170 and the costs of the civil action, eliminating the statutory penalties. Fn254

On direct appeal by the government, the Supreme Court defined the issue before it as: "[W]hether and under what circumstances a civil penalty may constitute punishment *for the purpose of the Double Jeopardy Clause*." Fn255 In discussing the issue of "punishment," the Court reasoned that "[t]he notion of punishment . . . cuts across the division between the civil and the criminal law," and that "civil proceedings may advance punitive as well as remedial goals, and, conversely, that both punitive and remedial goals may be served by criminal penalties." Fn256 Thus, the Court acknowledged that calling something "punishment" does not make that something "criminal," since punishment is also a commonly accepted function of civil proceedings.

The Court then proceeded to narrow the issue before it as follows:

[W]hether a given civil sanction constitutes punishment in the relevant sense requires a particularized assessment of the penalty imposed and the purposes that the penalty may fairly be said to serve. Simply put, a civil as well as a criminal sanction constitutes punishment when the sanction as applied in the individual case serves the goals of punishment. Fn257

That is, the Court could determine if the civil statutory penalty provided for in the False Claims Act subjected Halper to Double Jeopardy only by comparing the size of the penalty to the damages caused.

Under the facts of *Halper*, the Court held that the statutory penalty was excessive, and that it triggered Halper's Double Jeopardy protection. Fn258 The Court went on to note that, "[w]hat we announce now is a rule for the *rare case*, the case such as the one before us, where a fixed-penalty provision subjects a prolific but small-gauge offender to a sanction *overwhelmingly disproportionate to the damages* he has caused." Fn259

Since defendant in the *Love Canal* case had not been subjected to any criminal proceedings as a result of its actions in creating the public nuisance at Love Canal, the holding and analysis in *Halper* was simply not relevant to defendant's challenge based on Eighth Amendment Excessive Fines provisions. Moreover, the *Halper* case does not support the position that a government's imposition of punitive damages is a *per se* violation of the Fifth Amendment, or by implication of the Eighth Amendment, for several, significant reasons.

The Court in *Halper* expressly narrowed its decision to the "rare" facts of the case before it. Fn260 The Court was not precluding a private party from filing a civil suit seeking damages for the same conduct that was previously the basis for a criminal prosecution and punishment. The Court in *Halper* also expressly held that, "[n]othing in today's ruling precludes the Government from seeking the full civil penalty against

a defendant who previously has not been punished for the same conduct, *even if the civil sanction imposed is punitive*." Fn261 Thus, *Halper* supports the proposition that a government is entitled to recover civil sanctions, even if the sanctions are punitive in nature.

Last, and most critical, the Court in *Halper* did not hold that the civil penalties authorized by the False Claims Act are unconstitutional *per se*, but rather only *as applied* to defendant Halper, the specific penalties were so excessive as to trigger defendant's Double Jeopardy protection. As noted above, the government was seeking penalties of $130,000 for the damages of $585 caused by Halper. This civil penalty was more than 220 times the actual damages, and was being imposed *in addition to the criminal penalties*. This reading of *Halper* is confirmed by the Court's remand to allow the district court to determine the appropriate size of a penalty which would not be so disproportionate to the actual damages as to offend the Double Jeopardy clause. Fn262 The Court stated in strong terms, "We must leave to the trial court the discretion to determine on the basis of such an accounting the size of the civil sanction the Government may receive without crossing the line between remedy and punishment." Fn263 Thus, the holding in *Halper* is that the size of a statutory civil penalty, following a criminal conviction and sentencing, might, under the particular circumstances, violate a defendant's Double Jeopardy protection.

In a dissenting opinion in *BFI*, Justice O'Connor opined that the Eighth Amendment did apply to that private party case, and then proceeded to address the question of whether the $6 million award was "excessive" within the meaning of the Eighth Amendment, finding it was "not an easy task." Fn264 Justice O'Connor proposed the proportionality analysis adopted in *Solem v. Helm*, Fn265 wherein: (1) the reviewing court accords "substantial deference" to legislative judgments concerning appropriate sanctions for such conduct; (2) the court should examine the gravity of defendant's conduct and harshness of the award; and (3) the court should compare civil and criminal penalties (both in amounts of money and any possible prison term) in various jurisdictions. Fn266 However, to the extent that such analysis relies largely on a comparative approach, the plurality opinion in *TXO* Fn267 expresses skepticism of its usefulness in the punitive damages context.

Seizing on only one of the factors proposed by Justice O'Connor in her dissent in *BFI*, the defendant in the *Love Canal* litigation claimed that any award above $2,000 would be excessive as a matter of constitutional law because that is the penalty for a criminal nuisance misdemeanor in New York. Fn268 Judge Curtin responded to such an argument as follows, "Indeed, assuming *arguendo* the truth of the State's allegations concerning OCC's conduct at Love Canal, the court suspects that OCC's assertion that it can be punished by no more than a misdemeanor conviction and a $2,000 fine would be greeted by New York's legislature and courts with a fair amount of incredulity." Fn269

Moreover, requiring a set statutory penalty as the measure for the amount of punitive damages undercuts the very function of punitive damages. The effectiveness of a particular punitive damages award as a deterrent depends, in part, upon the wealth of the defendant, and a set penalty ignores that key factor. In the context of antitrust litigation, it has been noted that, "An absolute fine level that might be an enormous deterrent for small firms might not deter larger firms from anticompetitive activity." Fn270 Following this line of reasoning, in *Silkwood v. Kerr-McGee Corp.*, Fn271 the Supreme Court declined to hold that a punitive damages award of $10 million, for plutonium leak at a nuclear facility, was preempted by a federal law authorizing a maximum civil penalty of $25,000 for such conduct. The Court in *Silkwood* reasoned that large punitive damages awards complement, rather than undercut, smaller, legislatively prescribed fines. Fn272

While the *BFI* opinion, and perhaps by implication the *Halper* decision, have raised the possibility that a state's right to recover punitive damages could be affected by the Eighth Amendment, an interesting development may raise similar questions. That development is the recent passage by a number of states of

legislation requiring a percentage of punitive damages awards in actions between private parties to be paid to the state or to some public fund. Fn273 Most often, such legislation was enacted in the mid-1980s as part of a wider tort reform, in response to outcries about the size and frequency of punitive damages awards. Fn274 Because of their newness, it has been only in the last few years that such statutes have been attacked on constitutional grounds, and the results have been mixed.

In several cases, the statutes have been declared unconstitutional. In *Kirk v. Denver Publishing Co.*, Fn275 a distributor of newspapers, Kirk, was successful on a counterclaim against a newspaper publisher for malicious prosecution, for which the jury awarded $118,980 in compensatory damages. An equal amount of $118,890 was awarded Kirk for exemplary damages. Fn276 Kirk challenged the constitutionality of a Colorado statute which was enacted in 1986 as part of a tort-reform legislation and which required a party receiving an exemplary damages award to pay one-third of all such damages to the state. Fn277 The Colorado Supreme Court, *en banc*, held that the statutory provision violates the Fifth Amendment Taking Clause of the United States Constitution, as well as the parallel provision of the Colorado Constitution. Fn278 The court reasoned that an exemplary damages award was a private right, the "taking" was confiscatory, and there was not a reasonable nexus between the statutory taking of one-third of the exemplary damages and the cost of any governmental services that arguably might support a significantly smaller forced contribution. Fn279 A dissenting opinion argued that if the legislature can take away, in its entirety, any award for punitive damages, then surely it is not a "taking" to direct one-third to the state, inasmuch as the party possessed only an expectancy, not a property right in the one-third of the award. Fn280

In *McBride v. General Motors Corp.*, Fn281 plaintiffs brought product liability actions against a car manufacturer claiming that their vehicles contained a defective rear seat lap-belt-only occupant restraint system (i.e., there was no shoulder restraint). The plaintiffs sought a declaratory action seeking judgment that certain sections of Georgia's Tort Reform Act, applicable to punitive damages, were unconstitutional. Subject to challenge were the sections which allowed only one award of punitive damages for a products liability case, regardless of the number of causes of action, Fn282 and which directed that 75% of any punitive damages award, in products liability actions, shall be paid to the state. Fn283 Plaintiffs raised a number of constitutional objections, including an argument that the statute violated the Eighth Amendment.

In strong, no uncertain words, the court found that, in general, "This provision is a thinly disguised arbitrary restraint in favor of business seeking to deter punitive damage actions against egregious business practices by reducing incentives for injured plaintiffs to take action to punish and deter such practices." Fn284 With regard to the statutory provision imposing a one-time only punitive damage award, the court found that a particularly egregious course of conduct could go unpunished if the first case brought against such a defendant had not uncovered all the facts revealing reckless conduct and the injury to the first plaintiff to the courthouse was slight, conceivably resulting in a relatively slight, single punitive damage award. Fn285 Thus, the statute was not rationally related to a legitimate state interest. Fn286

With regard to the Eighth Amendment argument, the court found that the statute violated that constitutional provision inasmuch as the state's receipt of 75% of any products liability punitive damages award, "converts the civil nature action of the prior Georgia punitive damages statute into a statute where fines are being made for the benefit of the State, contrary to the constitutional prohibitions as to excessive fines and contrary to the Double Jeopardy Clause of the Fifth Amendment to the Constitution of the United States." Fn287 No further analysis was offered, so it is unclear what constitutes "excessive" or how the Double Jeopardy Clause was implicated. Fn288

In contrast, in *Burke v. Deere & Co.*, Fn289 an Iowa statute provided that 75% of any punitive damages

award was paid to a civil reparation trust fund which was administered by the court. Fn290 An appeal was taken, in part, on the ground that the provision violated the Eighth Amendment prohibition against excessive fines. Noting the *McBride* decision, this federal court distinguished Iowa's statute on the ground that while in Georgia the funds were paid to the state treasury, in Iowa the funds were paid to a civil reparation trust fund. Without further analysis, the court held that the Iowa statute did not provide the state with any interest in the punitive damages award, and so the award did not implicate the Eighth Amendment. Fn291

The same Iowa statute was upheld in *Shepherd Components, Inc. v. Brice Petrides-Donoghue & Assoc., Inc.*, Fn292 against an attack that the statute was an unconstitutional taking. The Iowa Supreme Court rejected the argument, finding that punitive damages awards are discretionary and not allowed as a matter of right; that punitive damages are not intended to be compensatory; and that plaintiff is a "fortuitous beneficiary" with no vested right to punitive damages prior to the entry of a judgment. Fn293 The court held that the distribution of punitive damages does not constitute an unconstitutional taking. Fn294

Finally, in *Gordon v. State*, Fn295 plaintiff was falsely imprisoned and battered by employees of a K-Mart store. The jury awarded plaintiff $72,500 in compensatory damages and $512,600 in punitive damages. The Florida statute Fn296 required that 60% of any punitive damages award be paid to the state and so judgment was entered for $307,200 in favor of the state. Plaintiff appealed the judgment in favor of the state on the grounds that it constituted an unconstitutional taking of a property right without due process and that it was arbitrary and unreasonable.

The court rejected the "taking" argument finding that plaintiff had no cognizable, protected right to recover punitive damages and the legislature was fully in its right to restrict any recovery or, indeed, to abolish it altogether. Fn297 The substantive due process argument was also rejected on the ground that the statute bears a rational relation to a legitimate legislative objective. Fn298 The court noted that the purposes of punitive damages, to punish the wrongdoer for what amounts to a public wrong and to protect the public by deterring others, are properly served by allotting a portion to the state as representative of the public. Fn299 Moreover, the court reasoned, the legislature made it clear that one reason for the statute was to discourage punitive damages claims by making them less remunerative to plaintiffs and their attorneys. Fn300

CONCLUSION

While it was thought that the Supreme Court had the power, and had signaled the inclination in *Crenshaw* and *BFI*, to deliver a fatal blow to punitive damages through one or more constitutional provisions, the *Haslip* and *TXO* decisions were more instructive than destructive. Though addressing the concerns of critics of punitive damages, as well as the Court's own deep concerns, the decisions did not result in any "mathematical bright line" for constitutionally limiting punitive damages. The fact that the ball was less than crystalline can be seen in the progeny of *Haslip*. Interestingly enough, the most successful efforts in delimiting the size and/or frequency of punitive damages awards seem to have come through legislative changes in the states. Perhaps it is there that the Supreme Court intended the changes in punitive damages jurisprudence to be effected. Fn301

What, then, has been the contribution of the *Love Canal* case to the developing body of punitive damages jurisprudence? Perhaps the most interesting aspect is that the case has provided an opportunity for examining the roots of punitive damages in that border between civil and criminal law and, particularly, the position of the state in those sometimes quite distinct, sometimes not so different fields. Digging along these lines is rarely done in private-party litigation involving punitive damages, where the eye remains

focused more on the bottom line - "How much is it going to cost?" - than on the policies behind, indeed the very function of law.

Having explored the boundary questions raised by a state's request for punitive damages, in a public nuisance toxic-waste-site case, Judge Curtin concluded that the status of plaintiff as "state" does not disturb the boundary: A state's claim for punitive damages, in a public nuisance action, remains civil, in form and substance.

Once it was determined that the common law presented no barrier to the state's right to recover punitive damages, it was then necessary to determine if the Constitution presented any barriers. The standard for determining the basis for liability, as well as the more contentious issue of the standard for assessing the amount of any punitive damages, and the standard for the burden of proof are constitutionally sufficient, or not, irrespective of the status of the plaintiff as "state." Thus, the fact that the plaintiff in *Love Canal* was the State was more peripheral than central to the due process analysis, as we have seen.

As a result of the State's recent settlement with OCC, the *Love Canal* case will not be the test case for the implications of the Eighth Amendment on any actual punitive damages awarded to a state. Even assuming that it was determined that the Eighth Amendment is applicable to a civil action for punitive damages - an open question still, even under the *BFI* case Fn302 - the analysis still has to resolve the standard for determining whether there was "excessiveness" in an award. That analysis awaits another day.

---- Begin EndNotes ----

* Assistant Attorney General, Environmental Protection Bureau, New York State Department of Law, and one of the attorneys who represented the State in the *Love Canal* trial in federal court, along with Eugene Martin-Leff, C. Michael Bryce, Oymin Chin and H. Johannes Galley. The author received a B.A. (English) from The University of Notre Dame (1964), a M.A. (English) from The University of Wisconsin (1965), and a J.D. from Temple University (1980); he also did graduate work in Psychology at Temple University (1969-70). Prior to joining Attorney General Koppell's Office in 1988, the author taught college English (1965-80), and was an associate (1980-85) and partner (1985-88) in a Philadelphia law firm. The opinions and analysis expressed in the article are those of the author, and do not reflect the opinions, positions or policies of Attorney General G. Oliver Koppell nor of the New York State Department of Law. Finally, the author gratefully acknowledges the invaluable contributions of Eugene Martin-Leff, Esq., Assistant Attorney General, in managing the *Love Canal* case and in developing the analysis for the case.
Fn1 . WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY 1843 (1981).
Fn2 . The definition of "exemplary or punitive damages" in BLACK'S LAW DICTIONARY is more expansive, and more "legal," but not more succinct: "Exemplary damages are damages on an increased scale, awarded to the plaintiff over and above what will barely compensate him for his property loss, where the wrong done to him was aggravated by circumstances of violence, oppression, malice, fraud, or wanton and wicked conduct on the part of the defendant, and are intended to solace the plaintiff for mental anguish, laceration of his feelings, shame, degradation, or other aggravations of the original wrong, or else to punish the defendant for his evil behavior or to make an example of him, for which reason they are also called 'punitive' or 'punitory' damages or 'vindictive' damages." BLACK'S LAW DICTIONARY 390 (6th ed. 1990).
Fn3 . For several articles critical of various aspects of punitive damages, albeit not in the tone ascribed above, *see, e.g.*, John Dwight Ingram, *Punitive Damages Should Be Abolished* 17 CAP. U. L. REV. 205 (1988); John Calvin Jeffries, Jr., *A Comment on the Constitutionality of Punitive Damages*, 72 VA. L. REV. 139 (1986); James B. Sales & Kenneth B. Cole, Jr., *Punitive Damages: A Relic That Has Outlived Its Origins*, 37 VAND. L. REV. 1117 (1984); Malcom E. Wheeler, *The Constitutional Case for Reforming Punitive Damages Procedures*, 69 VA. L. REV. 269 (1983); JOHN C. JEFFRIES, JR., &

GEORGE CLEMON FREEMAN, JR., ISSUES IN PUNITIVE DAMAGES LITIGATION: AN AGENDA FOR DEFENSE COUNSEL, FOR THE DEFENSE 9 (1989).

Fn4 . *See* Pacific Mutual Life Insurance Co. v. Haslip, 499 U.S. 1 (1991).

Fn5 . United States v. Hooker Chems. & Plastics Corp., 748 F. Supp 67 (W.D.N.Y. 1990).

Fn6 . *Id.* Fn7 . The original complaint was based on the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901-92 (1976), The Clean Water Act, 33 U.S.C. §§ 1251-1376 (1987), The Safe Drinking Water Act, 42 U.S.C. § 300 (1974), The Rivers and Harbors Act, 33 U.S.C. § 403 (1899), as well as common law claims.

Fn8 . OCC was known as the Hooker Electrochemical Company between 1909 and 1958, including the period of 1942-1954 when the disposal of chemical wastes at Love Canal occurred; as the Hooker Chemical Corporation, between 1958 and 1974; as the Hooker Chemicals & Plastics Corporation, between 1974 and 1982; and, as OCC since 1982. OCC's parent, the Occidental Petroleum Corporation, had purchased the Hooker company in 1968. The term "Hooker" and "OCC" are used interchangeably in the article.

Fn9 . Plaintiff UDC-Love Canal, Inc., had been established for the purpose of acquiring title, on behalf of the State of New York, to residential properties in the vicinity of Love Canal which were purchased when it became necessary to relocate families away from the site.

Fn10 . 42 U.S.C. §§ 9601-75 (1988).

Fn11 . OCC's cross-claims against the City and School Board were based on the fact that they each own a part of the Love Canal property, and are therefore potentially liable as current owners of a hazardous waste facility, under CERCLA §107(a). The cross-claim against NCDH was based on alleged negligence in failing to protect the public health at Love Canal. OCC's counterclaim against the State also was based on the fact that the State owns a piece of the property, which the State acquired by eminent domain in 1968, due to a highway construction project. The counterclaims against the United States were based on claims that the U.S. Army dumped hazardous wastes at Love Canal during the Second World War, thereby making it a "generator", or, alternatively, that the U.S. had "arranged for" the disposal of hazardous wastes as a result of its control over Hooker's operations during the war emergencies, both bases giving rise to potential liability under CERCLA §107(a).

Fn12 . United States v. Hooker Chems. & Plastics Corp., 680 F. Supp. 546 (W.D.N.Y. 1988).

Fn13 . United States v. Hooker Chems. & Plastics Corp., 722 F. Supp. 960 (W.D.N.Y. 1989).

Fn14 . United States v. Hooker Chems. & Plastics Corp., 748 F. Supp. 67, 80 (W.D.N.Y. 1990).

Fn15 . United States v. Hooker Chems. & Plastics Corp., 739 F. Supp. 125 (W.D.N.Y. 1990).

Fn16 . United States v. Hooker Chems. & Plastics Corp., No. 79-CV-990C (W.D.N.Y. March 12, 1994).

Fn17 . *Id.* at 188.

Fn18 . *Id.*

Fn19 . The court's recent Order and Decision of March 17, 1994, contains a lengthy recitation of the facts. What is included here is a summary of some of the facts which led to the assertion of the punitive damages claim in the first instance.

Fn20 . It also can be noted that in products liability litigation, punitive damages awards are often based on conduct that occurred decades before injuries manifested, and before an action was brought. *See, e.g.*, Johnson v. Celotex Corp., 899 F.2d 1281 (2d Cir.), *cert. denied*, 498 U.S. 920 (1990); Racich v. Celotex Corp., 887 F.2d 393 (2d Cir. 1989); Hansen v. Johns-Manville Prods. Corp., 734 F.2d 1036 (5th Cir. 1984), *cert. denied*, 470 U.S. 1051 (1985).

Fn21 . There was no dispute about the toxicity of the chemicals which were dumped at Love Canal. The waste or residues dumped at Love Canal included, among many other toxic compounds; chlorobenzenes, chlorinated naphthalenes, thionyl chloride, benzene hexachloride (BHC), including an isomer named lindane, dodecyl mercaptan, arsenic trichloride, and trichlorophenol (which contained dioxin). *See, e.g.*, *Hooker*, 722 F. Supp. at 961.

Fn22 . OCC's principal defense (the state of the practice defense) to the punitive damages claim was that it disposed of wastes in a manner appropriate to the 1940s and 1950s, and should not be judged by

contemporary standards.
Fn23 . OCC admitted that Hooker took a tax deduction for a charitable contribution in the amount of $2,382.96 for the transfer. *See* United States v. Hooker Chems. & Plastics Corp., No. 79-CV-990C (W.D.N.Y. March 17, 1994).
Fn24 . Contrary to some popular opinion, neither the school nor any homes were actually built directly on top of the waste disposal areas on the Love Canal property, but rather were built directly adjacent to the disposal areas. However, the Canal property itself was used extensively as a playground by the school children and the residents in the area. *Id.* at Appendix A-2.
Fn25 . *See* Court Docket No. 867. Further briefing was as follows: State's Memorandum in Opposition, (No. 881); OCC's Reply Memorandum, (No. 896); and, State's Surreply Memorandum, (No. 910). Oral argument on OCC's Motion to Dismiss was held on January 12, 1990. In addition, several of the legal issues addressed in the pre-trial Motion to Dismiss were resurrected, briefly, in post-trial briefs. *See* OCC Post-Trial Memorandum in Opposition to State's Claim for Punitive Damages, (No. 1188); State's Post-Trial Reply Memorandum on Punitive Damages, (No. 1203).
Fn26 . *Hooker*, 748 F. Supp. 67. The court also denied OCC's Motion to Certify the question to the Second Circuit. Supp. Order No. 54 (No. 1011). In the March 17, 1994, decision denying the State's claim for punitive damages on the facts, the court reaffirmed its earlier ruling that a state is entitled as a matter of law to recover punitive damages on the common law theory of public nuisance although the court expressed some question about the issue.
Fn27 . *Hooker*, 748 F. Supp. at 74.
Fn28 . *Id.* at 74-5.
Fn29 . *Id.* at 76.
Fn30 . *Id.*
Fn31 . *Id.* at 77.
Fn32 . *Id.* at 79.
Fn33 . *Id.* at 80.
Fn34 . *Id.*
Fn35 . While defendant stated, in passing, that state constitutional provisions were being violated, the argument was not specified or explicated, and was not, therefore, treated in substance by the court. In effect, the parties treated the federal and state constitutional provisions to be co-extensive, for purposes of the motion. *Id.* at 68-69.
Fn36 . This premise, that analogous concepts should be treated as if they are identical, is fallacious. An "analogy" is a rhetorical device of comparison whereby two things *otherwise unlike* are asserted to have a resemblance in some particulars. Thus, for example, punitive damages rhetorically can be compared to criminal sanctions on the ground that both have punishment and deterrence as purposes. Likewise, public nuisance rhetorically can be compared to a crime in that both began as offenses against the sovereign. However, a fundamental qualification is that punitive damages and criminal sanctions, and public nuisance and crime, are not the same things; they are not identical or synonymous. To assert that they are synonymous is tantamount to positing that deterrence is a purpose behind the imposition of punitive damages and the death penalty, and therefore, anyone found liable for punitive damages should be subject to the death penalty. Such a notion is too extreme.
Fn37 . W. PAGE KEETON ET AL., PROSSER AND KEETON ON THE LAW OF TORTS § 86, at 617 (5th ed. 1984); RESTATEMENT (SECOND) OF TORTS § 821B cmt. b (1977).
Fn38 . *Id.* Fn39 . Jorgensen v. Squires, 39 N.E. 373 (N.Y. 1895).
Fn40 . *Wheeler*, *supra* note 3, at 283-84.
Fn41 . JEFFRIES, JR. & FREEMAN, Jr., *supra* note 3, at 9.
Fn42 . Professor Jeffries was listed on OCC's Motion to Dismiss as "Of Counsel," and OCC cited one of his articles as authority for its position. It should be noted that in at least some of his published articles, Professor Jeffries is serving more as an advocate, less as an objective, disinterested observer. For example, in his article, *A Comment on the Constitutionality of Punitive Damages*, 72 VA. L. REV. 139 (1986),

Professor Jeffries candidly reveals that, "This comment grew out of work for a law firm and was, therefore, in origin not disinterested." This comment is not meant to dismiss the analysis of Professor Jeffries, but only to place it in context. Of course, this same comment, indeed criticism, should be leveled against the author of this article.

Fn43 . JEFFRIES, JR. & FREEMAN, JR., *supra* note 3, at 10.

Fn44 . *Id.* at 9.

Fn45 . *Id.*

Fn46 . *Id.* at 17 (emphases added).

Fn47 . *Id.* at 11.

Fn48 . *Id.* at 15-16.

Fn49 . *Id.* at 16.

Fn50 . *Hooker*, 748 F. Supp. at 71-72.

Fn51 . *Id.* The court also noted that a $250 million civil claim by the State did not appear any more coercive or oppressive than a $250 million civil claim by a private party.

Fn52 . N.Y. PENAL LAW § 240.45 (McKinney 1989). The statute provides in pertinent part: "A person is guilty of criminal nuisance in the second degree when:

1. By conduct either unlawful in itself or unreasonable under all the circumstances, he knowingly or recklessly creates or maintains a condition which endangers the safety or health of a considerable number of persons; or

2. He knowingly conducts or maintains any premises, place or resort where persons gather for purposes of engaging in unlawful conduct . . . . Criminal nuisance in the second degree is a class B misdemeanor. (L.1965, c.1030; amended L.1989, c.585, § 1)."

Id. Fn53 . *Id.* at § 5.10(3).

Fn54 . *Id.* (Historical Note).

Fn55 . 121 N.Y.S. 3, *aff'd*, 95 N.E. 1125 (N.Y. 1910).

Fn56 . *Id.*

Fn57 . 177 N.E. 14 (N.Y. 1931).

Fn58 . 6 Hill 466 (N.Y. Sup. Ct. 1844).

Fn59 . JAMES D. GHIARDI & JOHN J. KIRCHER, PUNITIVE DAMAGES L. & PRAC. § 5.33, and cases cited therein; *see also* 22 AM JUR 2D *Damages* § 757.

Fn60 . See below for discussion of possible double jeopardy implications for such a case if the government were the plaintiff in the civil action.

Fn61 . *Cook*, 6 Hill at 467. *See also* Colligan v. Fera, 349 N.Y.S.2d 306 (N.Y. City Civ. Ct. 1973); Renwick v. Morris, 7 Hill 575 (N.Y. Courts of Errors 1844); and State v. Shevlin-Carpenter Co., 108 N.W. 935 (Minn. 1906) (holding that in an action with the State as plaintiff, the awarding of exemplary damages in a civil action was not violative of any constitutional provision or otherwise objectionable, even though the same conduct was punishable as a criminal offense).

Fn62 . 748 F. Supp. at 69.

Fn63 . *Id.* at 71.

Fn64 . 459 N.Y.S.2d 971 (Sup. Ct. Rensselaer Co. 1983), *aff'd in part, rev'd in part*, 479 N.Y.S.2d 1010 (3d Dep't 1984).

Fn65 . *Id.* at 978.

Fn66 . 1B JAMES W. MOORE ET AL., MOORE'S FEDERAL PRACTICE ¶ 0.402[2], at 40 (2d ed. 1985).

Fn67 . 459 N.Y.S.2d at 978.

Fn68 . *Id.* (emphasis added).

Fn69 . 544 N.Y.S.2d 273 (Sup. Ct. Kings Co. 1989), *aff'd*, 551 N.Y.S.2d 253 (2d Dep't 1990).

Fn70 . N.Y. v. Taliaferrow, 551 N.Y.S.2d at 254. *See also* Brink's Inc. v. City of New York, 546 F. Supp. 403 (S.D.N.Y. 1982), *aff'd*, 717 F.2d 700 (2d Cir. 1983) (allowing the City to recover punitive damages in a civil action based on negligence); Caso v. District Council 37, American Federation of State, County &

Municipal Employees, 350 N.Y.S.2d 173 (2d Dep't 1973) (stating, a local government was entitled to pursue its public nuisance action, including its claim for punitive damages, against a union responsible for a work stoppage which resulted in environmental damage).
Fn71 . *See* Peitzman v. City of Illmo, 141 F.2d 956 (8th Cir.), *cert. denied*, 328 U.S. 718, *reh'g denied*, 323 U.S. 813 (1944); Unified Sch. Dist. No. 490, Butler County v. Celotex Corp., 629 P.2d 196 (Kan. Ct. App. 1981); State ex rel. Pollution Control Coordinating Bd. v. Kerr-McGee Corp., 619 P.2d 858 (Okla. 1980); Village of Peck v. Denison, 450 P.2d 310 (Idaho 1969); State v. Shevlin-Carpenter, 108 N.W. 935 (Minn. 1906).
Fn72 . 108 N.W. 935 (Minn. 1906).
Fn73 . *Id.*
Fn74 . Statutory penalties are not the same as punitive damages, but there are similarities sufficient to make cases involving statutory penalties helpful in analyzing issues raised by punitive damages. *See* BLACK'S LAW DICTIONARY 1266 (5th ed. 1979) (defining statutory penalties in part as, "One which an individual is allowed to recover against a wrongdoer as satisfaction for wrong or injury suffered without reference to actual damage sustained.").
Fn75 . *Id.* at 938.
Fn76 . *Id.* (emphasis added).
Fn77 . *Id.* at 939.
Fn78 . 629 P.2d 196 (Kan. Ct. App. 1981).
Fn79 . *Id.*
Fn80 . 619 P.2d 858 (Okla. 1980).
Fn81 . *Id.* at 861 (emphasis added).
Fn82 . *Id.*
Fn83 . 108 N.W. 935.
Fn84 . *Id.* at 939.
Fn85 . Brown v. Board of Trustees, 104 N.E.2d 866, 868 (N.Y. 1952); *see also* 55 N.Y. JUR., "State of New York," §190; 40 A.L.R. 2d 927.
Fn86 . 450 P.2d 310.
Fn87 . *Hooker*, 748 F. Supp. at 73.
Fn88 . *Id.* at 75.
Fn89 . 569 F.2d 716, 723 (2d Cir. 1977).
Fn90 . *Id.* at 722.
Fn91 . *Id.* at 723.
Fn92 . *Hooker*, 748 F. Supp. at 76.
Fn93 . *Id.*
Fn94 . Defendant made a number of statements about the vagaries, and "whims and prejudices" of jury awards for punitive damages, suggesting that it was in the jury box that the punitive damages disease was started, a perspective common to many attacks on punitive damages awards. Since in the *Love Canal* action there was no jury, those concerns were not relevant. Defendant did not suggest that the court was vulnerable to such "vagaries" and "whims and prejudices," as Judge Curtin noted. 748 F. Supp. at 78. For an analysis of the issue of juries and punitive damages, *see* Scheiner, *Judicial Assessment of Punitive Damages, The Seventh Amendment, and The Politics of Jury Power*, 91 COLUM. L. REV. 142 (1991); *see also* the discussion below of the *Haslip* and *TXO* cases before the Supreme Court.
Fn95 . To the extent that such argument was based on a claim that the standard is unconstitutional as applied, then it was not ripe for adjudication. For purposes of the Motion, the argument was treated as a claim that the standard is *per se* unconstitutional.
Fn96 . As noted above, OCC did not analyze, nor cite cases on, the Due Process Clause of Article I, § 6 of the New York Constitution and it was assumed for purposes of the Motion that the State Due Process protection is the same as provided for in the 14th Amendment of the United States Constitution. *See, e.g.*, People v. Gazulis, 212 N.Y.S.2d 910 (Poughkeepsie City Ct. 1961).

Fn97 . Before we begin the inquiry into whether this common law rule satisfies the due process protections, we need to establish the context for the inquiry. First, the substantive due process requirement of adequate notice is ordinarily applied only to criminal statutes. J. D. LEE & BARRY A. LINDAHL, MODERN TORT LAW § 21.07, at 736. Second, the Supreme Court has applied the doctrine of void-for-vagueness to civil actions, although infrequently. *See, e.g.*, Jordan v. DeGeorge, 341 U.S. 223, *reh'g denied*, 341 U.S. 956 (1951) (discussing standards used in civil deportation hearing); Giaccio v. Pennsylvania, 382 U.S. 399 (1966) (reviewing standards used to impose the costs of unsuccessful criminal prosecution on acquitted defendants). Third, when substantive due process requirements are applied in civil actions, it usually involves an interpretation of a state statute. Note, *The Void-For-Vagueness Doctrine in the Supreme Court*, 109 U. PA. L. REV. 67, 68 n. 4.
Fn98 . Sharapata v. Town of Islip, 437 N.E.2d 1104 (N.Y. 1982).
Fn99 . *Doralee Estates*, 569 F.2d at 723.
Fn100 . Hartford Accident & Indemnity Co. v. Village of Hempstead, 397 N.E.2d 737 (N.Y. 1979).
Fn101 . Nellis v. Miller, 477 N.Y.S.2d 72 (4th Dep't 1984).
Fn102 . O'Donnell v. K-Mart Corp., 474 N.Y.S.2d 344 (4th Dep't 1984); *see also* Note, *The Imposition of Punishment by Civil Courts: A Reappraisal of Punitive Damages*, 41 N.Y.U. L. REV. 1158, 1180 (1966). This factor is double-edged: the more wealthy the defendant, the larger the punitive damages award necessary to make it "smart"; the greater the percentage of the award is to some measure of defendant's wealth, the more suspect the award may be.
Fn103 . David J. Owen, *Problems in Assessing Punitive Damages Against Manufacturers of Defective Products*, 49 U. CHI. L. REV. 1, 9, 44 (1982). If one compares the factors adopted by various courts, often in the wake of *Haslip*, those factors can be seen to congregate around the three factors of the Restatement.
Fn104 . Fletcher v. Western Nat'l Life Ins. Co., 89 Cal. Rptr. 78, 96 (1976), *citing in part*, Lorenson v. Superior Court Los Angeles County, 216 P.2d 859, 866 (Cal. 1950).
Fn105 . 175 N.E. 177 (N.Y. 1931).
Fn106 . *Id.* at 179.
Fn107 . Christopher Gunther, *Can Punitive Damages Standards Be Void For Vagueness*, 63 ST. JOHN'S L. REV. 52, 64 n. 62 (1988), and cases cited therein.
Fn108 . *Hooker*, 748 F. Supp at 77.
Fn109 . *Id.* at 77-78.
Fn110 . *Id.* Fn111 . 887 F.2d 393, 398-99 (2d Cir. 1989).
Fn112 . *Hooker*, 748 F. Supp. at 78.
Fn113 . 492 U.S. 257 (1989).
Fn114 . 475 U.S. 813 (1986).
Fn115 . 486 U.S. 71 (1988).
Fn116 . 499 U.S. 1 (1991).
Fn117 . *Id.* at 3-4. Note *. Sixteen briefs *amici curiae* urged reversal; five urged affirmance; and ten others were filed. Each of the thirty-one briefs represented a group, association or institution, so the interest was extensive.
Fn118 . *Id.* at 4, 8.
Fn119 . *Id.* at 9-12.
Fn120 . The assumption was based on Haslip's counsel's argument to the jury requesting compensatory damages of $200,000 (which included $4,000 in out-of-pocket expenses), and punitive damages of $3 million. *Id.* at 7, n. 2.
Fn121 . *Id.* at 19.
Fn122 . *Id.* at 14.
Fn123 . *Id.*
Fn124 . *Id.* at 17.
Fn125 . *Id.* at 19.
Fn126 . *Id.* Other states differ markedly with regard to this issue, as many, including New York, permit

evidence of a defendant's wealth. *See* 36 N.Y. AM. JUR. 2D § 182 at 310.
Fn127 . *Id.* at 20.
Fn128 . 493 So.2d 1374 (Ala. 1986).
Fn129 . *Haslip*, 499 U.S. at 20.
Fn130 . *Id.*
Fn131 . *Id.* at 21-22.
Fn132 . 539 So.2d 218 (Ala. 1989).
Fn133 . 546 So.2d 371 (Ala. 1989).
Fn134 . While the Court includes the possibility of a reviewing court increasing the amount of punitive damages, such a phenomenon is rare, if it ever has happened.
Fn135 . *Id.* at 21-22.
Fn136 . *Id.* at 22.
Fn137 . The Court also noted that the punitive award was much in excess of any fine that could be imposed in Alabama for insurance fraud, but it also noted that such conduct could also lead to imprisonment, indicating the serious nature of the conduct, deserving of punishment. *Id.* at 23. *See infra* for further discussion of the applicability of analogous criminal fines.
Fn138 . *Id.* at 23-24.
Fn139 . *Id.* at 18.
Fn140 . *Id.* at 41.
Fn141 . *Id.*
Fn142 . *Id.* at 42.
Fn143 . *Id.* at 24-40.
Fn144 . 113 S.Ct. 2711 (1993).
Fn145 . 976 F.2d 118 (2d Cir. 1992).
Fn146 . *Id.* at 122.
Fn147 . *Id.* at 121.
Fn148 . *Id.*
Fn149 . For a critique of net worth as a factor for assessing the size of punitive damages awards, at least for corporate defendants, *see* ZAZU Designs v. L'Oreal, S.A., 979 F.2d 499 (7th Cir. 1992) (rehearing denied). The decision was 2-1, with Judges Posner and Easterbrook for the majority, both judges being outspoken law-and-economics critics. In turn, for a critical comment questioning the usefulness of law-and-economics analysis in the area of punitive damages jurisprudence (but not necessarily that of Judges Posner and Easterbrook), *see BFI*, 492 U.S. at 299 (O'Connor, J., dissenting).
Fn150 . *BFI*, 492 U.S. at 299.
Fn151 . 947 F.2d 95 (4th Cir. 1991).
Fn152 . There was some confusion at the trial regarding defendant's net worth, as it appeared to be $500,000 for 1988, and about $6,000 for 1989, when the award was entered. Defendant failed to object to the relevant jury instructions, and so the jury likely believed that defendant's net worth was $500,000. *Id.* at 111-12.
Fn153 . 304 U.S. 64 (1938).
Fn154 . *Mattison*, 947 F.2d. at 99.
Fn155 . *Id.* It must be noted that the reliance on *BFI* is seemingly as of limited assistance as the Court found in *Haslip*, since *BFI* also originated in state court, and the Court in *BFI* did not reach the due process provision before the court in *Mattison*.
Fn156 . *Id.* at 100.
Fn157 . *Id.* Fn158 . *Id. See supra,* for discussion of confusion at trial on actual net worth of defendant. If the jury believed that the net worth was $500,000, then the punitive damages award was 20% *of* defendant's net worth for one year, not 15 times net worth.
Fn159 . *Id.* Fn160 . *Id.* at 107.
Fn161 . *Id.* at 109.

Fn162 . *Id.* at 110. *See* Johnson v. Hugo's Skateway, 949 F.2d 1338 (4th Cir. 1991).
Fn163 . 946 F.2d 1085 (5th Cir. 1991).
Fn164 . *Id.* at 1095.
Fn165 . *Id.*
Fn166 . *Id.* at 1097.
Fn167 . *Id.* at 1097-98.
Fn168 . 934 F.2d 1377 (5th Cir. 1991).
Fn169 . *Id.* at 1380.
Fn170 . 499 U.S. 914 (1991).
Fn171 . *Eichenseer,* 934 F.2d at 1381.
Fn172 . *Id.* at 1385.
Fn173 . *Id.* at 1382 (emphasis added).
Fn174 . *Id.* at 1384.
Fn175 . *Id.* at 1385.
Fn176 . *Id.*
Fn177 . *Id.*
Fn178 . *Id.* Fn179 . 948 F.2d 1546 (10th Cir. 1991).
Fn180 . *Id.* at 1560.
Fn181 . *Id.*
Fn182 . *Id.* at 1561.
Fn183 . *Id.*
Fn184 . 978 F.2d 1493 (8th Cir. 1992).
Fn185 . *Id.* at 1496.
Fn186 . *Id.* at 1500. Jury instructions in punitive damages cases are fairly uniform, and do not give rise to much critical comment. *See, e.g.*, Dunn v. Hovic, 1 F.3d 1371, 1380 (3d Cir. 1993); Johnson v. Hugo's Skateway, 949 F.2d 1338 (4th Cir. 1991). It is the scope of the trial and reviewing courts' consideration of the jury award, and whether that consideration is guided by specific, particular factors, that draws the attention.
Fn187 . *Id.* at 1501.
Fn188 . *Id.*
Fn189 . *Id.*
Fn190 . *Id.*
Fn191 . *Id. See also* Benny M. Estes and Assoc. v. Time Ins. Co., 980 F.2d 1228, 1235 (8th Cir. 1992) ("[T]he Supreme Court's opinion in *Haslip* did not hold that the Due Process Clause is violated unless each aspect of the Alabama procedure is followed . . . other systems, like the Arkansas system under consideration here, [can] also comply with the Constitution, though they differ from the Alabama approach.").
Fn192 . 113 S.Ct. 2711 (1993).
Fn193 . *Id.* at 2716-17.
Fn194 . *Id.* at 2717.
Fn195 . *Id.*
Fn196 . TXO Prod. Corp. v. Alliance Resources Corp., 419 S.E.2d 870, 887-90, App. B 894-95 (W.Va. 1992).
Fn197 . *TXO*, 113 S.Ct at 2722-23.
Fn198 . *Id.* at 2720, (*quoting Haslip*, 499 U.S. at 18).
Fn199 . *Id.* at 2722-23.
Fn200 . *Id.* at 2719-20.
Fn201 . *Id.* at 2720. *See Haslip*, 499 U.S. at 24-42 (Scalia, J., and Kennedy, J., concurring).
Fn202 . For Justice O'Connor, this trait seems to be a weakness; for others, it would be seen as a strength.
Fn203 . 113 S.Ct. at 2728.

Fn204 . *Id.*
Fn205 . *Id.* at 2733.
Fn206 . *Id.* at 2734.
Fn207 . *Id.*
Fn208 . *Id.* at 2737-38.
Fn209 . *Id.* at 2738.
Fn210 . 1 F.3d 1371 (3d Cir. 1993) (en banc).
Fn211 . *Id.* at 1373.
Fn212 . *Id.* Fn213 . *Id.* at 1380.
Fn214 . Glasscock v. Armstrong Cork Co., 946 F.2d 1085 (5th Cir. 1991), *cert. denied*, 112 S.Ct. 1778 (1992).
Fn215 . *Dunn*, 1 F.3d 1371.
Fn216 . 58 N.Y. AM. JUR. 2D *Evidence and Witnesses* § 967, at 719.
Fn217 . People v. Briggs, 114 N.Y. 56 (1889); *see also* New York v. Dairylea Coop., Inc., 67 A.D.2d 971 (2d Dep't 1979).
Fn218 . 748 F. Supp. at 78.
Fn219 . *See, e.g.*, Nishikawa v. Dulles, 356 U.S. 129 (1958), Chaunt v. United States, 364 U.S. 350 (1960); *and* Woodby v. INS, 385 U.S. 276 (1966) (discussing deportation, denaturalization, and expatriation); Addington v. Texas, 441 U.S. 418 (1979) (discussing civil commitment proceeding); *and* Santosky v. Kramer, 455 U.S. 745 (1982) (discussing termination of parental rights).
Fn220 . In its motion, defendant stated that while it focused on the procedural protection afforded by a standard of proof beyond a reasonable doubt, "other procedural protection *may* also be applicable to this case . . . ." (emphasis added). Since defendant did not argue any reason or case law for the applicability of these other protections, the State and Court addressed only the standard of proof question.
Fn221 . *See supra*, note 217.
Fn222 . 232 U.S. 37 (1914).
Fn223 . 372 U.S. 144 (1983).
Fn224 . It is important to remember that the statute in *Kennedy*, which the Court found to violate defendants' procedural due process protections, implicated defendants' right of citizenship, "a most precious right." 372 U.S. at 159.
Fn225 . *See, e.g.*, United States v. Ward, 448 U.S. 242, *reh'g denied*, 448 U.S. 916 (1980).
Fn226 . *Id.*
Fn227 . *Id.* at 245.
Fn228 . *Id.* at 250.
Fn229 . The Supreme Court also has held that in an action by the SEC to establish fraud under the 1933 Securities Act, the SEC is required to prove its case only by a preponderance of the evidence. SEC v. C.M. Joiner Leasing Corp., 320 U.S. 344 (1943). Thus, in the field of securities litigation, the Supreme Court has required the same burden of proof - by a preponderance of the evidence - for public as well as for private plaintiffs.
Fn230 . 748 F. Supp. at 73.
Fn231 . *Id.* at 78-80.
Fn232 . Simpson v. Pittsburgh Corning Corp., 401 F.2d 277 (2d Cir.), *cert. denied*, 499 U.S. 1057 (1990).
Fn233 . *Hooker*, 748 F. Supp. at 79-80.
Fn234 . Pacific Mutual Life Ins. Co. v. Haslip, 499 U.S. 1 , 23 n.11 (1991), *see also Glasscock*, 946 F.2d at 1099.
Fn235 . Memorandum of OCC in Support of Motion to Dismiss the Punitive Damages Claim, at p.38 (Court Docket No. 867).
Fn236 . *Hooker*, 748 F. Supp. at 80.
Fn237 . 492 U.S. 257 (1989).
Fn238 . *Id.* at 259, 277.

Fn239 . *Kelco Disposal v. Browning-Ferris Indus.*, 845 F.2d 404, 406 (2d Cir. 1988).
Fn240 . *Id.* Fn241 . Interestingly enough, BFI seems to have failed in its attempts to drive Kelley out of business. By 1985, despite BFI's price cutting, Kelco had captured about 56% of the market. At that time, BFI decided to sell out to a third party and left the Burlington market. Thus, the case presents an instance when the actual damages caused by a "really mean" defendant were not great. Nonetheless, punishment was still imposed, deterring others from such egregious conduct.
Fn242 . *Kelco*, 845 F.2d at 410.
Fn243 . *Id.* Query: Is there a trend away from focusing on the ratio between the compensatory and punitive awards, and toward the ratio between the defendant's wealth (expressed often in terms of "net worth") and the size of the punitive damages award?
Fn244 . *Id.*
Fn245 . *BFI*, 492 U.S. at 262.
Fn246 . *Id.* at 264. To date, the Supreme Court has not ruled that the Excessive Fines Clause applies to punitive damage awards in civil cases. The holdings consistently have limited the Eighth Amendment prohibitions to criminal cases. *See, e.g.*, Ingram v. Wright, 430 U.S. 651, 666 (1977); Zwick v. Freeman, 373 F.2d 110, 119 (2d Cir. 1967), *cert. denied*, 389 U.S. 835 (1967). *But see BFI*, 257 U.S. at 287 (O'Connor, J., dissenting); McBride v. General Motors Corp., 737 F. Supp. 1563 (M.D. Ga. 1990).
Fn247 . 490 U.S. 435 (1989).
Fn248 . *Id.* at 275 n.21.
Fn249 . *Id.*
Fn250 . *Id.*
Fn251 . *Id.* at 438.
Fn252 . *Id.* Fn253 . *Id.* (emphasis added).
Fn254 . *Id.* at 440 (emphasis added).
Fn255 . *Id.* at 446 (emphasis added).
Fn256 . *Id.* at 447-48.
Fn257 . *Id.* at 448.
Fn258 . *Id.*
Fn259 . *Id.* at 449 (emphases added). It would not be out-of-line to suggest that the government seemed to be engaging in overkill in the case.
Fn260 . *Id.*
Fn261 . *Id.* (emphasis added).
Fn262 . *Id.* at 450.
Fn263 . *Id.*
Fn264 . *BFI*, 492 U.S. at 300 (O'Connor, J., concurring in part, dissenting in part).
Fn265 . 463 U.S. 277, 290-92 (1983) (convicting Helm of uttering a "no account" check for $100 and, because he had six prior felony convictions, he was sentenced to life imprisonment without the possibility of parole under a South Dakota recidivist statute).
Fn266 . *Id.* at 301.
Fn267 . *TXO*, 113 S.Ct. at 2720.
Fn268 . *Hooker*, 748 F. Supp at 80.
Fn269 . *Id.* at 71.
Fn270 . K. ELZINGA & W. BREIT, THE ANTITRUST PENALTIES: A STUDY IN LAW AND ECONOMICS 132 (1976).
Fn271 . 464 U.S. 238 (1984).
Fn272 . *Id.* at 257. *See also* discussion above of Judge Curtin's analysis of defendant's "public policy" argument for weighing punitive damages award deterrence against other deterrence.
Fn273 . Other developments, whereby states have attempted to address concerns about punitive damages, include: (1) standard of proof: some states have legislatively raised the burden of proof for punitive damages claims, in some or all types of cases, to a "clear and convincing" standard; some state courts have

declared that the common law of punitive damages requires a "clear and convincing" standard of proof, (New York requires proof by a preponderance of evidence); (2) CAPS: some states have legislatively imposed a numerical limit to the punitive damages claim which is recoverable, either by limiting the maximum amount of dollars or by limiting the ratio of punitive damages to the compensatory damages (New York does not have any such limit) *see, e.g.*, Martin F. Connor, *The State of the Punitive Damages Debate: 1993*, 8 TOXICS LAW REPORTER 357 (August 25, 1993).
Fn274 . *See, e.g.*, O'Connor, *supra* note 263.
Fn275 . 818 P.2d 262 (Colo. 1991) (en banc).
Fn276 . Under Colorado law, an exemplary damages award cannot exceed the amount of actual damages, except under certain circumstances. COLO. REV. STAT. §§ 13-21-102(1)(a) and 13-21-102(3) (1987). In addition, under Colorado law, the court may reduce an exemplary damages award if the deterrent effect has been accomplished or if the purpose has been served. COLO. REV. STAT. §§ 13-21-102(1)(a), (2)(a), and (c) (1987). In addition, a claim for exemplary damages must be proven beyond a reasonable doubt in Colorado. §13-25-127(2) (1987).
Fn277 . COLO. REV. STAT. §13-21-102(4) (1987).
Fn278 . *Kirk*, 818 P.2d at 264.
Fn279 . *Id.* at 265.
Fn280 . *Id.* at 274-75.
Fn281 . 737 F. Supp. 1563 (M.D. Ga. 1990).
Fn282 . O.C.G.A. § 51-12-5.1(e) (Supp. 1993) "[o]nly one award of punitive damages may be recovered in a court in this state from a defendant for any act or omission if the cause of action arises from product liability, regardless of the number of causes of action which may arise from such act or omission."
Fn283 . O.C.G.A. § 51-12-5.1(e)(2) (Supp. 1993).
Fn284 . *McBride*, 737 F. Supp. at 1570.
Fn285 . *Id.* at 1570-71.
Fn286 . *Id. See also* Bagley v. Shortt, 410 S.E.2d 738 (Ga. 1991) (holding as constitutional a different provision of the punitive damages tort reform legislation [OCGA § 51-12-5.1(g)], which set a $250,000 cap on each punitive damages award, on the reasoning that if punitive damages awards can be eliminated, as in Georgia's no-fault auto cases, then such awards may be circumscribed).
Fn287 . *Id.* at 1578. *See* Mack Trucks, Inc. v. Conkle, 436 S.E.2d 635 (Ga. 1993) (holding that the provision requiring 75% be paid to the state did not violate equal protection rights, under the Fourteenth Amendment, nor did it constitute a taking, under the Fifth and Fourteenth Amendments).
Fn288 . *See* Oberg v. Honda Motor Co., 851 P.2d 1084 (Or. 1993), *cert. granted*, 114 S.Ct. 751 (1994) (holding that the Oregon constitutional prohibition against "excessive fines" did not bar a punitive damages award involving private parties; *certiorari* was granted on the issue of whether another Oregon law bars judicial review of the size of a jury's punitive damages award, in violation of the Fourteenth Amendment), *rev'd*, 114 S.Ct. 2331 (1994). The Court held that the Oregon prohibition against post-verdict judicial review of the amount of punitive damages violated the Due Process Clause. In dissent, Justice Ginsburg, joined by Chief Justice Rehnquist, argued that while Oregon provided very little in the way of post-verdict judicial review, Oregon did provide specific, detailed pre-verdict jury controls, including a "clear and convincing" standard of proof and the application of seven substantive criteria.
Fn289 . 780 F. Supp. 1225 (S.D. Iowa 1991).
Fn290 . Iowa Code § 668A.1(2) (1987) (providing in part, that the state "cut" applies only if defendant's wrongful conduct was not directed specifically against plaintiff; if the wrongful conduct was directed specifically against the plaintiff, then plaintiff receives the entire punitive award).
Fn291 . *Burke*, 780 F. Supp. at 1242.
Fn292 . 473 N.W.2d 612, 618-19 (Iowa 1991).
Fn293 . *Id.* at 619.
Fn294 . *Id.*
Fn295 . 585 So.2d 1033 (3d Fla. Dist. Ct. App. 1991), *aff'd*, 608 So.2d 800 (Fla. 1992), *cert. denied*, 113

S.Ct. 1647 (1993).
Fn296 . FLA. STAT. § 768.73(2)(b) (Supp. 1986) (providing in part, that, "If the cause of action was based on personal injury or wrongful death, 60 percent of the award shall be payable to the Public Medical Assistance Trust Fund . . . ; otherwise, 60 percent of the award shall be payable to the General Revenue Fund.").
Fn297 . *Gordon*, 585 So.2d at 1035.
Fn298 . *Id.* at 1036.
Fn299 . *Id.* at 1036-37.
Fn300 . *Id.* at 1037.
Fn301 . *Haslip*, 499 U.S. at 42 (Kennedy, J., concurring); *see also BFI*, 492 U.S. at 279.
Fn302 . Moreover, other issues will have to be confronted at such a time, including whether the Eighth Amendment applies to the states through the Fourteenth Amendment, and whether the Amendment protects corporations as well as individuals. *BFI*, 492 U.S. at 276.

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Questions and Concerns

How do we know what good is
until we understand the facts?

CGN-9 U.S.S. Long Beach

Facts:

Guided Missle

Cruiser

•Weight- 17,525

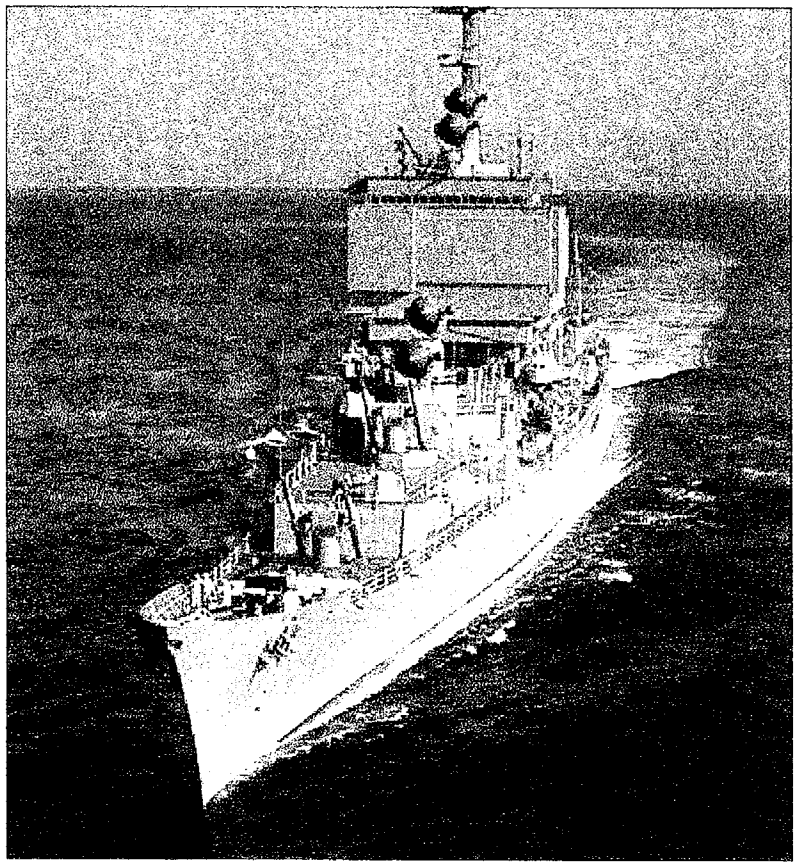
Tons fully loaded

•Length- 721 feet

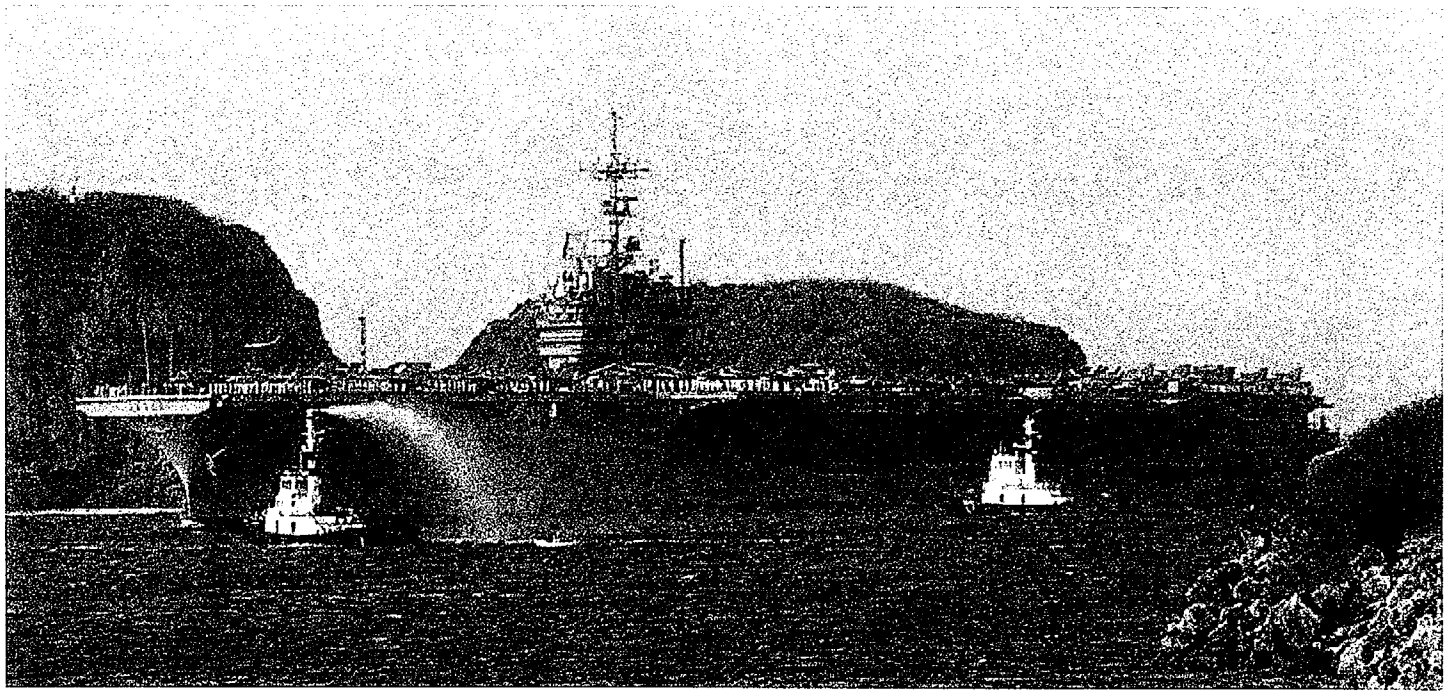
•Beam – 73 feet

Source- Military Analysis

Network



CVA –59 U.S. S. Forrestal



Facts: Aircraft Carrier

- Weight- 56,000 tons, Light Displacement
- Length- 1,046 Feet
- Beam- 129.33 Feet <u>Extreme Width-</u> 252 Feet
- Source- Dictionary of Naval Fighting Ships, Vol. 3, 1963

CVN- 75 U.S.S. Harry S. Truman

Facts:

Nimitz Class Super Carrier

•Weight-77,607 Tons light Displacement

•Length-1,092 feet

•Flight Deck Width

•252 feet

•Source-DOD, & NAVSCA

Composite Weight

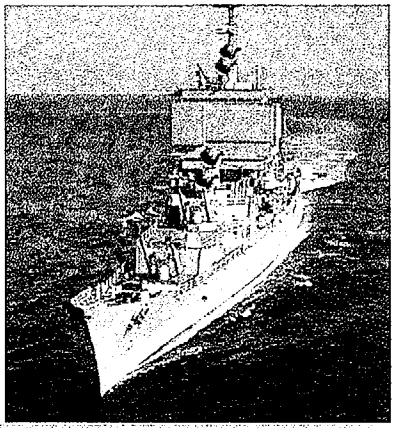
Vessel	Weight
USS Long Beach	17,525 Tons
USS Forrestal	56,000 Tons
USS Truman	77,607 Tons
Total Weight	151,132 Tons

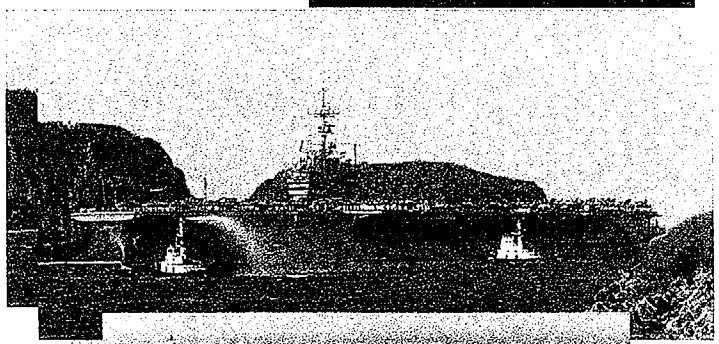
Proposed Weight of Material

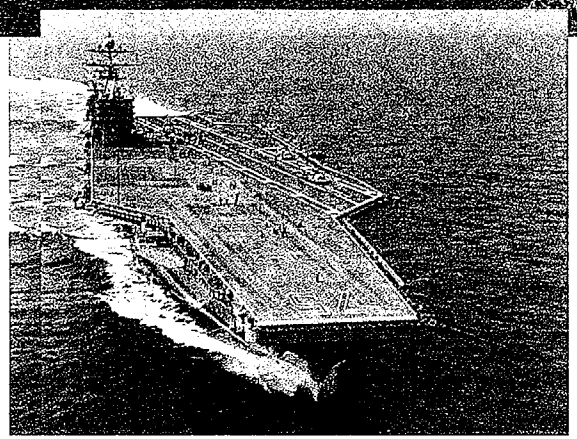
To be stored in cell

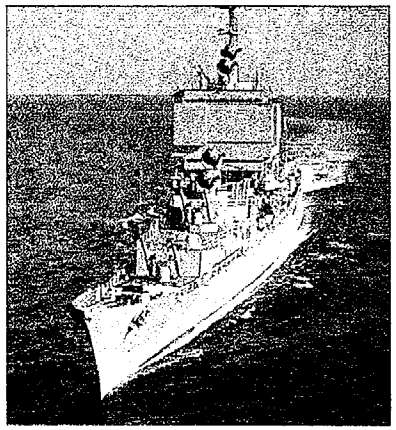
(90 lbs/cu ft)

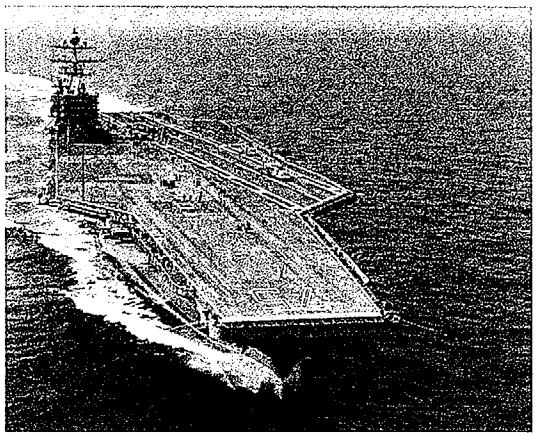
Mass	Total Weight
125,000 cu yrds	151,875 tons

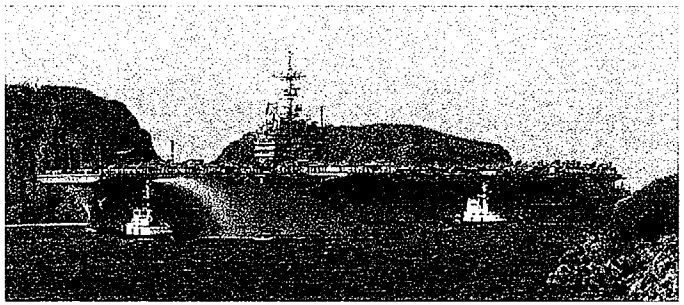


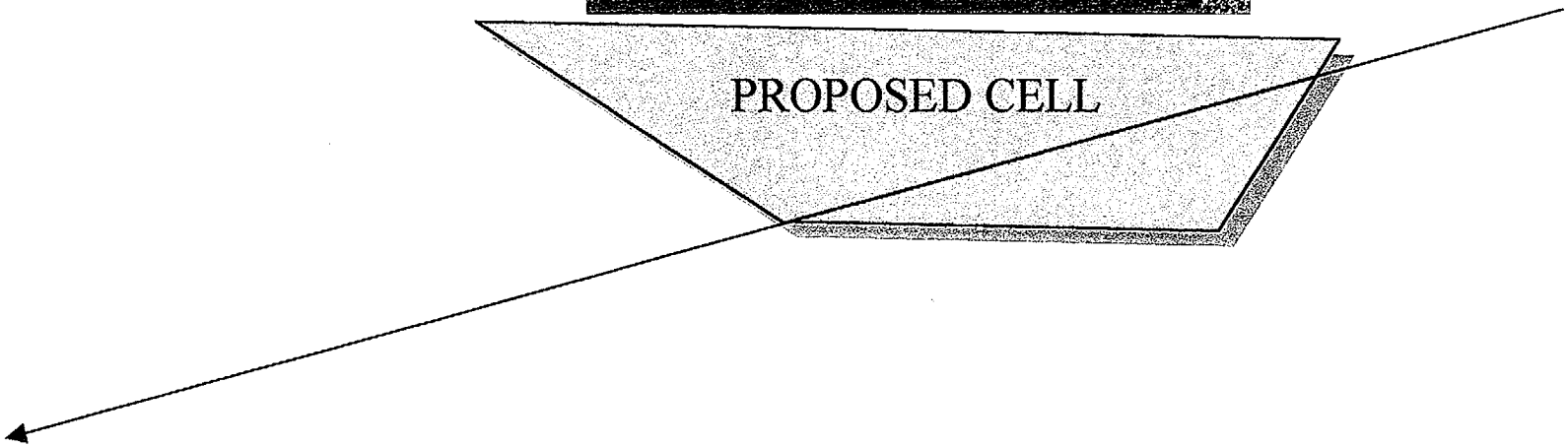












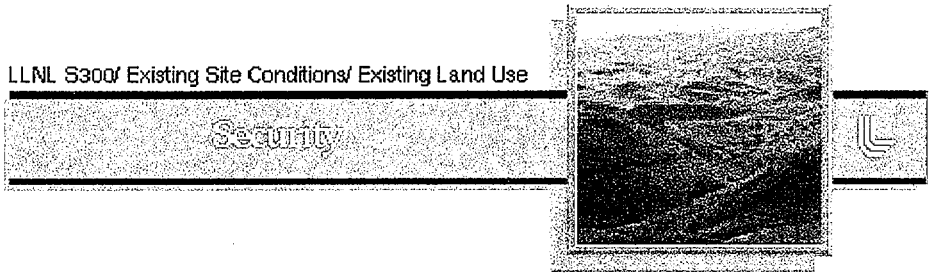
What Would Newton Say about this?

What is Good Public Policy?

- If Public Policy is made in light of outcomes, in this case;
- Who wins, who looses and who pays?
- The injury will be General and Particular

This is a copy of the original document: it contains the Explorer toolbar and highlights. You will find the original at

http://www.llnl.gov/pe/s300_comp_plan/secur.html



- On-Site Security Facilities and Procedures
- Emergency Response Characteristics
- Off-Site Agency Involvement
- Existing Security Zones and Pending Transition
- Transition in 1998
- Site Fencing

This section presents an overview of on-**site security**. Site 300, as part of the LLNL operation, shares the same security arrangements as the LLNL main Livermore site, including police services provided by off-site agencies participating in mutual aid agreements with LLNL.

On-Site Security Facilities and Procedures

The Laboratory meets DOE requirements by establishing safeguards and security policies and procedures. The Safeguards and Security Manual describes LLNL's security policies, program requirements, and organization responsibilities. It is organized to provide overall guidance for LLNL security practices at both sites.

It is the function of the Protective Force Division (PFD) to provide protection of LLNL personnel and assets. This protection is provided through several elements including access control, fixed access and surveillance points, random vehicle and foot patrols, response elements, and special response team elements.

The PFD at Site 300 is within the Safeguards and Security Department and is located in Building 882. Approximately 18 PFD officers are assigned to Site 300. The PFD maintains eight all-wheel-drive vehicles at Site 300.

Emergency Response Characteristics

The PFD has contingency plans to cover credible emergencies including work stoppages, bomb threats, natural disasters, site-wide evacuations, call-out procedures, satellite command center activation procedures, executive protection, alarm response procedures, and civil disorders. Based on compliance with DOE Order 5632.7A and the Safeguards and Security General Orders, the PFD provides adequate emergency response service to the LLNL Livermore site and LLNL Site 300.

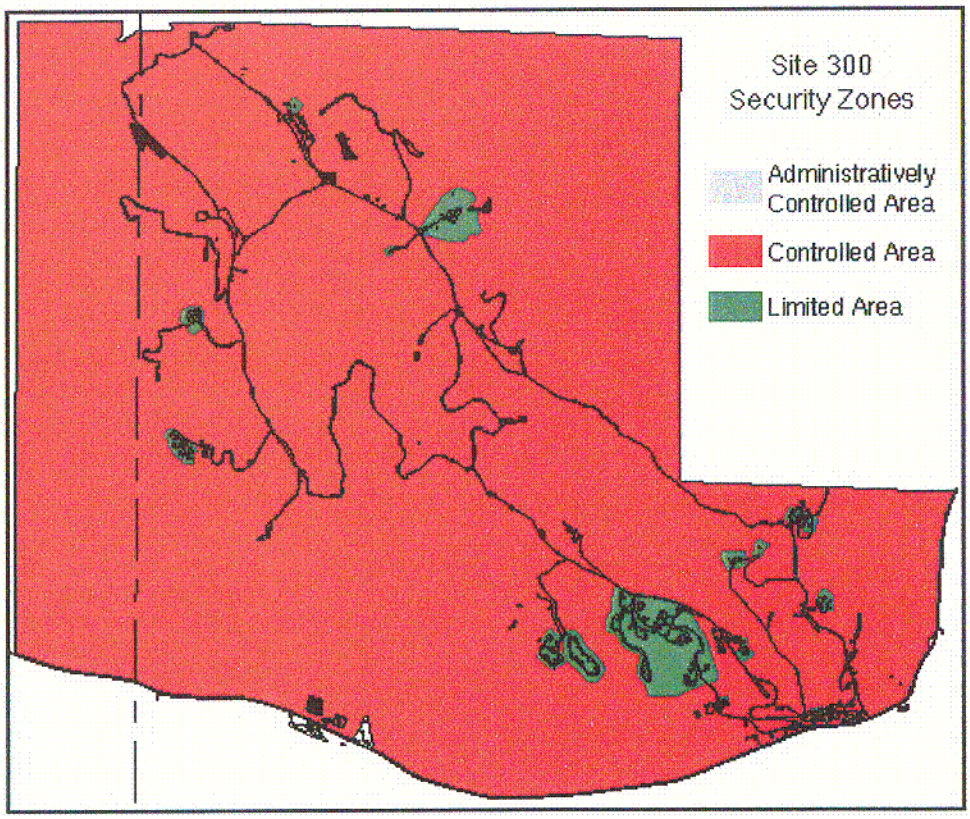
Off-Site Agency Involvement

Site 300 is within Patrol District 8 of the San Joaquin County Sheriff's Department. Sheriff's Department records show that its department received no calls for assistance at Site 300 and that the Department requested no assistance from LLNL's Protective Force Division in 1991-1997. Additional information on off-site agency involvement can be found in the 1992 EIS/EIR, Volume 1, Section 4.4.2, Police and Security Services.

Existing Security Zones and Pending Transition

Security fencing is used at Site 300 to delineate the differing geographical security zones (see map below). The security system at Site 300 is similar to the one employed at the Livermore site but it consists of only three zones:

Open	This zone is the southern portion of the GSA and includes the cafeteria, badge office, and employee parking lots.
Controlled	The greatest portion of Site 300 is controlled.
Limited	Facility clusters form Limited "islands" or fenced activity areas on the Site.



After normal working hours, generally 5:30 PM or 6:00 PM, the Open zone becomes a Controlled zone by the physical management of fencing and gates. The central portion of the site retains its Controlled status and the Limited areas remain unchanged.

Transition in 1998

The implementation of the DOE standard badge that began in the fall of 1997 will affect many different aspects of physical security including the various security areas and their designations. The access level on badges are designated with numbers. The DOE standard badge will indicate a "3" for "Q" access authorization, a "2" for "L" access authorization, and a "1" for uncleared personnel. When the DOE standard badge is fully implemented, the following security area designations will be standard:

Level 3	Denotes a "Special Limited Area." Unescorted persons entering these areas must display a badge identified with the number "3" indicating that a "Q" clearance is required for unescorted access.
Level 2	Denotes a classified area known as a "General Limited Area." Unescorted persons entering this area must display a badge identified with the number "2" or "3" indicating that either an "L" or "Q" clearance is required for unescorted access. However, some General Limited Areas have additional access control restrictions based on need-to-know.
Level 1	Denotes an "unclassified" area such as an "Open Area" that requires no badge or a "Property Protection Area" that requires a badge identified with the number "1," "2," or "3" indicating that a security clearance is not required for unescorted access.

Site Fencing

Site 300 has two types of fencing:

- **Perimeter Fencing:** Identifies the boundaries of the Site and warns potential trespassers that the land is government property utilized for the detonation of high explosives.
- **Security Fencing:** Delineates and protects the Controlled and Limited areas at Site 300.

Access to Site 300 is controlled by a PFD staffed entry point within the GSA. Additional staffed entry points within the Site control access to the Process Area. The West and East Firing Areas have electronic vehicle access controls for safety purposes.

A physical security survey was performed to determine the most efficient and effective way to bring the Site into compliance with DOE directives. Subsequent analyses determined that it would be possible to reconfigure and create Limited area "islands" within the Site. Since many of the individual existing facilities were already contained within fenced areas for safety reasons, it was deemed most cost-effective to simply upgrade those individual areas to acceptable DOE Security Plan standards.

The current physical security configuration incorporates specific Limited Area "islands" leaving the rest of the Site a Controlled Area (see map above).

Related WWW Sites: | LLNL Site 300 Home Page | LLNL Livermore CSP | 1992 LLNL EIS/EIR |

Last modified September 29, 1998.
For information about this page contact:
Debbie Marsh, marsh2@llnl.gov

and LLNL Disclaimers

UCRL-MI-130630

(SSP-98-0076-DT)

CONSUMER NOTICE

This notice has been posted for the purpose of identifying the possible existence of a problem that has been deemed dangerous by some people in the community.

With in a quarter mile of here lies the property of the Moly Corporation. On this site, plans exist to bury a type of hazardous waste. Although Moly Corporation, the E.P.A. and the N.R.C. has assured the community there is no danger we at Howard Hanna feel it our responsibility to let the consumer be aware of this fact and decide for themselves if they in fact feel comfortable.

We in no way are experts and cannot be held liable for any decisions regarding this or any properties affected by such circumstances.

It will remain the responsibility of the consumer to determine if a threat exist and to then proceed appropriately.

CONSUMER NOTICE

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http://www.hanford.gov/phmc/assessment/fdh/4-4opt.htm

PHMC FY97
CRITICAL SELF ASSESSMENT

4.4 OPTIMIZATION OF THE HANFORD SITE INFRASTRUCTURE

Introduction

Fluor Daniel Hanford (FDH) is committed to provide and optimize infrastructure services in a safe, secure, environmentally sound, and cost-effective manner.

Site security services include:

Information Security	Safeguards Material Control and Accountability
Physical Security	Locksmith Operations
Personnel Security	Protective Forces
Engineering Maintenance	Computer Security
Site Access Control	Security Analysis

Infrastructure services include:

Facility Management
General Purpose Office Space
Utility Services
Transportation Infrastructure
Site Transportation Services
Fire Department and Emergency Response Services
Emergency Preparedness
Fabrication Shops
Municipal Solid Waste
Clothing Supply
Real Estate and Property Management
Calibration and Engineering Laboratories
Land-use Planning and Management
Disposition of Excess General Purpose Facilities
Janitorial Services

Optimization of the Hanford Site Infrastructure	
Positives	**Negatives**
Isolation of Buildings	Calibration Lab
Excessed Rail Cars	Emergency Preparedness Command and Control Issues
Reduced Fleet Equipment	Outsourcing
DynCorp Tri-Cities Safety Record	Future Requirements
Security Deliverables	

Table 4.4-1: Infrastructure Self Assessment Ratings

Project Hanford Management Contract (PHMC) performance in **Optimization of the Hanford Site Infrastructure** is rated **Excellent**. Service quality has been maintained while improving safety performance and cutting costs. A few performance challenges are noted.

Infrastructure Services Performance Objectives: Reduce Hanford infrastructure to the minimum necessary consistent with current and anticipated mission assignment, prudent business practices, and strategic plans. Evaluate integration of site infrastructure levels with current and planned mission requirements, including management of capital-type expenditures and assigned contracts. Infrastructure levels shall include agreements with other prime contractors on the site. Include use of innovative approaches, new technology, subcontracting and outsourcing, and other creative ideas. (PHMC, Section C.4)

Successes and Accomplishments

Significant progress has been made toward the reduction of infrastructure to levels consistent with mission requirements. Examples include:

- Isolation and demolition of buildings
- Excess and disposal of contaminated railcars
- Reductions in general purpose fleet equipment
- Elimination of underutilized office space

Development of plans to vacate the 1100 Area through transfer of operations is progressing as planned.

Efficiencies of infrastructure services have improved. In general, established reduction and utilization goals have been exceeded for most equipment categories, manpower categories, and general purpose space. The vehicular reduction in Figure 4.4-1 is typical of performance in most areas.

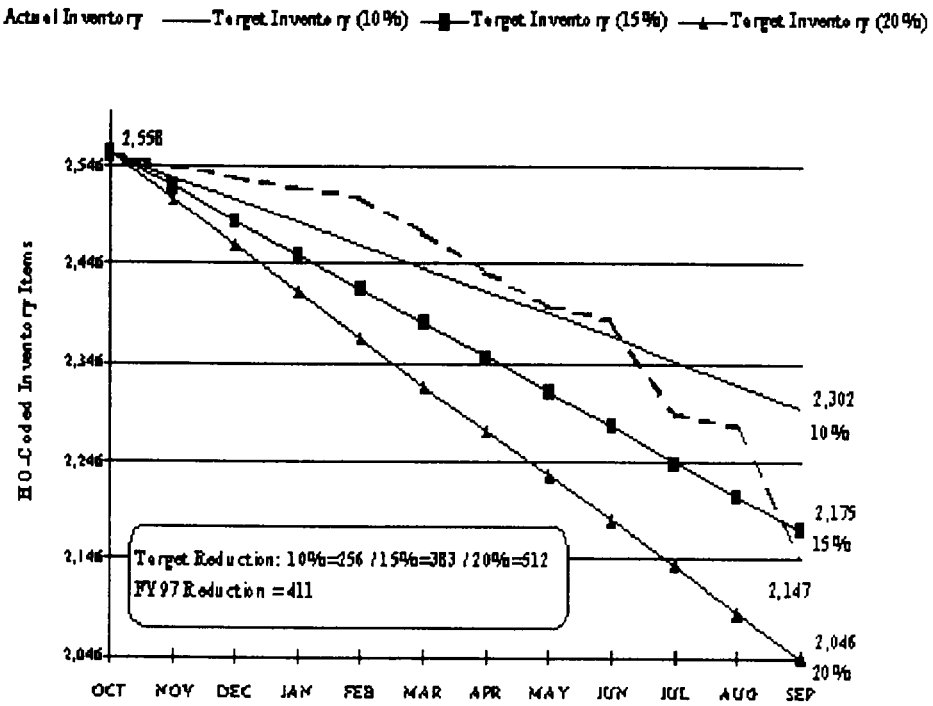

Figure 4.4-1: DOE Owned Vehicles and Heavy Equipment

Infrastructure reduced costs by $10 million from the October 1996 budget baseline of $95 million. Employees charging indirect budgets were reduced by 16 percent from 983 to 827 with little reduction in services.

DynCorp Tri-Cities Services safety and health performance improvement is illustrated in Figure 4.4-2 and Figure 4.4-3.

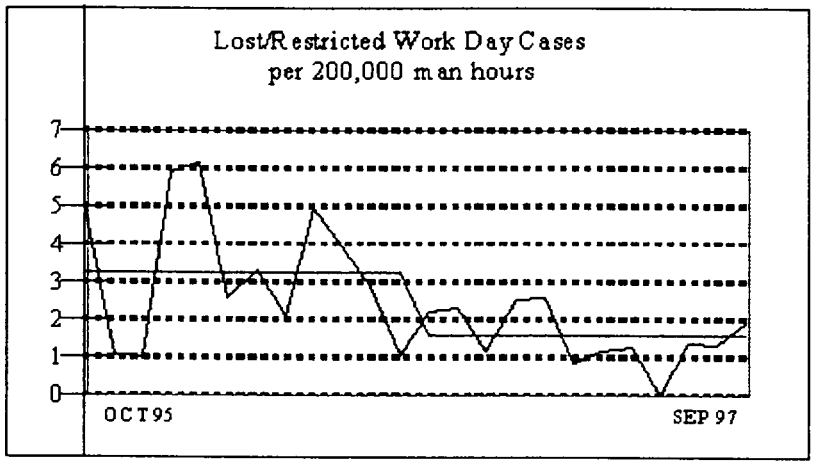

Figure 4.4-2: Lost/Restricted Work Day Case Rate for DynCorp Tri-Cities

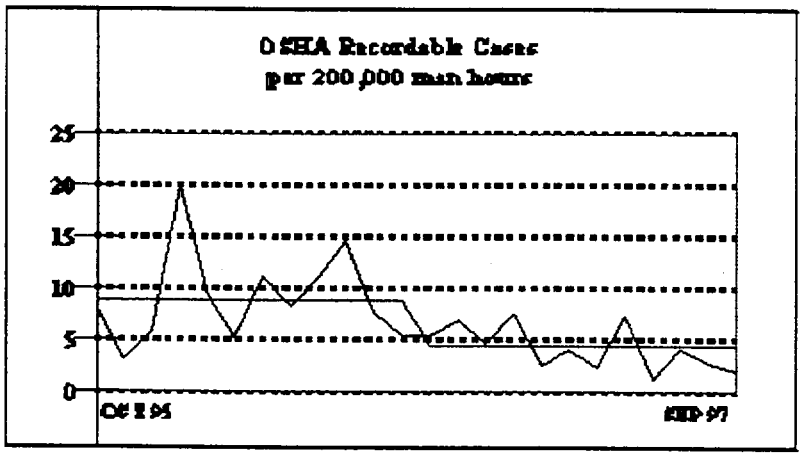

Figure 4.4-3: OSHA Recordable Case Rate for DynCorp Tri-Cities

Improvement related to the safety cost index is also significant. Average cost per claim has dropped from $9,406 to $2,459. Dollar cost index has been reduced from FY96 $115,000 per month to FY97 $13,800 per month.

DynCorp Tri-Cities achieved one million man hours without a lost time injury in March 1997. A second million man hours without a lost time injury was achieved on September 13, 1997. The company was awarded the World Safety Organizations Concerned Corporation/Company Award. This honor is presented to the worlds top six companies/corporations that have demonstrated open commitment to the safety and health of employees.

Environmental performance is also commendable. Examples include updating and negotiation of various site permits and dangerous waste management processes.

DynCorp Tri-Cities has demonstrated a positive commitment to the quality program as demonstrated by its early implementation of a comprehensive management assessment program.

Deficiencies

The Hanford Standards Laboratory has significant performance issues related to calibration of equipment. Initial response toward resolving the identified performance issue was slow. A corrective action plan has now been approved for addressing Hanford Standards Laboratory problems.

Outsourcing of infrastructure has not met management or client expectations. Existing barriers continue to be addressed through various negotiations.

Strategic planning for infrastructure was weak and not supported by systems engineering data. Programmatic identification of site service requirements was weak and not tied to strategic planning or systems engineering. DynCorp Tri-Cities placed a contract with Technical Resources International (TRI) to prepare a strategic plan for site support and infrastructure services which is not yet complete.

Security Services Performance Objective: Manage, operate, and integrate all Safeguards and Security services of the Hanford Site.

The Safeguards and Security program includes program protection management, Protective Forces, physical protection, nuclear material control and accountability, personnel security, and information security. Safeguards and Security operations are based on a graded approach to ensure a cost effective and risk-managed program that is compliant with DOE Orders, DOE-RL directives, and company procedures. The three major objectives of the Safeguards and Security program are to protect nuclear material, classified and sensitive information, and government assets. The Safeguards and Security program goals for the past 12 months were identified in 30 specific milestones in the FY97 Safeguards and Security Program Plan.

Successes and Accomplishments

All 30 Safeguards and Security milestones for FY97 were successfully completed with 13 completed ahead of schedule.

Department of Energy-Headquarters (DOE-HQ) conducted a three month Safeguards and Security management evaluation resulting in a rating of satisfactory (the highest rating

given) for the Safeguards and Security program, which indicated a stable, effective program. Twenty-four action items were identified as observations and recommendations in the final report. Of the 24 action items, 12 have been closed and seven are waiting for DOE-RL verification and closure. Five items are still being addressed.

DOE-HQ also required a Hanford Site profile to be generated for the Safeguards and Security program. They reported the overall status of the Protective Forces was sound and commented that the close integration and coordination of performance testing activities could serve as a model for other DOE sites in the complex.

The following performance indicators, tracked on a monthly basis, reflect an excellent level of performance.

- Security Evaluation and Maintenance (SEM) has maintained a 99 percent completion rate for priority one and two maintenance tasks.
- SEM has maintained a 99.5 percent security system up-time rate.
- Central Badging Operations has maintained a 99.2 percent customer satisfaction rate.

The Safeguards and Security program reduced cost in all areas including the indirect site-wide savings, general and administrative, and patrol self-liquidating pool as well as direct costs to specific programs. These cost reductions were consistent with Safeguards and Security commitments to site customers and best business practices. Reductions were in both labor and non-labor costs. Labor savings result from a combination of factors including rates and attrition while non-labor savings are in reduced costs for travel, materials, and contracted services. Consolidation of functions, cross training of employees, and process improvements enabled Safeguards and Security to meet objectives and outputs at a reduced cost. For the most part, Safeguards and Security savings have been passed on to PHMC customers throughout the fiscal year.

Several organizational changes were implemented within Safeguards and Security to enhance productivity, align similar functions, improve service to customers, and help provide back-up resources in cases of employee absences. In October 1996, the Northern and Southern Security sections were consolidated into one Security Operations section.

Deficiencies

A few weaknesses were noted in Safety and Security performance. An investigation of the May 1997 over-pressurization event identified weaknesses in Protective Forces respirator use, checklist accuracy, and emergency access control during lock down conditions. Actions to correct these issues have been initiated. Protective Forces management has requisitioned replacement respirators for Protective Forces members and has updated point-of-contact checklists after coordination with FDH Emergency Preparedness. There are also on-going discussions with DOE-RL concerning alignment of the Safeguards and

Security organization under the current contract.

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For questions or comments, please send email to Penny_M_Phelps@rl.gov
URL: http://www.hanford.gov/phmc/assessment/fdh/4-4opt.htm
Posted: November 4, 1997

Environmental Excellence
HANFORD WORKS!

The HANFORD REACH

October 11, 1999

A publication of the U.S. Department of Energy for all Hanford Site employees

INSIDE

PROJECTS

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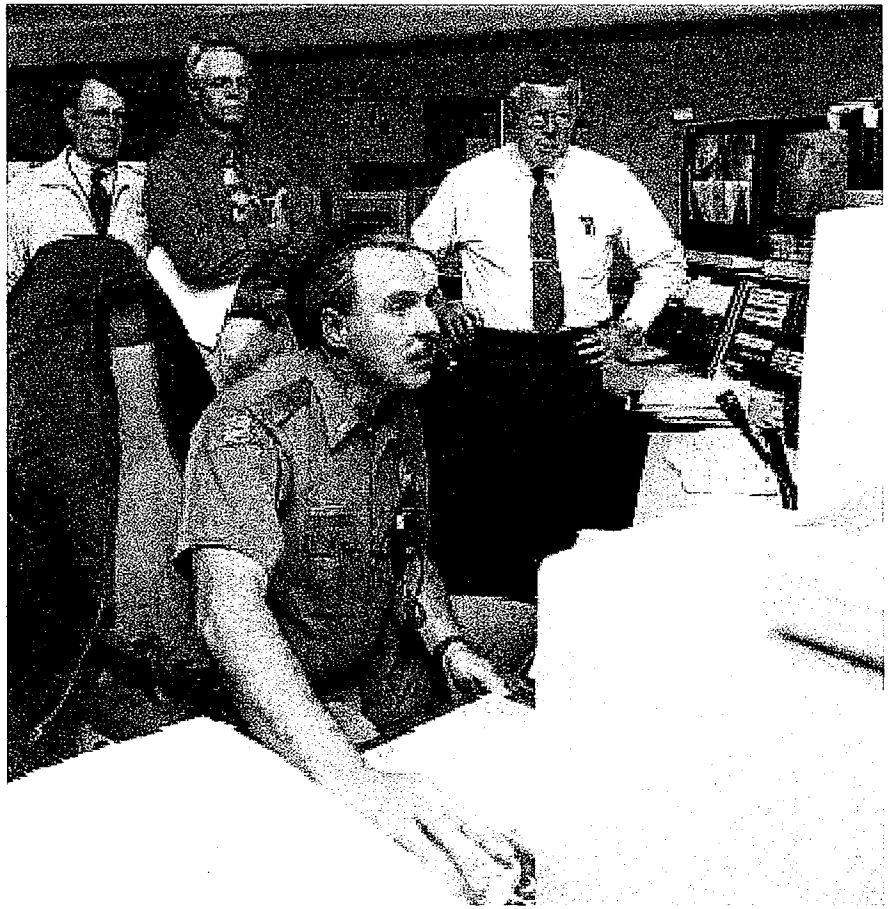

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REVIEWING HANFORD SECURITY: Gen. Eugene Habiger, right, director of the Office of Security and Emergency Operations for the Department of Energy, gets a briefing on emergency communications at Hanford's Patrol Operations Center on Sept. 28. At the console demonstrating computer displays used for communicating with other local, state and on-site entities is Lt. Terry Eberts of the Hanford Patrol. Others participating in Habiger's review of Hanford's safeguards and security program are, from left, Ben Essary, general manager of Protection Technology Hanford, and Jim Spracklen, director of Security and Emergency Services for the DOE Richland Operations Office.

This is a copy of the original document: it contains the Explorer toolbar and highlights. You will find the original at

http://www.srs.gov/general/aboutsrs/sources/PMMD/pr02.htm

WSRC Procurement

Home

WSRC PROCUREMENT DEPARTMENT LOCATION

Map

The Westinghouse Savannah River Company's (WSRC) Procurement Department is located in Building 730-4B on the Savannah River Site (SRS).

Our On Site Location requires SRS suppliers to prepare in advance when scheduling visits to the Site. Please pay close attention to the following information, because the Site rules are strictly enforced.

There are two preferred entrance and exit points for supplier visits to 730-4B: barricade 2 (New Ellenton), and barricade 8, located off SC Highway 125 at SRS Road 2. Signs have been installed along these routes to direct you to the "WSRC Procurement Department".

All procurement personnel telephone numbers will be available at Site barricades.

Suppliers wishing to meet with WSRC procurement personnel will have to make arrangements with those whom they wish to meet, in order to obtain a gate pass from Site Security at the barricades. Please keep in mind that your temporary gate pass authorizes access to 730-4B only.

When possible, avoid coming to the Site during SRS employee rush hours: 7:00-9:00 AM and 3:00-5:00 PM. Also allow yourself at least 30 extra minutes; there may be several vehicles ahead of you at the barricades.

All persons and vehicles entering and exiting WSRC are subject to random search inspections. Remove all contraband items from your vehicle before coming to the Site. The following items are considered contraband and are prohibited on the general Site:

Firearms
Weapons (bows, arrows, crossbows, martial arts weapons)
Simulated weapons (Toy Guns, etc.)
Ammunition
Incendiaries, explosive materials and related devices
Alcoholic beverages (Including NA Beer)
Non-prescription narcotics, illegal drugs, controlled substances, and drug paraphernalia
Chemical irritants (Mace carried for personal protection is not considered contraband)
Stun guns

Site security guards are duly sworn constables in South Carolina and have full police authority. ALL traffic lawsare STRICTLY enforced - please drive carefully.

Again, keep in mind that your visit to SRS will require advance preparation.

For More Information Contact: **Supplier Development Group at 800-888-7986.**

e-Mail: patricia.ochiltree@srs.gov

Westinghouse Savannah River Company
Building 730-4B, Aiken, SC 29808
FAX: 803-952-8469

Home

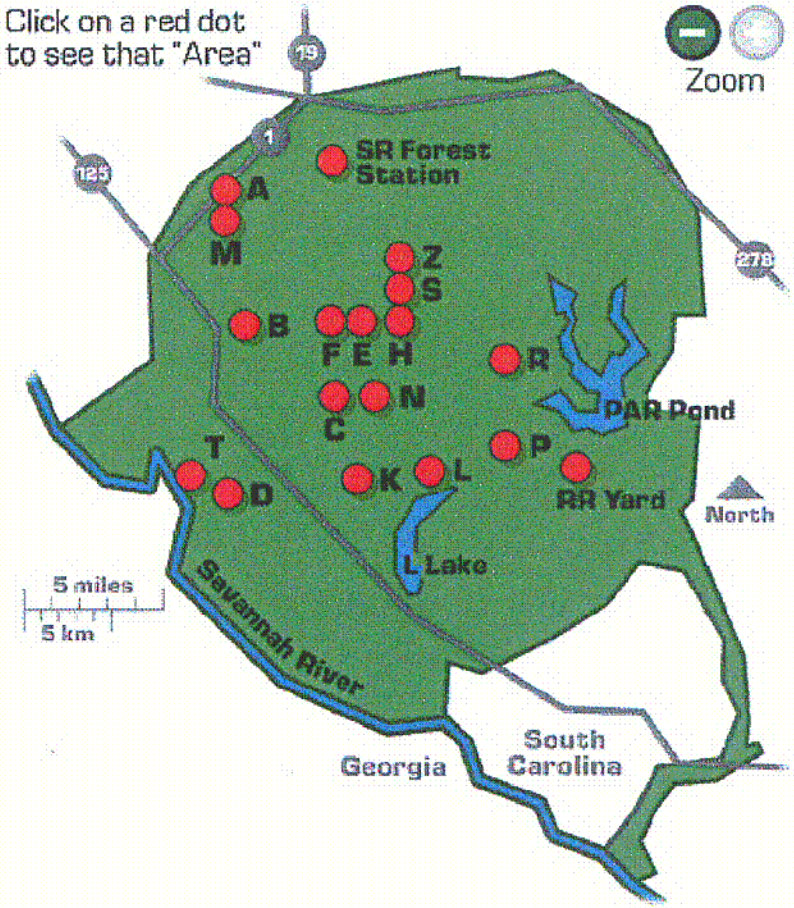
e-Mail: lynn.avila@srs.gov

DOE Savannah River Operations Office

Savannah River Site

- Information
- Opportunities
- Environment
- Technology
- Happening Now
- Feed Back

Click on a red dot to see that "Area"



C2

Molycorp, Inc.

Washington, PA Facility

Year	Cash Balance	Earned Interest	COSTS: Cell Cover Maint.	Perimeter Fencing Maint.	Security Inspection	Thermo. Dosimeters	Grade Haul Road	Cleaning/ Blasting Bridge	Management Fee	Groundwater Monitoring*	Bridge Inspection	Thermo. Dosim. TLD Replace.	Bridge Painting, Sandblasting	Well Replacement	Fence Replacement	Bridge Replacement	Total Costs	Cash Balance	Annual Change	Change to Date
1	2,094,853	115,217	11,029	1,320	2,000	520	4,856	1,447	5,000	13,600							39,772	2,170,298	75,445	75,445
2	2,170,298	117,292	11,415	1,366	2,070	538	5,026	1,498	5,175	14,076	7,452						48,616	2,238,974	68,676	144,121
3	2,238,974	121,255	11,815	1,414	2,142	557	5,202	1,550	5,356	3,642							31,678	2,328,550	89,577	233,697
4	2,328,550	125,607	12,228	1,464	2,217	577	5,384	1,604	5,544	3,770	7,983						40,770	2,413,387	84,837	318,534
5	2,413,387	130,403	12,656	1,515	2,295	597	5,572	1,660	5,738	3,902		1,377	21,275				56,587	2,487,204	73,817	392,351
6	2,487,204	134,766	13,099	1,568	2,375	618	5,767	1,719	5,938	4,038	8,551						43,674	2,578,297	91,093	483,444
7	2,578,297	139,301	13,557	1,623	2,459	639	5,969	1,779	6,146	4,179							36,352	2,681,246	102,950	586,393
8	2,681,246	144,637	14,032	1,679	2,545	662	6,178	1,841	6,361	4,326	9,160						46,784	2,779,100	97,853	684,247
9	2,779,100	150,160	14,523	1,738	2,634	685	6,394	1,905	6,584	4,477							38,941	2,890,318	111,219	795,465
10	2,890,318	155,909	15,031	1,799	2,726	709	6,618	1,972	6,814	4,634	9,813	1,635	25,268				77,020	2,969,207	78,889	874,354
11	2,969,207	161,137	15,557	1,862	2,821	734	6,850	2,041	7,053	4,796							41,714	3,088,630	119,423	993,777
12	3,088,630	166,591	16,102	1,927	2,920	759	7,090	2,113	7,300	4,964	10,512						53,686	3,201,535	112,905	1,106,682
13	3,201,535	172,980	16,666	1,995	3,022	786	7,338	2,187	7,555	5,138							44,685	3,329,829	128,294	1,234,976
14	3,329,829	179,612	17,249	2,064	3,128	813	7,595	2,263	7,820	5,317	11,260						57,510	3,451,932	122,103	1,357,079
15	3,451,932	186,498	17,853	2,137	3,237	842	7,860	2,342	8,093	5,504		1,942	30,011				79,821	3,558,609	106,677	1,463,756
16	3,558,609	192,790	18,477	2,211	3,351	871	8,135	2,424	8,377	5,696	12,063						61,606	3,689,793	131,184	1,594,940
17	3,689,793	199,331	19,124	2,289	3,468	902	8,420	2,509	8,670	5,896							51,277	3,837,846	148,054	1,742,993
18	3,837,846	207,010	19,793	2,369	3,589	933	8,715	2,597	8,973	6,102	12,922						65,994	3,978,863	141,016	1,884,010
19	3,978,863	214,959	20,486	2,452	3,715	966	9,020	2,688	9,287	6,315							54,930	4,138,893	160,030	2,044,040
20	4,138,893	223,238	21,203	2,538	3,845	1,000	9,336	2,782	9,613	6,537	13,842	2,307	35,643	13,458			122,102	4,240,029	101,136	2,145,176
21	4,240,029	230,420	21,945	2,627	3,980	1,035	9,662	2,879	9,949	6,765							58,842	4,411,607	171,578	2,316,754
22	4,411,607	237,920	22,713	2,718	4,119	1,071	10,001	2,980	10,297	7,002	14,828						75,729	4,573,798	162,191	2,478,945
23	4,573,798	247,099	23,508	2,814	4,263	1,108	10,351	3,084	10,658	7,247							63,033	4,757,863	184,066	2,663,010
24	4,757,863	256,621	24,331	2,912	4,412	1,147	10,713	3,192	11,031	7,501	15,884						81,123	4,933,361	175,497	2,838,508
25	4,933,361	266,509	25,183	3,014	4,567	1,187	11,088	3,304	11,417	7,763		2,740	42,333		159,833		272,428	4,927,441	(5,920)	2,832,588
26	4,927,441	271,172	26,064	3,119	4,726	1,229	11,476	3,420	11,816	8,035	17,015						86,901	5,111,712	184,271	3,016,859
27	5,111,712	276,077	26,976	3,229	4,892	1,272	11,878	3,539	12,230	8,316							72,332	5,316,457	203,745	3,220,604
28	5,316,457	286,747	27,921	3,342	5,063	1,316	12,293	3,663	12,658	8,607	18,227						93,091	5,509,113	193,656	3,414,260
29	5,509,113	297,676	28,898	3,459	5,240	1,362	12,724	3,791	13,101	8,909							77,484	5,729,305	220,192	3,634,452
30	5,729,305	309,056	29,909	3,580	5,424	1,410	13,169	3,924	13,559	9,220	19,526	3,254	50,278				163,254	5,885,108	155,803	3,790,255
31	5,885,108	319,396	30,956	3,705	5,614	1,460	13,630	4,061	14,034	9,543							83,003	6,121,502	236,394	4,026,649
32	6,121,502	330,182	32,040	3,835	5,810	1,511	14,107	4,204	14,525	9,877	20,916						106,824	6,344,859	223,358	4,250,006
33	6,344,859	342,825	33,161	3,969	6,013	1,563	14,601	4,351	15,034	10,223							88,914	6,598,770	253,911	4,503,917
34	6,598,770	355,950	34,322	4,108	6,224	1,618	15,112	4,503	15,560	10,581	22,406						114,432	6,840,287	241,517	4,745,434
35	6,840,287	369,574	35,523	4,252	6,442	1,675	15,640	4,661	16,104	10,951		3,865	59,715				158,827	7,051,034	210,747	4,956,181
36	7,051,034	382,011	36,766	4,400	6,667	1,733	16,188	4,824	16,668	11,334	24,002						122,583	7,310,463	259,429	5,215,610
37	7,310,463	394,941	38,053	4,554	6,901	1,794	16,754	4,993	17,251	11,731							102,031	7,603,373	292,910	5,508,520
38	7,603,373	410,130	39,385	4,714	7,142	1,857	17,341	5,167	17,855	12,141	25,711						131,314	7,882,190	278,817	5,787,337
39	7,882,190	425,853	40,763	4,879	7,392	1,922	17,948	5,348	18,480	12,566							109,298	8,198,744	316,555	6,103,891
40	8,198,744	442,226	42,190	5,049	7,651	1,989	18,576	5,535	19,127	13,006	27,543	4,590	70,922	26,778			242,957	8,398,013	199,269	6,303,160
41	8,398,013	456,411	43,667	5,226	7,919	2,059	19,226	5,729	19,796	13,461							117,083	8,737,341	339,328	6,642,488
42	8,737,341	471,222	45,195	5,409	8,196	2,131	19,899	5,930	20,489	13,933	29,504						150,686	9,057,877	320,537	6,963,024
43	9,057,877	489,368	46,777	5,598	8,483	2,205	20,596	6,137	21,206	14,420							125,422	9,421,823	363,946	7,326,970
44	9,421,823	508,192	48,414	5,794	8,779	2,283	21,316	6,352	21,949	14,925	31,606						161,418	9,768,597	346,774	7,673,744
45	9,768,597	527,737	50,109	5,997	9,087	2,363	22,062	6,574	22,717	15,447		5,452	84,234				224,041	10,072,292	303,695	7,977,439
46	10,072,292	545,624	51,862	6,207	9,405	2,445	22,835	6,804	23,512	15,988	33,857						172,916	10,445,001	372,709	8,350,148
47	10,445,001	564,226	53,677	6,424	9,734	2,531	23,634	7,042	24,335	16,548							143,925	10,865,302	420,300	8,770,449
48	10,865,302	586,033	55,556	6,649	10,075	2,619	24,461	7,289	25,186	17,127	36,268						186,231	11,266,104	400,802	9,171,251
49	11,266,104	608,614	57,501	6,882	10,427	2,711	25,317	7,544	26,068	17,726							154,176	11,720,542	454,437	9,625,689
50	11,720,542	632,133	59,513	7,123	10,792	2,806	26,203	7,808	26,980	18,347	38,852	6,475	100,043		377,725	998,272	1,690,939	10,671,735	(1,048,806)	8,576,882
51	10,671,735	615,788	61,596	7,372	11,170	2,904	27,120	8,081	27,925	18,989							165,157	11,122,366	450,630	9,027,513
52	11,122,366	599,338	63,752	7,630	11,561	3,006	28,070	8,364	28,902	19,653	41,619						212,557	11,509,147	386,781	9,414,294
53	11,509,147	622,367	65,983	7,897	11,965	3,111	29,052	8,657	29,914	20,341							176,921	11,954,592	445,446	9,859,739
54	11,954,592	645,253	68,293	8,174	12,384	3,220	30,069	8,960	30,961	21,053	44,583						227,696	12,372,149	417,557	10,277,296
55	12,372,149	668,985	70,683	8,460	12,818	3,333	31,121	9,274	32,044	21,790		7,691	118,820				316,032	12,725,102	352,953	10,630,249
56	12,725,102	690,174	73,157	8,756	13,266	3,449	32,211	9,598	33,166	22,553	47,759						243,914	13,171,363	446,261	11,076,510
57	13,171,363	712,153	75,717	9,062	13,731	3,570	33,338	9,934	34,327	23,342							203,021	13,680,495	509,132	11,585,642
58	13,680,495	738,426	78,368	9,379	14,211	3,695	34,505	10,282	35,528	24,159	51,160						261,287	14,157,634	477,139	12,062,781
59	14,157,634	765,549	81,110	9,708	14,709	3,824	35,712	10,642	36,771	25,005							217,481	14,705,702	548,068	12,610,849
60	14,705,702	793,742	83,949	10,047	15,223	3,958	36,962	11,014	38,058	25,880	54,804	9,134	141,121	53,282			483,433	15,016,010	310,309	12,921,157
61	15,016,010	817,347	86,887	10,399	15,756	4,097	38,256	11,400	39,390	26,786							232,971	15,600,387	584,376	13,505,534
62	15,600,387	841,951	89,929	10,763	16,308	4,240	39,595	11,799	40,769	27,723	58,708						299,832	16,142,505	542,118	14,047,652
63	16,142,505	872,930	93,076	11,140	16,878	4,388	40,981	12,212	42,196	28,693							249,564	16,765,870	623,365	14,671,017
64	16,765,870	904,980	96,334	11,530	17,469	4,542	42,415	12,639	43,673	29,698	62,889						321,188	17,349,663	583,792	15,254,810
65	17,349,663	938,177	99,705	11,933	18,081	4,701	43,900	13,081	45,201	30,737		10,848	167,607				445,796	17,842,045	492,382	15,747,192
66	17,842,045	967,772	103,195	12,351	18,713	4,865	45,436	13,539	46,784	31,813	67,368						344,065	18,465,752	623,707	16,370,899
67	18,465,752	998,484	106,807	12,783	19,368	5,036	47,026	14,013	48,421	32,926							286,381	19,177,836	712,084	17,082,983
68	19,177,836	1,035,199	110,545	13,231	20,046	5,212	48,672	14,503	50,116	34,079	72,167						368,571	19,844,464	666,628	17,749,611
69	19,844,464	1,073,113	114,414	13,694	20,748	5,394	50,376	15,011	51,870	35,271							306,778	20,610,799	766,335	18,515,946
70	20,610,799	1,112,520	118,419	14,173	21,474	5,583	52,139	15,536	53,685	36,506	77,307	12,884	199,065				606,771	21,116,548	505,749	19,021,695
71	21,116,548	1,147,502	122,563	14,669	22,226	5,779	53,964	16,080	55,564	37,784							328,628	21,935,422	818,874	19,840,569
72	21,935,422	1,183,929	126,853	15,182	23,004	5,981	55,853	16,643	57,509	39,106	82,813						422,943	22,696,407	760,986	20,601,554
73	22,696,407	1,227,375	131,293	15,714	23,809	6,190	57,807	17,226	59,522	40,475							352,035	23,571,748	875,340	21,476,895
74	23,571,748	1,272,374	135,888	16,264	24,642	6,407	59,831	17,828	61,605	41,891	88,711						453,067	24,391,055	819,307	22,296,202
75	24,391,055	1,318,977	140,644	16,833	25,504	6,631	61,925	18,452	63,761	43,358		15,303	236,426		892,656		1,521,493	24,188,539	(202,516)	22,093,686

Molycorp, Inc.

Washington, PA Facility

Year	Cash Balance	Earned Interest	Cell Cover Maint.	Perimeter Fencing Maint.	Security Inspection	Thermo. Dosimeters	Grade Haul Road	Cleaning/ Blasting Bridge	Management Fee	Groundwater Monitoring*	Bridge Inspection	Thermo. Dosim. TLD Replace.	Bridge Painting, Sandblasting	Well Replacement	Fence Replacement	Bridge Replacement	Total Costs	Cash Balance	Annual Change	Change to Date
			COSTS																	
76	24,188,639	1,335,939	145,567	17,422	26,397	6,863	64,092	19,096	65,993	44,875	95,030						485,337	25,039,140	850,502	22,944,287
77	25,039,140	1,353,761	150,662	18,032	27,321	7,103	66,335	19,767	68,302	46,446							403,968	25,988,933	949,793	23,894,080
78	25,988,933	1,403,272	155,935	18,663	28,277	7,352	68,657	20,459	70,693	48,071	101,798						519,905	26,872,300	883,367	24,777,447
79	26,872,300	1,453,684	161,393	19,316	29,267	7,609	71,060	21,175	73,167	49,754							432,741	27,893,243	1,020,943	25,798,390
80	27,893,243	1,506,052	167,041	19,992	30,291	7,876	73,547	21,916	75,728	51,495	109,049	18,175	280,800	106,019			961,930	28,437,365	544,123	26,342,512
81	28,437,365	1,549,092	172,888	20,692	31,351	8,151	76,121	22,683	78,379	53,298							463,563	29,522,894	1,085,529	27,428,041
82	29,522,894	1,593,907	178,939	21,416	32,449	8,437	78,786	23,477	81,122	55,183	116,816						596,603	30,520,198	997,304	28,425,346
83	30,520,198	1,651,185	185,202	22,166	33,584	8,732	81,543	24,298	83,961	57,094							496,580	31,674,803	1,154,605	29,579,950
84	31,674,803	1,710,363	191,684	22,942	34,760	9,038	84,397	25,149	86,900	59,092	125,136						638,096	32,746,069	1,071,266	30,651,216
85	32,746,069	1,771,574	198,393	23,745	35,977	9,354	87,351	26,029	89,941	61,160		21,586	333,503				887,038	33,630,606	884,536	31,535,753
86	33,630,606	1,825,359	205,336	24,576	37,236	9,681	90,408	26,940	93,089	63,301	134,049						684,616	34,771,348	1,140,743	32,676,495
87	34,771,348	1,881,054	212,523	25,436	38,539	10,020	93,573	27,883	96,347	65,516							569,837	36,082,565	1,311,217	33,987,712
88	36,082,565	1,948,483	219,961	26,326	39,888	10,371	96,848	28,859	99,720	67,809	143,596						733,378	37,297,670	1,215,105	35,202,817
89	37,297,670	2,017,956	227,660	27,247	41,284	10,734	100,237	29,869	103,210	70,183							610,424	38,705,203	1,407,533	36,610,350
90	38,705,203	2,090,079	235,628	28,201	42,729	11,109	103,746	30,914	106,822	72,639	153,824	25,637	396,096				1,207,346	39,587,935	882,733	37,493,082
91	39,587,935	2,153,061	243,875	29,188	44,224	11,498	107,377	31,996	110,561	75,181							653,901	41,087,096	1,499,160	38,992,242
92	41,087,096	2,218,563	252,411	30,210	45,772	11,901	111,135	33,116	114,431	77,813	164,780						841,568	42,464,091	1,376,996	40,369,238
93	42,464,091	2,297,658	261,245	31,267	47,374	12,317	115,025	34,275	118,436	80,536							700,475	44,061,273	1,597,182	41,966,420
94	44,061,273	2,379,448	270,389	32,361	49,032	12,748	119,050	35,475	122,581	83,355	176,516						901,508	45,539,212	1,477,939	43,444,359
95	45,539,212	2,464,013	279,852	33,494	50,748	13,195	123,217	36,717	126,871	86,272		30,449	470,438				1,251,254	46,751,972	1,212,759	44,657,119
96	46,751,972	2,538,008	289,647	34,666	52,525	13,656	127,530	38,002	131,312	89,292	189,089						965,718	48,324,261	1,572,289	46,229,408
97	48,324,261	2,614,596	299,785	35,880	54,363	14,134	131,993	39,332	135,908	92,417							803,812	50,135,046	1,810,785	48,040,193
98	50,135,046	2,707,831	310,277	37,135	56,266	14,629	136,613	40,708	140,664	95,652	202,557						1,034,502	51,808,175	1,673,129	49,713,322
99	51,808,175	2,803,439	321,137	38,435	58,235	15,141	141,395	42,133	145,588	99,000							861,063	53,750,550	1,942,375	51,655,697
100	53,750,550	2,902,865	332,377	39,780	60,273	15,671	146,343	43,608	150,683	102,465	216,984	36,164	558,733	210,956	2,109,564	5,575,276	9,598,877	$ 47,054,538	(6,696,012)	44,959,685

Factors:	
Annual Interest Rate	5.5%
Annual Inflation Rate	3.5%

* Groundwater Monitoring required quarterly for the first 2 years and annually after year 2.

Molycorp, Inc.

Washington, PA Facility

COSTS

Year	Cash Balance	Earned Interest	Cell Cover Maint.	Perimeter Fencing Maint.	Security Inspection	Thermo. Dosimeters	Grade Haul Road	Cleaning/ Blasting Bridge	Management Fee	Groundwater Monitoring	Bridge Inspection	Thermo. Dosim. TLD Replace.	Bridge Painting, Sandblasting	Well Replacement	Fence Replacement	Bridge Replacement	Catastrophic Event	Total Costs	Cash Balance	Annual Change	Change to Date
1	2,064,863	115,217	11,029	1,320	2,000	520	4,856	1,447	5,000	13,600								39,772	2,170,298	76,445	76,445
2	2,170,298	117,292	11,415	1,366	2,070	538	5,026	1,496	5,175	14,076	7,452							48,616	2,238,974	68,676	144,121
3	2,238,974	121,255	11,815	1,414	2,142	557	5,202	1,550	5,356	3,642								31,678	2,328,550	89,577	233,697
4	2,328,550	125,607	12,228	1,464	2,217	577	5,384	1,604	5,544	3,770	7,983							40,770	2,413,387	84,837	318,534
5	2,413,387	130,403	12,656	1,515	2,295	597	5,572	1,660	5,738	3,902		1,377	21,275					66,987	2,487,204	73,817	392,351
6	2,487,204	134,766	13,099	1,568	2,375	618	5,767	1,719	5,938	4,038	8,551							43,674	2,578,297	91,093	483,444
7	2,578,297	139,301	13,557	1,623	2,459	639	5,969	1,779	6,146	4,179								36,352	2,681,246	102,950	586,393
8	2,681,246	144,637	14,032	1,679	2,545	662	6,178	1,841	6,361	4,326	9,160							46,784	2,779,100	97,853	684,247
9	2,779,100	150,160	14,523	1,738	2,634	685	6,394	1,905	6,584	4,477								38,941	2,890,318	111,219	795,466
10	2,890,318	155,909	15,031	1,799	2,726	709	6,618	1,972	6,814	4,634	9,813	1,635	25,268					77,020	2,969,207	78,889	874,354
11	2,969,207	161,137	15,557	1,862	2,821	734	6,850	2,041	7,053	4,796								41,714	3,088,630	119,423	993,777
12	3,088,630	166,591	16,102	1,927	2,920	759	7,090	2,113	7,300	4,964	10,512							53,686	3,201,535	112,905	1,106,682
13	3,201,535	172,980	16,666	1,995	3,022	786	7,338	2,187	7,555	5,138								44,686	3,329,829	128,294	1,234,976
14	3,329,829	179,612	17,249	2,064	3,128	813	7,595	2,263	7,820	5,317	11,260							57,510	3,451,932	122,103	1,357,079
15	3,451,932	186,498	17,853	2,137	3,237	842	7,860	2,342	8,093	5,504		1,942	30,011					79,821	3,558,609	106,677	1,463,756
16	3,558,609	192,790	18,477	2,211	3,351	871	8,135	2,424	8,377	5,696	12,063							61,606	3,689,793	131,184	1,594,940
17	3,689,793	199,331	19,124	2,289	3,468	902	8,420	2,509	8,670	5,896								51,277	3,837,846	148,054	1,742,993
18	3,837,846	207,010	19,793	2,369	3,589	933	8,715	2,597	8,973	6,102	12,922							66,994	3,978,863	141,016	1,884,010
19	3,978,863	214,959	20,486	2,452	3,715	966	9,020	2,688	9,287	6,315								54,930	4,138,893	160,030	2,044,040
20	4,138,893	223,238	21,203	2,538	3,845	1,000	9,336	2,782	9,613	6,537	13,842	2,307	35,643	13,458				122,102	4,240,029	101,136	2,145,176
21	4,240,029	230,420	21,945	2,627	3,980	1,035	9,662	2,879	9,949	6,765								58,842	4,411,607	171,578	2,316,754
22	4,411,607	237,920	22,713	2,718	4,119	1,071	10,001	2,980	10,297	7,002	14,828							75,729	4,573,798	162,191	2,478,945
23	4,573,798	247,099	23,508	2,814	4,263	1,108	10,351	3,084	10,658	7,247								63,033	4,757,863	184,066	2,663,010
24	4,757,863	256,621	24,331	2,912	4,412	1,147	10,713	3,192	11,031	7,501	15,884							81,123	4,933,361	175,497	2,838,508
25	4,933,361	266,509	25,183	3,014	4,567	1,187	11,088	3,304	11,417	7,763		2,740	42,333		159,833			272,428	4,927,441	(5,920)	2,832,588
26	4,927,441	271,172	26,064	3,119	4,726	1,229	11,476	3,420	11,816	8,035	17,015							96,901	5,111,712	184,271	3,016,859
27	5,111,712	276,077	26,976	3,229	4,892	1,272	11,878	3,539	12,230	8,316								72,332	5,316,457	203,745	3,220,604
28	5,316,457	286,747	27,921	3,342	5,063	1,316	12,293	3,663	12,658	8,607	18,227							93,091	5,509,113	193,656	3,414,260
29	5,509,113	297,676	28,898	3,459	5,240	1,362	12,724	3,791	13,101	8,909								77,484	5,729,305	220,192	3,634,452
30	5,729,305	309,056	29,909	3,580	5,424	1,410	13,169	3,924	13,559	9,220	19,526	3,254	50,278					153,254	5,885,108	155,803	3,790,255
31	5,885,108	319,396	30,956	3,705	5,614	1,460	13,630	4,061	14,034	9,543								83,003	6,121,502	236,394	4,026,649
32	6,121,502	330,182	32,040	3,835	5,810	1,511	14,107	4,204	14,525	9,877	20,916							106,824	6,344,859	223,358	4,250,006
33	6,344,859	342,825	33,161	3,969	6,013	1,563	14,601	4,351	15,034	10,223								88,914	6,598,770	253,911	4,503,917
34	6,598,770	355,950	34,322	4,108	6,224	1,618	15,112	4,503	15,560	10,581	22,406							114,432	6,840,287	241,517	4,745,434
35	6,840,287	369,574	35,523	4,252	6,442	1,675	15,640	4,661	16,104	10,951		3,865	59,715					158,827	7,051,034	210,747	4,956,181
36	7,051,034	382,011	36,766	4,400	6,667	1,733	16,188	4,824	16,668	11,334	24,002							122,583	7,310,463	259,429	5,215,610
37	7,310,463	394,941	38,053	4,554	6,901	1,794	16,754	4,993	17,251	11,731								102,031	7,603,373	292,910	5,508,520
38	7,603,373	410,130	39,385	4,714	7,142	1,857	17,341	5,167	17,855	12,141	25,711							131,314	7,882,190	278,817	5,787,337
39	7,882,190	425,853	40,763	4,879	7,392	1,922	17,948	5,348	18,480	12,566								109,298	8,198,744	316,555	6,103,891
40	8,198,744	442,226	42,190	5,049	7,651	1,989	18,576	5,535	19,127	13,006	27,543	4,590	70,922	28,778				242,957	8,398,013	199,269	6,303,160
41	8,398,013	456,411	43,667	5,226	7,919	2,059	19,226	5,729	19,796	13,461								117,083	8,737,341	339,328	6,642,488
42	8,737,341	471,222	45,195	5,409	8,196	2,131	19,899	5,930	20,489	13,933	29,504							150,686	9,057,877	320,537	6,963,024
43	9,057,877	489,368	46,777	5,598	8,483	2,205	20,596	6,137	21,208	14,420								128,422	9,421,823	363,946	7,326,970
44	9,421,823	508,192	48,414	5,794	8,779	2,283	21,316	6,352	21,949	14,925	31,606							161,418	9,768,597	346,774	7,673,744
45	9,768,597	527,737	50,109	5,997	9,087	2,363	22,062	6,574	22,717	15,447		5,452	84,234					224,041	10,072,292	303,695	7,977,439
46	10,072,292	545,824	51,862	6,207	9,406	2,445	22,835	6,804	23,512	15,988	33,857							172,915	10,445,001	372,709	8,350,148
47	10,445,001	564,226	53,677	6,424	9,734	2,531	23,634	7,042	24,335	16,548								143,926	10,865,302	420,300	8,770,449
48	10,865,302	586,033	55,556	6,649	10,075	2,619	24,461	7,289	25,186	17,127	36,268							186,231	11,265,104	400,802	9,171,251
49	11,265,104	608,614	57,501	6,882	10,427	2,711	25,317	7,544	26,068	17,726								154,176	11,720,542	454,437	9,625,689
50	11,720,542	632,133	59,513	7,123	10,792	2,806	26,203	7,808	26,980	18,347	38,852	6,475	100,043		377,725	996,272	917,330,961	919,011,920	(906,689,246)	(918,379,787)	(906,754,066)
51	(906,689,246)	(24,610,814)	61,596	7,372	11,170	2,904	27,120	8,081	27,925	18,989								166,157	(931,435,217)	(24,775,972)	(933,530,070)
52	(931,435,217)	(50,547,596)	63,752	7,630	11,561	3,006	28,070	8,364	28,902	19,653	41,619							212,657	(982,196,372)	(50,760,155)	(984,290,225)
53	(982,196,372)	(52,624,841)	65,983	7,897	11,965	3,111	29,052	8,657	29,914	20,341								178,921	(1,034,997,134)	(52,801,762)	(1,037,091,987)
54	(1,034,997,134)	(55,472,794)	68,293	8,174	12,384	3,220	30,069	8,960	30,961	21,053	44,583							227,696	(1,090,697,624)	(55,700,490)	(1,092,792,477)
55	(1,090,697,624)	(58,456,606)	70,683	8,460	12,818	3,333	31,121	9,274	32,044	21,790		7,691	118,820					318,032	(1,149,470,262)	(58,772,638)	(1,151,565,115)
56	(1,149,470,262)	(61,604,617)	73,157	8,756	13,266	3,449	32,211	9,596	33,166	22,553	47,759							243,914	(1,211,318,793)	(61,848,631)	(1,213,413,646)
57	(1,211,318,793)	(64,921,699)	75,717	9,062	13,731	3,570	33,338	9,934	34,327	23,342								203,021	(1,276,443,513)	(65,124,720)	(1,278,538,366)
58	(1,276,443,513)	(68,413,463)	78,368	9,379	14,211	3,695	34,506	10,282	35,528	24,159	51,160							261,287	(1,346,118,263)	(68,674,750)	(1,347,213,116)
59	(1,346,118,263)	(72,092,949)	81,110	9,706	14,709	3,824	35,712	10,642	36,771	25,005								217,461	(1,417,428,693)	(72,310,430)	(1,419,523,546)
60	(1,417,428,693)	(75,970,041)	83,949	10,047	15,223	3,958	36,962	11,014	38,058	25,880	54,804	9,134	141,121	53,282				483,433	(1,493,882,167)	(76,453,474)	(1,496,977,020)
61	(1,493,882,167)	(80,061,049)	86,887	10,399	15,756	4,097	38,258	11,400	39,390	26,786								232,971	(1,574,176,187)	(80,294,020)	(1,576,271,040)
62	(1,574,176,187)	(84,371,605)	89,929	10,763	16,306	4,240	39,595	11,799	40,759	27,723	58,706							299,832	(1,658,547,624)	(84,671,437)	(1,660,942,477)
63	(1,658,547,624)	(88,906,155)	93,076	11,140	16,878	4,388	40,981	12,212	42,196	28,693								249,884	(1,748,006,343)	(89,157,719)	(1,750,100,196)
64	(1,748,006,343)	(93,688,457)	96,334	11,530	17,469	4,542	42,415	12,639	43,673	29,698	62,889							321,186	(1,842,014,987)	(94,009,645)	(1,844,109,840)
65	(1,842,014,987)	(98,725,559)	99,705	11,933	18,081	4,701	43,900	13,081	45,201	30,737		10,848	167,607					446,795	(1,941,186,341)	(99,171,354)	(1,943,281,194)
66	(1,941,186,341)	(104,038,037)	103,195	12,351	18,713	4,865	45,436	13,539	46,784	31,813	67,368							344,065	(2,045,568,442)	(104,382,101)	(2,047,663,295)
67	(2,045,568,442)	(109,635,757)	106,807	12,783	19,368	5,036	47,026	14,013	48,421	32,926								286,381	(2,155,480,580)	(109,922,137)	(2,157,595,433)
68	(2,155,480,580)	(115,529,123)	110,545	13,231	20,046	5,212	48,672	14,503	50,116	34,079	72,167							368,571	(2,271,398,273)	(115,897,694)	(2,273,493,126)
69	(2,271,398,273)	(121,739,168)	114,414	13,694	20,748	5,394	50,376	15,011	51,870	35,271								306,776	(2,393,434,220)	(122,046,947)	(2,395,529,073)
70	(2,393,434,220)	(128,282,619)	118,419	14,173	21,474	5,583	52,139	15,536	53,685	36,508	77,307	12,884	199,065					606,771	(2,522,323,609)	(128,889,390)	(2,524,418,462)
71	(2,522,323,609)	(135,183,340)	122,563	14,669	22,226	5,779	53,964	16,080	55,564	37,784								328,628	(2,657,506,978)	(136,511,968)	(2,659,930,431)
72	(2,657,506,978)	(142,454,378)	126,853	15,182	23,004	5,981	55,853	16,643	57,509	39,106	82,813							422,943	(2,800,712,899)	(142,877,321)	(2,802,807,752)
73	(2,800,712,899)	(150,110,063)	131,293	15,714	23,809	6,190	57,807	17,226	59,522	40,475								382,038	(2,961,175,017)	(150,492,118)	(2,963,269,870)
74	(2,961,175,017)	(158,176,918)	135,888	16,264	24,642	6,407	59,831	17,828	61,605	41,891	88,711							453,067	(3,109,805,002)	(158,629,986)	(3,111,899,855)
75	(3,109,805,002)	(166,676,951)	140,644	16,833	25,504	6,631	61,925	18,452	63,761	43,358		15,303	236,426		892,856			1,521,483	(3,278,003,446)	(168,198,444)	(3,280,098,299)
76	(3,278,003,446)	(175,664,732)	145,567	17,422	26,397	6,863	64,092	19,098	65,993	44,875	95,030							486,357	(3,454,163,515)	(176,150,089)	(3,456,248,368)
77	(3,454,163,515)	(185,134,316)	150,662	18,032	27,321	7,103	66,335	19,767	68,302	46,446								403,968	(3,639,601,800)	(186,538,285)	(3,641,786,653)
78	(3,639,601,800)	(195,080,746)	155,935	18,663	28,277	7,352	68,657	20,459	70,693	48,071	101,796							619,906	(3,835,292,452)	(196,000,651)	(3,837,387,306)
79	(3,835,292,452)	(205,562,067)	161,393	19,316	29,267	7,609	71,060	21,175	73,167	49,754								432,741	(4,041,287,289)	(206,994,808)	(4,043,382,112)
80	(4,041,287,289)	(216,605,942)	167,041	19,992	30,291	7,876	73,547	21,916	75,726	51,495	109,049	18,175	280,800	106,019				981,930	(4,258,866,131)	(217,587,872)	(4,260,948,984)
81	(4,258,866,131)	(228,253,916)	172,888	20,692	31,351	8,151	76,121	22,683	78,379	53,296								463,563	(4,487,572,610)	(228,717,479)	(4,489,667,463)
82	(4,487,572,610)	(240,526,763)	178,939	21,416	32,449	8,437	78,786	23,477	81,122	55,163	116,816							686,603	(4,728,986,976)	(241,123,366)	(4,730,790,829)
83	(4,728,986,976)	(253,447,366)	185,202	22,166	33,584	8,732	81,543	24,298	83,961	57,094								496,580	(4,982,630,942)	(253,943,966)	(4,984,734,796)
84	(4,982,630,942)	(267,081,738)	191,684	22,942	34,760	9,038	84,397	25,149	86,900	59,092	125,136							638,098	(5,250,340,776)	(267,700,834)	(5,252,436,629)
85	(5,250,340,776)	(281,406,970)	198,393	23,745	35,977	9,354	87,351	26,029	89,941	61,160		21,586	333,503					857,038	(5,532,634,784)	(282,294,007)	(5,534,729,637)
86	(5,532,634,784)	(296,531,828)	205,336	24,576	37,236	9,681	90,408	26,940	93,069	63,301	134,049							684,616	(5,829,861,228)	(297,216,444)	(5,831,946,081)
87	(5,829,861,228)	(312,468,365)	212,523	25,436	38,539	10,020	93,573	27,883	96,347	65,516								668,837	(6,142,998,430)	(313,038,202)	(6,144,984,283)

Molycorp Inc.

Washington, PA Facility

COSTS

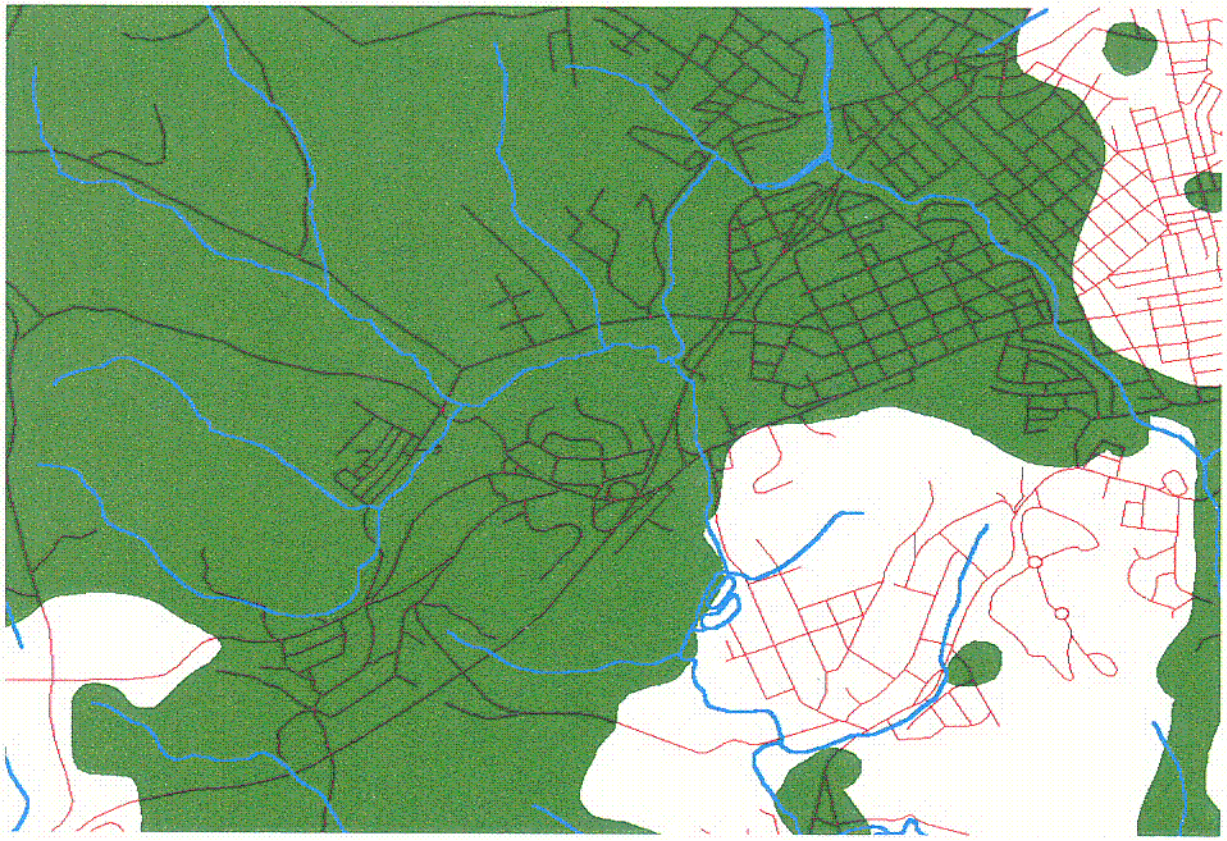
Year	Cash Balance	Earned Interest	Cell Cover Maint.	Perimeter Fencing Maint.	Security Inspection	Thermo. Dosimeters	Grade Haul Road	Cleaning/ Blasting Bridge	Management Fee	Groundwater Monitoring*	Bridge Inspection	Thermo. Dosim. TLD Replace.	Bridge Painting, Sandblasting	Well Replacement	Fence Replacement	Bridge Replacement	Catastrophic Event	Total Costs	Cash Balance	Annual Change	Change to Date
90	(6,142,999,430)	(329,250,368)	219,961	26,326	39,888	10,371	96,848	28,859	99,720	67,809	143,596							733,378	(6,472,873,176)	(329,983,746)	(6,474,988,029)
89	(6,472,873,176)	(346,933,472)	227,660	27,247	41,284	10,734	100,237	29,869	103,210	70,183								610,424	(6,820,417,071)	(347,543,896)	(6,822,511,924)
88	(6,820,417,071)	(365,565,482)	235,628	28,201	42,729	11,109	103,746	30,914	106,822	72,639	153,824	25,637	396,095					1,207,346	(7,187,199,899)	(366,772,828)	(7,189,284,752)
91	(7,187,199,899)	(385,209,192)	243,875	29,188	44,224	11,496	107,377	31,996	110,561	75,181								653,901	(7,573,062,992)	(385,863,093)	(7,575,147,845)
92	(7,573,062,992)	(405,908,680)	252,411	30,210	45,772	11,901	111,135	33,116	114,431	77,813	164,780							841,568	(7,979,801,240)	(406,748,247)	(7,981,896,093)
93	(7,979,801,240)	(427,703,491)	261,245	31,267	47,374	12,317	115,025	34,275	118,436	80,536								700,475	(8,408,205,206)	(428,403,967)	(8,410,300,069)
94	(8,408,205,206)	(450,670,177)	270,389	32,361	49,032	12,748	119,050	35,475	122,581	83,355	178,516							901,508	(8,859,775,892)	(451,571,686)	(8,861,871,745)
95	(8,859,775,892)	(474,869,508)	279,852	33,494	50,748	13,195	123,217	36,717	126,871	86,272		30,449	470,438					1,251,254	(9,335,897,654)	(475,120,762)	(9,337,992,507)
96	(9,335,897,654)	(500,381,050)	289,647	34,666	52,525	13,656	127,530	38,002	131,312	89,292	189,089							965,718	(9,837,244,422)	(501,346,768)	(9,839,339,275)
97	(9,837,244,422)	(527,261,407)	299,785	35,880	54,363	14,134	131,993	39,332	135,908	92,417								903,812	(10,365,309,641)	(528,065,219)	(10,367,404,494)
98	(10,365,309,641)	(555,570,237)	310,277	37,135	56,266	14,629	136,613	40,706	140,664	95,652	202,557							1,034,892	(10,921,914,379)	(556,604,738)	(10,924,009,232)
99	(10,921,914,379)	(585,398,661)	321,137	38,435	58,235	15,141	141,395	42,133	145,588	99,000								861,063	(11,506,174,103)	(586,259,724)	(11,510,268,956)
100	(11,506,174,103)	(616,827,433)	332,377	39,780	60,273	15,671	146,343	43,606	150,663	102,465	216,984	36,164	558,733	210,956	2,109,564	5,575,276		9,696,877	$ (12,134,600,413)	(626,426,310)	(12,136,695,266)

Factors:

Annual Interest Rate	5.5%
Annual Inflation Rate	3.5%

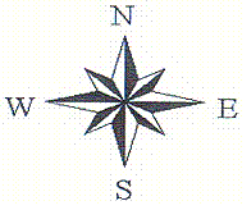
* Groundwater Monitoring required quarterly for the first 2 years and annually after year 2.

washington county



Unknown Units: washington county

Surface Water Features
Roads
Oil & Gas Fields
1



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washington county

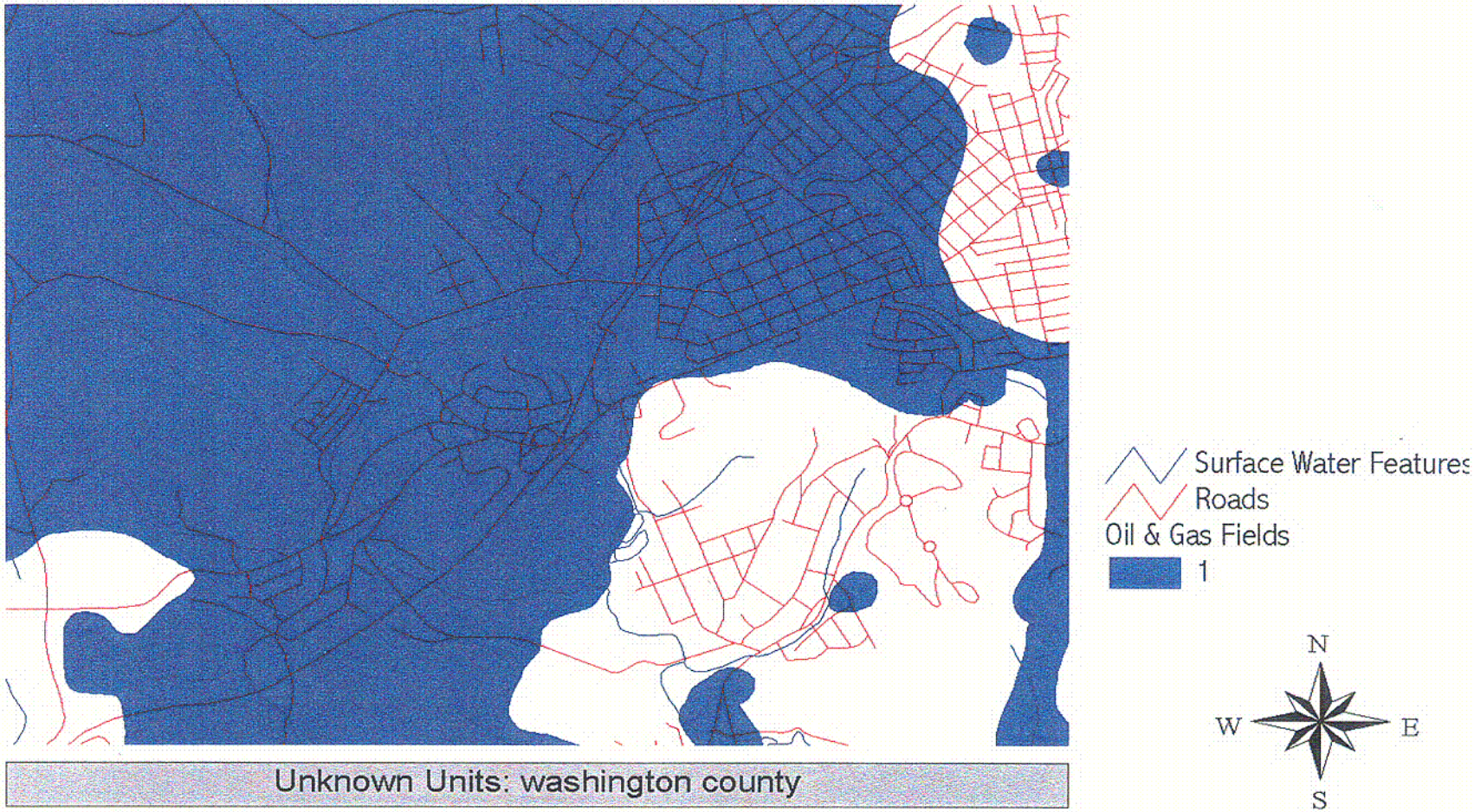
Unknown Units: washington county

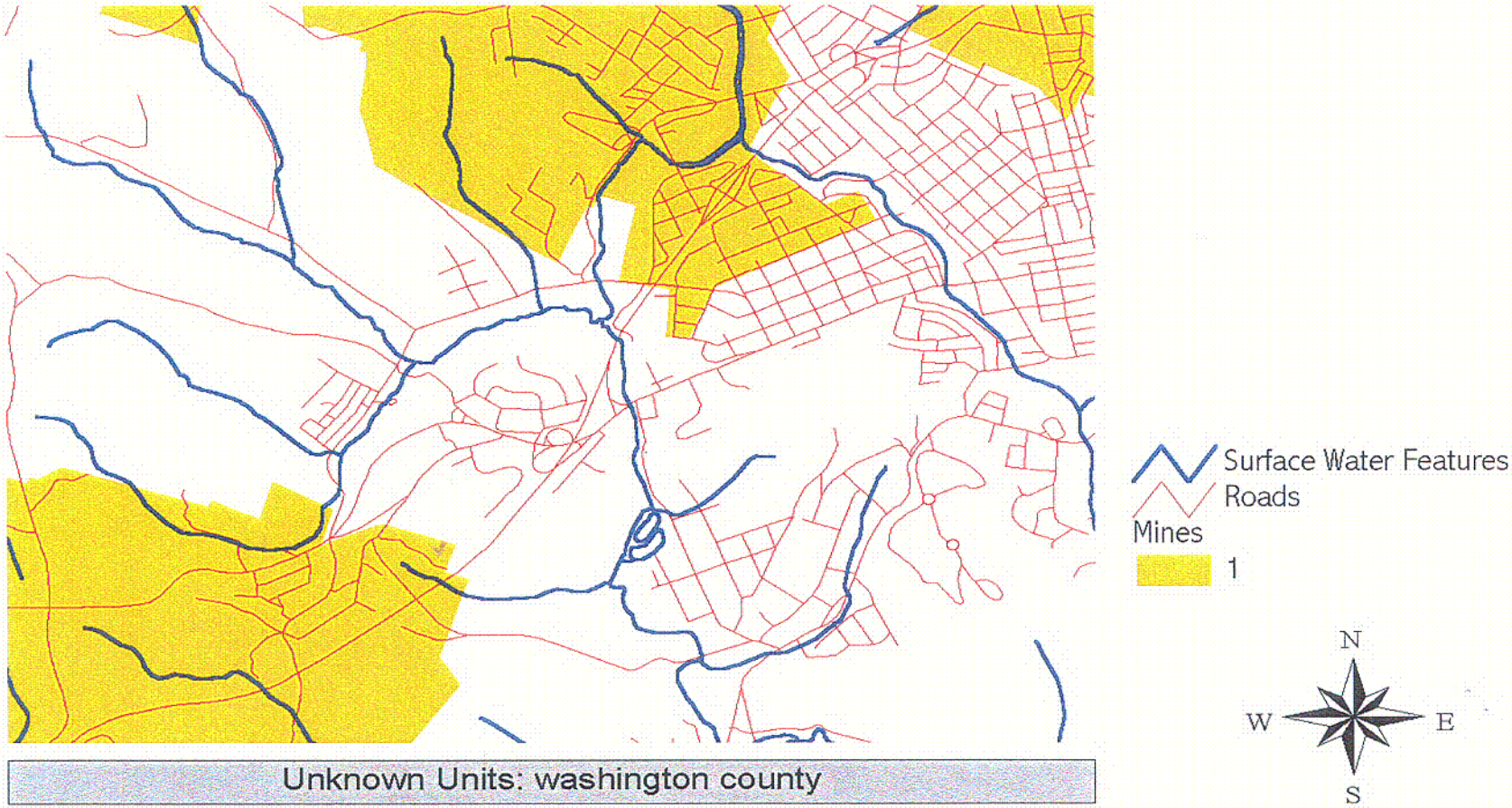
Surface W
Roads
Public Water Sup
1
Surface Water In
1

W

4h

washington county



C5

washington county