The DOE/ERDA/AEC Fire Protection Program

A Historical Analysis

FOR THE
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THE AUTHOR'S NOTES-1996

This document was originally begun in 1988, while the author was the senior Fire Protection Engineer at DOE Headquarters. Numerous press accounts were citing erroneous information, including citations from DOE safety people who should have known at least some of the real story. At the same time, DOE was being deluged with management schemes and reorganizations, appraisal systems, performance rating plans, and safety system planning that showed little or no knowledge of what had been accomplished in prior years, especially fire protection. Having been with the agency since 1962, we felt the record deserved to be recorded.

The first Chapters reported the record as it actually existed, and highlighted some of the problems caused by unknowing people issuing statements showing a total lack of knowledge of what existed within their own agency. Even some of the major events, such as the Paducah and Rocky flats fires were misunderstood or the lessens forgotten. Accordingly, we included chapters citing the important facts of these events.

In more recent years, we added chapters intended to retain some of the history, such as the performance record of sprinklers and halon systems, the independent fire protection appraisal program, the various rating schemes that had been tried, and information activities. Since we felt strongly that the people, far more than the organization or any "procedures", were the major factor in a good program, we added chapters on some of the notable people who contributed to the record.

Chapters were issued as written, by adding them to issues of the "HOT-DOEnuts" newsletter for DOE fire protection people or distributing them individually. Through the efforts of Dennis Kubicki and the new breed of DOE Headquarters professionals, permission was obtained to update and publish the history as a single document. This is the result. Some of the cruder or poorly reproduced graphics from the original issuances are omitted, but they are cited where appropriate. Most chapters have been updated to include information originating after their original publication.

Most important of all, as the "Reasons Why" chapter notes, and as developed in other chapters, the fire protection program was and is unique. Not only in the bottom line of performance data, but in the number of program elements that have never been exceeded, and seldom matched, by other safety programs, governement or private.

This is that story.

Walter W. Maybee
Seattle. July, 1996

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THE REASON WHY

In which we learn why fire protection is deserving of a history of its own; namely, that it had the largest accidents in the history of the program---and the best record in the history of the program.

[AUTHOR'S NOTE: This Chapter was originally written in 1990. It presented a number of contrasts as a quick summary of the apparent discrepancies between the magnitude of the fire protection problem and the success of the fire protection program. An update Chapter was prepared in early 1996 that presented additional data and notes for all the Chapters. That data is incorporated below. The contrasts are even more than they were in 1990 and the program is even more successful.]

From 1947 through 1992, the AEC, ERDA, and DOE suffered in excess of $68 million in fire losses,

but

The historical fire losses in AEC, ERDA, and DOE have been about one-sixth of what would have been expected of the best of private industry over the same period.

The first and second largest losses in the history of the program were due to fire,

but

Fire losses have continually been reduced to the point where fires have accounted for only 44% of the total loss from all causes combined.

DOE is spending upwards of $100 million per year on fire protection,

but

The fire protection program has saved AEC, ERDA, and DOE over $330 million dollars compared to what the best programs in private industry would have achieved.

The principal concern in DOE safety is the potential for radioactive contamination, but

The largest contamination incident in the history of AEC, ERDA, and DOE resulted from a fire.

After one major fire, the AEC spent over $100 million for added fire protection,

but

A single fire demonstrated that the savings due to the installation of that protection had paid for every fire protection system installed in the history of the agency.

For most of its history, the agency had about one-fourth of the number of Fire Protection Engineers that the major insurance companies had for the same values,

but

This number achieved the record cited above. Even including the contractor FPE's, they numbered less than half of the comparative staffing of the insurance industry.

At the 2/3 point in its history, the agency had about 1/5 of the total number of Fire Protection Engineers in the federal government,

but

There were more members of the Society of Fire Protection engineers from AEC than any other agency and more than the top two other agencies, combined.

The probability of a fire causing a loss of more than $1,000 in a DOE facility is 2×10^{-3},

but

The probability of fire is assumed to be 1.0.

As stated at the start, the above demonstrates that fire is not only the major hazard in DOE in terms of actual losses, but the fire protection program, paradoxically, is among the best safety programs ever. The balance of these Chapters will demonstrate the truth of both statements.

THE RECORD

.....in which we discover that fire protection has the biggest losses, and pays for itself more than any other safety program.

[AUTHOR's NOTE: In any history, the "bottom line' is the record. Not only of what happened, but how it compares to others. The fire protection program not only has a complete record of its losses (and costs), but of how it compares to the best of the private world. By any comparison, it has been, and is, superb.]

When a federal agency loses about $68 million in property losses from the peril of fire, some people may leap to the conclusion that something must be drastically wrong with the fire protection program of that agency. When the typical nuclear critics find out that is the loss record of the DOE, nee ERDA, nee AEC, you probably will hear no other data. In fact, that is the "bottom line" of one of the best programs in the government; one that surpasses the average record of the best class of industry. Not only has the record been good from the earliest days, but after suffering its largest loss, it took a program that was good and improved it by an order-of-magnitude[1]. It is a story worth recording, especially when the public perception is so at odds with the facts. This Chapter is the "bottom line" of the record. Following Chapters explain some of the background and history. Included are the author's opinions as to the "root cause"[2] of the record.

The cited $68 million is the total of all reportable fires from 1947 to 1992, a period of 46 years, or a mean of less than $1-1/2 million each year. When it is considered that the property values at risk over the same period grew from about $368 million to more than $100 billion, it becomes a little more obvious that the loss is not excessive. Quite the contrary, when placed in the terms commonly used by the insurance industry, the record is superb. A few explanations are in order:

The insurance industry compares losses to the amount of insurance in force. The common term is "cents per hundred dollars of value." The resulting figures (the cost of insurance is figured in the same terms) are generally in the range of "five" to a peak generally less than "one hundred." Thus, like most areas in which a numerical comparison is made, a term is chosen that places the typical terms in the 1-100 range. In easier-to-understand terms for the layman, the equivalent is "hundreds

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[1] It's easy to have a good average after a large loss if you include the bad year in the "before" average. in this case, it is the years after and before that are compared, as made clear by the tables.

[2] To steal a vastly over-worked phrase from current DOE mythology.

of dollars per million." Thus, a "five cent" rate is the same as a rate of $500 for each million dollars of insured value (or property at risk). Because AEC had always maintained that it would have a program at least equal to the best class of private industry (it could hardly say it would be less), making AEC figures comparable to well-established industry practice, with a long history of data accumulation, also enabled the AEC results to be compared directly with the programs they were trying to emulate.[3]

When the losses are placed in insurance terms, the cumulative rate for the entire forty-six year period is less than one-half of one cent per hundred dollars of value, or less than fifty dollars for every million dollars of property value. It is difficult to obtain cumulative current figures for insurance of the best class, but past rates of 2.7 cents/$100 were obtained and continued reviews, confirmed by several of the major insurance groups, indicated this was generally a reasonable figure to use. Thus, over forty-three years, AEC/ERDA/DOE maintained a record that is about six times as good as the best class of private industry.

Another way of looking at the record is to compare the losses to the best insurance rates. A well-protected plant with all the qualifying condition placed on "improved risk" commonly pays a rate of around five cents; the lowest cited to the author was a little under three cents, in a period of tight competition. In addition to being another confirmation of the good record, it illustrates the basic soundness of the agency being uninsured.[4]

Since not all losses, including fires, are "reportable", some further comparisons are in order. DOE losses are reportable (for property damage) when the replacement cost, including cleanup, decontamination, and any other restoration expenses, exceeds $1,000. For fire, the reporting level was actually at $50 from 1947 to 1975. There is nothing unusual in this since most companies, and individuals, do not report small losses to their insurers. In fact, most insurance is purchased with a "deductible", below which losses are absorbed by the insured. The figures in industrial insurance are generally well above the $1,000 level. That this makes little difference in total losses is evident from a study by the author of the 1970-1975 years; the last five before the new policy. If the $1,000 level of reporting had been in force, over 90% of the total dollar loss would still have been recorded, but less than 20% of the number of losses. This is typical of safety, where the rare large loss completely overshadows the statistics accumulated by the day-to-day losses.

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[3] The citing of the best insurance class of "improved risk", while stated in the first AEC fire protection standard, was not really original. The second edition of the "Federal Fire Council Manual of Federal Fire Loss Prevention" recommended the same for all federal agencies.

[4] Misguided people think the government is "self-insured." It is not. There is no pot of money to pay for a loss in the government. In the case of a large loss, you go back to Congress with a request for funds and start all over from scratch.

The figure is even better than the insurance comparisons indicate. The AEC/ERDA/DOE figures include vehicle fires and brush and forest fires. About half-a-dozen losses in these categories are incurred each year and the forest fires include some of the major fire losses in the agency's history. These losses are not included in insurance company figures . Further, fire has been the largest cause of radioactive contamination in the agency's history. The largest loss was both the largest fire loss and the largest contamination loss. This was the 1969 Rocky Flats fire. The $26 million-plus loss included $10 million for contamination, which is included in the fire category in the DOE record, not the contamination category.[5] Contamination losses are not included in commercial fire insurance. They can be covered under all-risk nuclear insurance policies, but at higher rates.

One of the stated goals in the history of the program has been to limit property losses, usually expressed as a maximum loss at which a protection system was required. For most of its history, $1 million has been listed as a potential loss level at which an automatic system was required. This has caused considerable confusion, even among the professionals at times, in that people kept confusing value at risk with the maximum potential fire loss.
Note that without allowing for escalation due to inflation, as was the case until 1980, the standard becomes more rigorous each year. The $1 million loss that was a goal limit when the Rocky Flats fire occurred in 1969, would be expressed as about a $3 million loss now. In reality, if inflation is not allowed, the goal becomes a little stricter every year. Considering this, it is informative to look at the actual annual losses. There were only 13 years of the 46 in which the total fire loss for all sites combined exceeded $1 million, let alone a single loss. This in itself is noteworthy, but when converted to a base adjusted for inflation, some remarkable results are illustrated. If the Rocky Flats fire year, 1969, is taken as one and the years before and after adjusted by a common index, such as the Factory Mutual index, the following is noted:

There were only five years in which the $1 million loss goal was not met.

Since 1969, there has been but a two years in which the entire agency's fire loss exceeded $1 million. (A Petroleum Reserve loss of $12 million in 1978 and the BPA transformer loss of 1990).

Despite the vastly greater number of facilities in DOE, as compared to ERDA, the adjusted losses show that the mean loss has gone down by over $100,000 per year at the same time the adjusted value of the facilities was increasing by more than double.

By the time the Rocky Flats fire occurred, the cumulative fire loss ratio stood at 0.65 cents/$100. In the twenty-seven years since then there has been only two years in

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[5] Note that this single loss accounts for over 1/3 of the 43-year total. The contamination component of this single loss is nearly 1/6 of the 43-year total. If the DOE fire loss was restricted to building fires only, the record would be about 255 better than is reported.

which the loss ratio was more than half of that. In fact, by 1994, the cumulative ratio for all the years since 1947, including the Rocky Flats fire, resulted in a loss ratio of less than 0.5 cents/$100, or about 25% <u>less</u> than the previous record.

In the last five years of the AEC's history, the cumulative loss ratio was 1/10 of the record established in the 22 years before. An order-of-magnitude achievement had been obtained by a program that was already excellent by the most widely-used measure.

A UNIQUE PROGRAM

.....in which a number of unique items concerning the fire protection program are discussed; none of which any other safety program quite discovered.

[AUTHOR'S NOTE: The bulk of this history is devoted to a number of programs that were the key to the success of fire protection in DOE. Not only were the majority implemented more thoroughly in the fire protection program, but some were unique to fire protection, and still are. This chapter is a summary of the principal programs that make the fire protection effort of DOE exemplary. Five years after the original chapter was written, a number of changes are occurring, some good, some bad, and some with the potential to move in either direction. This chapter is updated from the original by adding comments on the programs as they existed in mid-1996]

From the start, the fire protection program contained a number of elements that were unique. In time, others came to be added as the result of experience, a desire to strengthen the program, or to find a better means to communicate policy and information to the field office and contractor programs. All of these contributed to the remarkable record of the program in achieving good results from the start, and then improving on these by an order-of-magnitude. Not necessarily in chronological order, they included the following:

1. A READY-MADE SYSTEM OF EXCELLENCE EXISTED WHICH WAS UNDERSTOOD BY ALL AND COULD BE, AND WAS, ADOPTED AS THE AEC STANDARD FROM THE START.

In actuality, the standard was probably adopted before there was an AEC! The standard was that of "improved risk", or "highly protected risk" as it was defined and applied by the two major industrial insurers, Factory Mutual and Factory Insurance Association. As related in the "People" Chapter, the first Fire Protection Engineer came from Factory Mutual and would be aware of the system, especially since he had worked with the "National Bureau for Industrial Protection", an insurance group surveying war plants for the government. The principle had been ensconced in the Federal Fire Council's "Manual of Loss Prevention For The federal Government" and we know that by the second edition in 1945, at the latest, that it had been recommended for all government agencies.

Regardless of any gaps in the adoption story, it was clear from the first AEC fire protection documents (see the "Order" Chapter) that the principal was already applied in AEC. As explained to questioners in the early years, the AEC could hardly take any other position than to say that its plants would at least equal the best of private industry. In fact, some "nuclear" facilities contain far fewer "fire hazards" than the most prosaic of private plants, but you could hardly explain that to the type of person who considers nuclear materials to be the greatest of every kind of hazard! In any event, it served the fire community well. If it was hard to define to others, the professionals seemed to agree on what it was and a lot of protection was installed under the mantra of "improved risk" that might not otherwise have been.

(In the early '70's, at a post-Rocky Flats fire meeting on improvements, General Giller, Director of Military Application, cut short a complainer by saying: "Yeah, nobody knows what this improved risk is, but the fire guys understand it so lets not screw with them, and the million dollars probably isn't very scientific, but it's an easy number to use and most people still think a million is big bucks, so let's stick with it." Obviously, the General was the author's kind of guy).

Other safety disciplines have standards, but are heavily code-driven. Only in radiation protection is there a comparable doctrine in the ALARA (As Low As Reasonably Achievable) program, but it has been driven to ridiculous lengths as "achievable" became the engine, rather than "reasonable." And other safety programs lack the body of shared opinion as to what an "improved risk' is in there areas.

The "improved risk" concept has another advantage due to its long application in industry; it can be compared with private industry records and performance that extend back over a century.

2. THE FIRE PROTECTION PROGRAM IS THE ONLY ONE THAT HAS KEPT AND MAINTAINED A HISTORY, NOT ONLY OF THE ACCIDENTS, BUT OF THE PROGRAM.

This may seem a somewhat trivial item in maintaining a quality program, but it is actually one of the key elements. Most fires, as are other accidents, are rare events. The major losses are usually quite rare, such that even for an entity as large as DOE now is, any analysis of loss data that has less than five or ten years of losses is imperfect. In addition, the several techniques used for predicting losses require a number of periods with substantial losses, usually years, so that anything less is of little value.

More than keeping track of losses, causes are recurring. Many a protection plan has been ridiculed on the basis of such losses not happening anymore. All too often, the reason they don't happen "anymore" is they were protected against until someone decided that the fact they haven't happened isn't because they were protected but because they just "don't happen." A little history is an invaluable tool.

History has far more useful purposes than loss recording, however. It also provides a sense of continuity, a sense of what happened and didn't happen, what worked and didn't work, what organizations functioned and didn't function. In other words, it provides the patent record of what wheels have already been invented. In government, under political agencies' management, there is a tendency to work in two-year cycles, when everything stops while the new management gets started. The fire protection program managed to avoid a number of these stagnations.

One of the most useful series of documents was the early "WASH" listings of accident histories. More than one embarrassing incident occurred because DOE management of later times didn't know they existed, thus getting their picture on the front page of the New York times saying: "We don't know anything about such losses." (Of course, the Times was never smart enough to find out the truth--or just weren't interested after they had their front page).

The first programmatic history was presented as a speech by the author at a Fall NFPA conference in Montreal, after which it was printed as "A Review of Fire Protection in the Nuclear Facilities of the Atomic Energy Commission" in "Nuclear Safety" magazine for May-June, 1979. The annual updates of sprinkler performance in various publications, as well as the original document covering the history of sprinkler performance, proved of great value and was responsible for much favorable publicity for DOE.

As of 1996, the record is still being reported and probably more comprehensibly than for other safety disciplines. (The requirement for reporting all fire incidents involving extinguishing systems, regardless of loss or injury, is unique to fire protection). There has been a weakening of the record-keeping and data analysis aspects as the proliferation of Headquarters organizations and the dilution of field and contractor responsibilities has delayed report issuance and analysis. Lack of strong Headquarters enforcement of reporting requirements or for a single organization obtaining and maintaining the records complicates the collection of timely, complete, and accurate data.

3. THE FIRE PROTECTION PROGRAM IS THE ONLY PROGRAM THAT HAS A RECORD OF THE PERFORMANCE AND RELIABILITY OF ITS PRINCIPAL SAFETY SYSTEM, AND ANALYSES AND PUBLISHES THE RECORD FOR THE BENEFIT OF OTHERS.

Some special systems may have ample test and even performance data due to rigid quality requirements. Reactor scram systems may be an example. However, they are so specialized and there are so few identical systems, that transferring one site's experience to another is difficult, at best. Other common safety systems, such as seat belts, could be analyzed if plant safety kept all records of both on and off-the-job accidents, but outside of anecdotal evidence, and overly broad police or insurance data, there is little data useable for comparison purposes. In contrast the fire protection record of sprinklers has been kept for over one hundred years and is voluminous. Further, it exists for other countries as well as the U.S.

DOE made a major contribution to the record by publishing a study of all sprinkler fire incidents that could be obtained from a review of the files and a survey of the plants. This confirmed what had been suspected by many, namely that the record was much better than U.S. statistics were showing. The record, by not being subject to insurance deductibles or newspaper clipping limitations, proved to be close to the record established in Australia and New Zealand. Following this 1982 publication, the DOE required <u>all</u> sprinkler fires to be reported, regardless of loss. The later year's records, published in a number of fire press documents, continued to verify the record and also to generate much favorable publicity for DOE.

Perhaps more valuable than the fire performance record (the total number of cases was, after all, rather small), was the inclusion of reports of non-fire losses involving damage to sprinkler systems. This involved a significant (over 600) number of cases and was the first of its kind in print. It verified the reliability of sprinklers, as well as their effectiveness, and generated a great deal of interest as an original study. As such, it is almost unique to the safety field, and definitely to DOE safety programs.

The records have been continued and collective statistics recompiled annually. There is a current move towards combining various safety discipline records into an annual all-DOE safety record. This was done on a number of occasions in past years. The difficulty has always been that items unique to the fire protection interest tend to be omitted and the final all-safety report is of only slight interest to fire protection. The situation was of little concern to the fire protection people since the fire protection annual summary reports were maintained regardless of what the rest of AEC/ERDA/DOE was doing. Indeed, the reports were compiled for the agency as a whole, and distributed to the field, every year since the early 1970's. It is to be hoped that any consolidation effort will not loses the important fire protection items. (As an example, when critics were expressing in newspapers and Congress, stories about lack of protection and a "bad fire record", we were able to compile the record for specific sites of year-by-year performance since 1966, and of the agency as a whole since 1947.

4. FIRE PROTECTION IS THE ONLY DISCIPLINE THAT COLLECTS YEARLY SUMMARIES OF THE PROGRAM FROM EACH FIELD AND CONTRACTOR ORGANIZATION AND PUBLISHES THEM, TOGETHER WITH AN ANALYSIS OF THE DATA AND OTHER ACTIVITIES OF THE YEAR.

More than just another part of the history program, the "Annual Summary of Fire Protection Programs" serves as a communication vehicle with the field, a resource document, a data book, and a briefing book. It is the one means of ensuring that all the field has the same information, and all the information, that headquarters has. By listing the things that were done the previous year, and the things planned for the current year, it gives those planning similar projects yet another chance to avoid "reinventing the wheel." By virtue of its existence since 1975 (and by virtue of the retention of the field reports in headquarters since 1966), the continuity of a common program in DOE is assured.

With the exception of periodic reviews of certain types of accidents, or oral history type publications in technical or popular press, no other safety discipline has attempted what fire protection has long had, and certainly none have been a fraction as comprehensive.

Currently, the desire to publish a single, all-DOE safety document, gives rise to the same concerns noted in the previous item. As a further example, we prepared a number of specific site summaries of all the improvements they had made in fire protection over the years. This more than once squelched complaints about inactivity in fire protection at some sites.

5. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT HAS PREPARED A MANAGEMENT BRIEFING BOOK GIVING THE SCOPE, APPLICATIONS, PERFORMANCE, AND HISTORY OF THE DISCIPLINE.

By using the material noted above, it was possible to prepare a comprehensive briefing book that covered the entire fire protection program. Similarly, any special briefing material prepared during the year could be published in the Annual Summary and afford the field and contractor people the same opportunity, utilizing the same material. With a continuity established over a period of years, the opportunity to tailor materials to answer special requests on short notice was also established. As a result, the fire protection briefings were both the most complete, and the shortest, of most of the briefings requested by new management. In addition, a better record of the program was placed into the hands of management then was offered by any other program.

Originally prepared in 1987, the briefing book has largely been obviated by the extensive number of reorganizations. While the historical material is always current, the problem of continuously updating organizational charts and operational procedure materials to maintain an accurate book is too much effort; particularly when the intended readers express no interest in being informed.

6. THE FIRE PROTECTION PROGRAM IS THE ONLY ONE THAT MAINTAINS A HISTORICAL RECORD OF THE COSTS OF THE PROGRAM, AND OF THE SAVINGS ACHIEVED BY HAVING A GOOD PROGRAM.

The "recurring costs of fire protection" has been a required item in the annual reports since they began. This includes both the cost of fire departments (the major expense) and the cost of the fire protection engineering program. By comparing the data to values at risk, on the same basis as losses are compared, meaningful conclusions as to the effectiveness of the program can be made. Moreover, by comparing the data to the costs of insurance, computed on the same basis, an analysis of the equivalent "savings' compared to a commercial facility can be made. The fire protection program is the only program that can do this and do it on annual and cumulative bases.

Six years later, this statement is still true. The problem with collecting and reporting such data is that it is used by people who have no conception of what it means and there is no other data with which to compare fire costs. There is no current comparison of radiation protection costs or occupational safety program costs. If the costs of radiation protection people, instrumentation test and maintenance programs, radiation safety training, and film badge programs were maintained,, we would probably have people saying: "Why do we spend all this money when we haven't overexposed anybody in years?" Unfortunately, only the fire protection program is in such a position.

7. THE FIRE PROTECTION PROGRAM IS THE ONLY PROGRAM THAT REQUIRES PROFESSIONALLY QUALIFIED PEOPLE IN THE OPERATING FACILITIES.

Fire department people and Fire Protection Engineers have long been professional categories in the federal GS occupational series. Beyond this, the requirement was imposed on the contractors, following the Rocky Flats fire in 1969, that each facility would have a qualified Fire Protection Engineer on the staff. (Generally defined by membership grades in the Society of Fire Protection Engineers). The FPE position is the only professionally-cited position required in DOE facilities.

As a result of the encouragement of professionalism, and the attention paid to fire protection programs, the AEC in 1975 had more Fire Protection Engineers than any other agency except the Navy (there were only 85 FPE's in government then) and more of the AEC people were members of the Society of Fire Protection Engineers than any other agency's people. This did not include the contractor people, which would have made AEC by far the most numerous in both categories.

Six years after the above was written, and despite calls by the Defense Nuclear Facilities Safety Board, and others, for more professional requirements, the fire protection program is still the only one where a level of professionalism is defined in the Orders (now Rules, etc.) and contractors are required to have qualified people. Unfortunately, there has been a tendency to look for safety "generalists" as opposed to discipline professionals and it will be difficult to maintain the high level of the past.

8. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT HAS A COMPLETELY INDEPENDENT OVERVIEW----AND HAS HAD AN OVERVIEW PROGRAM LONGER THAN ANY OTHER SAFETY PROGRAM.

Following the 1969 Rocky Flats fire, the AEC contracted with the major insurers, FIA and FM, to survey the weapons plants. They agreed, although neither was in the contracting business. As a part of the increased emphasis program adopted in 1971, the survey program was extended to cover all major (those over $25 million initially) facilities. By the time the second round of surveys was in progress, the program was so established that the surveying companies were sent to the site and conducted the start-up, surveys, and close-outs, without Headquarters participation. The reports were sent direct to HQ and issued to the field without HQ editing. Although other survey programs have since been adopted for a number of reasons, covering a number of facilities, none have been as independent. In addition, no other appraisal program has covered as wide a range of facilities as the fire protection program.

Unfortunately, the program was allowed to expire. The increasing use of team appraisals, "Tiger Teams" and the like were viewed as eliminating the need for the independent overview. Six years later, it is still the only program where DOE had absolutely independent overviews of all facilities, by people responsible for reviewing private facilities to the same standards DOE was requiring. It is also the only program where the same appraisal system was used for a number of consecutive appraisals, allowing historical comparisons to be made. (It is also the only program where the people making recommendations reviewed them at subsequent surveys and reported the status, eliminating the need for extensive "exemption" and "equivalency" programs. The follow-up surveys repeated the recommendations, noted they were completed, or were no longer applicable for whatever reason).

9. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT REGULARLY KEEPS TRACKS OF THE PROFESSIONAL STAFF, INCLUDING REGISTRATION AND PROFESSIONAL SOCIETY MEMBERSHIP AND HONORS.

Beginning in the late 1970's the annual summary reports began to record the professional status of the fire protection people. Membership rosters in the Society of Fire protection engineers, National Fire Protection Association sections and Professional Engineer registration by States. This both honored the people who had achieved a degree of status and encouraged others to do the same. None of the other safety disciplines could say the same.

This is still the same in 1996. In at least one respect, the program has been further strengthened. While the former "Directory of Safety People" issued periodically in AEC and ERDA is no longer published, a specific directory of fire protection people has been published in several editions in the last five years. With telephone and Fax numbers, e-mail addresses, mail addresses, organizational address, and notes on professional qualifications and experience, it is unique. In this area, the fire protection program has become even more exemplary.

10. THE FIRE PROTECTION DISCIPLINE IS THE ONLY SAFETY DISCIPLINE THAT HAS AN ANNUAL CONFERENCE OF THE PROFESSIONAL MEMBERS OF THE DISCIPLINE.

Since the AEC days, there has been an annual safety conference which included almost all disciplines and appealed to almost all levels from the neophyte to senior management. Fire protection, since the early 1950's has had a conference almost every year, depending on the justifications required and time available. The meetings were originally for the federal personnel only, but expanded to include contractors by the end of the 70's. Later, approval was granted to hold annual conferences, alternating between federal only and federal plus contractor personnel. At that time efforts were also made to include fire department personnel and several conferences in the 80's had special sessions for fire departments.

Several field offices also had conferences especially for their fire protection personnel, notably Albuquerque and Oak Ridge.

This is another program that has been strengthened in recent years. While DOE has been hosting extensive all-safety conferences, and a number of conferences have been held on specific safety topics, the discipline-oriented fire protection conferences have continued. Not only are they still maintained, but attendance has increased considerably, the number of topics is more varied, workshop sessions are included, and sessions with the DOE Fire Protection Committee are included.

11. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT RECORDS ITS ACHIEVEMENTS FOR EACH YEAR.

As noted before, the annual summary requires this. No other discipline makes an effort to compile such a list.

12. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT PUBLICIZES ITS PLANS FOR THE COMING YEAR.

As noted before, the annual summary requires the goals for the coming year. No other discipline makes an effort to compile such a list.

13. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT RECORDS THE MAJOR PROBLEM AREAS.

For most of its history, the annual summaries required a listing of the facilities presenting the major fire protection problems. This has served as an incentive to shorten the list by providing fire protection improvements. Again, no other program has consistently done this. While no longer required in the annual summary report, the extensive lists of deficiencies and planned improvements required of contractor programs keeps the information available to Headquarters and Field office people.

14. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT PUBLISHES A MANUAL OF BACKGROUND MATERIAL, CODE INTERPRETATIONS, AND EXEMPTIONS GRANTED.

The "Fire Protection Resource Manual" originated as a method to provide further information to the field and as a method by which material could be provided without the problems inherent in trying to change the official Orders or other documents. Also, since there is no requirement to keep most material beyond two years, there is a tendency for most material that isn't incorporated into an Order to be lost after a few years, especially after a change in the people to whom the memorandums or instructions were first directed.

The Manual has been reissued by Headquarters in recent years and is being expanded with the intent of reprinting and issuing a complete new document. With the proliferation of Rules, Guides, Standards, etc. a document such as this is even more invaluable than in the "Order" years. Again, the fire protection program is the only safety program with such a document.

15. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM THAT ROUTINELY DIRECTS ITS PUBLICATIONS TO THE NATIONAL FIRE PROTECTION ORGANIZATIONS AS WELL AS THE AGENCY'S ORGANIZATIONS.

The annual reports, special studies, upgrades, and background papers, as well as historical documents, were routinely sent to the major insurance organizations, the National Fire Protection Association, the Society of Fire Protection Engineers, and others. No other safety organization in AEC, ERDA, or DOE made comparable distributions of the limited materials they developed.

16. THE FIRE PROTECTION PROGRAM WAS THE ONLY PROGRAM THAT ROUTINELY HELD TRAINING SESSIONS TO INSTILL ITS PHILOSOPHY IN FIELD ORGANIZATIONS.

Though now defunct, for a number of years, several sessions were presented each year in the "Fire Loss Management" series conducted by Frank Brannigan.

While the "Fire Loss Management" courses are no longer held, the basic and advanced training courses conducted by Factory Mutual (an outgrowth of the independent training program described in another chapter), are offered on a yearly basis. In addition, the DOE Fire Protection Committee has been meeting twice-yearly to review and establish the DOE fire protection requirements. Again, this is a unique program. Other safety disciplines use consultants, ad hoc committees, or selected contractors for similar purposes, and then only on specific subjects. Only the Fire Protection Committee has representation from contractor and DOE sites and reviews all DOE fire protection matters.

17. THE FIRE PROTECTION PROGRAM IS THE ONLY SAFETY PROGRAM WITH A PROFESSIONAL DEVELOPMENT PROGRAM.

Although there are major plans for a DOE training academy and there has been an emphasis on intern programs and outside training for nuclear safety in recent years, the fire protection programs had an intern program in the early 70's under which trainees were sent to many national training programs, meetings, and to field and contractor organizations. Also, beginning with the independent survey program in the early 70's, a special training program for AEC Fire Protection Engineers was conducted by Factory Mutual. The program was also unique in that AEC Headquarters financed the program, the field or contractor organizations paid only the travel, no per diem or training costs.

As noted above, the Factory Mutual program has become an annual offering, with both basic and advanced courses offered. In addition, many contractors have individually participated in courses offered by the major insurers and other fire protection sources.

18. THE FIRE PROTECTION PROGRAM WAS THE ONLY SAFETY PROGRAM THAT MAINTAINED A RESEARCH PROGRAM ADDRESSING THE PROBLEMS IN ITS DISCIPLINE.

Although other safety subjects were addressed by contracts for special studies at various times, the fire protection program had a continuing research effort conducted by Lawrence Livermore Laboratory, until it was canceled by former NRC management people as not being conductive to current interests.

While the full-time support of a single fire laboratory no longer exists, the program has become more extensive and has included research at various organizations. Recent projects have included storage facilities and containers, and penetration protection.

IT WAS THE PEOPLE

.....in which the principal reason for the success of the fire protection program is discussed, which gives every reader the opportunity of stopping at the end of this chapter, and thereby missing all the fun.

(AUTHOR'S NOTE: Several years after this chapter was written, it is clear to us that the premise is as true as ever, and more important now than it ever was. With the expansion and diffusion of safety, fire protection is a smaller part of DOE. Considering the dilution of requirements and a plethora of oversight groups and increasing political vilnerability of programs and facilities, it is more important than ever that a sound fire protection program be maintained. In short, the future success of the program will depend on maintaining the same high level of professionalism and dedication that characterized the program since its inception. The one factor more responsible for a historically remarkable program is the people.)

In the author's recollection, there has never been an appraisal of anything by anybody that didn't have something labeled "management' as a constituent of the format. In the author's recollection, there has never been an AEC, ERDA, or DOE document that defined what "management' was supposed to be. Considering that we're talking about 50 years of history, there must be something significant there. There is. As the Wise Old Fire protection engineer might have pointed out: "With good people, any organization can work. Without them, no organization can." From the beginning, AEC, ERDA, and now DOE have been extremely fortunate in having an inordinate number of the best people on their safety staffs.

The author has long prided himself on his knowledge of fire protection history in general and DOE history in particular, so it was a humbling surprise to receive a document from another of the good FPE's in DOE, Jim Hutton of Oak Ridge. This was excerpts from a history of the "National Bureau for Industrial Protection." In this, we found a reference to our first FPE (most fittingly, as later Chapters make clear, an FM person). The short paragraph:

> "Mr. R. E. Johannesson (Associated Factory Mutual), who was with the Bureau in 1941 and 1942, accepted a commission as Captain in the Plant Protection section of the Army Air Forces in May, 1942, and later served as Major with the Manhattan Engineering Project."

Since it is known that even some of the first "temporary" buildings at Los Alamos were sprinklered, it is clear that Major Johannesson had some influence. Unfortunately, he is omitted from the official AEC history. It would be interesting to learn of his impact on the "DP fire". Another impact is obvious. His promotion of one grade was typical of what was common practice in the AEC/ERDA/DOE to this day. That is, a grade at least one position higher than other agencies were offering was common practice. (When the author started in 1962, he began as a GS-12 at a time when other agencies were routinely offering GS-11 as the top grade for experienced people. When we received a promotion to GS-13, we were quite surprised, and even more so when we found that all field FPE's were GS-13's. We would have been happy to be a GS-12 forever!)

The number of Fire Protection Engineers in federal service has always been small. Thus, the 13 people in AEC in 1975 constituted the second-largest contingent in the federal service, behind the Navy. In terms of professionalism. the AEC was ahead in that there were more SFPE members from AEC then from any other federal agency. If the contractors were included, the numbers would be even more disparate.

The number of people who have progressed to higher positions (in DOE and elsewhere) as well as the number who have received honors in their profession is remarkable. Three people have been honored with the grade of Fellow in the Society of Fire Protection Engineers and at least two additional have high positions pending. Percentage-wise, this is a real tribute to the fire professionals.

The experience of the staff has been one of the strong points. At the same time, it has been a concern for the success of future programs. About 1/3 of the staff (as of 1988--it is even more now) was composed of people with 1-5 years experience. This was balanced by about the same numbers with more than 10 years experience; in fact over 10% of DOE and contractor FPE's had more than 20 year's experience. The lack of mid-level experience posed a problem. as made clear in the Caves Report (see following chapters).

Regardless of the statistics, the prime lessons of history lie in the anecdotes of individuals. These are scattered throughout subsequent chapters. If the lessons learned and delivered by the past staff can be learned by the newer staff, this document is justified.

This chapter was originally written in 1989, when the author retired from DOE. We note that HQ FPE's totalled only eight over all the years from 1947-1989, and three of those were interns. Several others, such as Carl Caves from Chicago Operations Office, and Arnold Weintraub from New York Operations Office, came to HQ, but in other positions and/or became Branch Chiefs with responsibilities broader than just fire protection. The June, 1996, Fire Protection Directory contains ten names in six different organizations. The problems in maintaining uniform policies are obvious when compared to a maximum of three people in a single organization that was the previous norm. The DOE Fire Protection Committee, with representatives from HQ, Field Offices, and contractor organizations, is proving to be an effective means of maintaining uniform policies.

In AEC as a whole, the maximum number of FPE's was reached inthe 1970's. There was a total of 21 people in HQ and the Field Offices in1974. Twenty years later, the June, 1994, Fire Protection Directory listed 71 people in a much wider assortment of Field Offices. Many of these are safety engineers, Branch Chiefs, or others included as that have collateral duties, but at least 31 were fire protection engineers.

The roster of the Society of Fire Protection Engineers included the company affiliation for many years. We used this to compile our lists of Government FPE's for the "804" newsletter. Two comparisons are revealing for AEC history:

In 1959, with 1,058 members, the AEC had three people (Brannigan-HQ, Keigher-RL, and McNamara-CH), while the AEC contractors also had three (Goetz-Ames, Reider-LANL, and Schultz-ANL). The rest of the Federal people were led by the navy with fifteen, Army with five, VA with three, Coast Guard, Aif Force and GSA with two each, and the Bureau of Standards with one. (In those days, the largest consulting group was U.S. Fire Protection Engineering of Kansas City, with five.)

By 1972, AEC has grown to thirteen (Maybee and Branigan-HQ, Shurick, Glover, Pryor, and Cruickshank-AL, Gockley-KCAO, Caves and Oldendorf-CH, Handler and O'Conner-OR, Phillips-NV, and Notley-SNR). There were another twelve in the contractor organizations (Blackmon-Y-12, Deitz-BNL, Magee and Purington-LLL, Cohrs and Duke-SNLA, McCormick-UCC, Ehrenkranz, Reider, and Keigher-LASL, McCracken-Mound, and Hess-RF). Total Federal members had expanded somewhat also. The Navy still led with sixteen, The Coast Guard, Air Force and GSA each had four. NASA, NBS, and VA each had three, DOT, Army, Labor, and the National Commission on Fire Prevention and Control each had two. Six others had one each; the Federal Fire Council, EPA, NIH, FAA, Commerce, and HEW. Total SFPE membership had also grown to 1, 519.

Thus, while SFPE grew by 43.5% in the thirteen years, AEC grew by 333% and the AEC contractors grew by 300%. This was in a period when total growth of non-AEC Federal people was 70%. (The growth in the number of Agencies employing FPE's was 100%.)

V

THE GOLDFISH BOWL

.....in which we learn why the people who "don't know the record", don't know the record.

[AUTHOR'S NOTE: A principal inspiration for this history was the events presented in this chapter. The original version was built around cuttings of the New York Times front page with side remarks pointing to items in the article. Almost eight years later, we can take a more reserved approach to the story, but the lessons are still a reminder of the necessity for a few history lessons and an appropriate "I don't know" admission from people who are too prone to speak off the top of their heads when they don't know the facts - and the facts are readilt obtainable.]

One of the saddest stories in the history of AEC/ERDA/DOE occurred on October 1, 1988, on the front page of the New York Times. Besides ruining the author's birthday, it illustrated the ignorance and incompetance of both the news media and the type of people who are appointed to high-level positions and don't learn what the record is before they are testifying before Congress as to what the record is. Worse, they had the time to learn and didn't bother. The Times' story follows:

Hearings by a congressional committee on terrible safety scandals in DOE made the front page when new safety directors for DOE were being questioned about a "terrible series of accidents and near misses" at Savannah River. In response to queries from a congressman (who should have had the whole story months before), the directors testified that they didn't know anything about a list of "serious" incidents prepared by a DuPont scientist at the site. One even added that "maybe they burned them" (the records). Other remarks were equally idiotic and prompted us to start another collection of similar stories.

Unfortunately, the story is all too typical of what can happen when newly - appointed political people can do when they are sent to "clean up" something they know nothing about (but it must be true, all the news media had those horror stories) and jump into something without adequate preparation beforehand.

In this particular case, a DuPont person made a list of what he considered the most significant reactor incidents at the Savannah River site each year for a period of thirty years. It was supplied as background material to one of the many safety review groups. It was over three years later when a Congressional Committee held hearings on "safety" and brought in the brand-new safety directors appointed to DOE from the NRC. The report was sprung on them, whereupon they made the idiotic statements quoted in the foregoing edition. It is difficult to conceive that the committee, the NRC people, the new DOE people, and of course, the New York Times were completely unaware of the three year-old report. Unfortunately, they all were unaware of the AEC history which contained the citations noted on the preceeding page.[6] The paranoid could consider it all to be part of a cooperative plot, but the realist has learned it's just the way things work in Washington.

The more observant would note that many cases obviously could not be described in a report that only picks what one person considered the most significant single event of each year. Again, this is due to the fact that the list was concerned with reactors and was basically limited to one incident per year. The New York Times naver did discover WASH 1192, or they might have noted that one of the "horrible" accidents, or near-misses, was followed within a short period by a similar loss.

A number of the incidents were not included in the AEC summary, which is probably the reason the DOE management never recanted their "may have been destroyed" observation. As the author pointed out to the new management, incidents involving no property loss or injury or major shut-down were not reportable at the time covered by the reported incidents. However, the kicker came some months later when 5,842 of the "incidents" were delivered to the office of the person who had said "Maybe they burned them."

The interesting point is that the entire incident actually confirmed the oft-quoted remark that "AEC safety is conducted in a goldfish bowl." Far from being secret, DuPont had published and kept the incident records since the day the recators started. The AEC had listed all the loss incidents in its annual summaries, collected summaries published every few years, and finally in the summary of the entire AEC program. The non-reportable "unusual incidents" were not only reported, but retained by DuPont for thirty years! In fact, since the NRC was not formed until 1975 and their "unusual incident" reporting system was developed sometime after that, it might be said that DuPont not only followed the system, they invented it! After all, they had been using the system since day one.

Some of the other parts of the article are equally self-serving[7]. Portions mentioned that DOE had started an "on-site inspection program in an effort to improve operations. By contrast the Nuclear Regulatory Commission has long imposed stringent regulations on operations at nuclear reactors." The reader will note that the subject is changed between sentences. The NRC did not have resident inspectors until late in its life. There were many AEC inspections by many types of people. A comparison of fire inspections is difficult since the organization that became the NRC had no Fire Protection Engineers on its staff until shortly before it was formed[8]. As for NRC fire inspections or fire standards prior to the Brown's Ferry reactor fire, they didn't exist.

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6. When the author was given the "Times" story, he yelled, grabbed WASH 1192, and found the incidents in two minutes, which were duly presented to Mr. Hulman. Three days later, after talking to Times reporters a number of times, he decided to ask for his own copy of Wash 1192.

7. On the basis of "things were terrible then, but now all us new people are really going to crack down."

8. Dave Notley, ex-Savannah River AEC and ex-Schenectady Naval reactors was, ironically, the first.

In the AEC years, a number of "Serious Accident Bulletins", were published each year, together with general safety information publications. One of the more interesting aspects was the fact that a number of the information bulletins were quotes of other private or public material (properly cited). Despite the citations, they were frequently reprinted in other safety journals, with the credit going to AEC! A comparison of the AEC job, essentially a one-person assignment, with the number of bulletins published by DOE in the late 1980's is a further commentary on the excellent job done by AEC.

In addition to the AEC publications. there are a large number of publications issued by the contractor organizations. Every site has employee publications (with safety featured prominently) and publications on the history and functions of the site.[9] Many are the history of the site and some were devoted to particular safety subjects, such as the Los Alamos series on criticality accidents.[10]

The last few pages of the original issue of this chapter contained illustrations of the covers of some of the different publications that were "on-the-record." One of the sadder aspects of AEC/ERDA/DOE history was the lack of availability of many good materials on the open-reading shelves in the agency Headquarters. There was a progressive reduction in the materials available as the agency progressed from AEC to DOE. This was doubly unfortunate as the number of new people grew to predominate in the safety organizations and a large part of the corporate memory was being lost. The fact that the published record exists may not be of help; after all, it existed when the opening "Times" story was published. Hopefully, the addition of other material, such as this history, and the continued fraternization of the majority of the DOE fire protection community will result in a continuation of the excellent record that fire protection established.

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9. The author always enjoyed buying the "secret revelations and suppressed horrors" anti-nuclear books and comparing them to open source material. We found most couldn't even copy their "revelations" correctly, let alone discover a "secret" one.

10. Paul Newman's "Fat Man and Little Boy" movie couldn't even get that right, in time, sequence. or person.

KUDOS

In which we learn a few things about some of the people from Chapter 4 who made the record so good, and brought honors to the agency as well as themselves.

[AUTHOR'S NOTE: We suffer the provincial problem of not having contacts with current DOE people and not having kept the records of all of the many great people we knew from the AEC days on. Accordingly, this chapter should be considered a "such as" document. While many have been overlooked, there is no question that those listed here are not only great, but typical of the DOE fire protection community.]

First, a few of the feds. Not because they deserve more than the contractors but because we knew more of them for a longer period of time. To avoid favoritism, we have, in alphabetical order:

FRANK BRANNIGAN. No more fitting person could be first. In fact, Frank deserves a Chapter of his own, and gets it later. Suffice to say, Frank was the best public relations officer the Atomic Energy Commission ever had. Unfortunately, they didn't know it.

Frank began in the fire service as a Chief. After Navy service, he joined the AEC's New York Operations Office in 1949. In 1954 he came to Headquarters as part of the small safety staff that included Dick Smith as the other FPE and J.P.H. Kelley as the Safety Engineer, with Humphry Gilbert and Ed Patterson as Jacks-of-all-Trades and Dan Hayes as Chief of what was then the Safety and Fire Protection Branch in Industrial Relations. This was the period when the Operations Offices, as contract managers, were also responsible for managing safety. Thus, all the real safety staff was in the field and the small HQ staff basically made policy and appraised the field organizations. One advantage of the organization was the clear-cut line of responsibility and the fellowship it fostered among all the staff, both AEC and contractors.

At HQ, Frank initiated a number of projects that brought great credit to AEC and made Frank one of America's best-known fire protection people. (People who know him say FPE stands for Fire Protection Evangelist in Frank's case). He developed the radiation training course and the material which became the two-volume "Living With Radiation" set. for a number of years, these were the number-two best sellers on the GPO list (behind a baby book). Frank also developed the structural material during this period and conducted a number of seminars each year. His books, "Building Construction for the Fire Service" also became a best selling NFPA publication, now being revised for a third edition.

Frank's widest fame came as a public speaker. The author once had the pleasure of accompanying him on a visit to the Stanford Linear Accelerator center where he was conducting the construction course. At the end of the day he was asked to address a group of fire science students at a local junior college who were taking a communications course taught by a telephone company officer. Frank accepted the offer, talked of other things while we were driving up the coast, then walked in, introduced himself, and proceeded to give an hour lecture on communications as related to the fire service, with a twist to every story and example that related it to the telephone company, college courses and fire students. Another standing ovation and another typical day of "Living With Brannigan".

JOHN BELL. John was one of the three interns from the University of Maryland FPE program that the AEC was fortunate to acquire in the 1970's. John was the first, serving from 1969 to 1970 with HQ and then moving to the Richland Operations Office where he served until 1974. He left the AEC for the Navy at San Bruno, Calif., and then for a while with DOT, Denver. He returned to Richland with the principal contractor, Westinghouse, where he now heads not only the extensive fire protection program, but occupational safety, industrial hygiene and others, all with one of the largest safety staffs in DOE. The fire protection group also provides service to DOE in a number of additional programs. He returned to DOE in 1988 for a year to assist the fire protection program in a number of areas, including the establishment and organization of the Westinghouse program at Savannah River.

DICK BEERS. Dick spent all of his career at Idaho and rose to the highest rank of any of the fire protection people. Starting as an FPE in 1960, he became a Branch Chief by 1975 when he became a Division Director in Engineering, and finally the Assistant Manager of the Operations Office with responsibility for all of safety and security matters. Dick had experimented with Hi-ex foam on records storage after Idaho took possession of the first Hi-ex foam vehicle produced by the manufacturer and after it had made a cross-country demonstration tour. The report was one of the first items in print on Halon on Class A fires. Dick was also typical of the earlier generation of FPE's when almost all came from an insurance company or rating bureau background.

BILL CRUICKSHANK. By 1989, Bill had become the senior FPE in DOE. Starting at Albuquerque Operations Office in 1956, from Factory Mutual, he has spent all of his career at AL. When it comes to institutional memory, Bill is also the senior. One of the "Caves Report" problems was the lack of a system for retaining or recording this information. Hopefully, this history will help.

CARL CAVES. Author of the "Caves Report", Carl was one of the Chicago Operations Office safety people who double in safety and fire protection, and have done a remarkably good job at both. In fact, Carl has been the SFPE representative on the Board of Certified Safety professionals, where he is also certified (and also has professional registration as an FPE). Another of the safety people with a strong background, and FM experience, Carl started at Chicago in 1969 and moved to HQ in 1975 where he concentrated on establishing the Safety Analysis Report program. Upon the retirement of Arnold Weintraub, he became the Chief of the Branch with the industrial safety and fire protection responsibilities in the then-Division of Operational Safety, when he was pegged to report on fire protection to the Assistant secretary, Mary Walker. (see the "Caves Report chapter). Carl also served on several NFPA committees. Following the 1989 reorganization, he transferred to the Office of Nuclear Energy, where he is in a management oversight position for the production facilities' safety.

R. E. JOHANNESSON. The only reference we have been able to find is in an undated history of the National Bureau for Industrial Protection. Composed mainly of insurance company engineers, it inspected wartime production plants for the government, producing over 800 reports a week in 1942. The history cites Johannesson as one of the engineers on assignment from Factory Mutual. In view of the many later AEC/ERDA/DOE associations with FM, it is fitting that he is mentioned. The history notes that he was commissioned as a Captain in the Plant Protection Section of the Army Air Forces in May of 1942. Without citing a date, it mentions that he became a Major and was assigned to the Manhattan Engineering District. It would appear that he was the prime reason two of the world's first nuclear reactors were sprinklered. (The first graphite prototype production reactor, a National Landmark and still at Oak Ridge, and the first solution reactor, the Boiling Water Reactor at Los Alamos, shut down in 1995). Both are in sprinklered buildings. (A 1943 sprinkler head from Los Alamos is a mounted addition to the author's collection. The heads were being replaced when the decision was made to close it down). Unfortunately, attempts at retreiving more of Mr. Johannesson's history from FM were unsuccessful and we have not found him mentioned in other AEC histories.

DON KEIGHER. Don, now retired, is one of the most distinguished of the long line of great FPE's in AEC/ERDA/DOE. Don was an IIT graduate and came to AEC in 1949 at the Chicago Operations Office (Andy Pryor's father was in personnel there and was responsible for acquiring a number of the early FPE's from IIT). In 1953 he moved to Richland where he became a Branch Chief, hiring both Andy Pryor and Pat Phillips on subsequent occasions. Don has held many distinguished positions in SFPE and NFPA, including Chairman of the Halon Committee and membership in the Computer Committee. He also made a survey of protection at all important AEC computer sites. In 1969, Dan Hayes had moved to NASA and recruited Don to be the industrial safety man in the safety office. (Bill Hanbury had fire protection). He retired to become the first FPE at Los Alamos and then leader of the fire protection group there. After his second retirement, he continued as an active member of the NFPA Standards Board and consultant to a number of DOE facilities and a participant in many LANL-support activities for other contractors. Don is also one of the three AEC people now holding the grade of Fellow in SFPE, being the first to receive the honor, in 1981.

WALTER MAYBEE. Walt (the author) is another FIA-trained FPE who started at the San Francisco office in 1962. After the Rocky Flats fire of 1969, he was invited to HQ by the Branch Chief, Ed. Patterson. Until his retirement in 1989, he originated the feedback of the annual summary reports to the field, and conducted the surveys of computer protection and sprinkler effectiveness that garnered much favorable publicity for DOE. He served on Computer and Atomic Energy Committees of NFPA, becoming Chairman of the Atomic Energy Committee. Retiring in 1989, he worked for a consultant analyzing the DOE Orders for Defense Programs and then accepted a position at Los Alamos National Lab. in 1990. While with DOE he started the "804" newsletter for federal FPE's and at Los Alamos started "Hot DOE-Nuts" for DOE FPE's; both publications continuing to mid-1996. He is another of the SFPE Fellows, a 1987 awardee.

TOM O'CONNER. Tom was a former FM employee who started at Oak Ridge in 1970. Transferring to Savannah River in 1974, he was the FPE until 1983 when he left to take a senior FPE position with a utility consortium. He is typical of a number of ex-federal FPE's who have gone on to wider responsibilities in industry. Tom was the first appointee to the NFPA's Life Safety Code Committee, Industrial Occupancy section, as an AEC effort to be in on the decisions affecting large-area facilities, a problem common to a number of AEC/DOE sites.

LARRY OLDENDORF. Larry was typical of the Chicago people performing both the industrial safety and fire protection role. This was occasioned by the fact that CH had so many of the university facilities (many inherited from the New York Operations Office) in which the dual role was the most feasible way of handling the numerous small facilities. Larry started in 1962 and became the only field FPE at the GS-14 level (after Chicago's Jim McNamara). In 1984 he switched to a management position when a personnel review threatened to reduce his grade. While in safety he was active in local FPE and ASSE society activities. He was on the ANSI committees developing nuclear fire protection standards and was Chairman of the ASSE Research Section. He is one of a number of excellent safety people who moved to other positions as circumstances warranted and left a legacy of devoted and distinguished service to the agency.

ANDY PRYOR. Andy is typical of several people who left an impression in areas beyond their own office. Andy is another IIT man who started at Richland in 1962. In 1964 he left for Southwest Research Institute where he authored a number of papers, some of which are still referenced in the NFPA Handbook. In 1969 he returned to DOE at Albuquerque where he has served to this date. After the Browns Ferry reactor fire he was loaned to NRC as a fire protection consultant and wrote the classic "dissenting" paper on the fire.

PAT PHILLIPS. Pat is one of the most distinguished and honored of FPE's, not only in DOE, but in the profession as a whole. Pat is another IIT and "Bureau" man who was hired by Don Keigher at Richland in 1965. He moved to Nevada in 1968 where he has remained until his retirement at the end of May, 1991. Pat was the second SFPE Fellow, in 1982. Pat has long been the principal expert in DOE on alarm systems, serving as the Chairman of the NFPA's Signalling Devices Committee and Alarm Systems Coordinating Committee as well as membership on Halon and Systems committees. This work led to his receiving the Fire Alarm Association's "Man of the Year" award for his contributions, He is also the author of the DOE guide to smoke detector installations and has been a long-time Brannigan co-lecturer with information on the latest developments in fire protection systems. His excellence has been recognized by DOE in nominating him for the GEIGO top federal employee in a safety area, and by sending him to Russia as part of a "People-to-People" program (the only FPE on the tour).

EARL SHOLLENBERGER. Earl was one of the most veteran, and one of the least-appreciated fire protection engineers in AEC/ERDA/DOE history. Another of the 1960's-era people, he went to the Pittsburgh Naval Reactors Office as a young University of Maryland FPE graduate and spent his career there, most of it as the only FPE on the DOE side of Naval Reactors. It was always difficult for the Naval Reactors people to participate in other AEC activities and, outside of headquarters, the rest of the agency had little awareness of the Naval Reactors programs. By 1993, not even the DOE Fire Protection Order applied to NR, but in the 1970's and most of the 1980's, DOE Headquarters made regular inspections of the two Naval Reactors offices and their associated contractor sites (for non-nuclear safety only). As the only professional on the government side of the program, Earl became the chief interpreter of the headquarters (non-Navy) actions and the chief explainer to the appraisers of what the Naval Reactors program was. We always found the program exemplary and much of the credit for that went to Earl. Although he became a supervisor with numerous other safety (and non-safety) functions, he was still "the man" for fire protection until a new FPE was finally hired in 1995.

RICHARD B. SMITH. "Little" Dick Smith (to distinguish him from Oak Ridge's "Big Dick" Smith) was one of the early DuPont veterans who came to DOE Headquarters with the formation of AEC in 1947 and stayed until his retirement in 1974. A quiet, chemist type, he was one of the number of unsung people who remained out of the publishing-speaking limelight, but kept the organization on a steady course through its formative years. Without the experience of the veterans, the AEC could never have achieved the steady successes of its early years.

ANDY WILSON. Andy was typical of another extreme in AEC service, the short-timer who went on to bigger things. Andy was a recent U. of Md. graduate when he came to HQ as one of the interns the agency was able to hire in the 70's. Andy came for a year in 1976 and spent some time in HQ and field offices before he left the agency. Hired as the first full-time FPE with the Smithsonian Institution, Andy now heads a staff of fire protection professionals that have become leading figures in the museum protection world. One of the better legacies of the AEC was the quality not only of the people who came to the agency and stayed, but of the people who spent a comparatively short time and went on to make an impact elsewhere. In some ways, this has been even more of a contribution to the fire protection world.

ARNOLD WEINTRAUB. Arnold was one of a very special few. Like Frank Brannigan, he had an intimate fire department background, having served with the New York City Fire Department from 1940 until 1960. While there he received his Bachelor's degree and several steps towards a Masters. Joining the AEC's New York Operations Office in 1960, he moved to Brookhaven Area Office when NY became a lab and then came to HQ, becoming the Branch Chief and earning a PhD, before his retirement in 1985. Arnold was one of the true gentlemen who helped advance the cause of fire protection while increasing its academic respect. His work on Hydrogen, in the days when no self-respecting accelerator was without a liquid hydrogen bubble chamber is still a classic. He was also a member of several NFPA Committees, including the Gasses and Computer Committees and was instrumental in several revisions of the DOE computer standard.

Next, a few of the contractors, not because they were second in anything, but because there were usually considerably more of them than of the feds, and because the author was less familiar with many of them. So, not because they are more outstanding than others, but because they stood out in our memory, we have:

DONALD B. DAVIDSON, Jr, Don's DOE tenure was spent at the Los Alamos National Laboratory; first as a fire protection engineer under Don Keigher and later as the Section Chief in the Fire Protection Group under Jim Gourdoux until his 1994 retirement. (He had previously been a senior FPE with National Cash Register). Don was active during the first major upgrading of Los

Alamos fire protection systems in the 1970's and presided over the expansion of the fire protection engineering effort in the early 1990's. Don is typical of many DOE fire protection people in his service to fire protection outside his employment. An officer and one of the organizers of the Rio Grande Chapter of SFPE, he was also a long-time member of the NFPA Lightning Protection Committee, ending as the Chair. He was at Los Alamos from about 1970 to 1994, when he retired. After retirement, he continued to work on updating LANL fire protection documents until the whole program went into turmoil and we didn't know what we were trying to be in compliance with.

JOHN DIETZ. John is typical of the finest FPE's in DOE. Coming from the U. of Md's program to Brookhaven National Laboratory at the time of the revolution in AEC fire protection, he has risen to head a group comprising a number of other experts, including an ex-FM replacement for himself in fire protection. More often, in recent years, John's name has appeared on a number of reports that BNL has done for groups such as the NRC reviewing various aspects of nuclear fire protection and adding expertise where it has been sorely lacking for too many years.

VERN DUKE. Vern is another of the distinguished professionals who has spent most of his career at a major site; in this case, Sandia National Laboratory, Albuquerque. Verne has been the lead FPE for over 25 years and has contributed to the many FP studies done by SNL for NRC and others. He has also represented DOE on a number of committees and has been active in the founding and leadership of the SFPE's Rio Grande Chapter. There is no doubt in the authors mind that the superb record established at SNL and some other facilities is due to the knowledge and integrity of people like Verne. They represent the single most precious asset in the DOE fire protection program.

KENNETH DUNGAN. Ken is perhaps the outstanding "graduate" of the AEC fire protection program. A University of Maryland FPE and ChemE graduate, he worked at the Oak Ridge complex of Union Carbide - run plants. Leaving to start Professional Loss Control in 1976, he built it into one of the foremost FP consulting firms in the country. With headquarters mover from Oak Ridge to Kingston, TN, PLC also has four offices in the U.S., three in Canada, and others in Hong Kong, Seoul, and Manila. While in Oak Ridge, he was a co-founder (and later President) of the Tennessee Valley Chapter of SFPE. He became the President of the entire SFPE, concluding his term in 1993, at which time he was elected a fellow in SFPE (the third from AEC). He is noted for his strong support for SFPE/NFPA, both financially and physically. Many NFPA standards committees have PLC members. See also the chapter on the independent survey program.

TOM FRANCK. Tom was one of the most dedicated and professional FPE's the author has had the pleasure of knowing. A WW II Navy pilot, he was an FPE with the Navy for a period. (We have some of his water test studies in our collection of exemplary examples). He was briefly at Portsmouth Gaseous Diffusion Plant, and then with Argonne National Lab. for nearly 29 years, retiring in 1986. At ANL he was instrumental in maintaining the policy of providing both alarm and extinguishing systems. A leader in systems design, he did most of the detail design work for ANL systems. At the 4/66 safety conference in Richland, he presented a talk on the installation of the first ANL Halon systems in an Idaho facility, at a time when most of the audience had never heard the term and the NFPA Halon standard was still several years in the future. Tom also designed most of the sprinkler installations, doing hand calculations when computer programs were just a dream. A number of DOE sites were essentially one-man operations in fire protection for many years and the agency was most fortunate in having many of the best to lead the way. Tom exemplified the best of any in AEC, ERDA, or DOE. The text on sodium protection, one of the most comprehensive produced by AEC, had substantial portions of his contributions.

DENNIS KIRSON. Dennis is one of the more experienced of the contractors, having served with the New York Port Authority, the Army in Korea, Brookhaven National Laboratory, and Sandia National Laboratory, Albuquerque. Dennis recommended the formation of a Clean Room fire protection committee to NFPA, and became the committee head after its formation. In 1990, he moved to the federal side by becoming part of the long line of superb FPE's who have served with Albuquerque Operations Office.

MIKE MAGEE. Mike was the center of fire protection activities at Lawrence Livermore National Laboratory. Beginning as a student in the veteran class of the early 1960's, he was the initiator of one of the high-expansion foam projects in the LPTR reactor. He moved to Site 300 as a high explosives specialist in the mid-sixties, and then left for a few years working with REECO's Leo Martin in the Nevada Test Site Fire Department. He returned to Livermore in the 1970's and was a prime mover in both fire department and fire protection engineering aspects. By the 1990's, he was Deputy Chief under John Shary and the principal operations officer. Mike was always one of the most active and innovative of the DOE fire protection people and a frequent participant at the annual conference. Another of the pioneers, he saw the programs grow from the single-handed efforts of one person in the early 1960's to the "corporate" staffs of the 1990's. His active career, until his 1993 retirement, typified all that was best about the program and was himself typical of the best of the people.

LEO V. MARTIN. In 1951, Leo came to the Nevada Test Site as a construction foreman. He had been Chief of the Overton Volunteer Fire Department and the arrival of the first fire truck at the Mercury Townsite was of particular interest to him. The pumper had been brought to the site by Captain Pete Allen of the Los Alamos Fire Department who was sent to organize a crew of firemen. One of the first successful applicants was Leo. In June, 1952, he was named Chief of the NTS firefighters and held that position until his retirement in 1992. The longest-reigning Chief, his influence extended beyond his realm and he earned the respect of all who had the chance to visit NTS, in addition to establishing a remarkable loss-free record in a site rife with temporary, combustible buildings, often at impossible distances from a fire station.

BOB PURINGTON. Bob was an Oakland, California fire officer who earned a University of California degree in Mechanical Engineering on his own. When the Lawrence Radiation Laboratory-Livermore decided to hire its first full-time FPE in 1960, Bob was the choice. He was the Fire Chief and FPE. Bob became one of the most prolific authors and advanced trainers and practical researchers in the agency. Some of his earliest work included tests and revisions of flows from small hose that merited nearly as much credit as Freeman's pioneering work near the turn of the century. His publications ranged from articles to several books, including a hydraulic text and a book of firemens terms. The most significant aspect of his work was his strong mutual-aid work and development of practical drills in radiation emergencies. His book on radiation emergencies for fire departments, published by the NFPA, was the best we had ever seen. Unfortunately, the book was not maintained in print and is now a collector's item. Upon his retirement, Bob stayed active in local areas and has done a considerable amount of consulting and is active in computer applications to fire science.

JOHN SHARRY. John is another of the newer crop of FPE's with distinguished service before coming to DOE. John had been the NFPA's Life Safety Code Laison when he accepted the senior FD-FPE position at Lawrence Livermore National Laboratory. He maintains his positions on several sections of the Life Safety Code and is now the DOE's resident expert on the subject. John is also a member of the DOE Fire Protection committee which, as of 1991, is active in revising the Fire Protection Order, the fire protection sections of the Construction Order, and updating the Fire Protection Resource Manual.

ELMER SILVA. Elmer was typical of much of the AEC in the days when the importance of doing the job outweighed a title. From the sheet metal shop at Lawrence Radiation Laboratory (Berkeley), he came up through the volunteer fire brigade to be the Chief and only full-time member. It wasn't until the mid-sixties that the Laboratory finally discovered that the Berkeley Fire Department wasn't going to be much help in a major riot, or earthquake, so they took another look at costs and decided to go to a paid department. In addition to Chief, Elmer also performed all the FPE functions. Although he attended the Factory Mutual courses and just about everything else he could, it was his own dedication that got the job done. Despite the disparities in background when dealing with top scientists, Elmer had a tremendous rapport. Despite the fact that the Laboratory had no professional FPE after the AEC had directed it in 1971, the Berkeley site was one of the least of the San Francisco Office's concerns. Elmer was a leader in the local fire service training programs and taught a number of the Associate degree courses in the Bay Area, all to great effect. Elmer, in his 30-plus years at Berkeley, demonstrated that it is the person who makes the job.

GORDON VEERMAN. No AEC/ERDA/DOE story could be complete without a number of items relating to the contributions of the fire service personnel. In addition to Elmer Silva, Chief Veerman of Argonne National Laboratory deserves special mention. Active in one of the most comprehensive mutual aid programs, he has originated a number of special-purpose vehicles, shared among several departments and concentrating on hazardous materials and command functions. He is among the top people in the IAFC's Hazardous Materials group. For DOE, he was instrumental in suggesting, and later heading, the ad-hoc committee on adopting the NFPA 1500 Standard on fire department safety and applying it in DOE. With one of the most comprehensive inspection-test programs, he has pioneered a number of activities in this field. In addition, with much of the FPE function in the department, he has achieved a pre-fire planning and plan review function that has not been exceeded in any other DOE facility.

DOE FIRE PROTECTION ENGINEERS

1947-1988

HEADQUARTERS

Richard B. Smith	1947-1974
Frank Brannigan	1954-1972
John Bell (Intern)	1969-1970
Walter W. Maybee	1970-1988
Al Swartz (Intern)	1972-1973
Andrew Wilson (Intern)	1976-1977
Arnold Weintraub	1976-1985
Billy Lee	1988-1988

ALBUQUERQUE OPERATIONS OFFICE

"Boots Sherril	1947-1961
Jim McNamara	1951-1957
Arnold Spavin	1951-1957
Bill Cruickshank	1956-1988
Richard Glover	1964-1970
Andrew Pryor	1969-1988
James Shurick	1970-1988
Robert Straba	1970-1984
Pat Copp	1976-1988

CHICAGO OPERATIONS OFFICE

Donald Keigher	1949-1953
Jim McNamara	1957-1963
Larry Oldendorf	1962-1984
Carl Caves	1969-1975
Frank Gorup	1975-1979
Justin Zamirowski	1976-1988
Joe Morely	1981-1982
Jim Maruka	1985-1986
Mike Saar	1987-1988

IDAHO OPERATIONS OFFICE

Dick Beers	1960-1975
Tom Asbury	1970-1972
Lee Williams	1973-1984
Dick McCluskey	1986-1988

NEVADA OPERATIONS OFFICE

Arnold Spavin	1961-1973
Pat Phillips	1968-1988

OAK RIDGE OPERATIONS OFFICE

Dick Smith	1947-1964
Jack Bolin	1957-1979
Richard B. Handler	1964-1981
Tom O'Connor	1970-1974
Ken Leifheit	1972-1987
Jim Hutton	1980-1988

RICHLAND OPERATIONS OFFICE

Don Keigher	1953-1969
Andrew Pryor	1962-1964
Pat Phillips	1965-1968
Dean Davis	1971-1981
Allen Rhodes	1982-1982
Dave Evans	1984-1988
Jerry Davidson	1986-1988

SAN FRANCISCO OPERATIONS OFFICE

Glen Orihood	1960-1961
Walter Maybee	1962-1970
Joe Juetten	1971-1988
John Barr	1984-1988
Don Kelley	1988-1988

SAVANNAH RIVER OPERATIONS OFFICE

Bob Parriott	1956-1984
Dave Notley	1962-1972
Tom O'Connor	1974-1983
Dario Luna	1984-1988

ITTSBURGH NAVAL REACTORS OFFICE

Earl Shollenberger	1969-1988

NEW YORK OPERATIONS OFFICE

Frank Brannigan	1949-1954
Arnold Weintraub	1960-1975

STRATEGIC PETROLEUM RESERVE

Jim Edwards	1979-1988

NOTES: Several people have served in more than one office. Only the period with each individual office is listed.

A number of people became Branch chiefs, or higher. This service is included in the years column.

VII

EARLY LOSSES

.....in which we learn that some of the more significant losses in the agency's history were not the most publicized, and more unfortunately, are not the best remembered.

[AUTHOR'S NOTE: Since fire protection is more history-dependant that any other safety discipline, it is a shame that many significant losses have been forgotten. This chapter is intended to partially rectify that.]

Many of the earlier losses in AEC history were as significant as the more publicized loses of later years. Unfortunately, while they are still recorded in the public record, their significance has been all but lost to the newer generation of DOE people. For instance, consider the plating shop fire at Los Alamos on January 15, 1945.

The fire involved a plating tank and a loss of $125,000. It is duly recorded in the loss history of AÈC. Other history books (with excerpts inserted into the original version of this chapter) noted that the fire caused some concern among the scientific management about what might have happened if it had occurred in the nearby plutonium shop. The result was that a new plutonium facility was built, "remote" from the existing site and called "DP-West." The new site was completed in a few months and the wear effort was not affected (What if it had occurred in the plutonium shop? Would the bomb be delayed a few months? Would Japan have been invaded by then? The fire might have been deadliest in history, but we would never have known it.)

It was not until 1994, when we read an unpublished memoir of one who had been involved in the firefighting operation that we learned the shop was sprinklered! (But not an adjoining shop. It spread to a concealed attic when the sprinklers overflowed an uncovered dip tank). Unfortunately, the details were not available to add it to our sprinkler fire history - as were a number of similar cases before 1952.

The aftermath is even more interesting. As of mid-1996, it is still the largest dollar loss in a building fire in Los Alamos history.

The Tiger team added another look at changing standards. When they made their 1991 Los Alamos survey, it almost seemed as if they would close the plutonium facility. DP-West? No. That had been replaced in the 1970's as one of the ten most important projects resulting from the Rocky Flats fire of 1969 and the subsequent review of AEC safety. It was the 1970's facility that was now so far below "standards."

A FISHY FIRE

The 1964 Aquatic Laboratory fire at Richland (No. 21 on the AEC list at $316,000) was almost a comedy when described by Don Keigher at the 1965 AEC Fire Protection Conference. The unsprinklered building ignited in a roof of such confined spaces that the building almost had to be torn apart piece-by-piece by the firefighters. The slow spread allowed time for the staff to scurry about, trying to retrieve papers and interfering with the department while the limited access almost guaranteed destruction. Obviously, any talk of "why sprinkler a building full of water?" lost any significance it may have had after this one. Unfortunately, the habit of building things cheaply continued to cause considerable expense to AEC/ERDA/DOE in years to come.

THEY'RE NUCLEAR FIRES, TOO

A number of losses seem peculiar. A $12,000 dwelling, a $24,500 bakery and grocery store, a burn fatality - from hot soup!, the total destruction of a dwelling (only $6,787), a $33,455 loss in a private office building (but government-loaned office equipment, and others of similar nature are all included in the loss record. The war-time, government-owned cities? No, the cited examples all occurred after 1959, in "private" facilities that were still AEC-owned. There were a number of similar losses during the war years, of course, when Oak Ridge, Hanford, and Los Alamos, were government owned towns. In fact, they are a significant portion of the total loss picture. All of which combine to make the "nuclear" fire loss record even better than the statistics indicate. So who counts those kind os losses when looking at the nuclear accident record. DOE does (and the critics, of course, do not exempt them.

THE ACCELERATOR FIRE

To anyone who goes back to the AEC days, there can be only one accelerator fire. It was the Princeton Accelerator fire. It wasn't much of a loss and doesn't even make the "over $50,000" list of the AEC chronology. To the modern safety specialist, it is the best example of discovering the root cause, - and in a hurry. The story is so good that we chose it to lead off two other chapters, one on accelerators and one on Frank Brannigan.

BUT CONCRETE DOESN'T BURN!

It doesn't, but it does conduct heat. (Too many people confuse conduction and non-conduction. Everything conducts heat; some things are just better than others). A 9/79 loss at Richland involved uranium machining turnings packed in concrete blocks in wood overpacks, and stored in a warehouse awaiting shipment as scrap. The spontaneous ignition of the turnings eventually heated the overpack, which ignited. The loss was $23,028, mainly due to the cost of cleanup and decontamination.

There was nothing very dramatic, or really unusual about the loss, but if you twist the stories in the right direction, you can get a good moral out of them. In this case, we said that, if the government is putting non-combustible garbage in concrete and then storing it in sprinklered warehouses, there may be a good reason. (This fire was one of the sprinkler successes).

WATER CAN BE DAMAGING

The average fire protection engineer spends so much time overcoming the concerns about water damage from fire protection systems (The world is full of people who can visualize how everything can be damaged by anything - except fire) that they sometimes forget that water can damage things. Of course, you may have to have some rather exotic combinations. AEC had several.

There were several instances, including a $16,200 loss at Battelle in 1979 where the only thing water damaged was - fish! When the fish are aquarium specimens, a water surge can break a tank, or unconditioned water can contaminate a tank, damaging the research value of the fish, even if they are apparently unharmed.

Among the more bizarre was a Savannah River incident where the only thing damaged by water was - water! When ordinary water leaks into a tank of heavy water (a reactor moderator), the heavy water can be "diluted" to the point that it has to be reprocessed. A 1980 incident cost $16,000.

THE ODDEST SPRINKLER FIRES

What has to be among the oddest incidents were Savannah River and Oak Ridge losses where dry-pipe sprinkler piping was being cut into for modifications. In both instances, a fire started <u>inside</u> the piping. Mold, or gas seepage, resulted in rather minor, but surprising, additions to the fire record.

UNDERWATER FIRE

if a fire inside a sprinkler pipe is not too surprising after the facts are explained, how about a fire under water? On 9/9/79, a tugboat - barge combination at the Strategic Petroleum Reserve's Weeks Island to St. James right-of-way on Lake Verret, LA, ruptured a submerged (but unburied) chemical company liquid hydrocarbon pipe. The 640 psi escaping liquids ignited, engulfing the tug in flames and killing two crewmen. Two others suffered burns, but escaped. Isolation valves functioned, but the nine miles between valves allowed the fire to burn for nine hours. But no great problem, it wasn't a nuclear accident.

NOT SO LITTLE

One thing the nuclear people were always aware of was that the smallest things (like atoms) can become the largest things (like galaxies) if you just have enough of them. So it really should be no surprise to a DOE fire protection professional to recall that a partially-burned battery fire was visible for 20 miles and resulted in an $85,000 loss.

As might be suspected, the battery and the circumstances were a little unusual. In this case (a 1971 General Atomic fire), the lab was on a hilltop, the fire was at night, and the battery was a WW-II submarine battery!

The anti-nuclear crowd are free to use this as a certified government cover-up. It was omitted from the WASH 1192 list, where it should have been number 66a on the list with a 10/25/72 date. (it is on out "Did You Hear The One About?" list).

BUT NOT A LOSS

A number of losses resulted in no actual dollar loss to DOE but were notable regardless. Two cooling tower fires are in this category, included in the chapter on cooling towers. Others were repaid, such as the Fermi fire in which polyurethane foam insulation, ignited by a construction worker's welding spark, ran 300 feet down a beam Quonset hut beam line tunnel in eight minutes. The money was eventually recovered through subrogation but the loss was notable as an indicator of the need for close control of construction activities. The 1973 loss was covered in a January, 1975 Fire Journal article, mostly a reprint of the DOE Bulletin.

Forest and brush fires are the classic example of what might be called non-loss losses. There are some reported at DOE sites almost every year. They are generally charged at some site-specific cost per acre. Even though a loss is assigned, there is usually no actual monetary cost. This is especially true of brush fires where the ground cover is usually allowed to regrow naturally, without artificial seeding.

The major forest fire was the 1977 Los Alamos fire where over various charges were listed at one-half to one million dollars (depending on which version of which report is read; final figure was about $1/2M). DOE did not incur any expenses beyond the firefighting and the forest is still naturally regrowing. (A small building fire was charged as a separate loss and is a story in itself. When we finally saw a descriptive report on the $50,000 loss, we asked why what was basically a shed was so highly valued. It turned out that, for some reason, a lot of the photographic supplies unaccounted for over the years had just happened to have bee stored there).

Savannah River is another loss example. A Forest Service unit (reported as a DOE contractor) manages the over three hundred million trees that have been planted there. They are contracted for annual harvesting as a regular tree farm. There are also one or two small forest fires almost every year. The forest fires are charged in the record as DOE losses, while the harvesting income goes to the U.S. Treasury, not DOE.

Over the years we kept informal totals of some of the no-losses included in the DOE loss records. these served as an informal, but effective offset, to the charges from time to time that DOE was hiding losses or not reporting them accurately. Since the record was still excellent, without deducting spurious losses, we left them in. When anybody said we should have reported "x + 3", we were quickly able to show them that we had also reported "x = 7" that should never have been included.

A WORTHLESS LOSS

Up until at least 1990, the worst loss in the history of the Strategic Petroleum Reserve's St. James Terminal was the loss of an electric-incineration type toilet when the electricity failed to shut off. The 8/6/80 loss was only %1,345, but in this case, you could certainly say that the only loss was the ignition source, the material certainly wasn't worth anything! One of the many oddities that had been included in the author's "So You Think You've Heard It All?" paper distributed to DOE fire protection people a few years ago.

NUCLEAR FIRES

One of the more pertinent observations from the loss record is the fact that the "ordinary" fires that strike any industry or facility were also the type that caused the bulk of the worst losses in DOE. Even in nuclear facilities, the common combustible materials, ignited by common ignition sources, were the ones that did the damage. Even in "nuclear" facilities, such as Savannah River, the common forest fire became the most prevalent type of fire and the largest loss generator at many facilities. The largest fire loss in the history of Los Alamos was the 1977 forest fire. The major dollar losses charged to forest and brush fires were also large at Richland and LLNL's Site 300.

BECAUSE THEY CAN'T GET OUT

A number of losses occurred in animal facilities. A $750 loss in 1968 was small because an automatic fire alarm summoned the fire department which promptly extinguished the fire. The threat was to experimental mice. Animal subjects have no exit passages and no panic hardware. Their very cage is an unacceptable "dead end", with locked exits, by any code. Worse, people may survive a little smoke and toxic products of combustion, but an experimental animal inhaling unknown quantities of unknown products is a loss. If the animal was the twentieth generation of a long-term study extending to the 24th generation, there is no shortcut. The first 20 generations must be reproduced, one generation at a time. The work, time, and money involved in this makes the funding agency think twice about resuming the work. After all, there are lots of other projects looking for money and they haven't (yet) burned themselves down. If this project didn't think enough about its work to protect it, why should somebody else start it all over again?

HIDDEN DEATHS

At Fermilab, another accident resulted in the "deaths" of a large number of plants. Fortunately, they were just to be used for landscaping purposes and were replaceable. But the effect is the same as the animal case when the plants are part of long-term experiments. The greenhouse may justifiably have two sprinkler systems in some cases, one for the plants and one for the fires. Since even sprinkler-controlled fires let some toxic (and plant-damaging) materials loose, it's another good reason to make sure all combustibles are out of the lab.

MISSING FIRES, MISSING PEOPLE

It is our major regret that we did not seriously begin collecting the information in this report until we went to DOE Headquarters in 1970. We had some information from our own San Francisco and other offices going back to 1962 and, of course, we found much available in the small headquarters safety organization. It was from talking and listening to that small band of people who came into the AEC program at very early stages, that we learned the most. We will never be able to express enough appreciation to people like Don Keigher and Bill Cruickshank and, of course, Frank Brannigan. Others have passed away, such as Tom Franck, Arnold Weintraub, and both Dick Smiths. We deeply regret that all our readings of the early years have failed to turn up any information on what may been the key player of all, Major Johannesson. (It was only a few years ago, when Oak Ridge's Jim Hutton sent us a history of the National Bureau of Industrial Protection, that we became aware of his existence). That would certainly be a fascinating story; getting the good protection that was provided into "temporary" buildings of a crash program where only the end goal mattered.

Only slightly less a regret is the oversight of people who contributed so much, but have not generally been included by name. The above Jim Hutton would certainly head the list. As fine a historian as the author hopes to be, Jim is another of the many people with both contractor and federal experience going back to AEC days. Los Alamos Howard Richerson is another. Starting with the (federal employee) fire department at Los Alamos in the late 1940's, he retired from the government and went to work for the Laboratory as one of the most valuable systems and liaison people in the fire protection organization.

We urge the readers to peruse the official AEC and ERDA safety histories. They contain many other notes on fires, as well as protection programs. The same is even more true of the annual summary series issued from headquarters since the 1970's. We urge readers to send any information they may have to the author at the DOE Fire Protection Directory address or FAX numbers. After all, there may be a second edition!

MEDINA'S MAD MAGNITUDES

....in which we learn that the desire to know everything at the moment it happens can lead to idiotic results; some of which become enshrined in stone (or GPO publications).

Contrary to popular opinion, there once were a number of nuclear weapons facilities that no longer exist. In other words, nuclear weapons assembly and modification facilities have not increased over the last thirty years, they have decreased. One of the facilities that used to exist was the Medina facility near San Antonio, Texas. One of a number of modification facilities operated by Mason & Hanger, Silas Mason Company, Inc., it was heavily involved in destroying obsolete nuclear weapons in 1963.

At one of the WW II ammunition igloos, weapons parts, consisting of metal shells lined with high explosives, were stored prior to being sent to a burning ground where the HE was burned off the metal, allowing reclamation of the metal parts. (All probably illegal under today's EPA philosophy). A fork truck, unloading assemblies, caused a unit being lowered to the ground to strike a fellow unit. The ensuing spark started a fire which caused the three employees in the vicinity to exit with utmost haste. All ran in different directions. Two who ran behind adjoining igloos escaped injury when the HE detonated. The third headed for a ditch in front of the igloo and also escaped injury, but had a piece of the heel of his shoe cut off by the rapidly disbursing building and contents. While none of the people suffered any actual injuries, all had various degrees of "nervousness' and temporary hearing loss.

Since the location at San Antonio's Kelly Field obviously caused a great deal of interest in San Antonio, and AEC Headquarters, the telephone lines were rather busy from almost the instant of the explosion. One of the obvious questions was: "How much HE exploded ?" Since the igloo was a staging area, the contents varied rather more frequently than a storage igloo. The initial result was that the site stated the amount contained was the posted limit. As inventory people (and the occupants) added the deposits, minus the withdrawals, the actual quantities came to be better defined. Unfortunately, the HQ people became rather upset as they were trying to define the amount for the news media and the site people kept arriving at different figures. (One of the best anecdotes was the newspaper call asking if: "there had been a nuclear explosion at Medina?". A more alert HQ PR type asked where the call was coming from. When told "San Antonio", they asked if there was a window in the office. When assured there was, they asked what the caller could see. When told it was "downtown San Antonio", they replied; "No,. it obviously wasn't a nuclear explosion"). It took a while, but an agreed-upon figure was finally reached, with many snide remarks from Headquarters types during the process.

The actual amount detonated was finally determined to be 116,000 pounds. The dollar loss was reported as $92,568. this was largely a fiction as the destroyed igloo was one of a large number of surplus facilities and the HE that detonated was going to be destroyed by burning, anyway. This was another example of where the AEC loss records reported losses that were not actually incurred, or where the reported amount exceeded the actual loss. The reported loss included the dollar value of the igloos. Since there were a large number of surplus magazines available, there never was any replacement. In fact, the facility was scheduled to be closed, and subsequently was. Thus no replacement was ever made, not even the utilization of another surplus storage igloo.

The odd part of the incident began with the AEC Annual Report to Congress for CY 1963. This said the amount was "120 kilotons." (The San Antonio reporter obviously wouldn't have been on the line if this was true). Since the error was so glaring (but not even the super market tabloids picked it up---"Atom Bomb Explodes in America!), the following year's Annual Report noted in the safety section that an error had been made in the previous edition and the actual loss was 120,000 pounds. this was "close enough for government work" and the incident should have come to rest.

The following year, the author was privileged to attend a meeting of the AEC's Explosives Safety Committee which was held at the Medina Facility. The plant safety people, following the traditional facilities tour, ended at the crater which they described as the amphitheater where they held their safety indoctrinations. In recounting the story of the incident, they noted that they had received a great deal of criticism for not instantly knowing the exact amount of HE involved in the explosion. They also noted that, while they didn't have a year or two to come up with the correct figure, they were never off by a factor of two thousand!

The problem would have been temporary, and of passing interest, except for one additional thing; the history of AEC safety, published by the GPO in 1975. Titled "Operational Accidents and Radiation Exposure Experience Within the United States Atomic Energy Commission, 1943-1975"(WASH 1192), contained the incident in its list of all accidents over $50,000. Sure enough, the 63rd largest accident was the Medina explosion with a loss of $92,568. The item merely stated, after the number, date, Field Office and contractor identities: "Chemical *explosion* in explosives storage igloo." (The italics identified the category of accident--see Chapters 1 and 2). That would have been well enough except that the report also contained a list of reportable accidents and injuries, going back to 1959. in this list, the incident was identified as 63-50A, meaning it was accident number 50 in 1963 that warranted some sort of investigation. All would have been well except that it included a one-line identifier. The sentence:

"High explosives (120 lbs.) detonated in storage igloo."

In an age when DOE wants to know everything the moment it happens, the lesson is clear; don't believe it if you hear it and don't believe it if you read it!

There was a final note that was unexpected. The author was reviewing a very thick paper-back on explosion topics from an NYU symposium when he noticed one of the articles concerned an analysis of collateral damage from the explosion that supposedly damaged structures in the San

Antonio outskirts. The story was also covered very well in the history of the Mason & Hanger Company which related the investigations and claims for foundation cracks that follow every explosion. The most interesting thing was the following photograph, which did not appear in the official report. A private pilot was flying in the area when the explosion occurred and took the following picture--another unique item in the AEC safety history.

PADUCAH PAYS THE BILLS

.....in which we learn of a $2.1 million fire that resulted in such concern that nearly $18 million was spent on protection that proved so effective that when a similar fire occurred at the same plant, the loss was only $2.9 million, a savings that paid for every sprinkler system in the history of the AEC.

[AUTHOR'S NOTE: the most important single story in DOE fire protection history is that of the two Paducah Gaseous Diffusion Plant fires. Unfortunately, they have never been publicized in a major fire journal. The remarkable story is that of a major loss, prompt and effective efforts to determine causes and corrective actions, federal-private cooperation, prompt application of corrective actions, and the setting of new safety records during a major upgrade program involving installing piping at high elevations, over operating machinery, and in hundred-degree heat. The aftermath is even more dramatic and one fire protection lesson that should never be forgotten in DOE: the corrective action not only paid for itself, but also paid for every similar system in DOE history!]

In WW-II, the atomic bomb project tried a number of different processes simultaneously in an effort to produce enriched uranium for a bomb. The most successful concept was the gaseous diffusion process. When the weapons program became a vital element after the start of the Korean war, the need for uranium for additional weapons, and a potentially large civilian reactor program, dictated the construction of new plants. Three new complexes were built at Portsmouth, Ohio; Paducah, Kentucky; and new buildings were added at the original Oak Ridge site.[11] (The original diffusion building was shut down. Movie fans will recognize this as contradicting one of the premises of the movie "Fat Man And Little Boy).

The diffusion buildings at the three sites were eleven in number, and totalled some 20 million square feet in area. All were of similar design and construction, consisting of high-bay, two-story, non-combustible construction with insulated metal deck roofs. The largest building was some 3,000,000 square feet of what was essentially one fire area.

At all three plants, onsite fire departments supplemented the extensive protection systems. Sprinkler protection was provided for offices, laboratories, shops, transformer yards, and cooling towers. The diffusion buildings themselves were not sprinklered due to the lack of proven fire

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11. The original plant was called K-25, which came to be known as the name of the site, as well as the original diffusion building. The original building was actually closed when the new facilities were built, but the numbers continued with K-27, K-33, etc. and the site is still frequently referred to as K-25.

hazards, limited combustible contents, and supposedly non-combustible construction. The principal fire hazards was a system of gravity-fed lubricating systems (to ensure reliability and continuity of operations--one of the first "safe-shutdown" mechanisms"). Extensive interior hose systems and even in-building 500 gpm pumpers were provided for this hazard.

Following the General Motors' Livonia (Michigan) Transmission Plant fire in 1953, the hazard of certain types of roof coverings on metal decks became apparent and the major insurers embarked on extensive programs to develop protection for existing systems and develop satisfactory roof covering systems for new buildings. The goal of the extensive test programs was to obtain a system that could again allow a metal roof deck to be considered non-combustible. In the absence of such a roof covering, the buildings were considered combustible and the insurers usually recommended sprinkler protection, even if the contents were noncombustible.

The AEC recognized the potential serious situation in the diffusion plants since they had the types of built-up roofing that duplicated Livonia. A number of evaluations were initiated to study the problem and decide on an appropriate means of improving what was still considered to be an unlikely problem, as the interior fire potential was considered capable of being handled by existing protection. Unfortunately, the studies were still under way on November 11, 1956.

On that date, one of the smaller buildings at the Paducah Plant suffered a compressor gas seal leak which resulted in a fire of sufficient intensity to ignite the under side of the roof deck. What happened is partially evident in the following photos: the entire roof of a 70,00 square foot building was essentially destroyed. One firefighter was also injured in a fall during efforts to escape from the intense heat. Although little damage was done to the process equipment[12], the total loss due to the collapse of the roof amounted to $2, 100,000, the fourth-largest loss in AEC history (1947-1975).

Following the fire, the investigations were intensified and specially-cleared, top-management people from both Factory Mutual and Factory Insurance Association made surveys of the plants and recommended protection and further investigations. Tests were run at Factory Mutual Laboratories. As a result of the evaluations, it was decided that replacement of the roofs, while possible, would still leave some potential for interior fires and that automatic sprinkler protection was both feasible and the best choice. The work was another of the early examples of AEC utilizing independent professional surveys and consultations. (See Chapter XII, "INDEPENDENCE."

A total of $18.5 million was authorized for the sprinkler protection of all the plants and the work was done between November of 1957 and June of 1961. Former AEC fire protection people told of attending the Congressional authorization hearings prepared to deliver volumes of testimony, test results, independent appraisal findings, and fire analyses. The Joint Committee (in the days when

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12. A dramatic photo of the Livonia fire shows stacks of undamaged cardboard cartons in the destroyed building; untouched by heat or smoke, but with the collapsed steel roof laying on top of the storage.

the congress was efficient) asked what was needed, how long it would take to restore production, and authorized the funds immediately, without any further testimony!

Because of the great size and value of the buildings and the impracticality of building fire walls where the ceiling was 85' above the floor and the area was a mass of continuous pipes and cell equipment, the reliability of the systems was of utmost importance. Design criteria was based on 400 heads per system and water supplies calculated on the basis that, with a system out of service, four peripheral systems could deliver 1,500 gpm each with a reserve of 1,500 gpm. Waterflow and valve supervision was provided for all systems and head spacing was limited to 120 sq. ft./head.

The contract was completed under the general supervision of the Grinnell Corporation. The final cost was $17,626,000, a cost underrun of nearly $900,000. Despite the fact that the work was performed over operating equipment, at ceiling heights up to 85' and with very high ceiling temperatures, a record of over three million man-hours without a lost-time injury was established. Up until the late 1970's, at least, the author continuously checked the National Safety Council's annual "best-record" books and always found this project listed as the all-time best record in the category of "public utility construction." Another of the many safety records established by AEC and its contractors, even though you had to know where to look. AEC was not credited with the record, then or now.

On December 13, 1962, the systems proved themselves. A small lube-oil fire had been successfully controlled by three sprinkler heads earlier that month, but on this date, an explosion, followed by an intense local chemical reaction type fire caused heavy damage to a cell at the same Paducah Plant. Water from the sprinklers was rapidly converted to steam which opened most of the 2,341 heads operating in the fire.[13] This is the all-time record for the number of heads opened in a fire and for which the water supplies were sufficient to ensure success.

Some of the fire statistics include a peak flow rate of 40,000 gpm for a working density of 0.146 gpm/sq. ft. The 66-8" sprinkler risers in the building were fed by a dedicated 14" and 16" loop about the building fed from a 300,000 gal. gravity tank elevated 275' above grade and four fire pumps of 4,625 gpm @ 125psi, each, taking suction from a 2,600,000 gal. cooling tower reservoir. Sprinkler heads on 23 systems operated, consuming some 2,800,000 gals. of water. The sprinklers extinguished the fire and only one manual hose stream was necessary to complete extinguishment of an expansion joint seal on the roof.

The figure for the loss was $2,900,000. This was the third largest loss in AEC history. Despite the magnitude of the loss, it was clear from the experience with the earlier fire that the roof would have been another "Livonia" if the sprinklers were not present. The loss in that event would have been in the range of $160,000,000 in this much larger building. Thus, it is clear that the sprinklers in the second Paducah fire paid their way. In fact, given that, some years later, the area of all AEC buildings

[13]. The AEC Construction Problems Bulletin No. 23, of August, 1966, discussing a cooling tower fire at Paducah, cited 2,350 heads as the number operating. Close enough.

was calculated in slight excess of 100,000,000 sq. ft., and the fact that sprinklers were being installed for about $1/sq. ft., it can be said that the sprinklers at the second Paducah fire saved the government enough to pay for the installation of every sprinkler system in AEC history!

To forestall the outcries from some critics who may discover the fires at some future date, it should be added that a report on "Fire Hazards of the Gaseous Diffusion Plants" was issued by Oak Ridge and still exists in at least a few people's collections.

In 1966, Paducah also had a fire in a $1.1 million cooling tower that the sprinklers held to a loss of only $500. But that's another chapter.

The original publication of this chapter included two illustrations, a picture of the collapsed roof in the original fire and a layout showing the water mains, sprinkler risers, and water supplies in the second fire building.

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ROCKY ROCKS THE BOAT

.....in which we learn a few things about the one loss everybody remembers, including the things that aren't true.

[AUTHOR'S NOTE: Since this was, and is, the largest dollar-loss fire in DOE history (and the largest decontamination cost accident), we summarized the information as a separate chapter. The floor plans shown by Ed Patterson with his talk at the NFPA conference were included in the original chapter. Subsequently, many copies were distributed to individuals with questions on the fire. As late as 1996, we learned of one DOE fire professional stating facts about the fire and the "subsequent" adoption of improved risk protection, that were incorrect. Obviously, there is a continuing need for maintaining the story as it actually happened. In our usual tongue-in-cheek fashion, we started with a paragraph of what was "known" about the fire, none of which was true. The original chapter follows.]

The Rocky Flats fire in 1969 was the one that taught the AEC a lot of lessons. We learned that water could be applied to plutonium fires and sprinklers could protect nuclear facilities where they had been forbidden because of criticality concerns. We learned that manual firefighting can't be depended on in radiation areas. We learned that fire retardant materials are necessary to fire safety. We learned that standard watchman service is an essential part of a fire prevention program. We learned that fire loss is nothing compared to the problems from radioactive contamination. We learned that prompt, factual information is essential to preventing public (press) misconceptions concerning an incident. We learned that a plutonium fire is just about the worst thing that can happen to a nuclear facility. We learned that primary attention to nuclear safety prevents the really serious losses. We learned that a "nuclear" fire can result in the worst industrial fire in U.S. history.

In the preceding paragraph, the 1969 date is correct. Every other statement is a lie! (Or, to be polite, is not true). Perhaps some further discussion is in order.

The Rocky Flats Plant, outside of Denver, Colorado[14] was operated by Dow Chemical Company[15] to produce plutonium triggers[16]

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[14]. Way outside. When it was built it was in the wilderness near Golden. Like the people who complain about the airport in their area, the plant was there before the neighbors.

[15]. This was in the days when U.S. industry was patriotic. After running Rocky, producing napalm for Vietnam, and other goodies, Dow finally saw the light and got out of the nuclear business, as did DuPont and other safe companies; but that's another chapter.

for nuclear weapons. they also did a number of operations with other metals and a few other functions that never caught the anti-nuclear fancy, so are irrelevant to our story.

The Rocky Flats Plant had a fire which contributed some radiation contamination to the surrounding area, although not resulting in much property damage. However, that happened in 1957, so our concern is with the fire that didn't result in much contamination outside the plant.

in the 1960's, the cold war was heating up with Vietnam, the Berlin wall, and a number of other activities sponsored by the "agrarian reformers" of the world. This, combined with some weapons engineering developments, resulted in an increased production of plutonium components at Rocky flats, the only facility producing these parts. The increased through-put of plutonium in box line conveyors resulted in increased hand exposures to workers. Since everybody "knows" that radiation is the world's worst hazard, steps were taken to reduce the exposures[17] The principal change consisted of adding additional shielding to the box lines, consisting of 2" Plexiglass material to the windows and 2" "Benelex" (another trade name) to the opaque portions. Since it was recognized that combustible materials are bad, the "Benelex" was subjected to a number of tests, including at Lawrence Radiation Laboratory, Livermore, and it was confirmed that the material was about as fire resistive as you can get. It was like a similar trade-name material, "Masonite" and couldn't be ignited with a blow torch. So far, so good.

In order to reduce exposures from taking material in and out of the box lines, storage facilities were built in some boxes. These consisted of cubby-holes built of 2" "Benelex" with 2" "Plexiglas" doors. Each was about the size of the tuna fish can- sized plutonium containers. Of course, the storage box filled the glove box, so some of the impediments had to be removed, like the thermal fire detector projecting into the box. They were placed under the box, where material igniting on the floor could actually be extinguished with CO_2 extinguishers![18] Since there had been so many plutonium scrap fires, the box of 2" plexiglass and pressed wood materials was not considered a major problem. Besides, the real safety need was to reduce hand radiation exposures from the increased production flow and transfers into and out of the box line. The production problem would be eased somewhat when the adjoining 707 Building, nearing completion, came on line. Besides, the 707 Building was sprinklered, the water/criticality problem having been resolved in this context.

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16. Personally, we've always felt that the plutonium is really the powder charge, or maybe the bullet, but why argue with media fads?

17. This was pre-"ALARA", when it was just good sense.

18. Yes, the plutonium will draw the oxygen out of the CO_2, but when applied to the outside of the box, against the bottom, the material is cooled below the point at which combustion is sustained.

The astute reader will recognize that "change' is in effect as it is at all accidents[19] None of the DOE accidents have occurred in those "old" facilities so beloved of the critics. All the big ones have involved new buildings, new processes, or new materials.

The story of the fire was not classified. The first press release was issued the same day and Safety and Fire Protection Branch Chief Ed. Patterson presented an illustrated talk at the NFPA Fall Conference the same year. The illustrations and some of the following are from that talk, excerpted in "Fire Journal" for January, 1970.

May 11, 1969, was a Sunday with few people in the facility. Guards were on duty, but had noted nothing on their rounds until a fire detector alarmed at 2:27 PM. Although the fire department responded promptly, the dense smoke and crowded conditions present at their arrival hampered their response. This was undoubtedly due to the very slow burning nature of plutonium. The fire had probably originated in a lidless can in one of the storage cubby holes in the storage box assembly 134-24, located in a box off the long conveyor box line (see illustration). The alarm did not sound until the box material had heated sufficiently to ignite (probably a miniature flashover), at which time the smoke generation must have been very rapid. Heat would have had to extend down the line to the next detector or have already burst through a "window" to set off a room detector.

The Fire Captain initially attacked the fire with a wheeled CO_2 extinguisher that he had picked up and carried down and up the steps constituting an underpass under the box line, but the attack was ineffective.[20] He immediately proceeded to attack with hose lines.

After the fire, it was determined that only about 1% of the combustible shielding materials had burned, but 1% of 600 tons is six tons. The fact that the fire was essentially extinguished by 6:40 PM of the same day is a tribute to the determined attack by the firefighters, although hot spots continued to flare up for some time after and a continuous alert was required for some time.

The firefighters naturally wore complete turnout gear and self-contained breathing apparatus. One did receive some plutonium inhalation but no injuries were incurred otherwise by either the occupants or firefighters.

The fire occurred close to a shift change, which meant that there were soon two full crews available for firefighting.

The smoke plugged some filters which allowed the normal airflow to reverse direction and follow the flow route through an overhead conveyor line, from west to east. It stopped at a cross conveyor when a combination of the flow direction and a (non-rated) barrier acted as an effective fire door. The fire was generally confined to the boxes, although considerable damage was done to

[19]. "Change" after all, is one definition of an accident.

[20]. After the fire, he couldn't even lift that size unit, let alone carry it up and down steps.

support equipment of both mechanical and electrical types, due to the amount of burning material. The building, however was never breached. Except for some plutonium tracked outside by fire crews, the material was confined to the building.

The investigating board concluded, in effect, that "safety' was the cause of the loss (as opposed to the cause of the fire). The concern for radiation protection led to modifications that increased the combustibles, eliminated the fire detection in a vital area, placed a known fire-prone material (pressed scrap briquettes) in the un-detected area, exposed a long box line to the fire, and lacked the principal extinguishing agent, water, needed to cope with the type of combustibles present. Needless to say (but subsequent chapters reemphasize it, anyway) fire protection became a much more important safety project than it had been before Rocky flats.

The fire, besides being the largest loss in AEC history, was also the largest contamination incident in AEC history, with amusing sidelights. The author attended a briefing at Lawrence Livermore Laboratory where the fire was described. Included was an extensive description of the decontamination and plutonium recovery and reprocessing effort. One slide showed amounts in boxes, both as per the inventory and as recovered in the cleanup. We noted that several figures indicated more was recovered than had been in the box at the time of the fire! This seemed to be no surprise to most of the attenders. Of course, the comprehensive cleanup enabled material to be recovered that was always there in various nooks and crannies but was unrecoverable in normal operations. It had become "material unaccounted for" in the accountability trade. Which tells you something the next time you see the annual article on all that plutonium "lost" and presumably in someone else's bombs.

The DOE Manager, who went on vacation shortly after, did not last long. The fire department received a very impressive award, the least that could have been done. (The success of DOE fire departments has had a perverse effect. Since the fire protection program is the only one that annually reports all its costs, some managerial types question the need for all those expenditures when "we don't have any fires.")

As mentioned, the story of the fire was the lead article in the January, 1970 "Fire Journal." The cover was a trivia item; a collage featuring the extinguisher stickers for three classes of fires, but not the combustible metals, Class D, which the feature story was concerned with.

Some afternotes in the Patterson article included the facts that over 99% of the plutonium had been recovered six months after the fire and cleanup was about 80% complete in the 211,000 sq. ft. fire area, Bldgs. 776/777 (one building). (In fact the fire actually involved a small portion of one building; the contamination area was more widespread).

The long conveyor system, mostly without fire breaks, contributed to the extent of the fire. The effectiveness of even a simple door was demonstrated by the North Line diversion to the North-South conveyor line.

One of the problems was the storage of briquettes in the cans without the lids. This was another step that supposedly sped up the handling and processing. If all the storage cans had lids, it is possible the fire in the original, spontaneous ignition can, might not have occurred or spread to the combustible material.

A number of items occurred as a result of the fire. These included:

A. The initiation of the independent survey program (see the Chapter on this subject).

B. Fire tests at a number of facilities, including Rocky Flats, which built a sizeable test facility to study portions of the problem.

C. The safety organization of DOE and contractors was studied.

D. The "Fire, Safety and Adequacy of Operations" program began (see the Chapter on the subject).

E. An outgrowth of the management/organization study was the AEC General Manager's letter requiring a Fire Protection Engineer on each contractor's staff[21]

F. A great many improvements were made at Rocky flats, including a $5 million glove box inerting item, sprinklers in the remaining areas that didn't already have them, and improved alarms, as well as glove box line and ventilation improvements. The biggest single item was a new Chemical processing Building, one of the top ten priorities in the FS&AOC program and one that was so advanced that it still wasn't working right by the time the plant ceased production and converted to cleanup only in the 1990's.

There were a few things that didn't occur as a result of the fire. To wit:

A. The AEC did not learn that you could apply water (sprinklers) to fissionable materials. That had been learned long before; the best proof being that the new production building, 771, which was nearly complete at the time of the fire, was a fully sprinklered building.

B. It wasn't the point when we learned that manual firefighting could be effective. Brannigan's "Living With Radiation" was a best-seller long before. Particularly Volume 2, entitled "Fire Service Problems."

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[21]. Some were a little slow. The last major facility to acquire its first FPE was in almost 20 years later!

C. It was not "the largest fire (or industrial fire)" in American history", as the more rabid critics have often cited.[22]

D. Finally, despite what even the WASH 1192 document says, it wasn't a $45 million loss. Which requires a little background:

The original estimate for all the work to restore the facility **and** improve the existing facility was estimated at $45 million, and this figure was included in Patterson's talk at the NFPA Fall Conference at Denver in November of 1969. That figure included decontamination, but was not expected to include the cost of plutonium recovery. The figure was repeated in the Line Item supplemental granted by Congress and remained the "Total Estimated Cost" of the project throughout its life.

The $45 million actually included upgrading projects in buildings that were not involved in the fire, and it was soon evident that this was a major portion of the project. (Additional work was done under other Line Items, the inerting project being a separate $5 million Line Item in itself).

By the time that the summary of accidents and exposures in AEC history was being published[23] it was obvious that the actual accident cost would be considerably lower than the project figure, including all decontamination and plutonium recovery. This was pointed out to the Safety Division Director, D. E. Patterson, but he decided that, since the project was still called the "Rocky Flats Fire Recovery" and the AEC loss record was still exemplary, even at the higher level, we would leave the figure as is. It could always be corrected in later editions of the WASH 1192 document, which was one of a series of accident summaries that AEC had published throughout its history.

The actual incentive for a change came from the State of Colorado. As is typical of major accidents in AEC/ERDA/DOE, the cry over the "near disaster" results in a great deal of extraneous oversight--which seems to be forgotten before the next incident. One of the complaints after this fire was that the State should review fire protection. The author of this book made a short analysis of the proposal and submitted it to management, who, unfortunately, wasn't capable of taking the offensive, even in a humorous way. What we wrote was an acceptance letter stating what a wonderful idea it would be. We then looked at SFPE members, NFPA Industrial Section members, and other national professional organizations. In every case, the majority of the professionals in the state worked at Rocky Flats! In fact, the only State of Colorado people we could find were NFPA Industrial Section members in a State hospital. Colorado didn't even have a State Fire Marshal! The State report, when issued, concluded that fire protection was good. Which presumably proves you don't really need experts!

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22. It wasn't even the largest fire of 1969. In fact, it wasn't even the largest government fire of 1969. See the authors "Fedfire" chronology of federal fire protection.

23. AEC became ERDA in 1975.

We also tried to compare fire loss records. About the only data available was from the NFPA books on fire data, several editions of which were published at that period before the idea was abandoned. We used these to calculate per capita fire loss and staff per capita. The first interesting thing was that only a few Colorado cities submitted data to NFPA. Denver and the next two or three largest cities didn't! Suffice it to say, Rocky flats was far better than any of the Colorado data could show. Unfortunately, there was no one in AEC to take a sardonic look at things and maybe correct the mis-impressions.[24]

When the Colorado report was finally published, it included a dollar loss for the incident that was much lower than the WASH document used, and one in keeping with what the project figures had shown, minus the upgrading done in buildings not affected by the fire. Headquarters wrote a letter to Albuquerque Operations Office, pointing out the two different figures and asking which should be official. When Albuquerque confirmed the lower figure, Headquarters issued an update page for existing copies of the WASH document that detailed the lower figure. Unfortunately. as in the typical media story, the truth never caught up with the lies and it is still common to see references to "$45 Million", and "The largest fire loss", etc. For one more stab at setting the record right, the correct figures are:

FIRE LOSS	$15,957,000
CLEANUP	9,999,000
Pu RECOVERY	517,000
TOTAL	$26,473,000

Plutonium is one of the few materials in which the ashes can be converted back to the finished product! In fact, massive quantities are commonly converted to an oxide before shipping; which is one reason a plutonium shipping fire is a misnomer; you can't burn the ashes!

A revised data sheet was prepared with the above figures and the breakdown of the other buildings (the entire $45 million project was completed for $40 million; another story the news media missed). Unfortunately, while the correct figures have been used by DOE ever since, they haven't been discovered by the critics. As Chapter V illustrated, they weren't even known to some of DOE's supposed safety "managers."

Illustrations from the Patterson Article included the floor plans and box line layout of the fire building, illustrating the extent of the fire damage. They are included with his speech as reprinted in the NFPA Fire Journal and were included in the original of this chapter.

In a 1996 update of various chapters, the following was noted as additions to the Rocky Flats chapter in response to numerous questions:

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[24]. Dr. Petr Beckmann, publisher of the "Access to Energy" Newsletter, calls it the "Kick me again; it feels so good when you stop" syndrome.

1. The story is still being distorted. As recently as 1/25/96, a newspaper story cited the uncovered cans as a new revelation from one of the many DOE safety people now at the plant. It cited this as part of a conspiracy of "secret" classifications to prevent embarrassment to AEC by hiding sloppy safety practices. Obviously, the "conspiracy" was not successful in preventing embarrasment and the "secrecy" did not work. The fact that such stories are believed even by some DOE people is another reason for this book.

2. The Benelex 401 material has an ignition temperature of 345°C, the Plexiglass, 300°C.

3. All power was lost within five minutes of discovery.

4. About 50,000 to 60,000 gallons of water was discharged in fire fighting.

5. Probably less than 2% of the plutonium got outside the boxes into the room.

6. There were spot failures of the first set of exhaust air filters. The filters were a standard but obsolete (in 1969) type and their good performance was largely attributed to automatic sprinklers on the building side of the filters in the plenum.

7. An estimate at the time was that sprinklers in the box line area would have limited the loss to about 1/10 of 1% of the actual loss, or well under $100K.

8. The "subsequent fires" frequently alluded to were limited to a glove burning on the floor in front of a carbon tetrachloride storage hood, a Pu storage box spontaneously igniting the following day, and a fire in a can of Pu oxide (with hydrides) picked up after the fire.

9. The new building (707, not 771 as originally noted) also had about $500K of changes incorporated before completion.

CHANGES

.....in which we learn about the changes that occurred after the Rocky Flats fire that accomplished an order-of-magnitude improvement in an already good program, and why they really weren't changes at all.

[AUTHOR'S NOTE: Some of the programs contributing the most to the excellent fire protection record were adopted after the Rocky Flats fire. While some were not all that new, most were rediscovered several times in the continuing pursuit for new safety systems. Unfortunately, the cost of the many upgrade projects was too difficult to categorize and any published totals are largely fictitious.]

After the Rocky Flats fire, a number of changes were instituted that brought a new awareness to the AEC fire protection professionals and new programs to the system. These included the inauguration of independent, outside appraisals, the hiring of professionals in the key facilities to conduct the fire protection programs, and the safety upgrading of old facilities and the construction of new facilities to replace the aging infrastructure which had been one of the AEC problems.

Like the opening paragraph of the Rocky Flats chapter, all of the preceding statements are lies. In fact, they are the worst kind of a lie, the truth - - but not the whole truth. The whole truth is worthy of a separate chapter describing each of the new programs. These follow, but first, the immediate changes, including the ones that never happened.

THE SURVEYS

The first, and most visible direct change, was the inauguration of the survey program by the two major industrial fire insurers, Factory Mutual and Factory Insurance Association. They both contracted with AEC and the first survey was completed before the end of the year (1969). The negotiations, contract signing, and completion of the first survey took about five months. Not too many years would pass before DOE would be unable to accomplish anything that fast.[25]

The surveys, one of the "new initiatives" were not new at all. The first thing the AEC had done upon its founding in 1947 was to organize an independent appraisal team of many disciplines to

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25. The construction of the Savannah River Plant is a similar story, as told in the chapter on construction practices. The Los Alamos Director reminded a news audience, on release of the "self-analysis" report in 1991, that the entire laboratory had been built and staffed, and developed, built, tested and deployed two atomic devices of widely different principle, using materials and methods that did not exist prior to then - - and all in 28 months! The first draft of the environmental statement for the first building couldn't be completed in the same time today!

conduct an independent survey of the Manhattan Project facilities.[26] The Oak Ridge Operations Office had previously had both FIA and FM survey the Gaseous Diffusion Plants after the 1956 loss and Factory Mutual was a consultant to Oak Ridge on many occasions. A number of facilities had been surveyed by other agencies (Even the State of California had surveyed Lawrence Livermore Laboratory in the 1960's) and many facilities had consultant surveys done on their own.

The really new item was the extension of the survey program to include all the plants. That didn't happen until a few years later, however, Even then, the original intent, expressed in a commitment to Congress[27], was never fully met as the frequency was reduced considerably after FIA dropped out of the program. Also several years were lost during some contract negotiations as the agency became fossilized like most mature government agencies.

The program continued, as per Chapter XII, devoted to it, until the 1989 changes. The new safety management apparently couldn't understand why a survey could take so long and decided to shorten the "appraisals" to a few weeks. This essentially destroys the original intent of the program. However, by this time, the plants had become so imbued with the "improved risk" fire protection philosophy (mainly because they now all had their own fire protection engineers), that little change was expected in the overall adequacy of protection. But it was a great program, one that was finally diluted and then dropped.

ORGANIZATIONS

Another "new" program was the request to field organizations to review all their contractor facilities to see how they were organized for safety. This program was as old as AEC, where the first fire protection "Manual Chapter" required surveys by the field office; fire protection being one of the first disciplines to do so.

The thing that was really different was the fact that many non-safety professionals were assigned to the project. At some sites, their reports remarked on how great some program was, such as the fact that they actually made valve inspections. After reviewing the inconsistent results, Headquarters put out some more detailed information requests, including staff capabilities, salaries, and everything that could be turned into a statistic.

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26. Of course, the cynical might say it was the standard ploy on taking over a new organization. Get everything bad blamed on a predecessor. If it's bad enough, the new regime has nowhere to go but up. All due to their superior programs, of course.

27. Like other "cast-in-iron" commitments, it was only good until the next administration or the next reorganization.

Attempts were made to plot every piece of data against every other and the author filled a notebook full of graphs[28]. Unfortunately, almost everything plotted like a shotgun target. No matter what the subject, people vs loss rates; safety vs regular staff; loss rates vs safety expenditures; fire protection recurring costs vs loss rate; and some thirty others; the results showed little correlation. In fact, the few that showed any evidence of a plotted curve consisted of meaningless comparisons, such as number of firefighters vs upgrading budgets. Ever since, the author has had little sympathy for suggestions as to what an "ideal" organization should be.[29]

As a matter of interest, a summary of some findings was put into a report from the Director of the Division of Operational Safety, Dr. Martin Biles[30] to the General manager of the AEC. Among the comments were the following:

> "Fire is the major cause of loss to both industry and the AEC. Private industry relieve themselves of this risk by buying insurance. The majority of large industrial companies obtain insurance from the so-called preferred, or improved risk insurance companies. Under the improved risk system the insurance company provides detailed fire protection advice, the insured installs the recommended protection systems (at his own expense), and the insurance company insures the industrial plant against financial loss. The cost of installing the fire protection devices is offset by the extremely low rate which industry is charged for the combination of engineering services and insurance. Because of the engineered protection, those companies sustain fewer losses to business, loss of property, and loss of life than do commercial and private property owners not following these practices. In fact, this system is so widely followed by large manufacturers that it is generally considered to be best practice throughout industry. For this reason, the AEC has attempted to use the concept of the system as the basis for its own non-insured loss prevention program."

The memo then went on to describe the differences in the AEC system, including: the non-insured aspects so that the costs and benefits of a loss prevention program were not readily apparent; the lack of financial liability for he contractors; the lack of insurance engineering services and poor incentives to provide their own; and the reliance on the small AEC staff in each Operations Office. The memo went on to explain the success of the AEC program, noting that we had a better loss ration than the insurance industry, with only about 20% of the professional staff, and that a major factor was the selection of the best of American industry to run the plants.

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28. Unfortunately, all in the pre-computer age.

29. Which may be one of the reasons "Organization" is included in every appraisal, but no appraiser has ever had a define "organization' as a guide.

30- In those days, scientific people had real clout in the agency--they even ran things!

The memo noted that the increasing public concern over any type of accident meant that AEC would have to improve its programs. Even though the record, including the Rocky Flats loss, was historically very good, it would have to improve.

At that time the major contractors (over 500 employees each) had a total employment of 95,000 and $11 billion in government property. Fire loss for the past 10 years (including Rocky Flats) had averaged $5.3 million/year.

The memo then listed the survey results as follows:

1. Of 38 large contractors, 17 had one fire protection engineer, two had two, and one had three. Of the remaining 18 without fire protection engineers, nine had (each) property in excess of $100 million, while six had from $20 million to $100 million.

2. Most contractors had fire departments, inspectors, technicians, or others doing most of the work, to the total of over 700 people.

3. Nine AEC offices had 18 fire protection engineers, while four had none.

4. Contractor internal reviews were generally limited to fire prevention and protection programs, with little real management or analysis programs.

5. The AEC field offices were the only organizations providing an outside appraisal function.

6. The Factory Insurance Association and Factory Mutual surveys, which had just started, were proving very beneficial.

Having set up a concise summary of the situation, the memo concluded with the recommendations which were to be the basis of the AEC fire protection program. These were:

1. <u>Using AEC staff, establish an organization which simulates the insurance system.</u> It was contemplated that the field staff would be augmented by about 15 new professionals, and would report directly to HQ, while remaining at field locations.

2. <u>Contract with one or more of the insurance companies to provide a service equivalent to that provided to their private customers.</u> This was estimated to cost about $2 million per year.

3. <u>Improve the present system by taking the following measures:</u>

a. Extending the FIA and FM contracts to include at least one inspection of every plant.

b. Requiring safety analysis reports on all operations on a continuing basis and a safety analysis prior to construction of all new facilities and modifications of new facilities.[31]

c. Require internal management audits by contractors.[32]

d. Require AEC staff to audit the safety analysis reviews.

e. Require greater in-depth inspections by the field staff.

f. Require increased HQ surveillance of field offices.

An estimated 100+ new staff was given as the personnel cost of the program.

UPGRADES

The third major change, which also wasn't a change, was the major upgrading projects. Several have already been mentioned under the Paducah, Early Losses, and Rocky Flats Chapters, and other aspects are covered in other Chapters. Suffice to say, upgrading of existing facilities to meet new or revised safety standards was a part of the AEC programs from before there was an AEC.

After the Rocky Flats fire, a major project, in addition to the organizational studies cited above, was the attempt to define and correct the existing "deficiencies" at all plants. The author's first project in 1970 was being assigned to the three man group evaluating the field submittal and requests for upgrading projects. A Comptroller Officer and an Engineering representative were the other two team members in what was to be a monumental effort at upgrading facilities to meet new or imagined requirements. As such, the project was an inspiration to the author in compiling this history or our concurrent "Idiotic" files;...but that's another story.

It soon became apparent that the number of projects being requested was so large that some ground rules were arbitrarily adopted. Two of these led to some amusing results, typical of headquarters micromanagement of a situation that became all too typical of safety in DOE in later years.

The first decision was to eliminate new buildings from the requested upgrades. This seemed logical to the committee and certainly reduced the number of projects to be prioritized. Unfortunately, it wasn't until a number of additional years had passed that we recognized the basic flaw. The best

31. Twenty years later, the Safety Analysis Report system still hasn't caught up to the scope of this proposal.

32. Again, the system hasn't yet caught up to the intent of this recommendation, although it was "adopted" over 20 years ago!

example was a request for new laboratory buildings at Sandia, Albuquerque that duplicated some other fairly new labs. These were eliminated from consideration since they were not "upgrades." For the next several years (when Headquarters was still reviewing summary project statements) numerous existing "temporary" structures at Sandia were revised and upgraded to new uses. We finally realized that construction of the new laboratories would have been far cheaper than the continuing efforts to alter existing space. Not to mention that superior construction, protection, and utilities, would have been the natural result. But AEC/ERDA/DOE did not always let logic stand in the way of good management decisions.

The second decision involved type of funding. Most safety projects in the past had been handled as "General Plant" projects. AEC was fortunate in that construction projects under a figure somewhat less than $1 million could be handled within a specified "General Plant Project" budget. Over that limit and each construction project had to be specifically approved by Congress. That is, it appeared as a "Line Item" in the Congressional budget. Needless to say, this was a sure way of delaying and politicizing any project and AEC was fortunate to have the "GPP" option. The committee review of requests by type of funding showed that those items that had been identified as "GPP" items did not amount to more than about two year's total of the normal AEC "GPP" budget. Thus, a directive from the General Manager resulted in which it was ordered that contractors would spend one-half of their GPP budgets on those items so identified until the projects were completed. This resulted in two major problems in itself.

The first was that the field offices and contractors never did understand that the rule applied only to those items already identified for GPP funding. They assumed that they had to spend 50% of their GPP budgets on safety and the attempts to do so were the subject of some frustration and hilarity. The author was tracking items monthly and had a problem with a number of facilities, including Los Alamos National Lab. LANL had identified half their GPP budget as safety upgrades and included an itemized list with such things as fencing. Half the total of over $1 million was identified as "miscellaneous." We asked for a list of what the "miscellaneous" consisted of and got a breakdown of the remaining half. It included some of the same items, including fencing, and again ended with half the total identified as "miscellaneous", at which we point we gave up on the itemized list and just followed the project construction status.

The second problem was typical of the agency up to this very day. While projects were identified and prioritized according to their safety priority for the agency as a whole, the funding continued to be by program offices. This meant that priorities were essentially meaningless. For instance, if the top ten priorities were all from one program, and exceeded their budget, some would not be done. By contrast, priority number twenty might be the only one for another program and it might be done immediately. Thus, priority rank had nothing to do with the order in which the major projects were completed. In addition, there were no firm rules on funding definitions. Thus, while almost every project was of a type that would normally be done with GPP funds, the requests might lump all the safety upgrading into a single "Line Item" project. For some plants, the Line Item was funded, meaning that all their projects were completed early. For others, the funding was not granted, meaning that none of the projects were completed that year. A great deal of time was spent trying to get contractors and field offices to break up the unfunded items into individual GPP projects and at least do some of them. This effort was to no avail in many cases and some upgrading projects did not begin until a number of years later.

The total funding needs resulting from the committee review amounted to $454 million. Position papers were prepared for Congress to justify the request. Unfortunately, before the scheduled hearings, Congress came up with an allocation of $26 million for "the ten most important projects." By some coincidence, somebody (not the committee) came up with ten projects that just happened to total $26 million! Two of these were design funds for new facilities (contrary to committee intent) and the remaining eight were fully-funded fire protection items of some real import.

The two new facilities were the new plutonium facility at Los Alamos (replacing the horrible DP West cited in the "Early Losses" Chapter) and a new waste facility for Rocky Flats. The projects each ended up costing more than had been contemplated for the total of what we considered the real fire protection projects and were one of the reasons we never tried to total upgrading expenditures.[33] Totals were available but any look at the details revealed that the total was somewhat fictitious.

The problem of costing was best typified by the Stanford Linear Accelerator Facility computers. These were located in temporary structures, but fully sprinklered. It was planned to build a permanent facility before the independent fire protection survey was made by the insurance organization. They took note of this and made the recommendation that, when the new facility was built, it should comply with NFPA and AEC standards. Reasonable enough, but when the cost of doing the 104 recommendations was totaled, the SLAC costs were around $3 million, almost all of which was for the new computer facility, which was not what the recommendation was about! Thus, any published dollar totals for either the post-Rocky Flats upgrading or the insurance surveys are dubious at best.

To summarize, most of the supposed changes that were made after the Rocky Flats fire were not changes at all. Most of the funded projects were open to vastly differing estimates of what were new costs as opposed to what were normal costs and even what were real protection costs. Many of the specific program recommendations accepted and adopted by the General Manager were not new, but merely new emphasis on long-existing programs and a number of the accepted improvements were never really adopted. The most startling change was that the post-Rocky Flats fire losses, for the five years until the end of AEC, were the lowest in AEC history,...and by an order-of-magnitude! The changes weren't what we expected, but the results surpassed our best hopes!

[33]. For the fire protection professional, we note that our estimate of real fire protection improvements was about $30-$40 million.

INDEPENDENCE

.....in which we learn that one of the "new" programs adopted after Rocky Flats wasn't really new at all, but did contribute to the order-of-magnitude improvement.

Contrary to the statements in the media, and even those by DOE people who should have known better (see the "Goldfish Bowl" chapter), the DOE did, indeed, have independent surveys. In fact, the only surveys that were ever truly independent were those conducted for fire protection, including the first.

As noted in the "Myths" paper, the first thing the Atomic Energy Commission did when it was created in 1947 was to have an independent survey of the facilities. This was a mixed group that included most safety disciplines, including traffic safety (AEC owned three cities, remember). The fire protection section was conducted by the NFPA's Ray Bond. A number of quotes from the report were used in the introduction to the 1979 Annual Summary report by Headquarters. The report remained basically unknown until an Albuquerque, New Mexico paper picked it up in 1991 and used it under the typically misleading headline that stated an early report had shown how bad things were right from the start...etc. They missed the point that it also proved one of the myths wrong, namely, that AEC had no oversight except its own. But then, you can't expect a newspaper to see the discrepancies.

As the "myth" paper points out, there have been a large number of independent surveys. This Chapter is concerned with the program that was one of the three adopted by AEC after the Rocky Flats fire. The three programs combined to produce an order-of-magnitude improvement in a program that was already superior to most. This is the independent appraisal story.

Since the Rocky Flats fire was by far the largest loss in the history of the program and generated so much bad (and erroneous) publicity, an understandable reaction was to have fire protection experts review this and other facilities. Since the AEC program had always been the insurance industry's "improved risk' program[34]. The headquarters' staff recommended trying to get the major insurers to make surveys. Since "improved risk" was their business, their word would be the most authoritive. Negotiations were entered into with Factory Mutual and Factory Insurance Association. Although neither conducted contract surveys as part of their business, they both agreed to conduct such a program for the AEC.

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[34]. Indeed, the second edition of the Federal Fire Council's Fire Protection Handbook recommended it for all federal agencies-in 1945!

The contracts were completed within a few months, clearances were obtained, and the first survey was completed by Factory Mutual in 1969, that of the Kansas City Plant. (Contrast this with later contractual efforts, which sometimes took over a year).

The initial surveys were devoted to the weapons plants, with computer facilities at the design laboratories and the Los Alamos plutonium facility thrown in. Thirteen surveys were completed within a year, and all sites had been surveyed by the end of 1972.

As part of the effort to improve the over-all fire protection program, headquarters decided to retain the survey program and expand it to include all AEC facilities and to make repeat surveys at a three-year frequency. Although the frequency was not kept, as explained below, the program did grow to encompass all facilities. In fact, when ERDA and DOE came into existence, the program was extended to cover the new facilities acquired with those agencies.
The program also covered the Naval Reactor Offices and contractor sites, something the much-touted "Tiger Teams" of later years did not.

By the time a second round of surveys had been completed (within the original three-year goal), the terms were being sent to the sites without headquarters participation, including at the closeouts. Reports were issued by the companies and promptly printed and reissued by AEC. In fact, in later years, the FM reports were printed by FM and the reports simply transmitted by headquarters, - until the final year.

The Factory Insurance Association (now Industrial Risk Insurers) stayed with the program until 1976, when they opted out since this type of work was not in their normal line of work. They had made two rounds of surveys at the sites they covered, however,

As a footnote to the FIA story, we found out a few years later that they had written the AEC off as a bad debt! It seems that the last vouchers had never been paid. Rather than press the government, they had written the debt off. When we found out, prompt payment was arranged, but the safety and fire protection group at headquarters was extremely embarrassed to say the least.

By the end of the 1970s (and with the advent of ERDA) headquarters administration/finance people decided that the program should go out for bid. The fire protection people argued that the program would be delayed, the number of "improved risk" companies was limited, the delay in clearance approvals would delay the program, and more people would have access to the plants. The program division did not support the argument, and neither did security, although we thought they would have a prime interest. As a result, the entire bid process had to be conducted. As the list of surveys shows, there was a delay in continuing the program. this was also worsened by the fact that FIA had dropped out and the program did not contain funds for adding their work to the new contract. Worse, some problems were encountered with the FM managers and a number of reports were long delayed. This is illustrated by the chronological list which shows the surveys in the order they were started, but jumps back and forth over several years at this time due to late deliveries.

Despite the problems, the program was continued with Schirmer Engineering obtaining a three-year contract. The fact that most of their people came from FM/FIA and that they did "improved risk" inspections for a number of clients meant that the program continued substantially as had been intended, although at a lesser frequency.

By the time that contract expired, a new competition had to be entered and the resulting delays lost a full year of survey time. Professional Loss Control of Oak Ridge, Tennessee won the new contract. While they were not insurers, the fact that they had originated from the AEC plants and had a number of people who already had Q clearances, sped up the start of work once the contract was granted and did allow for a level of expertise that would have been lacking in non-insurer bidders. (One two-man organization even bid, although the specs said they had to be capable of conducting up to three surveys at once!)

In the 1984 contract proceedings, FM won the bid and resumed the work they had previously performed. They have remained the contractor to date.[35] (The program ended the year after the author left DOE in 1989).

One advantage of the FM participation was the fact that the contract was used to provide special training programs for the new fire protection people. (This is covered in more detail under the other improvements chapters). Efforts had been made to obtain similar training from FIA but they demurred on the basis that they conducted courses only for their own people and that, if they were to expand, all their member companies would also want to take advantage of the opportunity and they just weren't staffed to do that.

The program suffered its most serious setback in 1988 when new safety management came into DOE with no understanding of the fire protection program (see the "Goldfish" chapter), and attempted to revise the program to look like a headquarters-conducted program. Considering the amount of bad publicity the DOE had garnered over not having outside surveys, one would think that the only truly independent survey program in DOE, one that had been going on for almost twenty years, would be held up a shining example. Instead, the new people even rewrote one survey to make it look like it had been made by headquarters. In fact, the words, "Factory Mutual" appeared nowhere in the text or titles. Two other surveys of Naval Reactors facilities were delayed for over a year because they were classified (by NR) and the new headquarters managers couldn't figure out how to get them out, what with copies going to every congressman in the state, a number of committees of Congress, etc.

The most ridiculous change occurred with the 1989 Factory Mutual report. By this time, headquarters was not issuing recommendations in its reports (only "findings"). Since the contract required recommendations, FM submitted them (as an appendix, after listing findings in the text). The DOE manager ripped out the recommendations at the closeout and no one saw them. He also tried

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35. They did a few special surveys prior to the new contract (and subsequent to the next renewal, also), but these were done with special funding arrangements outside he normal contract.

to have the report rewritten without mention of FM, and wanted the contract changed "immediately" to eliminate such "bad" practices. The result was that the May report was not printed until November and no other surveys were made in the six-month period. When finally issued, with recommendations, another year passed until the site, Los Alamos, received the report "officially".

Fortunately, by 1990, the surveys were being conducted more or less as originally planned (although with more headquarters involvement), and the training programs had been resumed.

As the attached chronology shows, a large number of reports and recommendations resulted from the program. This resulted in some major confusion, particularly when a congressional committee was unable to understand what the problem was in some Savannah River reports, and that the problem they harped on had been declared a non-problem in a later survey by the same people who made the original recommendations. What is missing is the opinion concerning the "improved risk" status of the sites, which is what the original intent of the program was back in 1969. Almost all sites now qualify as "improved risk." Another great accomplishment in a great program.

THE INDEPENDENT SURVEYS

No.	Site	Year	Recs.
1	Kansas City Plant	1969-1*	24
2	Rocky Flats Plant	1970-2	112
3	Pantex Plant	1970-2	111
4	Mound Laboratory	1970-1	33
5	Savannah River (Computers)	1970-1	12
6	Pinellas Plant	1970-2	66
7	Los Alamos Lab. (Computers)	1970-1	28
8	Sandia-Alb. (Computers)	1970-1	17
9	Los Alamos Lab. (DP Site)	1970-1	32
10	Burlington Plant	1970-1	34
11	Y-12 Plant	1970-2	147
12	Sandia-Lv. (Computers)	1970-2	8
13	Lawrence Livermore Lab. (Computers)	1970-2	30
14	Westinghouse Hanford Co., Bldg 308	1971-1	10
15	Douglas United Nuclear, N Reactor	1971-1	21
16	Pacific North West Lab., 231-Z Bldg.	1971-1	17
17	Atlantic Richfield Hanford Co., 234-5Z	1971-1	22
18	Atlantic Richfield Hanford Co., 202A	1971-1	26
19	Sandia, Alb.	1972-1	18
20	Stanford Linear Accel. Center	1972-2	204
21	HQ Computers	1972-2	23
22	Sandia, Tonapah	1972-1	3
23	Argonne National Lab.-West	1972-2	102
24	Los Alamos Lab.	1972-1	164
25	Atomics International	1972-1	25
26	Nevada Test Site	1972-1	75
27	Bettis Atomic Power Lab.	1972-1	28
28	Nuclear Rocket Development Site	1973-1	20
29	Savannah River, Administration	1973-2	52
30	Savannah River, 300 Area	1973-2	27
31	Savannah River, 200 F&H Areas	1973-2	80
32	Oak Ridge Gaseous Diff. Plant	1973-2	224
33	Lawrence Livermore Lab.	1973-2	491
34	Sandia, Liv.	1973-2	44
35	Argonne National Lab., IL	1973-2	2232

36	Princeton Plasma Physics Lab.	1973-2	54
37	Portsmouth Gaseous Diff. Plant	1973-2	172
38	Oak Ridge National Lab.	1973-1	39
39	Savannah River, 100 Area	1973-2	128
40	Savannah River, 400 Area	1973-2	22
41	Savannah River, General	1973-2	100
42	Pacific North West Lab., 300 Area	1973-1	15
43	ARHCo, 200 E&W Areas	1973-1	22
44	Hanford Eng. Develop, Lab., 300 Area	1973-1	18
45	DUN, 300 Area	1973-1	16
46	HEDL, Fast Flux Test Reactor	1973-1	23
47	Naval Reactors, Idaho	1973-1	19
48	Aerojet General Nuclear, Idaho	1973-1	128
49	Chemical Processing Plant, Idaho	1973-1	14
50	Fermi National Accelerator Lab.	1974-2	183
51	Fernald Plant	1974-1	17
52	Paducah Gaseous Diff. Plant	1974-2	175
53	Lawrence Berkeley Lab.	1974-1	76
54	Oak Ridge National Lab. (Y-12 Area)	1974-2	91
55	Brookhaven National Lab.	1974-1	168
56	Knolls Atomic Power Lab.	1974-1	23
57	Kesselring Site, Naval Reactors	1974-1	10
58	Windsor Locks Site, Naval Reactors	1974-1	19
59	Pinellas Plant	1974-2	20
60	Y-12 Plant	1974-2	109
61	Rocky Flats Plant	1975-2	49
62	Pantex Plant	1975-2	70
63	Mound Lab.	1975-1	10
64	Kansas City Plant	1975-1	10
65	Sandia Lab., Alb.	1975-1	4
66	Pittsburgh Energy Tech. Center	1975-1	16
67	Synthoil Plant, PETC	1975-1	19
68	Synthane Plant, PETC	1975-1	8
69	Grand Forks Energy Technology Center	1975-1	5
70	Bartlesville Energy Tech. Center	1975-1	14
71	Laramie Energy Technology Center	1975-1	11
72	PNWL, Bldg. 231-Z	1975-1	0
73	ARHCo, Bldg. 234-5Z	1975-1	0
74	DUN, N Reactor	1975-1	1
75	ARHCo, Bldg. 200-E Purex	1975-1	0
76	HEDL, Fast Flux Test Reactor	1975-1	14
77	Argonne National Lab., West (Idaho)	1975-2	43

78	Headquarters, Computers (Germantown)	1975-2	13
79	Oak Ridge Gaseous Diff. Plt. (Centrif.)	1976-2	25
80	Morgantown Energy Tech. Center	1976-1	10
81	Atomics International	1976-1	8
82	Nevada Test Site	1976-1	17
83	Bettis Atomic Power Lab.	1976-1	7
84	Stanford Linear Accel. Center	1976-2	226
85	Los Alamos National Lab.	1977-1	61
86	Oak Ridge National Lab.	1977-1	14
87	BNWL, 200 E&W Areas, 300 Area	1979-1	2
88	UNI, 100K & 300 Areas	1979-1	4
89	HEDL, 300 Area	1979-1	11
90	Rockwell Int., 200 E&W Areas	1979-1	9
91	Argonne National Lab, Il.	1977-3	19
92	Idaho National Engr. Lab.	1979-1	34
93	Chemical Processing Plant, Id.	1979-1	4
94	Fermi National Accelerator Lab.	1977-3	38
95	Princeton Plasma Physics Lab.	1977-3	17
96	Savannah River, Construction & Gen.	1978-3	20
97	Savannah River, 100C,L,P,R, Reactors	1978-3	49
98	Savannah River, 200 F&H Areas	1978-3	46
99	Savannah River, 400 Area	1978-3	10
100	Savannah River, 300 & 700 Areas	1978-3	35
101	Oak Ridge Gaseous Diff. Plant	1979-3	11
102	Pinellas Plant	1979-3	18
103	Portsmouth Gaseous Diff. Plant	1979-3	8
104	Strategic Petroleum Reserve	1979-1	86
105	H-Coal Plant	1979-1	34
106	Paducah Gaseous Diff. Plant	1979-3	9
107	Naval Petroleum Reserve, Wyoming	1980-1	6
108	Rocky Flats Plant	1980-3	132
109	Lawrence Livermore National Lab.	1979-3	394

110	Sandia National Lab., Livermore	1978-3	50
111	Pantex Plant	1980-3	43
112	Y-12 Plant	1980-3	34
113	Stanford Linear Accel. Center	1980-3	178
114	Headquarters Computers, Germantown	1980-3	19
115	Headquarters Computers, D.C.	1980-3	11
116	Morgantown Energy Tech. Center	1980-1	6
117	Laramie Energy Tech. Center	1982-4	32
118	Laramie ETC, Anvil Point Site	1982-1	4
119	Grand Forks ETC	1982-4	14
120	Western Area Power Admin. Huron Site	1982-4	8
121	WAPA, Watertown Site	1982-4	27
122	Pittsburgh Energy Tech, Center	1982-4	46
123	WAPA, Watsonvile Sub-Stn.	1982-4	9
124	Bartlesville Energy Tech. Center	1982-4	18
125	WAPA, Headquarters Computers	1982-4	10
126	WAPA, V&H Sub-stations	1982-4	8
127	WAPA, Montrose Area Office	1982-4	23
128	WAPA, Salt Lake City Office	1982-4	8
129	Fernald Plant	1982-4	15
130	WAPA, Elverta Station	1982-4	15
131	WAPA, Mead Sub-station	1982-4	24
132	WAPA, Phoenix Office	1982-4	33
133	Naval Petroleum Reserve, Calif.	1983-4	97
134	Rockwell International (ex-AI)	1983-4	14
135	Oak Ridge Gaseous Diff. Plt. (Centrif.)	1982-4	5
136	Lawrence Berkeley Lab.	1983-4	20
137	Brookhaven National Lab.	1984-4	57
138	Bonneville Power Admin.	1984-4	28
139	Kansas City Plant	1984-4	24
140	Argonne National Lab-West	1984-4	19
141	Princeton Plasma Physics Lab.	1984-1	34
142	Oak Ridge National Lab.	1985-1	51
143	Argonne National Lab.,Il.	1985-1	102
144	Sandia Nadional Lab., Albuquerque	1985-1	70
145	Gaseous Diffusion Plants (Special)	1985-1	4

146	Mound Laboratory	1986-1	25
147	Fermi National Accel. Lab.	1986-1	63
148	Nevadá Test Site	1986-1	79
149	WAPA-Miles City Station	1986-1	9
150	EG&G, San Ramon, Pkleasanton, Goleta	1986-1	6
151	Rockwell Hanford Operations	1986-1	46
152	Pacific North West Labs.	1986-1	21
153	United Nuclear Ind.-N Reactor	1986-1	10
154	J. A. Jones Cost. Co.	1986-1	2
155	Boeing Computer Services	1986-1	4
156	Hanford Eng. Devel. Lab.	1986-1	14
157	Savannah River Plant, 100 Area	1986-1	66
158	Savannah River Plant, 300 & 700 Areas	1986-1	107
159	Savannah River Plant, 400 & 600 Areas	1986-1	65
160	Savannah River Plant, Separations	1986-1	121
161	Savannah River Plant, Overall F.P.	1986-1	21
162	Lawrence Livermore National Lab.	1987-1	239
163	Sandia National Lab, Livermore	1987-1	27
164	Y-12 Plant (Special)	1987-1	58
165	Morgantown Energy Tech. Center	1988-1	15
166	Knolls Atomic Power Lab.	1988-1	27
167	Bettis Atomic Power Lab.	1988-1	22
168	Los Alamos National Lab.	1989-1	99
169	Pinellas Plant	1989-1	11
170	Paducah Gaseous Diff. Plant	1990-1	40
171	Portsmouth	1990-1	?
172	West Idaho Nuclear	1990-1	?
173	Idaho National Engineering Lab.	1990-1	?
174	Rocky Flats	1990-1	?
175	Strategic Petroleum Reserve	1990-1	?
176	Stanford Linear Accelerator	1990-1	?
177	Naval Reactors Facility	1990-1	?
178	I.T.R.I.	1990-1	?
179	Ross Aviation	1990-1	?
180	Princeton Plasma Physics Lab.	1991-1	?
181	KAPL Computers	1991-1	?
182	Y-12	1991-1	?
183	Allied Signal	1991-1	?
184	Defense Waste Processing Facility	1991-1	?

In 1991, reflecting the proliferation of assessment activity across the Department, the independent fire safety survey program was terminated as a Headquarter's funded program by the Deputy Assistant Secretary for Safety and Quality Assurance.

*Denotes year completed and Surveying Organization.
1=Factory Mutual. 2=Factory Insurance Association. 3=Schirmer Engineering. 4=Professional Loss Control.

XIII

LIVING WITH BRANNIGAN

.....in which we discover that the words of wisdom that would fill a textbook can be condensed into a sentence; and have been.

[A DOE Fire Protection Engineer, and epicure, told us that the only conference or training system at which he hurried back from lunch so as to be sure he didn't miss anything was a Brannigan "Fire Loss Management" session. The impact of Frank on the program; indeed on two generations of fire protection people, is so great that no DOE history could be compiled without some of Frank's work. We are also informed that, as of early 1996, Frank's "Building Construction For The Fire Service" has become the leading NFPA publication, selling over 100,000 copies. Those who ever attended Frank's course on the subject, or who ever heard Frank on any subject, will not be surprised.]

The epigrams of Frank Brannigan were a common source of amusement and instruction through most of the days of the AEC and later. Some of the material is included in the classic texts on building construction that he has written for the NFPA and in the similar series of articles appearing in "Fire Engineering" over the past several years, as well as the best-seller, GPO-published "Living With Radiation" texts. Unfortunately, the bulk of his wisdom resides in the series of courses he did for AEC up until the 1970's and the subsequent free-lance lectures on a variety of fire topics. The complete stories await the publication of a text we hope will be called "Brannigan On Fire." They are a tribute to his evangical personality as well as the subject. He has begun to chronicle some of his more famous stories in a series of draft computer outputs which have gratefully been made available to the author. If they are published, they should be mandatory reading for any DOE fire protection person. (Even more so by the non- fire protection types). In the meantime, we have taken the liberty of condensing some of his more famous stories into lessons, arranged by topics. Here they are.

COMMUNICATION

The many articles, lectures, and public speeches by Frank can all be condensed into the topic of "Communication." We feel there are a few more categories, and have included some below. But a few examples of good communications must come first.

Frank tells the story of trying to convince an Italian-American contractor to do the job right, after which an AEC lawyer-type explained the methods of obtaining contract compliance. You write a memo to...who forwards it to...who cites..., etc. Frank said: "No! First you yell at...in English, and then...(the AEC construction engineer) yells at him in Italian ...." Frank concluded by noting the difference between theory, or nice words, and the realities of life, concluding that anyone who hadn't spent some time in a working-level position should be barred from a HQ policy-level position.

A number of Frank's stories are concerned with teaching sprinkler philosophy. While the job is certainly easier than it used to be, many of the examples are still current. One concerned the demonstration of a sprinkler (outdoors, without a shield) in which the skeptics came to wonder if the sprinkler would ever open. When it did, Frank asked them if they would prefer that on their fire, or a hose stream through a window. The reaction was good.

Another sprinkler example was the case of an AEC manager who said no one would respond to a fire in his high-security area except the duty officer, who would come when phoned and put it out. Frank said: "Fine, you can control your people, including killing them, which you will under the conditions you described. My responsibility is to the rest of humanity. Accordingly, I have instructed the fire department not to enter your area but to throw hose streams through the window. When the water comes over the sill, we will know the fire is out." The manager, picturing secret papers floating over the window sills, decide he better talk about it. Which is 90% of solving the problem in the first place.

Frank had a problem with construction practices at a New York Operations Office job. When management didn't believe him ("Frank is just making trouble") he visited the job site with some of the "experts." It was a nightmare. Welding over cardboard cartons full of excelsior was one of the lesser deficiencies. Rather than expound on the problems, Frank just said: "Go ahead, burn the place down, I'm going home." Which he did, leaving some very irate managers and some very contrite construction people behind.

The last communications example is the one where you don't talk to the people you're really talking to. In this Navy case, Frank was in a warehouse with some fire department people, expounding on deficiencies. When he noted some high-ranking officers showing off their great facility, he spoke a little louder. One of the officers, being quick to note there were two fire people involved, a duplication of effort (Frank noted the Navy was always quick to recognize such waste; and then assigned ten men at sea to the same job). Frank explained the situation, as he did later on an Admiral's house, that he was responsible for fire prevention and was trying to explain the weaknesses in the facility to the other officer, who was a fire fighting officer. His job was trying to figure out how he was going to maneuver his equipment to effectively fight the fire and protect his people at the same time. Of course, the officer had no recourse but to ask what the problem was. It automatically then became a piece of his problems. Being a good officer, he then helped solve them.

A number of the author's writings have been concerned with the problem of solving problems. We have maintained that the best way is to spread your problem around. Only three things can happen. The first is that somebody has a solution. Good; that's what you're paid to do. You found the answer the cheapest way. The second is that you might get a consensus opinion that there is no solution. In which case, you have a perfect excuse to start a great research program, of which you will naturally be the manager. Finally, if no solution is evident, you have put people on record as saying that they don't know the solution either. It doesn't help, but at least it prevents them from pointing out how stupid you were if somebody else eventually finds a solution. Frank was a master of all.

EXPERT-EASE

There are a number of cases where the self-proclaimed expert has to be circumvented if the job is to be done. Some examples are included under such categories as pre-fire planning, but some are purely related to the "experts", such as those who know what water does to everything except the fire. Some examples:

The best retort, applicable to all those who know they are correct because fire is just "common sense" came from the comment that "You can't talk like that to..., he's an Admiral." To which the reply was: "He may be an Admiral, but not in my Navy." It is a lot harder to earn a PhD in physics then to qualify as an FPE, but the behavior of neutrons in the nucleus of a carbon atom has very little to do with the behavior of a carbon atom in a fire.

Another example, similar to stories in other categories, concerned the provision of a fire escape in a three-story wood building so the 300 women folding bandages wouldn't have to use the two open interior stairs leading to the bowling alley. When a doctor objected to the "waste" of government funds, Frank cut him short by saying: "When I joined, you told me to bend over and shoved a big needle up each cheek because you said you knew what was best for me. Well, we just did the same to you." Short, but effective.

MOTIVATION

As Frank pointed out on numerous occasions, there are many ways to motivate people. Fear is one. Unfortunately, it only works with one person or one time. But it can work. These and other examples are some good sources of motivation.

In a ship fire where the crew was becoming an impediment, Frank saw a bag of mail part burned. Asking the Coast Guard to come and guard it presented the wise-cracking crew with the picture of Tommy-gun men climbing aboard. They weren't any more help, but they sure weren't a hindrance anymore. Sometimes "show-and-tell" is the best and simplest motivation.

When Frank left his civil service job to join the Navy soon after the start of the war, a letter caught up to him in Panama. It said he was "dismissed with prejudice" for joining the navy and would never be able to get another civil service job again. That's not what motivated Frank back into civil service from 1945 to 1971, but it is the kind of reverse motivation that some agencies seem to be expert at playing.

PRE-FIRE PLANNING

There are many ways to plan anything. In some cases, the paper becomes more important than the "plan." Fortunately, there are a number of stories which assist real planners. Such as:

Frank always has the standard solution to the problem of the sign on the lab saying: "In case of trouble, don't do anything before calling Dr. Jones." The solution: "If Dr. Jones is so damn smart that he can get a phone call at three AM on a Sunday morning telling him there's smoke and flames coming out his lab window and what should you do about it?--and he can tell you--then why the hell can't he tell you now when you're nice and comfortable in his office?" Besides, then he won't always have to be at the end of a telephone every Sunday morning.

One of the best ways to solve a problem is to make sure nobody can say they didn't know about it. A nitrate-ship problem would blow up the naval base in the worst scenario. Alternatives were to tow it out to a point off the main housing area or to a point opposite the main Atlantic Fleet tank farm. When Frank made sure everybody knew his solution, and nobody thought of anything better, the base commander solved it; he had the operation moved several states up the coast to New Jersey. No, the problem didn't really go away, but if people persist in doing the wrong things in the wrong place, make sure they understand what will happen if worst comes to worst. They may solve your problem for you. (But beware of any transfers you may have in store).

A Canal Zone exercise involved an enemy attack, blowing up water mains among everything else. When Frank explained where he would put his trucks by saying he wouldn't; they weren't much good without water, he was told: "We are not interested in realism, we are interested in having a problem." For some people the game is more important than the outcome---and sometimes irrelevant to it.

When rotten hose broke in an exercise with VIP visitors it was promptly replaced because Frank knew it was rotten hose. He covered by explaining that the nasty enemy sometimes shot up the hose on purpose so you had to practice fast replacement. When his commander later accused him of rigging the break, he tried to demure. He gave up when the C.O. said: "That's what I like in my men; initiative and imagination!" Frank said: "Yes sir." Honesty is the best policy--until it insults your Boss.

At the Cambridge Electron Accelerator fire, Frank shows a picture of flames bursting from the roof-high windows all along the football field-sized accelerator hall, which is just the point at which the fire department arrived (it was a liquid hydrogen bubble chamber explosion and fire), and the point at which an excited academic came to the Chief and said: "We've got lots of electrical equipment in there. Can't you use dry chemical?" The Chief did some instant planning and gave what was the best, shortest, and most honest answer he could have given. "Yes", he said. "But we don't have enough."

PROFESSIONALISM

There are many ways to be a professional. It helps to have training, degrees and certification, membership in all the right societies, publications and titles. Contrary to all the evaluation methods, there is one that is unfailing; the respect of your fellow professionals. Some examples;

There are several variations, but one of the most telling comments came from an old professional fireman who remarked, when asked about one of his "firemen": "Look, there are firemen and there are members of the fire department. Don't ever confuse the two. A member he may be, but a fireman he ain't." We have often used it as a reminder of the difference between performing a professional act and being a professional. The real professionals know the difference.

Frank made points at an inspection out-briefing with a tough Navy officer who knew a lot more about what was wrong with his operation than any fresh new Ensign could tell him. Frank said he needed extinguishers and training and he would provide both. From then on, Frank had a godfather. The point is that sometimes safety must provide a service if it is to be accepted. The "crack-down Tigers" may get something done for awhile, but if they can't help the people who know what the problems are a lot more than they do, they will soon become irrelevant to the operation. Why do tigers have to fight for their food when pussycats get it for free? Because pussycats know how to purr.

Frank got his first actual fire job as Chief of the Department! He got it by pointing out that he was the only one in the outfit that new which end of the hose went where. Sometimes professionalism is relevant. If you can't have it all, take what you can get and learn to work around the parts you haven't learned yet.

Frank was once chided by a University manager for making a recommendation he had never made before. When asked why, he said: "Because I'm dumb. I don't always see everything the first time and it may take me some time to get around to everything. But I'm the best man they can get for the job, at the price they offer so I'm here." Which is true of everybody, but some of us aren't as honest.

When Frank was an Assistant District Fire Marshal, he had the position of Deputy Chief of a department as a corollary duty--except that for ship fires, Frank would act as the chief--because he was the only one at the time who knew Port was the left side. The situation was familiar to a lot of combat military organizations that had two sets of NCO's; one that could do the drills and one that knew how to lead men in combat. (Like a WW II Bill Mauldin cartoon that shows combat infantrymen Willie and Joe sitting on a curb in disheveled dress with a stern MP in front of them. Willie is saying: "Maybe he's right Joe; when we ain't fighting, maybe we should look like soldiers.")

SPEAKING THE LANGUAGE

As the old joke about the mule tamer goes: "First, you have to get their attention." In another sense, it's saying: "You have to speak their language." Many of Frank's stories contained this vital element. A few of the more pertinent ones:

One of the best examples occurred in the early 1970's when Frank was putting together many of the slides he used to illustrate his building construction series. Across the street from the Bethesda, MD building then housing AEC safety (and later NRC) was a new post-tensioned motel being built. Frank had taken a number of pictures of the construction and wanted to get one during the post-tensioning phase. He went over to the site when it looked like they were ready and asked a worker if they were going to post-tension the tenons that day. "Beats me", said the worker, "I'm too busy jacking cables."

At an accelerator site, lead bricks on cabinets were discovered. This had been of no concern until Frank said they had a neutron hazard. The unbelieving Director accompanied him to the site. "See", said Frank. "Twenty pounds of neutrons are going to fall on somebody and kill them." The lesson was reinforced when Frank added: "Remember, gravity accelerated neutrons are the very worst kind."

Frank was lecturing some CAB people on radiation when it became clear they felt the technical terms were beyond them. He then told the story of how NASA had invented a measuring system to encompass the affect of gravity on space vehicles. Although few people could really define the term, they had come to have a feeling for its application, just as the radiation protection people had come to have a feeling for "REMS". The term was called "POUNDS." It made a great difference to the attenders attitude.

One way to get the attention of certain people is to speak a language a lot of people don't really understand, but are afraid of - legalese. Frank used this to good effect on a number of occasions by simply adding "GJF" to the distribution lists on memos. When questioned as to its meaning, he explained it meant "Grand Jury File". Since somebody was very likely to go to jail if the action wasn't taken and somebody died, Frank was simply being prepared when he received that Grand Jury notice saying (in latin) "Appear with all your files."

THE PUBLIC SAFETY NEWSLETTER

One of the finest information programs to come out of AEC was the "Public Safety Newsletter". The first issue was published in October of 1966 and discussed the basic radiation hazard and answered 15 typical questions on radiation emergency. As indicated by the logo, it was a Brannigan effort from the start. The first issue was so informative that it was reprinted in its entirety in the NFPA "Fire Journal." (See the NFPA Chapter)

The second issue, in January, 1967, covered the purpose and how to get on the mailing list. It also suggested a liaison officer arrangement and then went on to discuss shipping labels as they applied to the fire departments. Information sections covered a San Francisco meeting with fire officers, a four-day training course coming up at Norfolk, VA, a new movie on transportation accidents, some notes on radiological assistance, and an introduction to a course on radiation hazards.

The third issue covered pre-fire planning and a continuation of the radiation basics training course.

Issue four continued the pre-fire planning and included some notes on foam and transportation regulations.

Issue five continued the instruction course and notes on training classes. It was also the last issue. The entire subject was so second-guessed by the headquarters types who were jealous of their turfs, but not willing to do the same, that Frank simply said "To hell with it", and quit. Another of the best AEC programs was killed in mid-stream, never to be duplicated.

MORE RADIATION

Somewhere between April and September of 1963, a special Brannigan issue of AEC's "Safety and Fire Protection Newsletter" was published. The date is approximate because it was unnumbered, between issues 54 and 55 of those dates. The title was "I DONT LIKE ATOMIC ENERGY BECAUSE...." The subject was some of the irrational things people had expressed during Frank's lectures and courses. The five pages should have been a primer for public information people, but saw little distribution outside the safety fraternity. It ended with a plug for another Brannigan film effort; "Radiation in Perspective." Another of the great film library that disappeared as DOE learned to say: "Kick me again; it feels so good when you stop" to its critics.

FOOTNOTE FOR AN HP

As a final Brannigan story, in this Chapter anyway, we note the time when he was conducting his "Chain Reaction" training program for fire and police officers. An unnamed know-it-all type from Idaho Operations Office came to headquarters and was horrified to find that Frank was the one teaching all the first responders about radiation (Well, somebody had to). He hit up Frank in the hall one day and complained that Frank was "trying to make half-assed Health physicists in three days." Frank responded with: "Vic, that's just not true. We both know it takes four days to make a Health Physicist."[36]

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[36]. Health Physicists who may read this are perfectly free to write their own histories of the HP program in AEC/ERDA/DOE and cast aspersions on the fire protection people while doing so. Come to think of it, this is another thing that makes the fire protection program unique in DOE. It's the only program that writes its history; - - or cares to write it; --- or knows it.

ACCELERATING LOSSES

....in which we learn that particle accelerators can also accelerate losses.

[The particle accelerator was a major factor in the birth of AEC and is still important to the high-energy physics programs. While the Super Conducting Super Collider project was abandoned after a considerable amount of construction work had started, a Virginia accelerator facility was completed and others have been modified and upgraded. Unfortunately, while some upgrading projects are continuing, other facilities are being curtailed or having their operations reduced. In any event, their fire protection story is an important part of DOE history.]

To the AEC Fire protection Engineer, there was only one accelerator loss. It was the Princeton Accelerator fire, as described by Frank Brannigan. Since it can't be improved upon, here it is, verbatim:

"Princeton's Palmer Physics Laboratory had a pre-war 72" cyclotron installed in a vault in the basement. It was sort of a "Model T." It had been shipped to Los Alamos during the war and then returned. A newer, bigger one would be much more useful."

"As a fire problem, the cyclotron was simply two six-foot wide tubs with wooden covers filled with electrical equipment and cooling oil. A radiation hazard existed only when it was running, except for the irradiated target which would be removed immediately after an experiment was finished."

"It was supported by the Office of Naval Research. It burned mysteriously one night. When Headquarters learned that we were supplying half the funds through ONR, I was asked to investigate."

"The fire was discovered by a watchman about 10:30 at night. At that time it was most unusual for a university to have a watchman making rounds in a laboratory building, though some did have dormitories patrolled."

"He called the Proctors, a sort of student Shore Patrol."

"They went down and confirmed: "It's on fire all right."

"They called the University police."

"They went down, looked and confirmed: "It's on fire all right."

"They called the town police."

"They went down, looked and confirmed: "It's on fire all right."

"They sent for the fire department."

"The fire siren was not blown in Princeton after midnight, because of complaints from the academics. A selected list of members was called individually and asked to drop over to the firehouse, if convenient, and take the apparatus to the fire."

"When they arrived, they laid a line down to the vault. The fire was just a heavy oil fire in the lower tub. Had they hit it with the line, they would have frothed the oil, and the froth, acting like foam, would have extinguished it. They had been ordered: "Don't use water."

"Incredibly, they failed with two, then quite new, dry chemical extinguishers, which they had never practiced with."

"They backed out. The huge three foot shielding doors were closed and the scientists took over. This was the first fire in history where the PhD's outnumbered the BTU's. They scoured the University for the "scientists friend", the CO^2 extinguisher, including President Goheen's personal extinguisher. They removed a shielding block and discharged these puny units into the huge vault, to "inert the atmosphere." These were all men with advanced standing in the physical sciences. Nobody asked where the smoke was going. The vault had a right angle radiation baffle which was an open passageway. The smoke was being retained in the great hall above."

"They called the Trenton Fire department."

"Atomic Energy, you say? You'll have to call the Governor for the National Guard. It sounds like an oil fire. If you will send a truck, we will give you foam."

"When the truck returned, they learned that no one knew how to use the foam equipment."

"Some genius recalled that the Navy was supporting the project and called the Naval Air Station at Lakehurst, 60 miles away."

"They responded over icy roads with a pumper and a foam truck."

"The Chief said it was the greatest fire he ever went to."

"We were first given coffee and donuts and a lecture on atomic energy."

"The Chief organized his own two men and the Princeton F.D. to man a fog and foam line. They went down and put the fire out in less than a minute."

"The "brain power" in the Princeton Physics department was awesome, but they had to scour hundreds of square miles to find a man with only a high school diploma, who knew only one thing, how to put the fire out."

"In attempting to determine the cause, I was told that the focussing magnets had been accidentally left on, but that they could not possibly have started the fire."

"I stated flatly that the only remaining cause was arson. One way to get a new and up-to-date machine was to get rid of the old one. They were stunned. When I called Dan Hayes (Chief of the AEC Safety Branch), he said: "Don't you even think that. Gordon Dean (the AEC Chairman) is a big Princeton alumnus."

"Everybody up here doesn't have a sanity certificate. A Professor blew his brains out playing Russian Roulette last week."

"When I returned to the meeting, the unanimous conclusion was that the focussing magnets had caused the fire."

While there were bigger accelerator losses, some with funny sidelights, but most with some tragedy, there was never another "Princeton". We like to think that it was because too many people had heard Brannigan's description of the incident and were determined that they would not be similarly described.

COMEDY AND TRAGEDY: THE CEA LOSS

One of the earliest, sizeable, accelerator losses occurred at the Cambridge Electron Accelerator (CEA). Being a joint project of Harvard University and the Massachusetts Institute of Technology, it was located in the convenience of Cambridge, MA. A circular machine, most of the accelerator was underground, with electrical equipment in the center and a football-sized experimental hall filled with the usual mixture of combustible solids, liquids, and gasses, and a maze of shielding blocks and cable trays that made the exit path a weekly variable;---all typical of what we will call the third generation of accelerators.[37]Naturally, with all that electrical, the experimental hall was unsprinklered. (Hey, it did have an explosion-relieving roof. How sophisticated do you want to get?)

On May 6, 1965, some capacitors in a modulator[38] failed. The fire was largely confined to the immediate electrical equipment area and was limited to $127,000. A sizeable loss for the time, and

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37. From a fire standpoint, of course. The physicists can write their own history.

38. A typical fire scenario in earlier power systems.

the 47th in rank on the AEC all-time list, but not of great moment (or memory). That came two months later.

One of the great devices of early particle physics was the bubble chamber. Liquid hydrogen was the common medium and no large accelerator was without at least one. In fact, several moved from one Laboratory to another [39] and formed the major "targets' of the large accelerators from the late '50s into the early '70s. The spark chamber and other diagnostic machines becoming the instruments of choice.

CEA was not without its own. A new device, it was being run for the first time when, late at night on July 5, 1965, the thin beryllium "window" failed.(The window is the part of the chamber through which the beam enters. Called a "window" it is opaque, solid, and as thin as can be for good physics results). In this case, a manufacturing defect allowed the window to rupture, releasing a large cloud of liquid hydrogen into the experimental hall. It promptly ignited, with enough violence to cause the roof to rise and relieve the explosion forces. Eight scientists and technicians were on the floor near the chamber and suffered various injuries, but managed to find their way out. Unfortunately, the youngest technician was at the foot of the ladder to the top of the chamber, by the window, He died. The fire destroyed much of the equipment in the hall and had to be fought for hours by the Cambridge fire department.

A propane gas tank in the hall failed and badly spalled the adjoining concrete wall, causing some initial investigation confusion as to which had failed first. Fortunately, a fire buff arrived early and took pictures, with a good sense of time and sequence, that established the true course of events.

The most humorous event arose from the fire department response. About the time that the flames were coming through all the vents at the top of the high-bay, a scientist appeared and told the Chief that "There's a lot of electrical equipment in there. Can't you use dry chemical?" The Chief replied with what had to be the best, and truest, possible answer under the circumstances.
"Yes", he said. "But we don't have enough."

Unfortunately, the roof, which functioned as designed, was not designed to come back down;...or nobody had thought about what would happen when it did. It hit the steel roof beams and broke up, dropping several tons of asphalt coating onto the experimental floor and helping to burn what the original fire might have missed.

Every major loss has a number of unfortunate chains which, if they had been broken at any point, would have lessened the loss. This leads many people to think that the magnitude of a loss is just an unfortunate chain of circumstances. Actually, every major loss has also had a chain that did "break", and greatly reduced the loss thereby. In this case it was the fortunate coincidence of the date. Can you think of any time that a major college facility, in the middle of a college town, might be less

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[39]. LBL to SLAC, for example.

populated than late at night in the middle of a three-day weekend on a national holiday in the middle of summer ?

A second (lucky?) factor was the crane location. Left near the ladder on a far wall, it was not damaged or moved by the explosion. In any other position, it probably would have been moved by the explosion, possible even being blown off the rail and adding to the damage or injuries.

The loss was the sixth largest in AEC history; one fatality, eight injuries, and $1,453,000 in loss. However, the benefits may have exceeded the dollar loss. Al Rizzo was one of the benefits.

Al Rizzo, then of the New York Operations Office, was a member of the investigating committee and of the later Accelerator Safety Committee. The incident, as the first major accelerator loss, and the first hydrogen bubble chamber loss, was the center of a great deal of interest throughout the accelerator community. The author, as a San Francisco Operations Office fire protection engineer, got to go back to Cambridge with a contingent of accelerator people from the various California laboratories and spend a day with the invited group of nation-wide representatives. the damage, as viewed from the mezzanine overlooking the experimental hall was awesome to those not familiar with typical fires/explosions.

By the time the report was issued[40], Al was in much demand as a speaker on the loss and on AEC's attitude to it. We were fortunate to attend one such session at Lawrence Berkeley Laboratory. When he indicated that increased safety formality was a likely result, the coolness of the audience was evident. In the question session, one obviously irate person asked if AEC thought it was going to be telling scientists what to do. The attitude of the entire audience took an immediate about-face when Al said that "of course, we can always exercise the ultimate control." Queried as to what that was, AL replied, "We can always turn off the money machine." It was obviously the first time that many of the audience had considered how vulnerable they could be to an accident, and especially to the consequences of an accident.

Oh yes, the Cambridge Electron Accelerator never ran again.

THE ACCELERATOR SAFETY COMMITTEE

As part of the effort to improve accelerator protection, the AEC formed an Accelerator Safety Committee. The 26 members included seven representing DOE: Dick Smith and Paul Reardon from Headquarters; A Rizzo and Jack Allentuck from New York; E. Conti, Chicago; Paul Klevin, Brookhaven Area Office; and Walt Maybee, San Francisco.[41]The other members were scientists and

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[40]. AEC published many losses as separate reports, available from the GPO, a practice that unfortunately was later discontinued.

[41]. Smith and Maybee were the only Fire Protection Engineers.

engineers from Argonne National Laboratory (3), Brookhaven National Laboratory (4), Cambridge Electron Accelerator (1), Massachusetts Institute of Technology (2), Lawrence Radiation Laboratory (now LBL-3), Stanford Linear Accelerator (2), and the Princeton-Penn Accelerator (2). In addition, another forgotten committee had two liaison participants. The Electrical Safety Committee was represented by W. Gardner of HQ and H. Hoy of Oak Ridge National Laboratory. The committee was organized, held a meeting, drew up a plan with four subcommittees writing the bulk of the guide, and having the first drafts ready between May and October of 1966.

The four subcommittees were Management Procedures, Buildings and Facilities, Experimental Equipment, and Operating Procedures. The entire committee met from October 25-28, 1966. An editorial subcommittee finished the work and published the draft in March of 1967. The 10-month effort was not a shining example compared to the war years and early AEC years. However, by comparison to the efforts of the later agencies, particularly the Department of Energy, the effort was remarkably fast.

The published report contained 33 pages. It is woefully short of "Formality of Operations" and "Safety Analysis Report" requirements by current standards, but it was the first standard particular to a specific type of facility in the "nuclear" category and did draw more attention than many of the later efforts. The fire protection section ended up as three paragraphs in the "Buildings and Facilities Guidelines" section after starting out as eight pages in the first draft. This was about average for the other write-ups and, of course, much of the equipment and procedures sections contained fire protection guides.

In current standards terms, the document has several unique features. Like a number of earlier documents, it was a guide and not a rule, standard, order, or similarly mandatory document. In those days, much more emphasis was put on professional interpretations in the field than is the rule since the mid-'80s.

A second feature was the virtual anonymity the Guidelines have achieved since the initial distribution. In theory, they are still in effect, but few people have heard of them and they do not apply to modern facilities. Some things, such as bubble chambers are now extinct, so the sections pertaining to them are no longer valid. However, much of the document would still be useable.

The final feature was typical of a number of things done in AEC and on into early DOE days. The document was available from the Government Printing Office to any buyer at the exorbitant cost of twenty cents! Another example of the way things were done. The federal register is a poor substitute for real openness. As Chapter V demonstrates, the AEC really did do most of its operations in a "goldfish bowl."

SOME OTHER LOSSES

Unlike the later computer fire protection document, the accelerator document did not contain a list and summary data of accelerator losses. This was partly due to the fact that there had just not been that many prior to the CEA loss. Some of the recorded losses are as follows:

The CEA second loss was number six in magnitude in AEC history. You have to go down the list to number 26 before another accelerator-related loss is reached. One of the war-time, two-story frame buildings at Lawrence radiation Laboratory (LBL-Berkeley) burned down on 4-23-50. It was not an accelerator facility, but the Laboratory was almost totally involved in accelerator work at that time, including an early linear accelerator in an adjoining building so, by a little stretch of facts, it could be considered an accelerator support facility. Dollar loss was $258,712.

The next sizeable accelerator fire occurred at Fermilab on 12-26-73 when a weekend burning operation attempted to cut off some door supports on a quonset hut-like beam tunnel. the tunnel was lined with urethane foam which ignited and did what it normally does, burning 430' in eight minutes. This was typical in two respects. First, it occurred in a building under construction. Second, it was the subject of a system-wide report which was reprinted in the NFPA Fire Journal of January, 1975 (See Chapter XX). In terms of the AEC ranking, it was the 41st largest loss.

Number 42 was another accelerator loss that didn't involve an accelerator. Like most losses in AEC/ERDA/DOE, the object of concern was not really involved.[42] This was the 4-23-58 failure of a generator on the Bevatron at Lawrence Radiation Laboratory when a rotor bolt sheared off and damaged a generator in the power building adjoining the accelerator building. The dollar loss was $140,000. As usual, no injuries.

Number 47 was the first CEA loss, discussed above.

The above is the extent of all losses over $50,000 that occurred in AEC accelerator facilities. A number of losses have occurred since the AEC became ERDA in 1975 and the number of accelerator facilities, particularly very large single-machine sites, has increased considerably. Loss ratios and comparisons can not be made on a strict basis of before-and-after CEA since values were not maintained for accelerators and new accelerator sites are so large that it would be necessary to separate support facilities from the accelerator proper. One thing is clear, however; the overall loss record in AEC/ERDA/DOE is so low and the specific accelerator losses are so few that the overall loss rates in accelerator facilities can also be considered to be quite low. A qualifier to this conclusion is the fact that individual accelerator "targets" are becoming so large that a sizeable loss potential exists that is not covered by traditional fire protection methods. Some of the concerns are discussed in a later section of this chapter.

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[42]. As other chapters discuss, fatalities led in construction, not operations and fire has been the leading cause of radioactive contamination.

Some of the accelerator losses in the post-AEC years are noted below.

On 1-18-76, a small loss of $7,000 occurred in an accelerator facility when a magnet overheated. The resulting fire was controlled by the operation of two sprinkler heads. the fire department completed extinguishment with two CO_2 extinguishers. A closed valve in the sprinkler alarm line prevented automatic notification of the fire department, but an employee's call served the same purpose. This was only the second instance[43] in AEC/ERDA/DOE history where a closed valve was a factor in a fire. In this case, it did not contribute to the extent of the loss.

A 3-16-76 fire in an accelerator detector area was another case of a fire department providing effective action in the absence of an automatic extinguishing system. The loss was $86,046.

One of the dangers of trying to compare "accelerator losses" with other categories, or even between accelerator sites, is illustrated by a 1976 fire loss at Fermilab. The loss was held to $20,000 by the site fire department when a heating furnace malfunctioned. The building was a century-old unoccupied farm house! At the same site, the same year, a building was totally destroyed by fire for a loss of $13,000. The building was a former dairy barn!

Several other small losses occurred at Fermilab in 1976. These included two electrical incidents. In one, some switchgear in an experimental area failed explosively for a $4,500. In the other, janitor's floor wash water drained into a bus duct elbow, shorting cable for a $1,250 loss. A purely "accelerator" loss was a beam collimator overheating and distorting into the accelerator beam, damaging the collimator and contaminating the area for a loss of $3,000.

Mechanically, fatigue cracks at Fermilab in 1976 damaged three cryogenic chamber supports for a $75,000 loss and 1,870 liters of 94% neon were accidentally vented from a bubble chamber when a fill line seal broke for a $16,250 loss.

In 1977, again at Fermilab, a deflected proton beam ignited magnet epoxy. The fire self-extinguished, but the loss was $10,000. Also at Fermilab, a shunt failure burned cable and the fire department held the loss to $5,755 while a Brookhaven lightning strike interrupted power supplies, causing an external beam line fire in an accelerator for a $9,000 loss.

Among the more typical losses was a hot water pipe that as turned off in freezing weather at Fermilab for a $2,000 loss. Typical at many sites, but not an "accelerator" loss. Again, several other losses of relatively minor nature were experienced at accelerator sites. As usual, most did not involve an accelerator and most were relatively minor in impact.

The year 1978 was one of negligible losses at accelerators. A rupture disc failed and released $6,000 worth of helium at Fermilab. Other losses were also slight and also typical in another sense;

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[43]. The first was a closed valve in a dust collector. It was a "cold-weather" valve, however, and of known status, unlike valves closed for unknown reasons.

they were due to acts of nature. $139,982 from a thunderstorm, $3,275 from a tornado, and $2,250 in wind damage to skylights. Over the years, acts of nature have accounted for about 10% of the losses in AEC/ERDA/DOE.

Another of the few losses actually occurring at an accelerator happened in November of 1980 when a Van de Graff accelerator was damaged to the extent of $40,000. However, it was caused by a service platform being moved without proper clearance. Another case of a non-fire loss due to faults not within the accelerator system itself.

A $20,000 loss did occur at Fermilab when a magnet overheated and ignited due to the failure of a plastic cooling water hose.

Another transformer loss at Fermilab in 1981 resulted in a $21,400 due to an internal short. This was the largest electrical loss in DOE that year. A $15,000 loss at SLAC was occasioned by crane operator hooking a vacuum pipe. Similar non-fire losses occurred elsewhere, including a $2,769 loss at Fermilab when a milk truck backed into an overhead door!. The largest actual fire loss was at SLAC when a $4,200 loss resulted from welding slag falling between openings in shielding blocks and igniting some fiberglass insulation.

1984 fires included a $48,000 loss at Brookhaven when oil-filled selenium diodes in a pit ignited and mostly smoke damage resulted, and a $4,000 power cabinet fire at Fermilab.

The largest loss of 1985 occurred at Fermilab when a utility transformer was destroyed to the extent of $1.2 million. The loss of power resulted in superconducting magnets venting some $60,000 worth of liquid helium. At the same site, a liquid hydrogen target in an enclosure in the High Intensity Laboratory ignited, but the small volume involved resulted in a loss of only $700, below the normal reporting level.

The largest loss of 1987 was the Wide Band Laboratory fire at Fermilab. This was the first fire in DOE to exceed a million dollars since the 1981 transformer loss at Bonneville Power Administration. The $1.1 million loss was caused by a misaligned conductor strip plugged into an instrumentation box which allowed the ribbon cable to overheat and ignite cables, spreading to overhead cable trays and adjoining physics targets. Although five overhead sprinklers operated and served to confine the fire to a relatively small area in the 50' x 227' x 50' high target room. The entire building was filled with smoke by the time the on-site fire department arrived and interior firefighting could not begin until the roof was ventilated with the help of mutual-aid companies.

The extent of the loss was increased by contamination..lead contamination from shielding vaporizing! The most interesting aspect was the videotape presentation of the incident and lessons learned. The tape was made available to all DOE offices and was the feature presentation at a number of fire conferences, including a seminar at the National Institute of Science and Technology. The lessons learned were applicable to any site utilizing custom-built[44] electronics assembled by researchers or graduate students.

There were no significant fire losses in 1988 and 1989. Typical of most incidents throughout the years was the minor fire at SLAC. A dry chemical system extinguished the fire, but it reflashed and was finally extinguished with a portable extinguisher. The location... a deep fat fryer in the cafeteria. As accelerators have grown in size, they have become major facilities in their own right, with all the support facilities that exist at any site. Thus, it is no surprise that the majority of "accelerator fires" and any other incidents at accelerators, are not related to the accelerator.

FOOTNOTES AND REASONS

Some of the reasons for both accelerator losses and lack of losses are inherent to the development of the accelerator facility. the author was fortunate in that the head of the engineering department at the California junior college he attended had been a graduate student at Berkeley when Lawrence was developing the first accelerator. His chief impression was the "horribly crude workmanship" involved.[45] When the entire accelerator fits in the palm of the hand, it can obviously be destroyed by fire[46], and the accelerator itself is not much of a potential hazard.

The small size of the early accelerators meant that they fit very easily into a single small room, or even building. The largest of the pre-WWII accelerators was the Berkeley 184" Cyclotron. The principal fire hazard came to be the oil in the electrical equipment as at Princeton and a number of machines had total-flooding CO_2 systems. Targets were basically confined to what could be inserted into the beam.

The development of the linear accelerator and the growth of the cyclotron machines soon resulted in beams being extracted from the accelerator and directed at targets on the floor of the accelerator room or building. By the early 1950s the result was a multiplicity of beams in the same building directed at a number of targets. With the constant changing of experiments and the growth of power needs, the areas soon became a nightmare of "temporary" wiring.[47] The fire hazards grew commensurate with the growth of the experimental floor.

By the time the Stanford Linear Accelerator was started in the very early '60s, the growth of accelerator sizes (SLAC was 10,000" long) and the proliferation of experiments had resulted in a

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44-Read "amateur-built".

45. If you've seen it in the Lawrence Hall of Science, you know what he meant.

46. Or by dropping it. Which may be the principal risk to future high-value computers.

47. Temporary in location and type, but permanent in existence.

situation where the target area was now completely outside the accelerator building. At SLAC, the beam was split into many in a subway-station sized area called the beam switchyard and then exited to a "research yard" the area of a football field or more. All the experiments came to be housed in portable structures with portable wiring and portable shielding. Needless to say, the hazard of the experimental building (except for one or two heavily-shielded structures had been eliminated.

The author was particularly proud of SLAC since it represented one of the first of the new generation. It also had all the permanent buildings, and some of the temporary buildings, sprinklered. This was a great advance and the author's pride and joy. It was thus a rather rude awakening when the first fire protection survey was made by Factory Insurance Association in 1972 and resulted in 204 recommendations! This was more than any of the other 19 surveys made prior to that time at such sites as Rocky Flats, Y-12, and Richland. The problem was that the permanent buildings were good but the research yard had become such a conglomeration of small "temporary" research machine or instrumentation shelters that the primary problem was turned into a conflagration hazard!

Changes at SLAC were made, and the actual costs demonstrated how relatively minor the needed improvements were, as outlined in the "Changes" Chapter. Thus it was not too much of a surprise when the followup survey was made by FIA in 1976 and most of the original recommendations were considered to be complete or no longer applicable. Of course, there were a few new ones. The new total in fact was 226! Science had not stood still in the interim and there were more experiments then before. Again, the proliferation of temporary buildings in crowded conditions were a root cause of the problems.

Things did improve at SLAC. By the 1980 survey, there were only 178 recommendations.[48]

Before leaving SLAC, it should be mentioned that it had two other distinctions; one of the few successful political radical (or just plain terrorist) attacks, was a bomb blast that damaged part of the injector area. The other was probably the first inside-the-beam line fire. Since the beam line was a 10,000' tunnel before it ever got to the switchyard and then the experimental area, protection was of some concern. Sprinklers were omitted from the tunnel due to the supposed absence of combustibles,(but not without some trepidation on the part of the author). Naturally, one of the first fires occurred in the accelerator tunnel! It was a construction fire. Some worker rode his motorcycle several thousand feet into the tunnel, where it promptly caught fire. Fortunately, that was before any of the accelerator was installed and the final configuration did, indeed, have negligible combustibles.

The SLAC story was a forerunner of future machines. The use of wave guides eliminated most of the wiring and the accelerator itself became of less concern than ever before. The growth in number and size of experiments, while resulting in what was best described as a "conflagration hazard" in the early SLAC days, came to be the solution to the problem by the time Fermilab was built.

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[48]. Or maybe the new appraiser, Schirmer Engineering, was easier to please.

LITTLE DROPS OF WATER

....in which we learn that item three in the "Unique Chapter" is number one in the reasons for the superb AEC/ERDA/DOE loss record.

[AUTHOR'S NOTE: For well over 100 years, the automatic sprinkler system has been recognized as the single most effective fire protection system. This is true in DOE and the agency's fire protection program is again unique in maintaining the performance and reliability record of its principal safety system, publishing it and comparing it to recognized national and international performance. Again, it is another area where the DOE experience has been exemplary.]

For well over one hundred years, the automatic sprinkler system has been the principal automatic means of providing property protection against fire losses. It is only in the last twenty to thirty years that the prime life-safety aspects of the system has achieved similar recognition and sprinkler system requirements have become ever-more mandatory in State-after-State. First for schools and for nursing homes, then high-rises, then hotels and apartments, and now even the private residence. The reason is two-fold: the system provides the best protection at the least cost and it is the best way of conserving fire department resources in an era of tightening budgets.

Several Chapters have already explained the savings to DOE, and the fact that sprinklers have long since paid for themselves, as well as providing the acme of protection. With the first of the Manhattan District fire protection engineers having come from the Factory Mutual system, it is not surprising that sprinklers were installed in a number of the earliest of the facilities, even though they were erected under a "temporary" wartime program.

The first AEC fire protection document, issued in 1949, established the "improved risk" policy that had been recommended as the standard for all federal agencies at least as far back as the second edition of the Federal Fire Council's "Manual of Fire Loss Prevention", published in 1945 (page 101). By the time the AEC "Manual Chapter" system was established (now the DOE "Order" system), the first issuance of MC 0552, "Industrial Fire Protection", defined the term as follows:

> "Normal" fire protection, as used herein, is synonymous with so-called "improved risk" fire protection, as used in the insurance trade.

Since the basis of the "improved-risk" insurance industry was the sprinkler system (in fact, it was the sprinkler system, that gave birth to the "improved-risk" insurance companies after the earliest Factory Mutual companies), it was natural that sprinklers would be considered the prime protection system. Indeed, since most of the early AEC fire protection engineers had all served some time in insurance organizations, they were familiar with the intent of the words "improved-risk" and were all strong advocates of the sprinkler system.

At Fermilab, the size of the machine and the machine, several miles in circumference, meant that each beam line took on the structural aspects of a sizeable accelerator in itself. The growth in complexity and size of targets meant that each target, while no longer posing exposure threats to other target buildings, was now a major hazard in itself. This has been exemplified at Fermilab where the newest of individual targets constitutes a value in excess of that contemplated for entire facilities in the DOE fire protection orders. And we're not likely to figure out how to build a fire wall down the middle of a target!

As with computers (a Chapter in themselves) the changes over the years have solved many of the original problems, but posed new ones. The increasing dollar density has made the provision of protection systems more necessary and, at the same time, more difficult. The fact that DOE has been able to maintain, and even improve the loss ratio through the years, is yet another tribute to the effectiveness of the fire protection programs.

Much of the early fire protection effort was devoted to expanding the scope of sprinkler applications in the face of the many "experts" who instinctively knew that "you can't put water on that", or that "the water would be worse than the fire." The efforts of these early people and the growing experience as systems were installed for protection of computers, fissionable materials, high-energy electrical systems, cooling towers, combustible metals and other exotics led to the system becoming universal in DOE.[49]

One of the many landmarks of sprinkler history occurred in 1968. The Australian Fire Protection Association published H. W. Marryatt's "Automatic Sprinkler Performance in Australia and New Zealand, 1886-1968." Many other sprinkler studies had been published, a number even before the turn of the century. The National Fire Protection Association had also published periodic updates of sprinkler performance, but these had become increasingly incomplete as the many small loss incidents were not reported to any central organization, while the big fires or failures make the newspapers. Thus the performance data was becoming increasingly skewed in the direction of poor performance. Marryatt's book was a landmark because the A-NZ authorities had required sprinklers to be supervised from the first. In addition, the responding fire authorities made a report of each fire/sprinkler incident. Thus, the body of data was the most complete ever published. It clearly established that sprinkler performance was better than 99% satisfactory. A second edition, published in 1986, updated the performance data for the full 110 years. It showed that overall performance was the same, despite the "new" hazards of high-value and highly combustible materials, high-piled storage, larger building fire areas, etc.

The study also confirmed what had been know, but not stressed by the property insurers, that the sprinkler system is the best single life-safety system from fire. Multiple-deaths in sprinklered building fires were essentially unknown. Even single-fatality incidents were generally confined to severe exposure to an individual at the point of ignition. Even in these cases, the number of people still saved by a sprinkler system was remarkable.

Needless to say, the other two objectives of the DOE fire protection system, to prevent off-site pollution from a fire and to prevent a fire from causing a major interruption to an operation, were also shown to have been met. While a number of later DOE safety managers seemed to have trouble realizing the concept, the fact remains that if you keep the fire small, you keep all the other effects small. Given the prevalence of fire in society, those little drops of water are the best pollution-control and public-protection devices known. The most immediate effect of the book was to raise the questions among U.S. experts as to why we weren't that good, or as to whether or not we could be that good.

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49. The battle never ends. Even as late as 1992, a high-level computer official at a National Lab wrote a memo to Associate Directors, inviting them to view the new $27M computer, and remarking on the stupidity of installing sprinklers in the building, including all the usual misconceptions.

The DOE fire protection community welcomed the Marryatt publication as a further tool for use in their arguments regarding installation in all those areas where "it can't be done." At a number of meetings, the fire protection people expressed the firm opinion that the DOE record must be at least equal to the recorded Australian experience, and for many of the same reasons; i.e., the systems were alarmed and supervised and usually summoned a plant fire department which had at least a run report for every incident. Further, the security provisions at most sites would discourage the tampering that might affect other systems. In addition, maintenance and inspections were provided by knowledgeable site people so that any system should remain effective for many years with a high degree of certainty. What was lacking was any real consolidated record of DOE experience.

With the above in mind, we attempted to collect data off-and-on for several years. Old reports were available but the brief summaries often did not mention how a fire was extinguished, let alone whether or not a sprinkler system had been present and operated. Like the national experience, the large losses[50] and the failures were well-documented, but the small successes were buried in the files and became lost with time. In addition, the fire reporting level had changed from the $50 mark in AEC to the $1,000 level common to other type losses after ERDA, and then DOE, were formed. A study of the 1970-1975 fire losses showed that over 90% of the dollar loss would still be reported under the changed rules, but over two-thirds of the fire incidents would not. Since so many sprinkler fires had resulted in a loss less than $1,000, they stood the chance of being lost to the record if efforts were not made to assemble the data.

One factor delaying the study was the very success of the DOE fire protection program. There just were not many fires, whether sprinklered or not, in DOE facilities. (Ten to twenty per year. See the "Probably" Chapter). Unless the sites could recover a majority of their old, minor losses, the number of cases might not have any statistical significance.

The decision to proceed with the study was based on two considerations. The first was the uniqueness of a number of DOE losses. This, in itself, was worth preserving and could make informative reading, even if no strong conclusions could be drawn. The second was the water-flow alarm. While common to nearly all systems, it means that professionals respond to all water-flow incidents, whether the result of a fire or not. The number of cases of water damage in DOE records, from all types of systems, was considerable. In addition, the fear of water damage among most sprinkler detractors would make some sort of comparison worthy of effort. We felt also, that some small, low-loss incidents might be recorded by the same on-site fire departments that were responding to, and recording, the fire losses. Thus, a search of all sprinkler operations, including damage to, or damage caused by, a sprinkler system, was undertaken. The result was published as DOE/EP-0052 "Automatic Sprinkler System Performance and Reliability in United States Department of Energy Facilities, 1952-1980." Printed in June of 1982, it was available from the National Technical Information Service, Department of Commerce, Springfield, VA 22161.

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[50]. Including the Paducah fire that paid for every sprinkler installation in DOE history. (See Chapter IX)

FIRE RESULTS

A number of studies were made using the fire data submitted in response to the questionnaire distributed in 1980. The results demonstrated that the fire loss in a sprinklered building had been one-fifth of the loss in unsprinklered buildings, despite the fact that it was only the low-value buildings that were likely to be unsprinklered. In addition; there had been no loss of life in a sprinklered building, the system performance was 98% effective in extinguishing or controlling fires, and about one-third of all fires had been completely extinguished by the operation of a single sprinkler head.

Tables and graphs (hand-drawn; this was before computers and the project was not exactly a top management priority) were included. Sections compared wet system performance with dry systems, extinguished vs controlled for each type of system, number of heads operating in controlled vs extinguished fires, dollar losses by type of system, sprinkler failures (there were only two), occupancy records, sprinklered loss vs total fire loss, the effect of large losses on the average, extreme value projections (see the "Probably" Chapter), no-loss sprinkler fires, effect of head height, standard vs old-style heads, frequency-severity plots, and 12 additional topics treated in a short paragraph or two.

As the study said, if the purpose was to demonstrate the value of sprinklers to DOE, it was really a case of preaching to the choir. The fire protection professionals needed no study and they had long-since sold the sprinkler system as the AEC's basic fire protection system. The real value came from the non-fire portion of the study.

THE NON-FIRE SPRINKLERS

This was the more important part of the study. First, the fire performance had already been demonstrated by the Australia-New Zealand experience, and with far more validity. Second, there were 407 instances from AEC/ERDA/DOE experience and this provided more statistically valid experience then the comparatively few sprinkler cases existing at that time. Some examples:

Of the 407 instances, only 13 losses resulted in a figure exceeding $5,000, - and four of these occurred while the system was under test.

The largest single loss was $96,000.

As might be expected, freezing was the principle cause of non-fire damage. Of seven "causes' of damage, freezing accounted for over half the incidents. Freezing was also the predominant cause of damage to or from dry-pipe systems.

The non-fire damage incidents had tables and graphs illustrating losses by cause for each type of sprinkler system, an analysis of reported "no-loss" incidents, a study of faulty system components, and a comparison of sprinkler system damage and non-sprinkler water damage.

A 1975 study stated: "The potential for water damage is often used as an argument against the installation of automatic sprinkler systems. However, it is seldom used as an argument against the installation of other water systems." The basic conclusion was that the average loss from a non-sprinkler water system was about twice that of a sprinkler system. (For computers, it was about a four-to-one ratio). Moreover the non-sprinkler losses occurred twice as often[51] Some of the non-sprinkler losses were also among the unique losses in DOE; such as the water damage that damaged only water (it got diluted) and the water damage that damaged fish.

The damage to, or from sprinkler systems, was equal to about 10% of the fire loss in sprinklered fires; and 1% of the total fire loss.

The chance of a sprinkler head failing was about one per million heads per year.

The chance of any incident involving sprinklers in a non-fire incident was about one per year for every 800 systems, and the average incident caused more dollar damage to the system then the system caused to its surroundings.

The most probable loss from a non-fire incident was about $1,100.

Appendices and bibliography included a description of all major fire and non-fire incidents, in-house sprinkler studies and research papers, survey method and background and estimates of total sprinklers and systems in DOE.

THE CONTINUING RECORD

It was obvious that a principle weakness of the study was the bias against small incidents. Although much less than was evidenced by the NFPA and insurance industry studies, it was clear that early fires operating only a few heads and resulting in minor losses had been lost. The apparent growth in number of incidents in later years was obviously due to the inclusion of all incidents.

With the publication of the study, the reporting requirement for fires was changed. Not officially (it might not have gotten past the bureaucracy), but by requesting each field office and contractor to report all losses involving automatic extinguishing systems, even when there was no loss. The next 8 years[52] saw the accumulation of a better collection of fire data. The Annual Summary of Fire Protection Programs report carried an update each year, together with a brief description of

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51. The non-fire water loss percentages did not include a number of the really large non-fire water losses; floods and roof failures!

52. The 1990 report had not been issued as of 1992. Another example of a mind-set described in the Chapter on "Getting Out the Word."

each fire. An updated summary for all the years since the first report was logged in 1952 revealed the following:

The DOE fire sprinkler record is now almost identical to the Australia-New Zealand experience, as illustrated by the accompanying graphs.

The sprinkler system has been 99.5% effective, and there hasn't been a failure since 1963!

Nearly half the fires in DOE history have been completely extinguished by the sprinkler system; before any portable extinguishers could be used and before the fire department could take action.

Over half of all the fires in sprinklered buildings operated but a single sprinkler head; and over 90% were controlled or extinguished by the operation of three heads or less!

As Parkersburg, West Virginia Fire Chief Lloyd Laymen, expounded in his classic article on the effectiveness of water spray, titled (what else?) "Little Drops of Water", printed prior to WW-II, sometimes the most effective method of fire control is so superior to other things that we take it for granted. The automatic sprinkler system is one thing that can never be taken for granted in AEC/ERDA/DOE history and the agency should be proud of the fact that it has not only paid for itself many times over in the agency's history, but the history of the agency has helped to prove the benefits, and spread the word about, the automatic sprinkler system.

The data has been updated each year. As of mid - 1996, the data was combined for the period through 1993. The 1994 report was not issued until may, 1996 and 1995 data is not yet available. Some difficulties have been experienced in collecting reports as new people have come into various organizations and familiarity with once-a-year requirements is lacking. LLNL reported an unusual sprinkler event in February of 1996. Two heads on a wet - pipe system controlled the fire, but one head (A flush pendant head where the deflector drops down on a chain) was simply squirting down on the floor, rather than spraying. The deflector had twisted and was not creating a spray. We leave it to the reader to determine if this was a sprinkler failure and a sprinkler system success.

Appendix-The Sprinkler Record

1952

The earliest sprinkler operation the study could obtain details on was a 12/9/52 incident at Los Alamos when a 3,000# mold of molten uranium ruptured in a foundry operation. Two heads operated to control the fire while the waterflow alarm summoned the AEC fire department to complete extinguishment. Loss was limited to $1,300. (Years later, a 1945 shop fire at Los Alamos was found to have been in a sprinklered building, but details were not available).

1953

No losses for 1953 were recovered.

1954

A 10/1/54 fire in a Savannah River anion exchange column in a Canyon Building operated the deluge system which extinguished the fire for a loss of $21,000.

Another 1954 loss occurred at a cooling tower where the ordinary sprinkler system extinguished the fire for a negligible loss.

1955

A 4/15/55 fire was started by ignition of ether in a fume hood at an Atomics International laboratory. Two sprinkler heads operated on the sprinkler system to extinguish the fire for a $2,117 loss.

A 12/30/55 Kansas City Plant fire was actually a fire in an unsprinklered General Services Administration area. Heat set off two heads on the Bendix side which controlled the fire, preventing it from penetrating the office wall. Water loss on the AEC side was limited to $650 while the fire department extinguished the GSA side.

1956

A single loss was recovered for 1956. At an Oak Ridge, Union Carbide plant, sponge rubber in a warehouse ignited and was controlled by two wet pipe sprinkler system heads while the plant fire department completed extinguishment. Loss was $13,091.

1957

The only recorded loss for this year occurred on 6/24/57 when welding sparks ignited some storage in a manufacturing area. The wet system controlled the loss while the plant fire department completed extinguishment. Loss was held to $669.

1958

A 2/21/58 loss of $12,000 at the Fernald Plant was the result of a cold weather valve being shut and sparks igniting dust collections in an electrostatic precipitator. The single head could not operate. THIS IS THE FIRST OF THE ONLY TWO SPRINKLER LOSSES IN AEC/ERDA/DOE HISTORY WHERE THE SPRINKLERS ARE CONSIDERED TO HAVE "FAILED."

1959

A loss of $350 was incurred at Richland on 10/5/59 when a heater ignited. One head on the wet system successfully controlled the fire while the plant fire department completed extinguishment.

1960

A fire occurred in a the laboratory of a sodium-cooled reactor at Atomics International on 5/20/60 when a heater on an isopropyl diphenyl system ignited the fluid. An unknown number of heads on the wet system extinguished the fire for a $5,000 loss.

Another 1960 loss was a wax bath ignition that opened one head on a wet system, extinguishing the fire for a loss of $674.

A third loss, also believed to have occurred in 1960 involved spontaneous ignition of a plastic waste bag in a laboratory at ORNL. A single head extinguished the fire for a loss considered negligible.

1961

This year was included in the "20-year" record retention period for some plants when this survey began and the sprinkler record begins to expand to what is probably more typical of the actual record. Note that few losses were recorded below the reporting level for the earliest years, while failures or large losses were included in the records. This becomes even more apparent for losses after 1980 when all sprinkler operations were required to be reported to HQ, regardless of the amount of loss.

A 1/9/61 loss at ACF industries was the result of a plating tank heater igniting plastic ducts. This $27,060 loss could only be controlled by an unknown number of heads on the wet pipe system as there were no heads over the tanks. (Plating tank fires were fairly common, as the later record demonstrates).

A 3/29/61 Brookhaven loss was the result of an explosion blowing open a dust collector door. One sprinkler head prevented ignition outside the collector and is credited with controlling the fire. Loss was negligible.

A 4/3/61 fire in cork insulation at ORNL was controlled by three wet pipe sprinklers for a $450 loss.

A 10/3/61 Y-12 plant loss was the result of the ignition of 40 gallons of gasoline in a garage. Thirty-four heads operated to control the fire, holding the loss to only $502 (plus $200 private).

Several more losses were reported for the year, although details were lacking due to low losses. At Oak Ridge, a $50 loss in a laboratory was extinguished by a single head. At UCLA, a burner ignited some furniture which was extinguished by a single head for a $260 loss, and a negligible loss was incurred at Y-12 when two heads extinguished a garage change room locker fire.

1962

On 9/5/62, an organic moderated reactor at Piqua suffered a $20,000 loss when 8 sprinklers on a pre-action system extinguished a static-ignited fire. (Loss was all private, no government loss).

In december of 1962, a negligible loss resulted from a lube oil fire at a gaseous diffusion plant that was controlled by three heads on the calculated (0.2 density) wet-pipe sprinkler system.

Another fire, on 12/13/62, also at the Paducah Gaseous Diffusion Plant, resulted in the largest, successful, sprinkler fire in history. Although the loss was $2,900,000, it could have been on the order of a billion dollars, based on an earlier fire in an unsprinklered, but similar building. (See Chapter IX). Some 2,431 heads are credited with controlling the fire.

1963

On 8/6/63, a duct fire at the Y-12 Plant resulted in a $43,400 loss. Six wet pipe sprinklers controlled the loss in the laboratory.

At the Portsmouth Gaseous Diffusion Plant, a transformer failure and explosion on 12/13/63, resulted in the second (and hopefully last) sprinkler failure when a deluge system failed to trip. Ironically, the failure had little to do with the $244,800 loss since the explosion caused most of the damage and ruptured some of the piping. The spray systems on the adjoining transformers tripped and prevented the fire from spreading to them. The cause was found to be a bent rod on the actuator, stopping the weight from dropping fast enough to trip the system.

Another negligible loss incident was recovered when a records search found fire in rubberized horsehair storage at Schenectady Naval Reactors smoldered and opened 20 old-style sprinklers on a dry system, controlling the fire.

1964

A 1/25/64 loss at the Kansas City Plant opened 4 heads on a wet system when a torch lit fiberglass insulation. The sprinklers
extinguished the fire for a loss of $6,730.

A 3/23/64 office fire at Portsmouth GDP was controlled by two wet heads.

1965

A 3/11/65 fire at ORNL resulted when an ethylene-acetone mixture was ignited after a temperature controller failed. A single wet pipe sprinkler controlled the fire for a $150 loss.

A 4/24/65 fire at the U. of Tenn resulted from a faulty water bath evaporating and the heater igniting the tank liner. A single wet sprinkler in the lab extinguished the fire, holding the loss to $450.

On 5/28/65, a $2400 loss resulted at the Weldon Springs Plant when magnesium fines burned a dust collector protected by a deluge system in the feed tray. The fire was controlled by the system for a loss of $2,400.

On 10/23/65, heaters ignited empty plating tanks at AL's ACF Industries site. Four heads on the wet system controlled the fire for a $41,000 loss.

Another fire at the Stanford Linear Accelerator Center started in a waste basket in a janitor's closet and was extinguished by a single wet sprinkler for a negligible loss.

1966

A 1/9/66 fire at Brookhaven National Laboratory, in a rubber mill, was controlled by a single wet sprinkler in the chem lab. for a loss of $127.

On 1/30/66, a fuel oil line on a furnace broke at Richland. the resulting fire was extinguished by a single wet sprinkler with a loss of only $10.

On the same day, the same incident recurred at Richland. This time, three wet sprinklers operated and the fire was controlled for a loss of $2,000. It was a pressure switch diaphragm that failed on the same boiler as the previous loss.

On 5/27/66 a cooling tower deluge system extinguished a fire at a gaseous diffusion plant for a $15,300 loss.

On 6/6/66, a $5,500 loss resulted when a hood fire ignited a duct. A damper operated correctly and a single head at the Union Carbide facility controlled the fire for a loss of $5,500.

The next day, 6/7/66, an oil quench tank at Y-12 ignited and five wet sprinklers extinguished the fire. loss was limited to $5 for replacing the heads. (A number of losses were listed at such small amounts that it is obvious only the cost of labor or a replacement sprinkler head was included).

On 7/11/66, another cooling tower fire at the Portsmouth Gaseous Diffusion Plant was controlled by the deluge system, for a loss of only $395.

On 12/20/66, a small calculator shorted electrically at LLNL, resulting in a $2,125 fire controlled by a single sprinkler head. As is common with most of the "controlled" fires, the sprinkler waterflow alarm brought the plant fire department to the scene fast enough so that they were able to use extinguishers or hose to complete extinguishment. Only the fires in which neither sprinklers nor hose was used are listed as "extinguished" in this study. This means that sprinklers would have an even better "extinguishment" rate if the fire departments were farther away, as in a city. (It also means that a few of the losses might have been much larger, even though "extinguished").

1967

A 3/2/67 fire at ORNL started in a warehouse office and was controlled by two sprinklers on a wet pipe system for a loss of $250.

The other 1967 fire occurred on 6/21/67 at Richland when a heat exchanger cell at the N-reactor suffered an oil fire. eight spray nozzles on a manual deluge system controlled the fire for a loss of $155,000.

1968

At the Oak Ridge Gaseous Diffusion Plant on 1/23/68, a transformer short ignited a laboratory attic. A single wet sprinkler controlled the fire for a loss of $500.

A 5/14/68 fire in an acetone bath at the U. of Tenn. was extinguished by a single sprinkler for a $50 loss.

Another 1968 fire was reported when a desk calculator ignited for a $500 loss, extinguished by a single wet sprinkler.

1969

A 4/29/69 fire at Mound resulted from an oven failure. One wet head controlled the fire.

A 5/11/69 loss at BNL was the result of the ignition of a dormitory stove cabinet. One wet head controlled the loss to $1,350.

A 5/11/69 fire at Rocky Flats originated in some utility equipment and was controlled by a single wet head.

1970

On 1/23/70, a heater ignited an attic. A single sprinkler controlled the fire for a $173 loss.

A 3/22/70 loss in a plating tank at the Pinellas Plant was controlled by a single wet sprinkler for a $323 loss.

A 6/18/70 methane gas fire in a glove box at Y-12 operated five sprinklers which controlled the fire for a loss of $300.

On 11/23/70, a Y-12 Plant heater ignited a joist roof in a switchgear building. One wet head controlled the fire for a loss of $2,88.

1971

A 2/9/71 loss at the K-25 Plant occurred in a 4' crawl space and was controlled by a single wet head for a $5,362 loss.

On 5/19/71, 2 wet pipe heads extinguished a fire at the Y-12 Plant when a film lab tank heater came on when the tank was dry. Loss was $891.

On 7/20/71, a fire in the Technical Information Center at Oak Ridge was controlled by two sprinklers for a loss of $6,000.

An 8/3/71 fire at the Y-12 Plant was extinguished by two heads for a $238 LOSS.

An 8/19/71 loss at Y-12 resulted from the ignition of paper in a drying oven. One head controlled the fire for a $110 loss.

At Argonne National Lab on 10/5/71, a fire in a heavy timber area resulted in a exposure fire to a warehouse loading dock that was controlled by two heads for a $5,3330 loss.

On 11/22/71 a Fermilab fire resulting when a wall heater fell on pump house wall insulation, resulted in a $150 loss after being extinguished by a single wet sprinkler.

Another exposure fire in a timber area in 1971 at ANL opened three heads which controlled the fire for a $300 loss.

In the 1970 - 1971 time frame, the Y-12 Plant installed four multi-cycle sprinkler systems of 2,773 heads in 225,684 sq. ft. of space at an average cost of $2.10 per sq. ft. In the same period, ten wet systems were installed in 195,012 sq. ft. of space at an average cost of $1.01 per sq. ft. The complete story of the systems and Y-12 experience with them was the subject of paper Y-12-92 presented at the joint AEC and contractor conference at Albuquerque, March 21-23, 1973. The multi-cycle systems were installed in areas requiring 10% relative humidity. Fast detection systems gave an alarm prior to sprinkler system operation.

1972

A 3/11/72 fire at Kansas City was another plating tank fire that extended to a hood. One wet sprinkler controlled the duct fire for a $1,500 loss.

On 4/27/72, a waste basket in a janitor's closet at Sandia, Albuquerque ignited. One wet head extinguished the fire for a $26 loss.

A 9/25/72 loss at Y-12 was caused by welding sparks in a manufacturing area. A single wet head controlled the fire for a $208 loss.

A motor short at a gaseous diffusion plant resulted in a "no loss" fire when 8 heads were set off but "no ignition occurred." (?)

Another of the prevalent dip tank fires occurred at Y-12 when a temperature controller failed in a manufacturing area. A single wet head controlled the fire for a $590 loss.

1973

A 3/8/73 oil bath fire at Y-12 resulted in a $2,210 loss. A single wet head controlled the fire.

An 8/6/73 loss at Y-12 occurred when retort gasses ignited, setting off two wet heads which extinguished the fire for a $1,268 loss.

Paper and cardboard in a locked storage area at a Schenectady Naval Reactors site ignited and set off 4 wet heads for a controlled loss listed at under $50.

A fusion lab suffered a $25 loss when a resistor short ignited a box of chem-wipes. One head extinguished the fire.

1974

A 1/15/74 loss at Kansas City of $236 was extinguished in a shop by two wet heads.

An 8/5/74 loss at Kansas City occurred when a paper shredder in a waste-disposal building ignited for a negligible loss, extinguished by two wet heads.

On 10/31/74, a flammable liquid tank fire at Atomics International was extinguished by a single wet head for a $330 loss.

On 12/2/74, a diffusion plant switchgear explosion resulted in a $170,000 loss. Two wet heads controlled the resulting fire.

Another 1974 fire resulted in a negligible loss when some fiberglass insulation at Oak Ridge spontaneously ignited. A single wet head extinguished the fire .

__1975__

On 1/18/75, a magnet overheated and ignited at BNL. Two wet heads controlled the fire for a loss of $7,000. In this case, the waterflow alarm valve was shut off, but the alarm had been sounded almost immediately by area employees so the magnitude of the loss was not affected. This was the last incidence of any system defects and, again, the magnitude of the loss was not affected. The incident is not included as a sprinkler failure.

On 1/26/75, at ORNL, a light bulb ignited combustible warehouse storage, setting off seven wet system heads which controlled the fire for a 416,493 loss.

On 5/19/75, a Sandia, Albuquerque fire was extinguished by a single head for a $950 loss.

A 7/22/75 fire at Idaho was the result of an arson attempt in a small shed. the arsonists were trying to burn the insulation off some stolen scrap wire when a single head on an anti-freeze loop extinguished the fire. No loss was charged to the incident.

A Kansas City Plant loss of a negligible amount resulted from ignition of paper in a waste shredder on 8/23/75. Two wet heads extinguished the fire.

A 9/30/75 fire at the Portsmouth Gaseous Diffusion Plant was the result of the ignition of a cooling tower deck. A deluge system controlled the fire for a $7,000 loss.

On 11/17/75, at Atlantic Richfield Hanford Co., oil that accumulated in a boiler room furnace ignited and set off seven wet heads which controlled the fire for a $1,500 loss.

On 11/18/75, a spontaneous fire in a Savannah River laundry was controlled by a single wet sprinkler head for a $750 loss.

On 12/30/75, paint fumes ignited in a drying oven at LANL. A single wet sprinkler extinguished the fire for a $100 loss.

__1976__

A Y-12 fire on 2/21/76 resulted in a $91,500 loss when an electric heater ignited a plating shop polyethelene tank liner. Seven heads controlled the fire.

At the Nevada Test Site on 3/14/76, cardboard boxes in a USCGS warehouse were ignited by a wall heater. A single wet head extinguished the fire for a $2,600 loss.

On 5/27/76, a cigarette ignited a 22-cell cooling tower at the ORGDP (K-25). The deluge system held the fire to a $15,300 loss.

On 5/28/76, a short in radiation monitoring equipment in a Richland laundry resulted in a fire that was controlled by two wet system heads for a $3,500 loss.

On 8/10/76, another waste shredder fire at the Kansas City Plant resulted in another negligible loss, extinguished by two wet system heads.

A 9/18/76 fire at an ORNL facility (at the Y-12 plant) was the result of an overheated air conditioner in an office. A single wet head extinguished the $252 fire.

On 9/27/76, at ANL-Idaho, a heater in a laundry trailer ignited clothing bags. A single wet preaction system head extinguished the $300 fire.

On 10/25/76, a laboratory fire at Richland resulted from a pipe soldering operation. The minor insulation fire was extinguished by a single wet head for a negligible loss.

A 10/27/76 fire at Y-12 was a chip fire in a machine shop which was controlled by two wet heads for a $1,400 loss.

On 12/13/76, the Paducah Gaseous Diffusion Plant had a 2,000 HP motor fire which operated 20 sprinkler heads on the wet system. The loss was controlled for a total of $76,030.

On 12/20/76, a furnace overheat in a residence (former farm house) at Fermilab, was controlled by the operation of a single head on a dry system. loss was $4,000.

<u>1977</u>

A 1/27/77 at ANL-Idaho resulted when an acetylene cylinder in a maintenance shop blew, igniting the ceiling. A single wet head controlled the fire for a $500 loss.

A 2/16/77 fire at the Paducah GDP resulted when an electrician working on switchgear went around to the rear of the row of cabinets and entered a cabinet next to the one he had been working on. A massive electric discharge killed the worker and resulted in a fireball explosion, setting off two sprinkler heads on the wet system which controlled the fire (protecting other workers in the area) for a $50,000 loss. This was the only fatality in a sprinklered facility and the fatality occurred simultaneously with the fireball. As a result, even if the fire had not occurred, the fatality would have.

A 7/10/77 fire at the Y-12 Plant in a cooling tower was held to a $450 loss by the actuation of the deluge system.

On 11/24/77, an immersion heater ignited a plating shop tank at the Nevada Test Site. Two wet heads extinguished the fire for a $1,705 loss.

1978

On 1/3/78, at Paducah GDP, a compressor chemical reaction in a diffusion cell was controlled by the operation of 25 wet system heads. Total loss was $200,104. the cells themselves, are unsprinklered, and surrounded by a metal enclosure.

A 2/6/78 fire at ORNL was the result of a heat gun igniting combustible material in a laboratory. A single wet head extinguished the fire for an $892 loss.

On 5/5/78 a $12,000 loss at Rocky Flats was the result of a plastic tank overheating in a plating shop. Three heads on the wet system controlled the fire for a $12,00 total loss.

A 5/26/78 fire at Y-12 was contained within a glove box by the operation of a Fire-Cycle sprinkler system. One head controlled the fire for a negligible loss.

A Kansas City Plant fire on 6/29/78 was another paper shredder fire in a waste disposal building. Again, two wet heads extinguished the fire. Loss was negligible.

A Lawrence Berkeley laboratory plating tank fire on 6/78 resulted in $2,000 damage. Two wet heads controlled the fire.

A duct heater ignited felt insulation, setting off 5 wet heads which controlled an ORNL fire for a $7,095 loss on 10/5/78.

An 11/21/78 fire at Richland was the result of working on a gas tanker in a garage. The tank leaked and gasoline was ignited. the workers escaped but every sprinkler head in the garage opened, 149 heads on a wet system. The sprinklers controlled the fire, preventing it from spreading to adjoining shop/storage areas, while the plant fire department completed extinguishment. Total loss was $243,000.

An 11/29/78 fire at ORNL was the result of an internal computer short. A single sprinkler extinguished the fire for a $9,000 loss.

Another 1978 fire was reported, involving a plywood duct which was controlled by a single wet sprinkler for a negligible loss.

A final 1978 fire involved the ignition of a capacitor bank. Again, a single pre-action sprinkler extinguished the fire for a $21,000 loss.

1979

A 2/17/79 loss at LLNL was another capacitor bank incident. In this case, a single wet sprinkler extinguished the fire for a $23,000 loss.

A 5/4/79 loss at Richland was spontaneous ignition of a coal conveyor. A single dry sprinkler controlled the $350 loss.

A 7/23/79 Richland loss was another incident of spontaneous combustion in a coal pile fuel storage. This time, two dry heads controlled the loss to $38,000.

A 7/28/79 ORGDP fire resulted from pilot gas ignition of electrical equipment. One wet head controlled the fire for a negligible loss.

An 8/79 loss at Lawrence Berkeley Lab. was the result of a cutting torch igniting paint residues on a spray booth being removed. Three wet heads extinguished the fire for a negligible loss.

1980

A 2/17/80 NTS fire was another immersion heater-plating tank incident. The loss was extinguished by two wet heads. $1,451.

On 3/15/80 an overheated motor at Oak ridge GDP opened a single head under a duct. The head was out of the fire area but the alarm alerted the plant fire department, controlling the largely electrical loss.

A 5/8/80 loss at LANL was the result of a carton on a chemical cart in a laboratory self-igniting. A single sprinkler extinguished the fire for a $925 loss.

On 5/24/80, also at LANL, a nitro-cellulose barrel in a HE lab spontaneously ignited. Four heads on the wet system extinguished the fire for a $250 loss.

A 7/2/80 filter screen in a plutonium recovery operation at Rocky Flats ignited. One manual and one automatic deluge system controlled the fire for a $5,000 loss.

A 7/19/80 fire at LANL involved a closet in which a single wet sprinkler extinguished the fire for a $50 loss.

An 8/26/80 paper shredder fire in the Kansas City Plant waste disposal bldg. again opened two heads which extinguished the fire.

A computer center fire at ORNL was controlled by two wet heads on 10/7/80 for a loss of $574. The fire was actually in the grease hood of a kitchen adjunct in the computer building.

Another 10/80 fire at LBL resulted from a laboratory chemical reaction. The $5,000 loss was controlled by a single wet head.

A 12/27/80 fire , possibly from a cigarette, at an ORNL Change House was extinguished by two heads on a dry system. Loss was negligible.

<u>1981</u>

A transformer fire in a shop at ORNL on 1/4/81 was controlled by a single wet sprinkler for a loss of $450.

A 7/81 loss at the Savannah River Plant resulted from the ignition of uranium fines in a waste container. One wet head extinguished the fire for a $100 loss.

Another 7/81 fire was due to ignited grease in a dormitory kitchen range. The $1,950 fire was controlled by a single wet sprinkler.

A 7/13/81 fire in a records storage room at DOE HQ was extinguished by two wet heads for a negligible loss.

A 7/18/81 transformer fire at Y-12 resulted in a $50,000 loss although two wet heads controlled the fire.

A 10/19/81 fire at ORGDP resulted from torch ignition of cork insulation. Two wet heads controlled the fire for a $3,000 loss.

A 12/20/81 fire in a Pantex shop was controlled by one wet sprinkler for a $350 loss.

<u>1982</u>

A 3/31/82 loss at Richland was due to a duct fire. Seven sprinklers outside the duct (none were inside) controlled the fire, but the loss was $338,600.

A 7/1/82 fire in the EML lab in New york City was extinguished by a single sprinkler for a negligible loss.

A 9/14/82 loss at Richland occurred in an alcohol cleaning tank. One wet head controlled the fire for a $200 loss.

Another 9/30/82 loss at Richland was a fire in a chemical lab that was extinguished by a single wet head for a loss of $950.

Yet another 9/82 loss occurred at Pittsburgh Energy Technology Center when a lab fire opened one wet head which extinguished the fire for a $50 loss.

1983

A 2/11/83 loss was the result of using a propane torch in remodeling a shower stall at the Y-12 plant. loss was held to $940 when two wet heads extinguished the fire.

A 2/22/83 power supply fire at LLNL resulted in a $24,000 loss. The fire was controlled by the operation of two heads on a dry system.

A 4/8/83 loss at Pacific Northwest Laboratory-Richland was in an electric lab. resulted in a $12,800 loss, although controlled by a single wet head.

A 5/26/83 loss at ANL occurred in a cooling tower. One sprinkler head on a dry system controlled the loss for a $7,000 loss.

An 11/15/83 loss at PNR in an electrical equipment lab resulted in a $12,240 loss when one wet head controlled the fire.

A 12/19/83 Richland compressor fire loss was held to $6,789 when it was extinguished by a single wet sprinkler head.

A 1983 fire at Fermilab in an oil reclaiming unit was extinguished by two wet heads for a $250 loss.

Another 1983 fire at the Energy Systems Group, Canoga Park, CA, was in a trash cart in a janitor's closet. A single wet head extinguished the fire for a negligible loss.

A 1983 ORGDP fire under a motor stand was started by a welder's torch. Again, a single wet head extinguished the fire, holding the loss to $100.

1984

A LANL fire on 2/27/84 was the result of a repair torch igniting paper-backed insulation in a wall cavity. Seven heads on a preaction system controlled the fire for a loss of $13,760.

At the Y-12 Plant on 3/20/84, a cutting torch ignited combustible duct insulation. The fire was extinguished by four preaction heads, but not until a $$47,000 loss resulted.

AT LLNL's Site 300, an exposure fire destroyed some sun screens on 6/28/84. Three heads controlled the fire for a $500 loss.

On 9/29/84, a compressor fire at LANL resulted in an $8,000 loss, although the fire was extinguished by four wet sprinklers.

A 10/16/84 loss at the Y-12 Plant resulted from the ignition of a dumpster at a loading dock. The negligible loss was controlled by two dry system heads. (In many fiires, the loss was so low that none was recorded, especially when below the $50 or $1,000 loss reporting levels. In this case, "no-loss" is a truism, as were many garbage, waste collector and similar fires). Fires involving buildings about to be demolished were reported at replacemenyt cost, including at least one in the sprinkler series. This is another example where DOE loss figures may be in excess (brush abd vehicle fires) of what private industry/insurers report.

An 11/16/84 loss at ORGDP originated in a paint spray booth. A single wet head extinguished the fire for a $120 loss.

On 11/21/84, a wiring error in a voltage divider ignited flammable materials in resistor trays at LLNL. A single wet head extinguished the fire, but material damage was $10,000.

A 12/22/84 fire at LANL was extinguished by a single dry head A heater ignited cable and plywood in a guard station. The loss was held to $750.

On 12/26/84, an electric arc burned a hole in a mineral oil tank at the Y-12 Plant. The resulting fire was controlled by a single wet sprinkler for a $750 loss.

__1985__

A 2/9/85 fire at LANL was the result of the ignition of equipment under a diamond lathe in a shop plastic enclosure box. A number of delays in finding the fire area, due to the heavy smoke, and confusion as to the nature of the incident, due to the smoke color and fairly small size of the actual fire, resulted in the largest single-head loss in DOE history. A single wet head controlled the fire and building damage was limited to about $15,000. However, the total loss due to the extremely valuable equipment was $449,000.

On 4/4/85, a uranium chip fire on a machining conveyor activated the deluge system which extinguished the fire for a negligible loss at the Fernald Plant.

A 4/25/85 fire at Savannah River involved an unattended trash can in a lunch room. A single wet head extinguished the fire for a negligible loss.

On 5/7/85, a generator at the Portsmouth GDP burned. A single head on an anti-freeze system extinguished the fire. the unit was still under warranty so there was no loss to the government.

A 7/9/85 fire at LBL occurred in a shop paint spray booth and was extinguished by the combined action of a 100# CO_2 system and two heads on a wet sprinkler system.

A 7/14/85 fire at Y-12 occurred in a maintenance shop lunch room when a window A/c unit ignited on a weekend. Two wet heads extinguished the fire for a $2,140 loss.

A 9/15/85 fire at Princeton Plasma Physics Laboratory resulted while removing polystyrene-lined track from a pump house. Three wet heads controlled the fire for a $900 loss.

On 9/19/85, two wet heads at Fermilab extinguished a fire resulting from an electric soldering iron.

On 11/6/85, an electroplating bath overheated, igniting the plastic tank. Loss was held to $1,000 and extinguished by a single wet head.

Two Portsmouth GDP losses also occurred in 1985. One involved one wet sprinkler which extinguished a diesel emergency generator fire. The unit was still under warranty so there was no government loss.

The second Portsmouth loss was a $28,000 substation loss when an accidental release of hydrogen from a process line ignited. One wet head controlled the fire.

A final 1985 report was from Brookhaven National Lab where gas leaks in a residence utility room ignited, burning some towels. A single wet head extinguished the fire for a $1,400 loss.

1986

On 2/10/86, an abrasive saw spark in a Y-12 shop ignited metal. Two wet heads extinguished the fire for a $5,877 loss.

An LBL lab fire on 2/28/86 was extinguished by a single wet head for a $1,000 loss.

A Y-12 paper shredder fire on 4/30/86 was controlled by two wet heads for a loss of $3,557.

Again at Y-12, on 5/2/86, a spark from an abrasive saw ignited metal fines. Two wet heads extinguished the fire and held the loss to $2,951.

A 5/10/86 fire at Sandia, Albuquerque originated in a locker room when urethane sealer was ignited by a water heater. A single wet sprinkler extinguished the fire.

A 7/29/86 LLNL lab fire was extinguished by a single wet head, but equipment values resulted in a $25,000 loss.

On 8/12/86, uranium fines in a Y-12 duct ignited. The fire was extinguished by manual water spray, but one exterior wet heat operated to control the spread exterior to the duct.

On 9/30/86, an acetylene cylinder on a welding cart at Y-12 ignited. One wet head controlled the fire for a negligible loss.

A 12/2/86 fire at LANL involved oil in a Marx Generator. Six heads on an AFFF sprinkler system extinguished the fire for an $18,000 loss.

1987

On 1/2/87, a bunsen burner ignited oil in a beaker in a Y-12 lab. One wet sprinkler controlled the fire for a $1,791 loss.

On 4/5/87, another closet fire resulted in a $971 loss. This Y-12 fire was extinguished by a single wet head.

A 5/24/87 loss at Y-12 was an office fire, controlled by two wet heads for a $2,641 loss.

On 6/18/87, another of the paper shredder fires occurred at Kansas City. A single wet head extinguished the negligible fire.

A 7/27/87 Sandia, Albuquerque loss involved a clean room duct fire. Two wet heads extinguished the fire but the clean room atmosphere was compromised and total loss was $220,000.

An 8/17/87 fire at LBL was the result of a bunsen burner igniting a chemistry lab hood. A single sprinkler extinguished the fire for a negligible loss.

On 9/23/87, a fire in a Bonneville Power Administration conference room was controlled by a single preaction head for a $4,727 loss after the fire breached a wall.

A 10/2/87 loss at Kansas City involved fire in fiberglass ducts. Three wet heads controlled the spread, but the loss was $27,700.

A 10/3/87 loss at Fermilab was the largest of the year. The fire in a large target hall opened five heads at the ceiling, which limited the fire to the area covered. The value of the target materials, electronics and cable, and the cost of cleanup raised the loss total to $1,100,000 (over $1M, but within the allowable escalation in the 1980 DOE 5480.7 Order). A film of the incident was produced by CH-FNAL and is a classic in loss reconstruction and lessons learned. Copies were made available to all and a number of showings held at gatherings such as the semi-annual Federal Fire Forum meeting at NIST.

On 10/16/87, uranium chips under water at the Y-12 Plant boiled off. One head on a local preaction system operated to extinguish the fire and hold the loss to $642.

A 10/21/87 fire at Y-12 occurred in a water treatment building closet when weld slag ignited a mop. Loss was insignificant.

A 10/21/87 fire also occurred at LANL when a dioxane leak ignited. The loss was extinguished by a single preaction head, but the dollar loss was $14,000.

On 11/11/87, A Kansas City Plant dust collector burned. The $3,691 fire was controlled by a two wet heads.

A 12/17/87 Y-12 Plant fire was due to cutting operations igniting paper insulation in a carpenter shop. Nine old style wet sprinklers finally extinguished the fire for a loss of $2,226.

1988

A 1/21/88 (or 4/27) fire at Pantex resulted from leaking hydrazine igniting stored cardboard and wood pallets. One wet sprinkler controlled the fire for a loss of $30,000.

On 2/23/88, a 12,000 KVA transformer ignited. A manually-tripped deluge system held the loss to $10,000.

On 4/13/88, an electrical incident ignited breakers and PC computers at OSTI, causing a $20,500 loss. A single wet head extinguished the fire.

A 5/26/88 fire in a janitors closet at Y-12 was extinguished by a single wet sprinkler.

On 6/30/88 a major series of electrical faults caused much damage at LLNL. Among the incidents was a transformer exposure. Two wet sprinklers protected the unit from the exposure fires.

A 7/19/88 roof fire at Y-12 had the heat drawn into the building by an air intake fan. A single wet sprinkler operated and prevented extension of the fire. Loss was $3,821.

A 7/21/88 Y-12 elevator electric fault ignited hydraulic fluid. One wet sprinkler controlled the fire for a $30,000 loss.

On 8/7/88, a short in an electrical wire ignited cardboard boxes in a cafeteria at SLAC. A single wet sprinkler extinguished the fire.

1989

On 2/14/89, a single wet sprinkler extinguished a methanol fire in an LBL lab.

In March, 1989, a diesel engine fire in a cooling tower pump house at Rocky Flats was extinguished by a single head. It was estimated that the $48,000 loss would have exceeded $250,000 without the sprinkler.

On 6/27/89, an alcohol fire in a small laser at Sandia, Albuquerque opened one wet head which controlled the fire while extinguishment was completed with a hand-held Halon extinguisher. Loss was $20,000.

On 7/25/89, a single wet sprinkler extinguished a lab methanol fire at LBL. The fire originated in a trash bin and loss was negligible.

At Westinghouse Hanford, a coffee pot fire was extinguished by a single head. Loss was $3,050.

Three small losses occurred in Oak Ridge facilities. Each involved but a single sprinkler head. In two of the cases, the sprinklers completely extinguished the fire, while in the third case the fire was held in check until the plant fire department completed extinguishment.

1990

Only two incidents were included in a short note. In one fire, two sprinklers heads fused, and only one in the other. Combined damage was $3,000.

1991

At Y-12, fire in an unattended gel electrophoresis unit ignited the plastic casing. One head operated in a $10,775 loss. No distinction was made as to "extinguished" or "controlled."

A coal bunker fire at the Paducah GDP activated one head which summoned the plant fire departmnent. no loss. (Refer to the "Coal Burns, Too" chapter. A clearly non - nuclear fire in a clearly nuclear plant. As an exercise, the reader might determine the percentage of fires that actually involve nuclear materials or equipment).

At ORNL, overheat in an electrical test chamber fused one head. No loss.

At LBL, a flammable liquid fire in Bldg. 73 activated one head in a $10,000 loss.

Overall performance was noted as 213 out of 215, but should be 215/217 or almost 91.1% successful.

Wet - pipe performance was updated to 90 incidents. Some 93 % of the total involved three heads or less. This is 37% more effective than reported by insurance industry statistics cited in Table 5-9A of the NFPA Handbook, 17th edition.

1992

Another Y-12 fire in an electrophoresis gel DNA sequencer activated one wet - pipe head which extinguished the fire in a $4,800 loss.

At the K-25 plant (ORGDP), one wet - pipe head activated in a cooking fire, extinguishing it. No loss reported.

At LBL, four wet - heads activated while a lithium fire was being manually extinguished. the system was credited with preventing the spread of the fire. Loss was $1,000.

There were numerous accidental operations reported; 16 wet, seven dry, seven deluge, and one foam. All accidental. Human error accounted for nine; mechanical failure for nine; freezing for four; and six miscellaneous.

One Naval Reactors facility experienced leaking Grinnell Aquamatic on - off heads in a tape library. All were replaced.

1993

At Mound, a process temperature controller started a fire, opening three wet heads, which controlled the fire. Los was $45,000.

At Y-12, an electrical short in a building awaiting demolition activated five dry sprinklers, controlling the fire in a $1,320 loss.

A Paducah GDP purge/evacuation pump shorted, and one wet head extinguished the UF_6 fire for no loss.

Performance was now 221/223 or 91.1% satisfactory.

looking at the number of heads operating in the 1952 - 1994 period, we produce the following table:

No. of Heads	No. of Fires	Cumulative %
1	114	57.0%
2	48	81.0
3	10	86.0
4	7	89.5
5	5	92.0
6	2	93.0
7	5	95.5
8	2	96.5

The ten or more head fires included two of 20 heads, one of 25, one of 34, one of 149, and the Paducah fire of 2,431. All are described in the 1982 report. There were also five fires in which the number of heads was not reported. Also, there were eleven deluge system fires extinguished, and one failure. The success rate is then:

All systems: 216/218 = 99.1%

Closed head systems: 204/205 = 99.5%

Deluge systems only: 11/12 = 91.7%

Note that if the deluge system and the one "cold weather - valve" system are deleted, then the success rate for wet - dry - preaction - antifreeze systems is 100% Another enviable record and one that now exceeds even that of the Australian - New Zealand experience defined in the classic text. The reasons are much the same as for the ANZ experience. Namely: good design, frequent inspection, hazards control, valve supervision, water supply adequacy and supervision. Above all, good people assuring that the systems are good.

SELECTED LINE ITEM PROJECTS

Year-Number	PROJECT	TEC
76-7-a	Test Reactor Fire Main Repl., ID	$2.2M
76-10-a	Fire Wall Const., Kansas City	$2.0M
76-10-b	Fire Prot. Impvm'ts, LASL	$4.45M
TOTAL		$8.65M
77-1-a	Mods & Addn's to ERD, ERC's	$6.9M
77-10-a	Fire Prot. Upgrading, GDP's	$8.3M
77-10-b	OSHA Mods, GDP's	$8.2M
77-12-a	Fire & Safety Impvm'ts, LLL	$2.76M
77-12-b	Life Safety Corridors, Kansas City	$3.1M
77-12-c	OSHA mods, Y-12	$6.4M
77-12-d	Upgrade FP Reliability, " "	$7.8M
TOTAL		$43.6M
SMP78-18-E	Env, Sfty, Sec Mods to Waste Fac,RL.	$40.0M
78-16-D(F)	Central Alarm St., LASL	$7.0M
W-78-16-F	Replace 10" Fire Main, Kansas City	$2.0M
SMP78-18-H	Plant-wide FP, SR	$6.95M
78-02-A	Mods & Addns to ETC's	$3.0M
TOTAL		$58.3M
79-07-B	FP Impvmt's, LASL	$3.7M
79-09-C	FP Impvmt's, BNL	$1.3M
79-01-E	FP Impvmt's, ID and ANL	$3.1M
TOTAL		$8.1M
80-AE-07	Relocate Water Towers, Mound	$1.5M
TOTAL		$1.5M
81-0-133	EQ Restoration, LLNL	$12.05M
81-0-134	EQ Restoration, SNL	$3.7M
81-E-323	FP Impvmt's, ANL-E&W	$3.3M
81-E-324	FP Impvmt's, INEL	$4.4M

81-R-506	Env & Sfty Impvmt's, GDP's	$20.0M
TOTAL		$43.45M
82-D-126	Reactor Safety, Reliabilty, Various	$63.925M
82-R-415	Fire Alarm Repl, PadGDP	$5.366M
82-D-124B	N Reactor Safety	$12.85M
82-D-126A	SR Reactor Safety	$28.127M
TOTAL		$108.268M
83-E-311	Emer. Response Ctrl. Ctr, ORNl	$4.2M
TOTAL		$4.2M
85-R-707	Fire Alarm Upgrade, RL	$4.85M
TOTAL		$4.85M
86-R-726	FP Impvmt's, Phase II, BNL	$2.5M
TOTAL		$2.5M
87-D-127	ES&H Upgrade, Mound	$4.099M
87-D-159	ES&H Impvmt's, Phase I, DP-NMP	$82.0M
87-R-756	Water Line Repl, ANL	$5.2M
TOTAL		$91.299M
GRAND TOTAL		$374.667M

XVI

LAYING IT ON THE LINE

.....in which we learn that large upgrading projects were not an invention of the Admiral or the Tiger Teams, but were an intrinsic part of normal AEC/ERDA/DOE operations; -- and "old" buildings were being upgraded before there was an AEC.

[AUTHOR'S NOTE: No fire protection history would be complete without some discussion of major projects. the most dramatic expenditures are included here and in the chapters on the Paducah fires and the aftermath of the Rocky Flats fire. One of the dangers of noting major expenditures is that some people, rather than saying; "That shows it must be important"; will say; "Why do we spend so much money when we have such a good record?"]

The accusations of "old buildings" being a major DOE problem and no money being spent on upgrading is one of the more often repeated "faults" of DOE. Like most such accusations, it is not only a lie, it is "180° out of phase." In other words, the exact opposite is true. Not only have "old" buildings been upgraded, but all the major losses have occurred in new buildings or processes! As readers of the author's: "Footnotes To DOE Mythology"[53] have learned, upgrading of facilities for safety reasons was done when the "old" facilities were less than two years old[54], and major upgrading projects were a way of life ever after.

The first major safety change was the replacement of an existing building by a new building, not because of any defects in the "old' building (the Los Alamos plutonium facility), but because the "what if" aspects made a new facility seem desirable. This might be considered the first case in which a "safety analysis" lead to facility changes even though no real deficiency existed. The story of the Los Alamos fire and the subsequent rebuilding of the plutonium facility was covered in the "Early losses" chapter.

One of the problems in accounting for safety upgrades in fire protection is that they were too common. Since only projects involving construction costs of over $1M generally fell within the category of "Line Item" (large enough to appear in a Congressional budget as a specific item) and smaller costs were included in the "General Plant Projects" category, the record of a GPP item came to be lost with time. In addition, since sprinkler systems, the major fire protection improvement, maintained a cost of around $1/sq. ft. for many years, it is obvious that sprinklering a building less than 1M sq. ft. in size will generally be below the "Line Item" range. Further perusal of the Annual Summary reports for fire protection will show that the fire protection improvements, while large in

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53. Unpublished, but widely distributed in DOE and available from the author.

54. See Chapter VII.

number every year, were small enough, individually, to be absorbed in the General Plant Project budgets.

The fact that upgrading was a way of life is demonstrated by the list of fire protection system improvements included in the Annual Summary reports each year. The least number of systems installed in any year since 1970 was: 36 for sprinklers (with a maximum of 248); 26 for halon (with a maximum of 93; and one for other types of automatic extinguishing systems (with a maximum of 18). These figures, themselves, are another of the unique items about the DOE fire protection program. No other safety program can produce a list of their major system additions for even a single year, let alone most of the agency's history.

The earliest large upgrade for purely fire protection purposes was the project for installing sprinklers in the gaseous diffusion plants and other Oak Ridge facilities (see Paducah Pays The Bills, Chapter IX). The next massive upgrading program was the one following the 1969 Rocky Flats fire (see Chapter X). The author's first major assignment on becoming part of the Headquarters safety program in 1970 was to be one of the members of the small team reviewing field submittals for priority upgrading projects and recommending priorities and acceptable projects to the AEC management. This gave rise to a number of interesting topics, as noted in Chapter XI. The original estimate of $454M included the design money for the two major construction projects; the plutonium facility at Los Alamos and the Waste treatment facility at Rocky Flats. Each of the two construction projects eventually came to equal or exceed the original total and the Rocky Flats project was never successful. The actual fire protection improvements were estimated at some $30M-$40M by the author. However, as Chapter XI notes, it was difficult to pin down an exact number, partly due to the inherent structural difficulties in the organization and handling of large projects, a difficulty that continues to this day.

Another major source of improvement funding was the initial independent fire protection surveys that began in 1969 as one of the Rocky Flats-inspired upgrades. The recommendations were funded from a number of sources over a number of years (and are to this day). However, the original tracking system was good and by the time the tracking system deteriorated to nothing after 1978, about 90% of the original group of recommendations had been completed and the total cost was about $60M. A number of the projects were parts of the other Line Item projects and there is some overlapping. However, a number of projects are not included and the gross total is approximately correct in this authors opinion.

A list and graph of selected projects is included. The sample Line Item projects, from the years, 1976 to 1987 total nearly $375M. To this can be added most of the $60M independent survey expenditures, the $18M diffusion plant upgrade projects, a number of immediate post-Rocky Flats fire protection improvements of about $10M, and numerous safety projects with varying amounts of fire protection over all the years of AEC/ERDA/DOE from 1947 to 1991, and a total of over $500M is generated. This is an impressive sum, but the "savings" from the single Paducah fire can still be said to have paid for it all. From another viewpoint, the $500M total equates to just over $11M/year, hardly an excessive sum considering the costs of major systems spread over the size of the agency. From another standpoint, an average of 10,000 buildings (assumed over the life of the agency) means that about $50,000 per building was spent over a 45-year period, or about $1,100 per building per year. Rather expensive for a trailer, but remarkably cheap for a reactor, diffusion building, or major laboratory!

An interesting aspect of the increased attention to all types of safety that is a supposed legacy of the new DOE, starting with the Admiral's ascension in the late 1980's and the coming of the Nuclear Regulatory Commission policies to DOE, along with many of the NRC administrators, is the fantastic growth in costs and paper studies, administrative procedures, and documentation of every move. A single upgrading project, the Savannah River Plant, approached $900M by 1990. By 1992, it had been "reduced" to some $400M, but it still represents a larger sum at one facility than had been spent at nearly all DOE facilities over 45 years. It is obvious that such expenditures can not be shown to be cost effective in terms of reducing a loss record that is already fantastically low. It must be based on preventing the "future" loss of indescribable magnitude. More of this aspect is discussed in the "probably" chapter.

With the total value of DOE facilities exceeding $100 billion, the total fire protection expense has been about 0.5% of current value. This is very low by most guides for the amount that fire protection represents in a building. Of course, most facilities have the fire protection built in as part of the project and the costs do not show as a separate major expenditure. However, the major cost cited here include water system and alarm system improvements that are not easily charged to individual buildings. From any aspect however, while actual figures may be unclear, it is evident that DOE has both spent a great deal of money on protection improvement projects and that the amount spent has not been large by any comparison standards.

Another aspect of the supposedly great increase in expenditures is one of the few things that can honestly be ascribed to "old facilities." Namely; at some point things are old enough that they have to be replaced. Replacing portions of water systems and alarm systems that cover many square miles is no simple project. The amount chargeable to fire protection is never definite and frequently is judged just by the title of the overall Line Item. For instance, a major water main replacement or upgrade may be called either "fire" or "utility". If it is a combined fire/domestic system, the best charge may be to call the distribution "utility" where water is needed for domestic uses, and just charge the "fire" portion to the increased size of pipe and the short laterals leading to sprinklers and hydrants. While this may satisfy the nitpickers, it does not improve the overall arithmetic.

Finally, most work has traditionally been done with General Plant Project funds and thus the total spent on fire protection has never been truly summarized!

SUMMING IT UP

.....In which we learn that DOE not only failed to recognize the things that made the fire protection program the best safety program in DOE, they almost eliminated the one thing that served as a continuing proof of 10 of the 18 things making the fire protection program unique.

[AUTHOR'S NOTE: The annual summaries of fire protection programs, prepared by each Field Office, were one of the most valuable resources to the fire protection program. With bound copies of each report, for each year since 1966, in the author's office, it was a simple matter to compile a list of accomplishments for any facility for periods of up to 20 years. This proved invaluable on many occasions, such as when newspaper reports began citing lack of fire detection at Rocky Flats as one of the horrible problems of DOE. We were able to show dozens of incidents of fire detection and alarm installations and upgradings. Combined with the cumulative recommendations from the independent appraisal program (almost none for detectors), we were able to satisfy management that there was no horrible unknown problem lurking there.]

The first fire protection requirements in the Atomic Energy Commission (see the "That's An Order!" chapter) contained a requirement for the field offices to submit an annual summary report documenting many of the things that came to make the program so successful. More than 40 years later, other safety programs had still not learned the value of such a report.

The reports were received by the small safety group in Headquarters and used as background for appraisal planning, standards development, bulletins, and topics of the annual fire protection conferences of the AEC fire protection engineers (the meetings with contractors and fire departments participating came some years later). Thus it was not unusual that there was no complaint about the lack of feedback; - - the small group of people involved made formal feedback programs unnecessary.

Following the growth of AEC and contractor fire protection staffs as a result of the 1969 Rocky Flats fire (see the "Rocky Rocks The Boat" chapter), the use of the annual report came to be more important and more appreciated. It also led to a number of field complaints that they were supplying the data every year, but never got anything back. This led to the author's issuance in 1975 of the first "Summary of Fire and Property Damage Experience in the Energy Research and Development Administration" (the AEC having become ERDA for a few years in 1975). This edition, in 5 parts, inaugurated a number of the things that were to become standard in the following years. A summary of the loss record for the year (a 0.24 cents per $100 fire loss ratio) included notes on maximum losses, cumulative loss ratios, and fire losses as compared to other losses. This also included the first statement of the dramatic improvement that had occurred since the Rocky flats fire. The five years since Rocky flats showed a loss ratio 1/10 that of the five years <u>before</u> the fire! An order-of-magnitude improvement in any field is noteworthy. In fire protection, it was even more noteworthy, considering that the pre-fire record was already better than that experienced by the "improved-risk" insurance industry.

The year 1975 was also the first year in which the level of fire loss reporting was increased from $50 to $1,000, the same as other losses. A section on "Loss Reporting" was included in this first report and a number of following reports. Since the record was generally better than reported officially, there was little interest in going back and trying to upgrade each year's record to be indicative of final information. Unfortunately, this situation continues into the nineties. As noted previously, the things that are not reported correctly would tend to make the record even better. This is also true of things such as vehicle fire and forest/brush fires, which are reported by DOE, but are not generally included in property insurer's statistics.

One of the more interesting items was the inclusion of the recurring costs of fire protection. Basically, this was the cost of fire department operations. It showed a continuing decline from the 1960's to the 1980's when it began to increase as more fire departments were added to sites formerly without them. Unfortunately, this record has been overlooked in recent years and little new data has been added to the record. Since the costs were in excess of $40M when the last reporting was done, it is probably all to the good. While the fire protection professional considers the cost ratios to be indicative of the importance of the departments, the new breed of "safety manager" came to look upon it as an expense that could be "conserved."

The remainder of the report was considered perfunctory at the time, but came to be one of the most valuable parts. It was simply a reiteration of the "Major Fire Protection Improvements" of the year. This came to be the basis for refuting the claims that no improvements in safety were made and to serve as a basis for recording the numbers of fire protection systems installed.

The first of a series of special reports appeared in this first issue and came to be a major feature of the annual summaries and one of the best sources of information on the program. This first issue included some comments on water damage, beginning with the remark that is as true today as it was in 1975:

> "The potential for water damage is often used as an argument against the installation of automatic sprinkler systems. However, it is seldom used as an argument against the installation of other water systems."

The first of another repetitive series also appeared the first year. This was a listing of ERDA and ERDA-contractor employees on NFPA committees.

The Appendices that first year included: Significant Accidents; Summary of Materials Handling Incidents (a growing concern at the time), Other reports Involving Forklift Trucks, Railroad cars, and Other handling devices; Five-Year Loss Summary. (by category); Five-Year Total Loss summary; Recurring Fire Protection costs (since 1966); Fire Extinguishing Equipment Performance for Five Years; Water Damage Incidents Comparison: an NFPA Committee List; and a page on recommendations (some of which are pertinent today as new people and new organizations are included in the reporting requirement who had never previously seen or prepared and annual summary report).

1976

The 1976 report continued the format established with the first. Notable items in the loss record section included a summary of fire deaths; thirteen, all of which occurred in flash fires or explosions. A comparison to the U.S. per capita fire loss rate of $19 was also made; the ERDA rate being $2.50.

The first graphs on annual and cumulative loss ratios appeared in this issue, together with a table showing the order-of-magnitude improvement that had been made since the Rocky Flats fire.

A three-page analysis of reported data was included as background information and as an incentive to provide better and more comprehensive reporting.

1977

The 1977 summary was the last of the three initial, Xerox-copy publications. Again distributed only to the field offices, it was similar to the first two.

Special topics in this report included the first listing of the "Planned Improvements" for the coming year, notes on the independent fire protection survey program, notes on fire protection standards, another listing of NFPA committee members, more notes on data, and the first summarizing of comments from the field offices, with headquarters responses.

1978

One of the first projects under the newly-formed DOE management was the formalization of meetings and documents. As a part of the program, the Administrative Services people contacted us for justification of the annual summary as an official DOE document. The document received formal blessing and it was published as DOE/EV-0053, "Summary of Property Damage Experience and Loss Control Programs of the United States Department of Energy." As an official publication, it was available from the National Technical Information Service (NTIS) for a price of $6.00 for a printed copy or $3.00 microfiche.

Unfortunately, in the pre-computer era, the desire to get the report issued in a timely manner led to printing the graphs as hand-drawn items. While it may have detracted from the official appearance, it at least got the information out.

In addition to a special introduction from the Director of the Operational and Environmental Safety Division, the standard lists of losses, improvements, recurring costs, and planned improvements, a special effort was made to include a number of studies illustrating aspects of the program. This inaugurated the practice of reprinting any special studies as sections of the annual summary. This preserved them in a manner that no other safety program has yet duplicated. While much of the data is, of course, obsolete, it can all be used to build on and compile a cumulative record. It may also serve as ideas for individual contractors seeking ways to perform further analyses of the effectiveness of their own programs. This has always been a problem with good programs where the available loss data is so small that more sophisticated analyses are necessary.

The 80 pages of this report included a comparison of ERDA/DOE Loss Ratios and a section with comments on comparative "improved risk" loss ratios.

A study of frequency-severity data was included for the first time. A conclusion: "Historically, ERDA/DOE experienced a reportable (over $1K loss) every three days, a loss exceeding $100K every two months, and a loss exceeding $1M every year." (This was all losses, not just fire).

One of the most informative programs from the SSDC was the "Extreme Value Projection." After the fact, this demonstrated that the Rocky Flats fire was not an anomaly but simply a to-be-expected result of the safety system as existed at the time. The plot illustrated that the AEC system could expect a fire on the order of Rocky Flats to occur about every 19 years (it occurred after 23 years). The post-Rocky AEC experience showed the order-of-magnitude improvement noted elsewhere. By contrast, the four years of ERDA/DOE experience showed a near-reversion to the previous record. this was due to the fact that the "non-AEC" sites were contributing about 90% of the losses while constituting 10% of the values. It was obvious that not applying the AEC fire protection system to the new entities was having a deleterious effect on the overall record, even though the "nuclear" facilities still continued their improved record.

A separate study (with the crude hand-drawn graphs) looked at maximum annual losses and major losses.

Appendix F consisted of a summary of all fire fatalities in the history of the organization, together with firefighter fatalities from non-fire situations (there were no firefighter fatalities in fires).

Appendix H was devoted to a study of improved risk "savings", or the difference between actual losses and what losses would have been as an "improved risk" insured. This is another comparison almost unique to fire protection. Only occupational safety (and a few radiation exposure examples) can compare their experience to national statistics. Several pages of comments expounded on the resulting data.

Appendix I was the first summary of the "FIRES" program, listing the recommendations resulting from the independent survey program (see the "Independence" chapter), costs by field office, category of compliance actions (sprinklers, water supply, housekeeping, fire department, etc.),

Appendix J was the first listing of major Line Item projects and Appendix K listed all projects in DOE exceeding $25M in total estimated cost.

Appendix L consisted of six pages of editorial comments on such subjects as sprinkler effectiveness, insulation effects on sprinklers, forest land experience, coal-fired boiler losses, and mutual aid fire department costs.

1979

The CY 1979 report, DOE/EV-0053/1, was the second published as an official document available from NTIS. At a slightly-shorter 70 pages, it continued the effort to include studies of special interest to fire protection people and not otherwise available.

The Introduction, while common to all reports, included comments from the NFPA Chief Engineer, Horatio Bond. In 1947, he had been a member of a distinguished committee looking at AEC safety. (Contrary to "common knowledge", the reviews by outside people were a common feature of safety in AEC/ERDA/DOE). His comments were as relevant in 1979 as they had been 32 years earlier and formed a basis of this author's endeavors in later years.

The 1979 report was the first to include a summary of Headquarters activities. To most field people, and especially the contractor staffs, the actions of HQ were largely unknown, and often irrelevant. This was the first of a number of similar sections in later reports to attempt to solve this problem (and to ironically lay the groundwork for the near-destruction of the system).

Another summary of the "FIRES" program reported on the progress in complying with the recommendations resulting from the independent survey program. Sections included: Cost by Field Office; Expenditures by Categories; Funding Sources; Cost per Recommendation; Status of Recommendations; Completion Percentages; and DOE and Field Office Status by Year. Eleven pages of the usual hand-drawn graphs and charts completed the study.

The first article on Department of Energy fire departments appeared in this issue. it was a three-page summary pointing out some of the distinctive features and varying capacities of the 27 departments that employed over 700 full-time and 600 brigade employees.

Two special loss studies were included in this issue. One on vehicle fires and one on water damage incidents. The vehicle fire study was prompted by an apparently high frequency at NV, even considering the longer-distances and higher speeds entailed in NTS driving. The result of the recommended studies showed nothing conclusive, but vehicle losses at other field offices in subsequent years grew to approximate the NV statistics!

For the first time, a list of fire protection research projects receiving DOE support was included.

The cumulative loss ratios for each field office from 1975-1980 were included, with comments on the magnitude of losses needed to improve/worsen the record.

A final Appendix gave the status of a number of property protection projects as of the end of CY 1979.

1980

The 1980 report, DOE/EP-0056[55] was another of the official publications. In fact this one was farmed out to the CIA for publication, unbeknownst to the author. Needless to say, HQ management people were somewhat concerned when the author received a giant envelope from the CIA. No comments were made, but a number of people were present when we opened the envelope and audible sighs were observed when the envelope was opened to reveal only page photo proofs.

Again, this issue contained the usual topics on the Loss Record, Improvements, Planned Improvements for CY 1981, Items of Interest (from the field reports), Losses of Interest, Reported Losses, Headquarters Actions, Recurring Costs, and Cumulative Loss Ratios.

Special studies included the first of what was to become an annual topic; the sprinkler performance record. This was an advance copy of a study completed in 1982 and updated every year since. (See the "Little Drops of Water" chapter).

The second special study in this issue was a summary of several risk assessment techniques, including updates of Extreme Value Projections and Frequency-Severity, and one new study, Losses by Month of Occurrence.

1981

The 1981 report, DOE/EP-0056/1 was the last of the official DOE reports. The 51 pages contained the usual topics and graphs and the updated sprinkler performance record. Special topics included charts of cumulative loss ratios by field office , lists of property protection improvement projects and a first, the list of sites in order of property value. On this list, Oak Ridge Gaseous Diffusion Plant led with $6.593B in value. Seventeen sites exceeded $1B and the lowest of the 41 sites listed was valued at $119M.

1982

The 1982 report had been prepared and was circulating for review when two people from the office of the Assistant Secretary for Administration dropped by the fire protection office to review the justification for continuing the annual summary as an official DOE publication. They spent a half-

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[55]We tried to keep a consistent numbering system, but government changes organizations too often and allows too many "instant experts" to assume authority by political appointment. After AEC became a political organization in 1975, nothing ever stayed the same more than one term of office.

day reviewing the previous justification and strengthening the wording for a renewal. About a week later, we were informed that the document had received further approval as an official DOE publication. This was not considered significant until...

...Within a week after the publication was again approved, a "manager" in the Assistant Secretary for Safety's office decided that the publication was not of the quality warranting further sponsorship and the project was basically dead.[56] In frustration, we sent a copy of the draft to each field office with a short note saying they could do with it as they pleased (and implying that they might want to send a copy to their contractors).

The 1982 report remains the "collectors item" of the series.

1983

By the time the 1983 report was due (the requirement was still in the DOE Orders, after all), we discovered that the HQ copy people could make 100 copies on request. We decided to go ahead and compile the HQ summary of the field submittal and have the copies made without a "review" in Headquarters.

The 1983 report had a forward prepared by the author, since it wasn't in the review cycle. In addition to the usual items of the 70-page report, a section on extinguishing system performance was included. This included 13 new sprinkler fires and six other incidents involving other systems.

The report was sent to the field on a "buck slip" in a low-key manner and copies were distributed to HQ people later. No comments were received and the groundwork had been laid for future actions.

1984

The 1984 report was issued on the same basis. Being a little bolder, this edition totalled over 80 pages.

In addition to the now-standard sections (and a Forward again signed by the Acting Director of the Office of Operational Safety), updates of the Frequency-Severity Analysis, Fires by Month, and Extreme Value Projections were included. A new analysis technique, Box plots, was also featured for the first time and another section resurrected was the "Notes on data" listing 12 specific losses with discrepancies in reporting.

[56] It wasn't "scientific" enough.

1985

The 1985 report was the first of the "yellow" reports in which the author took credit for the report, added a summary, and multiple copies were sent to each field office, sufficient for all the contractors. Somehow, the "unofficial" status was overlooked.

The 1985 report grew to over 90 pages as the graphs and charts (now computer-drawn) were expanded and additional details were added to most sections. Site valuations and property protection project lists were repeated, as well as the sprinkler performance and status of the independent survey program. No new subjects were introduced in this issue.

1986

The 1986 report paid less attention to loss data, since this was being done in the SSDC reports. Losses were summarized and the complete record of losses and other data since 1947 was included as a table, with graphs of cumulative loss records.

The Headquarters action section became a permanent fixture after a number of field comments that this was an appreciated benefit. Updates of the sprinkler record, systems installations, Line Item projects, and the independent survey program were also included again.

The DOE Halon experience was also updated and a list of all the reported fires and accidental discharges since 1977 was included.

A new section on personnel changes was included. This was to prove to be one of the most valuable, (and near-fatal) additions.

One unique addition in this edition was the inclusion of a section on property notes condensed from a FY 85 statistical handbook on property.

1987

The 1987 edition was another in the "yellow book" series introduced after the official publication of the annual summary came to a halt. All of the previous items were included, such as the Summary Notes, Loss Notes, Losses of Interest, Headquarters Actions, Items of Interest, Personnel Actions, Independent Survey Programs, Extinguishing System Installations, Sprinkler Performance, Halon Systems Update, and CY 1987 Improvements, and CY 1988 Planned Fire Protection Improvements.

The one new item in the 1987 report was a history of the fire protection orders. This was a study of the Orders (and the preceding Manual Chapters) for the Caves study (see the related Chapter).

1988-1989

By the time the 1988 report was being consolidated, the author of the series had retired from DOE Headquarters. For the remainder of the year, there was no fire protection engineer in DOE headquarters with the experience or time available to prepare the report. The new staff recruited the following year were caught up in major changes from organizational details to philosophical considerations of safety policy. The preparation of an annual summary was on nobody's priority list; especially since it didn't officially exist.

In 1990, the former author accepted a position at Los Alamos National Laboratory. Since the material for the annual summary was available (the requirement was in the Orders), it was available to Headquarters. The Senior Fire Protection Engineer, Dennis Kubicki, desired to reinstate the report and assigned the task to James Scott, a new engineer. He was assisted by the author, who prepared the graphs and tables. The elapsed time meant that another year of field reports was available before the report was initiated. As a result, the issue was the first to combine two years into one report. All of the now-traditional items, including Headquarters Action, Personnel Actions, and Items of Interest were included.

1990

By the time in mid-1991 when the field submittal of the annual reports were in Headquarters, the workload on the Headquarters fire protection staff had increased enormously. Jim Scott left to accept a position at Stanford Linear Accelerator Center and new people were added to the staff. In addition, other Headquarters offices had fire protection people added, increasing the new coordination workload. In addition, since the report was no longer "official", there was no one pushing for its issuance.

Despite the problems, a report was prepared. Unfortunately, the same mistake that had been made by the original author was made again; the report was distributed for review before being issued. Again, a safety manager decided the report was not fitting for DOE's image. It was too "chatty." (Like including personnel notes, for instance).The report was a bare-bones effort distributed to Field Offices in September of 1991.

In mid-1992, the field had again supplied the material to Headquarters and a new report was again being prepared. Unfortunately, there were many new people in the field and new organizations and the reports submitted were very uneven in quality. What could be made of them was still in the air as of September, 1992. (Let alone how they would be issued).

Fortunately, additional reports were prepared and a 1994 summary was ready and distributed at the DOE Fire Protection Conference in May of 1996.

Since the report had proven value to the DOE fire protection program, but was in danger of being diluted to ineffectiveness, this author submitted a suggestion to DOE Headquarters in September of 1992 that the requirements be combined from the different Orders and consolidated in a guide to be included in the Fire Protection Resource Manual. This would offer a standard format and guides to the types of material to be submitted and the detail required. The performance of fire protection systems, analysis methods, and organizational and personnel reporting could be formalized in a manner that would prove to be of considerable value to all of the new DOE audience, many of whom had never seen an annual report or been aware of the material presented. It could also help by-pass the second-guesser type of people in Headquarters who always seem to be ready to impose their own judgements on programs with which they have no familiarity.

The Annual Summary of DOE Fire Protection Programs was the documented record of the effectiveness of the fire protection program. It was the only program that:

1. Maintained a history of the program.

2. Maintained the record, both annual and cumulative, since the start of AEC.

3. Published its record and achievements every year.

4. Recorded the performance and reliability of its principal systems.

5. Kept track of, and reported, the program costs.

6. Kept track of annual accomplishments and improvements and plans for the forthcoming year.

7. Recorded the major problem areas in its discipline.

8. Kept track of, and published, the records of its people.

9. Distributed its record to national fire protection organizations.

In short, the Annual Summary was one of the things that contributed to making the DOE fire protection record superb. As such, it is too valuable a subject to be abandoned. As of mid-1996, it is understood that a combined safety report will again be issued by DOE, with fire protection included. This system existed on several occasions in the past and a separate fire protection summary was still found to be invaluable. It is to be hoped that the information will still be supplied to headquarters and be available to the fire protection program people, even if all of it is not incorporated in an all-DOE report.

THE ANNUAL FIRE PROTECTION SUMMARY
SOME SPECIAL APPENDICES

Each year, an effort was made to save some aspect of the fire protection program by including it as one of the appendices in the annual summary. Those that became a part of the report are noted below:

<u>1976</u>

Large-loss Potentials.
Notes on Data.
An Order-of-Magnitude Improvement.

<u>1977</u>

Fire Protection Standards.
DOE Members on NFPA Committees.
Notes on Data.

<u>1978</u>

ERDA/DOE Loss Ratios.
"Improved Risk" Loss Ratio Comments.
Frequency-Severity.
Extreme Value Projection.
Fire & Firefighting Fatalities.
Improved Risk savings.
"FIRES" Program.
FP Safety Projects.

<u>1979</u>

"FIRES" Program.
Fire Protection Engineering Manpower.
DOE Fire Departments.
Vehicle Fires.
Water Damage Incidents.
Fire Protection Research projects.

<u>1980</u>

Property Protection Goals.
Risk Assessment Techniques.
Automatic Sprinkler Performance (1st of an annual series).

1981

Cumulative Loss Ratios, 1975-1981.

1982

DOE Participation in Standards Groups.
Personnel (1st of annual).
Computer/Control Room Protection.

1983

None

1984

Frequency-Severity Analysis.
Fire Frequency by Month.
Extreme Value Projections.
Order-of-Magnitude Fire Frequency.
Box Plots.

1985

Field Office Fire Loss Data.
Independent Survey Program.
Cost Indexes.

1986

DOE Halon Data.
Fire Protection Systems Installations.
Property Notes.

1987

Fire Protection Orders.

COAL BURNS, TOO

..... in which we learn that less-exotic substances also burn; and Lo and Behold, the bigger the BTU's, the bigger the bonfire!

In 1975, the Atomic Energy Commission was split into two agencies. The Licensing people became the Nuclear Regulatory Commission and the rest of the agency became the Energy Research and Development Administration. Of course, the physical aspects remained with ERDA, so the separation, to avoid that horrible "conflict of interest" that arises from both regulating and developing nuclear energy[57] left ERDA with the reactors and the programs and NRC with some people. The result was that all the safety research by NRC was done on ERDA (and then DOE) reactors and even the training of NRC people was originally done by ERDA.

The principal difference in ERDA was the addition of a number of Power Administrations to the agencies and the old Office of Coal Research programs from the Bureau of Mines. Two problems resulted. The Power Administrations were all federal employees and the organization didn't lend itself to the ex-AEC system[58]. The other
was that the great search for "alternative energy" resulted in a lot of money going into fossil and conversion plants that were intended to be short-term contractual affairs, after which they reverted to (usually) the people who built them. A basic problem was the reluctance to spend money on protection for a plant that was only going to be in use for five years, or so. From the safety standpoint, the argument was that a plant that was worth spending many millions on for a few years was certainly important enough to protect for those few years.

Regardless of the arguments, few of the pilot plants were provided with much in the way of protection and nothing like the "improved risk" that was the ERDA standard. The plants that the author inspected were woefully deficient in many aspects of good fire protection[59]. The result was that the loss record of these "non-nuclear" facilities was out of all proportion to the share of the

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57. Some might ask why Congress, which created the AEC in 1947, after two years of debate, never knew what they were doing--to the extent that it took them 28 years to discover their stupidity--but we won't.

58. And still doesn't. After 16 years, the Power Administrations are still largely outside the DOE safety system.

59. Fortunately, the author was something of a "kiss of death." Every plant he surveyed was shut down within two years--and at least one never got started!

agency that they represented. In fact, even in "nuclear facilities", it was the non-nuclear aspects that suffered the biggest losses.

One of the problems arose from the Safety Division effort to have a safety professional assigned to the administrative groups. The Headquarters facility was large enough to warrant specialized attention. After ERDA was founded, the agency acquired a new downtown HQ in addition to Germantown[60] and a safety professional was acquired. Unfortunately, the jurisdiction was "federal employees" and that included the Power Administrations and the former Bureau of Mines Research centers, which were federal entities. A two-person safety staff (and no fire protection people) just couldn't handle it all by themselves.

60. Political managers seem to have a propensity for wanting to be near the seat of power. Germantown was 20 miles outside the beltway.

IT WAS COOL, MAN

.....in which we learn that cooling towers do, indeed, burn. But in AEC-DOE, all the losses occurred in sprinklered towers. The unprotected tower fires resulted in no loss.

[AUTHOR'S NOTE: This chapter discusses what was once a major industrial fire problem, the cooling tower fire. It also demonstrates one of the problems of superficial thinking by instant fire protection experts; - "They're always wet so they can't burn." They do burn and the early emphasis on sprinkler protection resulted in another remarkable record. This was detailed in the following chapter.]

The water cooling tower is an essential part of many industrial processes generating heat. From the earliest days, they were an essential part of AEC operations. In addition to being components of typical fossil-fueled power plants, they were vital components of the Oak Ridge Gaseous Diffusion Plant (K-25) which was the war-time uranium enrichment project.[61] The diffusion plant towers were like the switchyards, some of the largest examples of their kind in the world. When the plants were expanded and multiple new buildings were built at three locations in the 1950s, the towers grew in number and size. Some towers had more than 20 cells.

The cooling tower was not considered a significant fire problem prior to and for some years after WW-II. After all, they were deluged with running water and everybody knows how hard it is to start a bonfire in a rainstorm![62] Unfortunately, towers don't run continuously and when they have a little shut-down time to dry out they become perfect bonfire arrangements. Even when running, the fan deck and fan shrouds are dry and that's where the electricity is, so they can burn very nicely even when running. By the 1950s, there had been enough fire experience acquired in industry that the NFPA organized a cooling tower committee and they developed a standard for the protection of cooling towers. Not surprisingly, the solution was the automatic sprinkler system.

The first edition of the cooling tower standard, NFPA 214, came from the work of a 1958 committee and was published for the first time in 1959. Although the committee has been reduced to only four people as of 1991, the committee was one of the more innovative ones when formed. It was developed in response to a number of fires in units that were becoming increasingly valuable as well as important to production. The insurance companies had recommended protection for some

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61. The most successful of the four processes considered, and of which three were built.

62. It was a cooling tower comment that started the author's collection of fire protection trivia and oddities. A 1950's memo to FIA from a broker said: "The assured does not believe the towers are combustible. Except for some fill materials, they are built entirely of redwood."

years prior to this and, like the sprinkler standard, the diversity of requirements was one of the reasons the standard came into being. Like most standards, the subject had been a matter of varied requirements and protection systems were often being applied before the NFPA standard was developed. The new standard was not retroactive.

The AEC's gaseous diffusion plants certainly epitomized the value and importance of the towers. Huge, multi-cell units serving buildings of several million square feet each and with heat-producing equipment that never shut-down, the towers were as vital to production as any in the country. They were also some of the first to be completely sprinklered. This was when they were built in the early 1950's, long before the NFPA standard was completed.

The first AEC towers were usually provided with dry-pipe, closed-head sprinklers. This was the common insurance industry recommendation at the time. Later, as problems developed in the closed head systems and the size of towers made fast-acting protection imperative, the deluge system became the norm and most of the early towers were retrofitted in accordance with the new NFPA standard, but the prime mover was the investigative work done by Union Carbide's Oak Ridge plants.

Joe DeMombrum was one of the first NFPA Cooling Tower Committee members, later becoming the Chairman of the committee and at the same time, the Chairman of the Protection Sub-Committee of the Cooling Tower Institute, an ideal double job. It was largely due to his investigative work at Oak Ridge that the problems of cooling tower protection systems were resolved.

The first report was a 9-page summary titled: "Fire Engineering Survey. Cooling Tower Sprinkler Systems" issued by the Y-12 Plant. It discussed the problems with tower protection systems as they had been revealed by Union Carbide studies, circa 1972.

The second report was a classic. "Cooling Tower Sprinkler Systems Final Report, Y-JA-91." By J. R. DeMonbrum and J. A. Parsons. It gave a summary of sprinkler system problems, tests, and recommendations. Air pilot deluge systems were recommended with increased cell separation, copper piping and hardware, and special attention to head locations near structural members.

As in many other areas, major fire protection projects in the '70s saw the extensive upgrading of cooling towers and their protection systems. Another area where upgrading was the norm in AEC facilities.

With all the concern over cooling towers, the fire record of the towers in AEC history was unique. The fire loss in all of AEC's unsprinklered towers was less than in sprinklered towers! As usual, it turned out to be for some very understandable reasons.

One spectacular fire, on film, highlights the problem. A no-loss, total-loss, it shows the deliberate burning of an old tower at Savannah River as the quickest means to raze it. The picture, a continuous shot from ignition to total destruction, lasts only a few minutes and certainly makes the right impression!

Of course, you don't expect to report much of a loss when you deliberately burn something to get rid of it, but what about the accidental fires that severely damaged towers but still represented no loss to the AEC? One of these was the partial destruction of a two-cell unit at Stanford Linear Accelerator Center in the early 1960s. A welder was fastening a revised ladder fitting and ignited the tower near the top. A deluge system was being installed but was not yet in service. Prompt fire department action saved most of the unit. The loss was zero--to AEC. The tower was still under construction, so it was the contractor's loss, not the AEC's. Ironically, after the fire, it was discovered that the only part of the sprinkler piping not finished was the 2" drain valve. If the main control valve had been opened, the bulk of the water, in an 8" riser, would probably have saved the tower with much less damage than was incurred waiting for even the on-site department to respond.[63]

Another no-loss occurred at the Kansas City Plant in the 1970s. The tower was unprotected and sprinklers had been recommended for some years. However, the tower was run by GSA, who operated part of the plant[64], including the utilities. The "long-range plan" was to replace the tower with a new unit which would be either sprinklered or of non-combustible construction. At the time of an Albuquerque Operations Office fire protection conference in the mid-'70s, the tower was still unprotected. One of the subjects on the program was pump tests and hoses from the pumps were tied to the cooling tower discharge basin as a sink; a prophetic event! The tower was finally being replaced and the new tower had been built and was under test with half the cells running. Half the cells on the old tower were still operating when the old tower ignited and burned. Fortunately for AEC, the construction contractor had been given the old tower as part of the project. Thus, the property loss was his. In addition, since the new tower was already complete, there was no production interference. Again, a major fire was a "no loss" fire to AEC!

Another credit due to cooling towers is the origin of this author's collection of oddities and fire trivia. While still with FIA in the 1950s, we saw a number of statements that were so incredible we started collecting them. One of the first was a Broker's memo about a client's opinion regarding the need for sprinklering a cooling tower as had been recommended:

> "They do not believe that there is much hazard due to the structure of the cooling towers. Except for some internal members, these towers are entirely of redwood."

The cooling tower loss story is another of sprinklers paying for themselves, even if the effects on production are not considered. the loss record includes the following:

No losses in excess of $50,000 occurred in the 1947-1975 period.

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63. The perceptive reader will note that it was the installation of a safety device that led to the safety failure; a not uncommon circumstance.

64. The plant had been a WW-II aircraft engine plant and was later split between GSA and AEC. Another case of the basic problem being the result of doing things on the cheap.

1954

One of the earliest losses recovered in the sprinkler study (see Chapter XV), was a sprinkler success. The damage was negligible, so details, other than the fact of the fire, were not available.

1966

A deluge system extinguished a fire in a tower at a gaseous diffusion plant, holding the loss to $15,300. Towers at this time were running close to $1M in replacement costs for the larger towers, as at the diffusion plants.

A second cooling tower fire occurred at the Portsmouth Gaseous Diffusion Plant. A deluge system limited the loss to $ 395. Again, a savings of probably several hundreds of thousands of dollars over what the loss would have been without the sprinklers.

1975

At the Portsmouth Plant, on 9/30/75, the cooling tower deck was ignited by sparks from the explosive failure of a motor junction box. The sprinklers did not operate until the fire burned through the deck, but even so, they held the loss to $7,000. Again, a savings of several hundred thousand dollars over what the loss would have been without the sprinklers.

The 1975 NFPA committee membership included both J. R. DeMombrum of Union Carbide, and S. Budzynski of Portsmouth Gaseous Diffusion Plant, on the NFPA 214 Committee.

1976

A 22-cell tower at the Oak Ridge Gaseous Diffusion Plant was ignited by a discarded cigarette. The deluge system held the loss to $15,300. (Again, the system could not actuate until the fire burned through the deck).

1977

A Y-12 Plant cooling tower fire was held to a $450 loss by the actuation of the deluge system.

1978

At Argonne National Lab., on 6/12/78, a pump motor lost oil, overheated and ignited. The fire was extinguished by a single 15# CO_2 portable extinguisher, but the loss was $15,300.

1981

On 5/25/81, a cooling tower motor at a Brookhaven National lab. tower burned for a $6K loss.

Fire is not the only hazard to the cooling tower. On 1/21/81, ice buildup at the Kesselring Naval Reactor site damaged a tower to the extent of $30K.

<u>1983</u>

A 5/26/83 cooling tower fire occurred at Argonne National Laboratory. A single sprinkler head on a dry pipe system controlled the fire, helping limit the loss to $7,000 until the fire department completed extinguishment. The cause was unique, sun reflecting off an aluminum cooling shroud.

XX

THROUGH NFPA'S EYES

.....in which we look at the Agency through the National Fire Protection Association "Quarterly" and "Fire Journal", and thereby have an opportunity to add a few more footnotes to history.

[AUTHOR'S NOTE: As 1996 is the 100th anniversary of the NFPA, it is fitting to look at the many contributions made by the AEC/ERDA/DOE fire protection community.]

Looking through back issues of the NFPA's chief publications gives us an opportunity to see ourselves as others saw us at the time and to rethink the things that were considered worthy of publishing then...and now. (Some people seem to have forgotten them). It also gives us the opportunity to add a few italic remarks; some of which are duplicated in other Chapters, but most of which seem to fit best in this format.

The year 1947 was the first year the Atomic Energy Commission existed as an entity. It was most fitting that the winner of the NFPA Fire Prevention Week contest was Oak Ridge, still a federally-owned and operated city. Second place went to a northern town - - Chicago.

The 1948 Fire Prevention Week contest was stiff; there were 2,928 entries. The winner - - Oak Ridge again. Chicago dropped to third, behind Memphis. The towns of Los Alamos, Richland, and North Richland were all in the top ten. In the Industrial Section, two Oak Ridge contractor sites tied for first place and another was fourth.

The record of the three federally-owned and operated cities was another unique feature of the AEC. Their fire record was so good, even after they became privately operated, with their own fire departments, that we made a table and some graphs of their experience. For some reason, Los Alamos was never a reporting city during the brief decade that city reporting was listed. However, both Richland and Oak Ridge were included every year. Perhaps it was because the Los Alamos fire department remained a federal department until 1989 and various management people weren't interested in that sort of thing.

Two other items from 1948 included a $350,000 fire at Brush Beryllium in Lorain, Ohio and the first definite instance of a fire originating in a TV set. (Haverhill, MA on 6/24/48).

The Beryllium fire was to have later significance when a DOE Assistant Secretary for Environment Safety & Health decided to make a national registry of all Be exposures. The project caused a great deal of pain to the Industrial Hygienists, but *few results. Brush's big patron for years was the AEC. The electronics fire was the first example of an area of later great interest to AEC.*

In 1949, a new entry in the Fire Prevention contest appeared; Los Alamos. It came in 7th of some 3,762 entries. A 2/2/50 DOE memo observed that the Chicago Operations Office had entered for the first time as a unit in the Industrial Section in the 1949 contest and won sixth place. It was the only AEC or other governmental unit so honored.

The April, 1950 Quarterly had the first of many articles by AEC people in print. Fittingly, it was by Ed Kehoe, Frank Brannigan, and Merril Eisenbud, all of the New York Operations Office, and was titled "Fire Precautions With Uranium."

The same issue also reported on some American Petroleum Institute data. Fire ratio was 7.2 cents/$100 and frequency was about one fire per 200 years per plant. Lest one thinks of giant refineries, the average insured value of a plant was $18,000!

The prolific Mr. Brannigan, of the New York Operations Office, was a fitting winner of the "first to publish" race. Needless to say, he has never slowed down. More interesting is the fact that almost exactly 41 years after this article was published, Los Alamos Lab was queried by a DOE entity about "where it says you can't put Halons (Halon 104 in 1950) on a uranium fire?

The second item was one of many collected by Headquarters people over the years in an effort to have a comparable data base against which to judge the AEC-ERDA-DOE record. Nothing was ever quite comparable, but nothing was ever quite as good, either.

The July, 1950 Quarterly had an article called "Radioactive Materials in Fires" by a member of the Chemistry Branch of the Canadian National Research Council that was so full of bad advice that it helped prompt Brannigan to begin setting the record straight.

The October, 1951 Quarterly had the first mention of Halons 1211 and 1301 in an article titled "Halogenated Extinguishing Agents Report.

The National Fire Waste Council also had a contest. The 1951 award, for a city in its class, went to the AEC's Richland.

The Halon topic became so important to the agency that we made a separate Chapter on the subject. It was some years before the first fixed systems were installed, but AEC was in the van.

The subject of misinformation in print can hardly be news to anyone on even the fringes of the nuclear business. However, the Brannigan "Living With Radiation" books and classes were one example of the great benefits that can be derived from *correcting misinformation. Unfortunately, the wheel seems to need reinventing every fifteen or twenty years.*

The Richland award was only one of many still to be cited. Good fire protection programs didn't stop at the plant gates.

The January, 1953 Quarterly had the annual large-loss fire record which included the first AEC fire to be reported in an NFPA publication. It was listed as a Richland warehouse burning on 1/30/52 for a $261,000 loss.

The actual loss was carried in WASH 1192 as number 24 on the all-time AEC loss record with a dollar loss of $269,578. The loss actually occurred on 1/28/52. It was also the subject of Serious Accidents Bulletin No. 21, published on 3/7/52. Like many other events, the publication within AEC exceeded the publicity given outside the agency - - until the growth of the anti-nuclear movements.

The October, 1954 Quarterly carried an article entitled "Combating Fires Involving Radioisotopes" by G. Manov. It was an article sponsored by Dan Hayes, AEC Safety & Fire Protection Branch Chief.

In the January, 1955 Quarterly, the 1954 Fire Prevention Contest winners were announced. Richland took seventh place.

The January, 1957 Quarterly noted that the new Industrial Fire Protection contest had 102 entries in 1955, up from 84 in 1954. Among the first twenty winners were Sandia (two locations), Argonne National Laboratory, and Argonne National Laboratory-Idaho.

AEC contractor facilities went on to win a number of first place awards. Almost every year, one or more facilities placed high in the standings. Unfortunately, the NFPA did not publicize the award winners each year and the contest was eventually disbanded. Another excellent showing by AEC facilities and one for which the record is, unfortunately, incomplete.

The July, 1957 Quarterly contained another Brannigan article. This was: "Uranium Scrap Fire Control" and included photographs and data on a number of tests on normal and depleted scrap run at the Fernald facility. (Where burning drums of chips are just moved outside and placed under an open sprinkler or shower head and the water turned on). Unfortunately, thirty-five years later, some people who should have known better were still saying; "You can't put water on uranium, it produces hydrogen and you might have an explosion!" Another example of the stupidity that often results when history is forgotten and even the people who should know better are all too willing to pass off an off-the-cuff opinion as revealed wisdom. New people can do no better than to be slow to speak and quick to read for their first few years on the job.

In October, 1957, Merril Eisenbud (New York Operations Office) was the subject of a reprint interview titled: "Lessons From A Pyrophoricity Incident" (see the "Early Fires" chapter). This was the "Bayside" plant, Sylvania explosion. In the same issue, Dick Smith (Headquarters' Smith, not Oak Ridge's) had an article: "Pyrophoric Metals - A Technical Mystery" which is still a classic in the field.

The explosion that merited panic headlines in the New York Press was really a thorium-burning operation in which a golf ball-sized piece of thorium exploded, injuring a number of people and creating consternation about the horrible secrets at the "Atom-Lab." You will note how little things have changed since July 2, 1956.

By 1958, Richland's Don Keigher was an old hand and one of his first ventures into print appeared in the July, 1958 Quarterly, titled: "Radioactive Filter Design Fire Problems." It was an excellent review of the development of improved filters and of installation and protection practices of the day.

Needless to add, the author remembers a 1989 question from a "safety" expert that indicated a rather complete lack of filter expertise, like being aware of anything in the Keigher article. We are becoming more convinced each day that every technical discipline should have at least one required course in how to research the history of the field!

The January, 1959 Quarterly contained the first exercise by a future great safety veteran. It was D. E. Patterson's article on: "Land Shipping of Radioactive Wastes." It had been presented at the AEC Safety & Fire Conference at Germantown in 1958.

Ed (or Dave) Patterson went from Idaho to AEC Headquarters where he later became the Branch Chief of Industrial Safety & Fire Protection and then the Director of the Division of Operational Safety until retiring and then serving in a consulting capacity for Defense Programs and others. Ed is another example of the all-around safety professional and competent safety manager - - an increasingly rare breed, in the authors' opinion (or have you guessed that by now?).

In 1961, the April Quarterly, which contained the fire record of cities, included Richland and Oak Ridge for the first time. AEC-owned and operated, they were just becoming private entities. Los Alamos never did report during the period the records were carried in the Quarterly. The data is interesting enough to rate a separate section and we had hoped to include some of the information in a special fire departments chapter, but were prevented by the early publication of this edition. Maybe the second edition!

The story of the townsites' fire protection has largely been lost. They did submit annual reports and a few survived in the author's possession for some years. When the "Manual Chapter" system was instituted, the "Industrial Fire Protection" Chapter was so-titled because there was going to be a Chapter called: "Municipal

Fire Protection" but the cities became private entities before such a Chapter could be issued.

The April, 1963 Quarterly contained an article by ANL's H. V. Rhude, on: "Fire & Explosion Tests of Plutonium Glove Boxes." Movies were made of the tests and were also available on loan during the years AEC had a movie-loan program.

The April, 1963 Quarterly also had a small item on the Paducah fire in its list of large-loss fires of the preceding year.

Few fires ended up on the NFPA lists, primarily because there were so few of general note. The second Paducah fire would have been a natural for a fascinating report as it is still the record-setter for number of sprinklers operating with enough water behind them to be effective. However, until the author's inclusion of the story in his history of AEC fire protection published in "Nuclear Safety" in 1979, it was largely unknown.

The film loan program was another great feature of intra-agency information. Unfortunately, the program was disbanded, and many of the films were discarded. In the age of videotape it is incredible that the agency now has no comparable information-exchange program. Some facilities, such as Rocky Flats and FNAL have produced professional-quality tapes on their own, as have some of the fire departments. The effort is to be encouraged.

The April, 1964 Quarterly contained a photograph of the Portsmouth transformer explosion of 12/13/63 and a loss stated as $250,000.

The loss was carried as $244,800 in WASH 1192 and is number 30 on the all-time list of AEC losses. Portsmouth Gaseous Diffusion Plant was the "oddball" in the system at the time, being operated by Goodyear Atomic Corporation for many years, while the other diffusion plants (and Y-12 and ORNL) were operated by Union Carbide. Which reminds us that a chapter on who ran what for what years might be very appropriate.

The final issue of the NFPA Quarterly, the one for October, 1964, contained another AEC article. This was "Glovebox Fire Protection" by Jim McNamara of AEC-Chicago and Fred Pancner of Argonne National Laboratory.

The March, 1965 issue contained a reprint of Serious Accident Bulletin #237, dated 12/04/64, concerning the 11/06/63 fire in a plutonium processing facility at Richland. The loss was $237,000.

The story was typical of a number over the years in that it was basically the reprinted AEC bulletin. There was no uproar, probably because most of the anti-nukes never read a semi-technical *publication. But can you imagine the same story today? Which is another reason fire protection, among other safety disciplines, has to be a lot tighter now that it was years ago.*

The May, 1965 issue carried the item that Argonne National Laboratory was the Grand Award winner in the Industrial Fire Prevention contest.

The same issue also carried the first of a series of Automatic Sprinkler Corporation of America ads titled: "Assignment at Jackass Flats." The ads featured varying pictures of the deluge systems installed on the LH tanks and rocket stands at the Nuclear Rocket Development Station at the Nevada Test Site.

That issue also noted, in a column carried for a few years that listed NFPA library acquisitions, that they had added: "The Extinguishment of Uranium and Plutonium Fires" to the library. It was an English paper developed for presentation at the AEC annual safety and fire protection conference at Germantown, MD in May of 1961.

The "acquisitions" list was a valuable item the few years it existed. We used it on a number of occasions to acquire things we might otherwise have never learned existed. Those who can't find that nuclear fire protection paper they're looking for might try the NFPA library.

The July, 1965 issue was the one that carried the Wayne Ault article on the development of the low-differential dry pipe valve, an alteration employed for many years at the original K-25 diffusion building at Oak Ridge.

Also in this issue was an article on the 7/24/64 criticality accident that resulted in one fatality, not at an AEC facility.

The citing of an AEC bulletin for non-AEC incidents was a common practice. Even though the AEC bulletin gave credit to the other source, and might be repeated in the article, it was still cited as AEC information. More credit to a fine program.

The low-differential valve was of interest to AEC since a number of Gaseous Diffusion Plant systems were so converted when heat was removed. The systems remained in service for a number of years before finally being converted to dry pipe. At the time of the sprinkler study, it was determined that we had at least one of every single type of sprinkler system except the combined dry pipe and pre-action developed for piers.

In the November, 1965 issue, another Jackass Flats ad appeared and the library noted the acquisition of "Operational Accidents and Radiation Exposure Experience."

The publication was not the noted WASH 1192, but an earlier version. Every few years, a summary report was issued. The last section with a brief summary of Class A and B incidents was continually expanded backwards. Unfortunately, the last issuance in 1975 didn't quite bring the series back to 1947. It would have been even more interesting if it had.

The March, 1966 issue contained an article on the NFPA standards story. There were 63 Technical Committees and 71 Sections, with 193 codes and standards. There were 119 federal memberships (99 individuals) on 39 of the 63 committees. There were 22 government departments or agencies represented. The AEC was represented by Hayes and Brannigan on Atomic Energy, Dick Smith, Chairman of the Combustible Metals Committee, Don Keigher on Computers, Arnold Weintraub on Gasses, and Brannigan on Portable Extinguishers. There were also a number of AEC contractors on committees at that time, but the article was only concerned with the federal representatives.

That issue saw the library acquiring AEC Safety & Health Bulletin #9, dated 6/64 and titled: "Fire & Explosion Hazards From Spills Involving Liquid H^2 and Other Flammable Fluids."

The subsequent November, 1966 issue had the publication of the Public Safety Information Bulletin #1,, "Transportation Accidents Involving Radioactive Materials." A Brannigan endeavor.

The Brannigan item was the first of a series of radiation hazards for the firefighter newsletters published by Frank. It died an untimely death, as noted in the Brannigan Chapter. A fate that was to be identical with many other good safety ideas that fell afoul of the beauracratic manager's instincts.

The fed participation in standards article prompted the author to begin the annual check of the committee list, which resulted in an annual "804" newsletter article. The AEC participation more than doubled with the addition of contractor people and the AEC-ERDA-DOE was usually at the top in numbers of participants. Adding contractor participation, it was always at the top in numbers of committee members; another fine tribute to a great fire protection program.

The September issue contained items on the Annual Conference, including a summary of Brannigan's talk on Building Construction Elements, Don Keigher's place on the SFPE Nominations Committee, and the public showing of the Brannigan film; "Fire Loss Management-Computers."

The Brannigan film, a discussion with Pat Philips, combined with film clips and/or stills illustrating various points, was one of a number Frank made. They were widely available in AEC and could be purchased from the NTIS. Some years after the film library was junked at Headquarters, we heard of a computer film one of the major insurers had and borrowed it. It was the Brannigan film !

The Keigher item gave some background and additional information. In researching these items, we have omitted mentions that simply repeat a name as part of a committee or on some project or other.

The November, 1968 issue carried what was to be a classic in terms of number of copies distributed (and the number of times we reprinted it!). It was Don Keigher's: "Water and Electronics Can Mix." It also contained a photo we had acquired at Lawrence Berkeley Lab. showing cleaning electronics with water spray. Old hat, even then, but a revelation and good talking point for the fire protection people.

The same issue carried an item about "Safety & Fire Protection Technical Bulletin #12", titled Fire Protection of AEC EDP Systems.

The early AEC fire protection standards for computers were based on Federal Fire Council FP 1, but also on the reports of a number of surveys made by Don that covered most AEC facilities. From the earliest, most AEC computer facilities had sprinkler protection.

The March, 1969 Journal had an article by Andrew Pryor of Southwest Research Institute. Andy had left Richland for several years work at SRI and then returned to AEC at Albuquerque Operations Office where he formed part of the most-experienced FP team, (along with Bill Cruickshank and Dennis Kirson) in DOE. (Both Andy and Bill had retired by 1995).

Andy also had an article with C. Yuell on "Mass Fire Life Hazard" published in the Journal while he was at SRI.

The July, 1969 Journal had a Brannigan article; "Fire Spread Through Noncombustible Concealed Space." It concerned a Bethesda, MD office building, not AEC, but was a forerunner of the great articles, and book, he was to do on building construction.

The November issue contained an excellent article by Sandia's Vernon Duke. "Salvage of Data-Processing Equipment; A case In Point" concerned salvage from a transportation incident involving a truck load of Sandia-owned equipment. It was one of the first noting the comparative ease with which much equipment could be decontaminated - - even from dreadful water damage !

Dave Patterson gave a talk on the 1969 Rocky Flats fire at the NFPA Fall convention and it was reprinted in the January, 1970 Journal as "The Rocky-Flats Fire."

It was called "the largest fire"--"largest industrial fire"--"largest government fire"--or similar by the anti-nuclear forces from the start. The May, 1970 Journal gave the annual rundown of large losses for the previous year. On 12/22/69, an F8J Crusader jet crashed into a navy hangar at Miramar NAS, destroying 15 Phantom jets and most of the hangar. Thus the Rocky fire was not even the largest government fire of 1969. Oh yes, the deaths at Rocky were zero. Fourteen died at Miramar.

The July, 1970 Journal noted another library acquisition. This one was "Evaluation of Protection From Explosion Overpressure in AEC Gloveboxes" by C. Yao et. al. of Factory Mutual Research. Published on 12/69, 88 pages, it was one of the series done for AEC by FM.

The FM series on gloveboxes had started in the 1960's. managed by Chicago operations Office. The assorted volumes made one of the major contribution to AEC fire safety. It was also the author's first meeting with one of the guiding lights of the study and the finest "nuclear" fire protection engineer we have known, FM's George Weldon.

The 9/70 issue covered the annual meeting, including summaries of talks. One was Brannigan's "Building Codes For The Fire Officer." A forerunner of many things to come.

Don Keigher's participation on a computer protection panel was also discussed.

Another of the FM glovebox series was "Evaluation of Improved Fire Resistant Glove materials for Gloveboxes." This one, by A. E. Johnson, was noted in the 11/70 Journal as a library acquisition. Also, that it was available from the GPO for 25 cents !

In keeping with the political manager's impression that everything was invented when he took office, none of the DOE "Tiger Team" investigators have inquired as to the extent of the reference materials available to the people they are appraising. As none of the appraisals have looked at what the actual record was, so none have inquired into the knowledge that established that record.

The January, 1971 Journal contained an AEC article none knew was AEC-connected. The terrorist anti-US/Vietnam "idealists" had set off a bomb at the University of Wisconsin's Army Mathematics Research Center. Part of the work was AEC-sponsored and a late-working researcher was killed. While not mentioned in most stories, it was included in AEC incident records.

It was AEC accident 70-20-A and occurred 8/24/70. The low-energy physics equipment that was damaged was insured and the fatality was determined to be non-chargeable. Thus, there was no real loss to AEC. Besides, the bombers undoubtedly were caring people with noble intentions.

Another of the few AEC losses was reported in the March Journal. This was the Idaho NaK incident of 10/13/70. While the loss was too small to warrant a substantial report, the article does reference the "Liquid Metals Handbook" developed by AEC and the Navy's Bureau of Ships (This was the era of the "Seawolf" liquid sodium reactor submarine).

This 1955 publication is still current. Another of the long list of basic references nobody knows about.

Argonne National Lab's great FPE, Tom Franck, had an article in the March, 1971 Journal titled: "Clean Room Fire Protection Using Halon 1301. A reference was to the 1967 publication: "Fire Protection in Chemistry Hot Cells by the Use of Halon 1301."

We well remember a 1966 AEC Safety Conference at Richland, where Tom presented a paper on a new protection system he had designed for a hot cell at Idaho. It was the first time we had ever heard the word "Halon."

The September, 1971 Journal contained an item about the Larry Oldendorf paper on: "Evaluation of Today's grouped Electrical Cable Fire Problem." The paper itself was printed in the November Journal.

The November issue also had an item on another library acquisition: "Guidelines For Sodium Fire Prevention, Detection and Control: Report of ad hoc Committee on Sodium Fires". This was document ANL-7691 by four ANL authors, including Fire Chief Fred Pancner.

Another of the "lost" basic references, it was available from NTIS for $3.00. With 166 pages.

The Journal report of the annual meeting included Brannigan's general session talk on: "Catastrophe Potential in the Construction of Post-Tensioned Concrete Buildings."

By that time, Frank had retired and his title was Assistant Professor at Montgomery (MD) College. The work was largely a continuation of his great series begun with the AEC.

The September, 1973 Journal noted that Larry Oldendorf had delivered a paper on "Human Factors in Fire Protection Engineering" at the annual conference in May.

The November issue included a John Sharry article on an Atrium fire. An NFPA Fire Record department specialist at the time, John was to progress through many more responsible positions until he transferred to the Chief's position at Lawrence Livermore National Laboratory. This was one of the earliest of a great many articles he wrote before he came to DOE.

John wrote the article: "Foamed Plastic Fire Spreads 430' in Eight Minutes' in the January, 1975 Journal.

The plastics article referred to the FERMILAB fire of 12/26/73. Loss was $80,000. This was a unique story in two ways. For AEC, it was one of a number of losses in which the actual loss was less than we recorded; the loss was eventually recovered through subrogation. Thus, the AEC loss record, again, was actually better than we recorded.

The second item was that this was one of the earliest examples of a Journal-reported loss in which the date and location were not specified. There was no reason for this, since nothing was classified. In fact, "classified losses" were not an agency practice. (A Federal fire Council annual summary refers to a "classified loss" on at least one occasion, but it was not an AEC loss.)

The March, 1975 Journal contained an article: "Carbon Microspheres as Extinguishing Agents For Metal Fires." An article concerning another of several extinguishing agents developed through AEC/DOE effort, it was A Y-12 site project, Report Y-1890, UC-4, available from NTIS for $2.25.

The January, 1976 Journal had an article: "Federal Agencies Involved in Firesafety." Included were NRC and ERDA with a short note stating: "With the billions of dollars being devoted by ERDA to develop new sources of energy, it is seriously hoped that the fire problem inherent with any energy source will receive adequate recognition and attention."

Several energy source related projects were undertaken by ERDA (see the "Research" chapter), but little came of them - - or the projects to which they might have been applied.

The June, 1976 Journal contained an article on the Browns Ferry Reactor fire, but by two Nuclear Energy Liability and Property Insurance Association authors.

Ironically, the NRC had an FPE at the time, but he wasn't used. Dave Notley had been at SR and SNR (see the "People" chapters), but was not in the section that got involved in the actual investigation. NRC borrowed a person from ERDA. Andy Pryor, of Albuquerque was selected and did a superb job. NRC didn't listen to his true analysis, though, and went ahead with additional requirements that Andy had explained were not the real "root cause" of there problems.

The next Journal article was by Andy Pryor. Titled: "Browns Ferry Revisited." It was a short version of a talk he delivered at an SFPE session at Karlsruhe, West Germany in September of 1976.

Andy subsequently wrote a report on what. in his opinion, were the true lessons to be learned from Browns Ferry. It boiled down to "none" but with much more fascinating details. Another document that should be in every "nuclear fire protection" library, but undoubtedly isn't.

The various Ralph Nader organizations had been the most critical of ionization smoke detectors because of the "radiation hazard." The July, 1978 Journal contained an article titled: "Dose Rates from Various Smoke Detectors" by C. L. Graham, a health physicist at Lawrence Livermore Laboratory. Together with other articles and letters on the regulatory aspects, it helped quell the complaints.

This issue also contained a number of Don Keigher items; his appointment to the NFPA Membership committee; his membership on the Board of Directors; and his Executive Committee membership.

Of all the people in the history of AEC-ERDA-DOE, Don Keigher has been the one person who has contributed more to the NFPA then any other single individual - and probably more than the next two or three combined. His combination of committee memberships and executive participation has been unmatched by anyone. Considering the current state of DOE, it is doubtful if his record can be equalled in the future.

The next appearance is in the July, 1981 journal. An article by Dennis Kubicki titled: "Fire Protection and Rescue Planning for the NASA Space Shuttle."

Dennis was with NASA at the time, so the article isn't included on the "DOE" list. However. it is typical of several people, particularly John Sharry, in that prolific contributors to the field have been able to be recruited to DOE and help to continue the tradition of an extraordinarily high competence and a dedication to the field beyond their job requirements.

The November, 1981 issue noted that Albro Rile, LASL Consultant, had been appointed to the Member Advisory Council.

Albro was another of the many who gave far beyond their required level of performance. A retired veteran of the AEC-operated fire department, he worked for LANL as a trainer, consultant, Fire Marshall type. He was so involved in the community that his 1991 death was front page news in the Los Alamos paper and his funeral service was the largest the author had ever attended. The ideal Fire Marshall type, he was the personification of his community to the fire field and the personification of fire protection to his community.

The November, 1982 Journal contained a letter by Dennis Kirson, of Sandia, concerning Nursing Homes.

Another item that is not germane to DOE except that it is typical of the type of person the agency has been able to obtain in the past. So many people extended their knowledge and interest beyond their immediate jobs that the overall reflection on the agency in the fire community was one of a very high level of professional competence and interest, - an impression that was true.

In the March, 1983 Journal, John Sharry had his first article in which he was identified as the "LLNL Chief, formerly Assistant director of NFPA's Engineering Division." The article was "Real-World Problems With Zoned Evacuation."

The September, 1983 issue had an article: "An Evaluation of Wall Partition Systems For Wood-Burning Appliances." The article was by Loftes and Peacock of NBS and was one of four reports done for DOE on wood-burning stoves.

> *The articles are typical in another manner. While some research was safety-directed, a number of projects were done that the safety group at Headquarters had no knowledge of. In fact, the publication in "Fire Journal" was the first we had heard of them. Considering that was at a time when headquarters safety was centered in one organization, rather than fragmented as in the present organization, it is an indication of the problems inherent in the current system.*

In the May, 1986 Journal, a "Chairman's Profile" centered on NV's Pat Phillips as head of the Detection Devices Committee.

The same issue had an article: "Fire Endurance of Sprinklered Glass Walls" by Donald Beason of Lawrence Livermore National Laboratory.

> One of the more interesting items is that the above is the last entry in the Fire Journal up until mid-1991. The peak years were 1963 to 1977, as shown on the graph on the next page.[65] The publications story is not complete with the Fire Journal of course. many articles have appeared in other fire magazines and a number of authors, notably Pat Phillips, have been prolific in publications such as "Actual Specifying Engineer" outside of the general fire field. But, as the "senior" publications, the summary is certainly interesting, and perhaps a little revealing.

> Another item from the NFPA publications was the employment ads that began by the early 1980's. We have been collecting these. For the 1991-1995 period, there were ads from 32 consultant, insurance, or private firms for FPE's. In the same period, there were 13 ads from DOE or DOE contractors, for 15 positions. All other government agencies combined had only seven ads in the same period.

For the years from 1991 through 1995, there were no articles published that had been written by DOE people. There were a couple of letters to the editor, (including the author's March/April 1995 letter), an article by ex-AEC Ken Dungan, a reference to our sprinkler study experience, and a note on Livermore brush fire assistance. However, in the 1991-1995 issues, the new "Profile" series featured current and former people. Included were Ken Dungan, J. Blair (DuPont engineering), J. Sharry, W. Testor (Grinnell GDP project), Frank Brannigan, and Don Keigher. All except John Sharry dated back to AEC work.

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[65]. Remember, the NFPA "Quarterly" became the bi-monthly "Fire Journal" beginning with 1955. Although formats were not identical, one can say there were 50% more opportunities to publish after 1964.

IT WAS CRITICAL

..... in which we lean that a criticality accident can cause a fire but not shut a facility down, if you're unlucky; while a fire after a criticality can shut the facility down for good if you're stupid. Of the two, stupidity is worse than luck.

[AUTHOR'S NOTE: No fire protection history would be complete without a chapter on the fire vs. criticality controversy. While only one criticality accident created a fire, and no fire has created a criticality accident, the fear of water has been a prevalent concern.]

In the history of criticality concerns vs. fire concerns, which is extensive, as opposed to the history of criticality accidents, which is insignificant, the real concern for fire wins out over the pseudo concerns for fire protection caused criticality. There has been one case in which a criticality accident caused a fire. There have been no cases in which a fire or a fire protection system caused a criticality.

If the above isn't enough, the only time a criticality accident managed to shut down a facility, it wasn't the criticality contamination that did it, it was the fire contamination.

Criticality accidents are covered in WASH 1192, the 1975 publication of AEC accident and radiation exposure history and in TID-5360, a summary of criticality accidents published by the Los Alamos Scientific Laboratory's Critical Experiment Facility. The LACEF is the only criticality training facility in the free world and the source of much of the expertise in the subject. Both the AEC summary and the Los Alamos study represented the work of W. R. Stratton. (Updated by Dave Smith as DOE/NCT-04 in 1989).

There were 26 occasions in the 32 years of AEC history (1944-1975), when "the power level of fissile systems became uncontrollable because of unplanned or unexpected changes in the system reactivity."[66] On three occasions, the power excursions were planned; however, the fission energy released during the excursion was significantly larger than was expected. There were six deaths and $4,455,000 in property damage resulting ; however, half the deaths and 98% of the property loss was the result of a single accident, the military SL-1 reactor excursion at Idaho.[67] There were no criticality accidents during the last 7 years of the AEC and no injuries or fatalities the last 15 years. This record has continued to the point that we can add that, in the 17 post-AEC years, only one additional criticality occurred, an Idaho Chem. Plant incident.

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[66]This is the definition of a "criticality."

[67] The second-largest loss in AEC history and still the third-largest loss in AEC/ERDA/DOE history.

There were seven incidents involving metal systems in air atmospheres. One of these was the only one that resulted in a fire. This was the 03/26/63 incident at Lawrence Livermore Laboratory (as it was called at the time). The active material was 47 Kg of 93% U-235 in the form of a reflected cylinder. A too-rapid assembly resulting from a hang-up of the travelling mechanism, followed by a sudden release, resulted in 3.76×10^{17} fissions and a fire that resulted in $94,881 damage. About 15 Kg of the material actually burned (and 10 Kg melted on to the floor). Despite the dollar loss (second only to the SL-1 accident) the incident was confined to the small cell. The author visited the scene the following day and the only evidence that something had happened was the somewhat charred piece of binder paper taped to the edge of the table.

The above incident was unique in two respects: it was the only fire resulting from a criticality and was one of the few in which measurable property damage occurred. Of the 26 AEC incidents, 17 had no measurable property damage.

By contrast to the above, fire has not caused a criticality, and no fire protection system (the "classic" sprinkler water leak), has ever caused a criticality. However, we can say that the absence of a fire protection system worsened a criticality accident and created a pollution-control problem unallowable in this age of environmental concerns.

This incident occurred at the Hanford Works, Richland, Washington, on 11/16/51. A plutonium sphere of 1.15 Kg Pu $PuO_2(NO_3)_2$ 63.8 liters of water, 93% full unreflected geometry, suffered a criticality accident when a poison control rod was withdrawn too fast. This resulted from an attempt to gain some additional information after the completion of some volume measurements. In an attempt to determine where criticality might occur, a control rod was pulled with minor reactivity effect. Following this, a safety rod was withdrawn intermittently at a high speed. A waiting period for delayed neutron effect of about 15 seconds was made just prior to the incident. This was insufficient and a criticality incident resulted with a fission inventory of 8×10^{16} fissions. There was no physical damage as a result of the incident itself, but the incident resulted in contamination of the building. The resulting decontamination operation had been completed, except for the test room and assembly, when a pail of nitric acid-soaked combustible waste spontaneously ignited the night of 12/04/51. The contamination was converted to a three-dimensional problem by the fire smoke. What the criticality could not do, the fire did. Further decontamination was no longer feasible and the building was abandoned. The building was abandoned in place, locked and posted. The incident was covered in TID-5360, p.14, and the building abandonment in TID-5360, p.53. Another example of the "unknown" incidents that periodically come to light in the press as horrible "new" revelations, when an anti-nuclear activist bothers to read an old document.

The loss was charged off as $50,000, the value of the small building and equipment,[68] and the incident would have ended there
except for another factor arising in the 1970/s.

Following the Rocky Flats fire, the major effort to discover all possible safety "improvement" projects resulted in the inclusion of this facility as a "problem." What if a windstorm should destroy the building and spread contaminated materials across the desert? The result was that this was one of the post-Rocky "Fire, Safety and Adequacy of Operating Conditions" projects. The building was torn down and buried, as contaminated waste, in 1970 - - - at a budgeted cost of $300,000! (And that was not included as part of the fire loss). The building is one of the illustrations in Brannigan's "Living With Radiation, Vol. II, and was reprinted in the original version of this chapter.

The problem with criticality had always been considered a major one. Two of the early post-war deaths at Los Alamos resulted from criticality accidents and criticality protection was an early mandate and major concern. The effect of a new science and an exotic atmosphere helped to give it an importance out of proportion to its actual effects. Of course, the practitioner will point out that the safety record is largely due to the extreme care with which the subject is treated, The cynic, however, may point out that numerous people have survived a criticality accident in a room where the same weight of high-explosives or gasoline would have killed everyone in the room. Be that as it may, the problem of providing criticality safety resulted in some of the earliest fire protection problems, and some of the most enduring ones.

Since water is a moderator and reflector of neutrons, it is possible, under some extreme conditions, to have a system of fissionable materials sufficiently close to a critical assembly that the addition of water or water spray can bring the assembly to criticality. As history has shown, however, a criticality accident has never shut a facility down for more than a brief period[69] Fire, of course, has destroyed many facilities and the only "critical' facility shut-down was shut-down by the subsequent fire, not the criticality.

If you are concerned with assuring safety in the face of a single hazard, the ultimate is obtained when you can demonstrate that the subject is safe from any manifestation of that hazard; - - - and then the hazard is outlawed from being present! This is manifestly evident in the "hazard" of water. There have been several cases where a fissionable material facility (usually storage, was proved to be safe even under conditions of maximum water moderation, meaning flooded, and then sprinklers

[68] Note that this is another loss where the amount of loss is carried at replacement cost in the AEC history, even though no actual replacement of the facility was ever made.

[69] Both the 1945 and 1946 criticality accidents at LANL that resulted in fatalities occurred in buildings that are still in operation.

were prohibited as an extras "safeguard."[70] In earlier days, this was an aggravation, but not a severe problem to fire protection engineers since the areas were generally quite free of ordinary combustibles, at least initially. Unfortunately, the practice spread to the point that water and fissionable materials were frequently deemed incompatible, always to the detriment of the fire protection water.

The subject is easier to define in this day of computers and advanced modelling techniques. The result is that there is no longer any excuse for blanket prohibitions, the subject should be demonstrated to be a real hazard. In fact, this has been done in major facilities for many years. For some reason, the word never seemed to get around to the extent that story of supposed "water damage" does.

Some of the earliest work in better defining the actual hazards was done by General Electric at Richland in he early 1960/s with the encouragement and support of the Safety and Fire Protection Branch Chief, Don Keigher. The result was a 5/15/64 issuance on "Nuclear Safety Guidance In The Use Of Water To Fight Fires In CPD (Chemical Processing Department) Facilities." Risk categories from "A" to "D" were defined. "A" was zero risk and "D" was where the normal or fire-caused configuration could become critical with the addition of water. The analysis included the Purex process, hot cells, caves, canyons, glove boxes, process boxes, storage and transportation areas and facilities, and others, The only items ending in the "D" category were some process and inspection hoods in the weapons line and 3 hoods in one room of one laboratory. Extensive discussions and explanations accompanied the list and the whole package was distributed to all the AEC's Operations Office Managers by the Director of the Division of Operational Safety on 7/23/64. Unfortunately, the wheel had to be reinvented on many occasions after that. The 33-page document was destined to become another of the many good "memos" that got lost because there was no system for retaining the pertinent fire documents. As new people replaced the old, the corporate memory receded and the questions that had once been laid to rest were reinstated. Like the computer-sprinkler myth, the criticality-water myth is one of the most enduring in fire protection.

The Richland work prompted others. Like most such work, much of the specifics have been lost, but Dick Beers at Idaho was instrumental in getting the Phillips Petroleum Company[71] to broaden their Standard Practices manual to include more specific procedures for firefighting in fissile materials storage areas. The 3/7/66 manual addition established four classes of storage, all of which allowed water in some form. Only the fourth class was severely restricted, being limited to the traditional non-water agents. Even in this category, high-expansion foam was permitted.

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[70] Note that the water prohibition is "sprinklers." It seldom was applied to other water systems. Those trying to protect electrical areas will recognize the syndrome.

[71] Yes, a petroleum company ran the site. Most of the better American industries once had nuclear affiliations, in this case, Phillips' Atomic Energy Division.

The Idaho manual listed 33 fissile materials areas where there were no restrictions on water of any kind. There were 16 where water was limited to sprinklers, low-velocity hose, and portable water extinguishers. A single vault was low-velocity water fog, foams, and "broken spray from hand extinguishers." A storage corridor in the Chemical Processing Plant was the sole location where water was limited to high-expansion foam.

Following the Rocky Flats fire in 1969, a large number of sprinkler installations were added throughout AEC, many in locations previously considered unthinkable. The issue gradually disappeared, not because the "problem" had been resolved, but because fewer new facilities were built and protection in existing facilities came to be taken for granted.

By the 1980's, the advent of personal computers, greatly expanded fire research, and the growth of more detailed fire hazards analyses in extensive "Safety Analysis Reports" led to reconsideration of the water-criticality interface. The most useable data was incorporated in Professional Loss Control's report by Wayne Holmes, P.E.. Titled "Fire Protection By Sprinklers Where Fissile Materials Are Present", it was a delivered paper at the International Symposium On Fire Protection And Fire Fighting In Nuclear Installations held at Vienna, Austria in 1989.

The Holmes paper began by citing the international nuclear standards, which said sprinklers "should be installed in <u>all</u> areas of the plant", and the NFPA standard which contained strong, if advisory, comments on the use of water. DOE data and historical experience was also quoted extensively. The meat for calculations purposes came in the section on sprinkler drop sizes and calculations of sprinkler mist densities. A number of sources on density vs. criticality considerations were cited from Factory Mutual and American Nuclear Society papers and culminated with plots of density vs. neutron multiplication factors. The conclusion was simple:

> "Fires, including those which may occur in areas containing fissionable material, can result in significant damage and endanger personnel. Suitable fire protection should be provided where combustibles are present. Fire sprinkler systems should not be excluded simply because fissile materials may be present. The effects of mists developed by sprinklers can be predicted and should be included in nuclear criticality safety analyses."

One of the principal faults in most of the early analyses was the assumption that water would interact with the material, even though the material was in a storage area in unopened steel drums that would never have the contents exposed. This was generally compounded with the "requirement" that there would be no combustibles in the area. Unfortunately, the building plans may have shown no combustibles, but the practice was generally one that was impossible to enforce. Typically, the combustible contents were present much more often than exposed fissile materials. Early solutions sometimes resulted in sprinklers with shut-off valves. The sprinklers could be in service the 99% of the time they would be desirable and shut-off the 1% of the time materials might actually be exposed. With the new spray calculations exemplified in Holmes' paper, there is no longer any justification for half-way measures. Any storage facility should be able to be designed as fully criticality-safe, even with all sprinklers operating.

A personal experience is one of the best examples of being sensitive to a problem while overlooking the real problem. In our early days, we were called on to look at a newly sprinklered trans-uranium facility. There was a small vault, several feet deep, in the floor and the operator was concerned that water from overhead sprinklers could flood the vault and cause a criticality. If the concern was real. then the single tree had obscured the giant forest. The only other occupancy in the approx. 20' x 40' room was a large water isotopes storage basin, extending about three feet above floor level. The basin was filled by a garden-hose type faucet which was turned on and left to slowly refill whatever had evaporated from the tank since the last time it was topped off. There were also four hot water heaters suspended at each corner of the room at ceiling level and fed by a supply loop of hot water with another loop for the return. It takes very little accident analysis capability to visualize some possible accidents, of which sprinkler leakage must surely be the least. The fact that the incident happened about 1963 means only that it is ripe to happen again.

THAT'S AN ORDER!

....in which we learn that the fire protection program is not only among the oldest safety programs in DOE, the fire protection policy is older than DOE -- or ERDA -- or AEC -- or even MED and it hasn't changed all that much in 50 years.

[By early 1966, the basic DOE documents regarding fire protection were in a state of flux. A draft Order revision had been prepared and accepted by the DOE fire protection community when the entire Order system was changed. Rules, Guides, Standards and other items became the new system. Rules were the mandatory requirement, but frequently were only general (and fire protection was not even a "Rule" of its own) with the meat being contained in the "Guides" and "Standards." In view of the mixed and changing state of affairs, it is well worthwhile recording a history of what was once a well-understood and smoothly operating system.]

Contrary to popular opinion, safety has always been a strong program in DOE and its predecessor agencies. Fire protection was one of the "founding fathers" in safety organizations in the original Atomic Energy Commission and even in the war-time Manhattan Engineering District. The "Order" governing the fire protection program, however, precedes any of them. The fact that it still survives in basically the same context is a tribute to the nation's professional fire protection people and their earliest and best practitioners; the insurance industry and their "improved risk"[72] class of insured properties.

The "improved risk" concept of fire protection was developed among the textile mills of New England when some owners after the Civil War developed superior construction standards[73]. These were so successful in reducing losses that owners began to form their own "mutual" insurance companies to take advantage of the better record obtained by superior construction. Coupled with the invention of the first practical automatic extinguisher (sprinkler) systems and their immediate application to the textile industry, the record of the mutuals became so impressive that the stock insurance companies had to adopt the same system, or lose their business to the mutuals. "Improved Risk" was a standard term and a standard philosophy of protection by the start of the 20th century. It even gave birth to the National Fire Protection Association, but that's a different story, well told in the many NFPA historical books and articles.

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72. Synonymous with "Highly Protected Risk" with some insurers.

73. The best early construction was "mill" construction, implying not only what it applied to, but from where it came.

It is not surprising that industry-oriented government agencies like AEC would adopt "improved risk" practices or that the early war-time bomb project would do the same, since the companies involved were almost all in the same classification, but the real reason goes even deeper. The heart of the concept was usually defined as a strong management interest in protection programs, coupled with superior construction, protection, and practices (including prevention, maintenance, self-inspection, fire brigades, etc.). In fact, by the 1930's, anybody dreaming up an idealized program would probably write down just the elements that had come to constitute the program. It was the application of the program, not the elements, that established its superiority as a property and business preservation system.[74]

The Federal Fire Council was established in 1930[75] as an interagency, (following a Christmas Eve fire in the White House and a January 3 fire in the Capitol) informal information exchange group of federal fire protection people; a limited membership, indeed! In 1936, the Council was formally chartered by Executive Order and assigned to the NBS Director in the Department of Commerce, the first of many homes. One of the first efforts was to develop a "Manual of Fire-Loss Prevention of the Federal Fire Council." From the first, the improved-risk concept was defined and recommended as the standard for all government agencies.

By the time the first AEC standard was promulgated in 1949, the application was already old. In addition to the existence of the Manual, the earliest Manhattan Engineering District fire protection staff included Major R.E. Johannesson[76], formerly with the Air Corps, National Bureau for Industrial Protection, and Factory Mutual. It was thus natural that the improved risk philosophy was being applied long before the AEC was even established. The prototype of the Hanford production reactors was built in a sprinklered Oak Ridge building and the first water reactor was in a war-time temporary wood building[77] at Los Alamos and it was also sprinkler protected.

The first issuance of an AEC document specific to fire protection occurred on 12/14/49. This was a draft of what was then called "General Managers Bulletins". In this draft, "normal" fire protection was defined as being synonymous with "improved-risk" as used in the insurance trade and the AEC policy would be to establish and maintain a level of fire protection equivalent to the standard for facilities enjoying an "improved-risk" classification in the fire insurance trade. It noted that "Improved-risk fire protection requirements are further described on p.101, 1945, 2nd edition of the Manual of Fire-Loss Prevention of the Federal Fire Council."

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74. The realization that the principal hardware of the system, the automatic sprinkler, was also the best life safety and environmental protection system, would come later.

75. The organizing influence was 60 people meeting to discuss three major fires in D.C., two in the Capitol.

76. See page IV-1.

77. Still standing, of course.

A 1954 "pen-and ink change"[78] order was issued to delete the reference to the 1945 FFC Manual, as a change was in the offing. Indeed, the third edition was prepared by the Council and issued in 1955. Copies of the 187-page manual were available at least through 1964, when it was among the list of FFC publications in an appendix to their annual report.

Richard B. "Dick" Smith[79], with AEC HQ (by way of DuPont, Savannah River and Richland) was one of the original AEC fire protection engineers and was Chairman of the Fire Prevention Committee of the FFC in the 1960's. The 1964 annual summary noted that a revision was being prepared, but the project never was completed before the demise of the FFC.[80] The lack of the federal manual[81] was of little consequence, however, as the AEC had long since established its own program.

Through the AEC's life, the "Manual Chapter" (as the system became) had seven editions or partial revisions. In the brief life of ERDA, there were two issuances, and four in DOE (including a re-issue that wasn't) until the 1992 revision was finally issued. Although numerous, there were few real changes over the long life, a tribute to the basic soundness of the philosophy. Some of the details, however, remain of interest, and are further described below:

THE FIRST EDITION

Somewhat of a collectors item by now, the General Manager Bulletin, No. 158 (which had originally been issued as GM-SFP-5) was issued to the field as a draft on 12/14/49. In typical AEC fashion, but unheard of in present-day DOE, the field and headquarters comments were received and incorporated in a revision and sent back out as of 2/21/50. Even more amazing, the document was reviewed, finalized, signed by the General Manager, and sent out as GM-158 on 3/15/50! Pertinent requirements of the brief, 4-page document were:

1. The definition and discussion of "improved risk", mentioned above, lead off the requirements.

2. It was stated as AEC policy that AEC would provide or supervise fire protection engineering coverage and advice for all facilities in which the AEC had a monetary

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78. One of the earliest, and simplest, of the "Formality of Operations" precursors.

79. See p. IV-4.

80. A stupid Freshman Congressman and an ignorant news media combined to eliminate the Council, but that's a different story.

81. The FFC library had been given to the NBS library. By the time the author finally got there to examine the old FFC records, they had largely been expunged and a copy of any of the editions of the Manual has never been recovered.

interest. (As a practical matter, Operations Office Managers could omit coverage of facilities having an investment less than $10,000.

3. Each Operations Office would maintain a list of facilities qualifying under the above and each would have a complete fire inspection by the Operations Office at least once a year. In addition, facilities stockpiling SS materials, essential bomb components, or critical materials, or at which uninterrupted production was vital to the AEC mission, would be inspected "as frequently as conditions warrant", but not less than twice a year.

4. Inspections by the Operations Office would have as their objective; the evaluation of fire hazards and the submission of a written report to responsible line management covering recommendations for appropriate action.

5. Effective 5/1/50, an annual summary of the fire program and experience would be submitted to the General Manager of the AEC[82] and include:

a. Major accomplishments of the year.

b. Major objectives for next year.

c. Summary of fire losses, including causes, and numbers.

d. Summary of operating expenses for fire protection and prevention.

e. List of AEC properties and inspection schedules.

f. Description of any fires causing over $500 in loss.

6. Commencing 5/1/50, the Washington Safety and Fire Protection Branch, would prepare an annual summary for the AEC General manager, containing the above information.

We leave it to the reader to compare the first and latest, and decide how much progress has been made.

Looking at the subsequent Orders from the standpoint of the subjects that were addressed, rather than chronological changes, we can review some of the developing consensus opinions that were becoming codified as subsequent revisions were issued, or new topics introduced:

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[82]. Note that, 43 years later, the fire protection program is still the only one that does this, and thus is the only one that can document its success, as noted in Chapter XVII.

INSPECTIONS AND APPRAISALS

With a new directives system adopted by AEC, the directives became "Manual Chapters" and the Fire Protection "GM" became the Manual Chapter 0552 (0500 being the safety series). The title word "industrial" was inserted to distinguish it from "municipal". The AEC ran three towns, each with municipal fire protection and there was to be a separate Manual Chapter covering fire protection requirements for the government towns.

The principal change was to alter the target level for surveys from $10,000 to $50,000. This was considered highly desirable for an Operations Office manager's option since there were a number of manufacturing sites, particularly in the Albuquerque Operations Office complex, where contractors had no government property but a single machine which, by itself, exceeded the survey trigger value. (AL made a number of cycles of surveys of these supply contractors. Generally, they were already improved-risk insureds and there were no additional protection requirements deemed necessary).

The trigger-level for surveys was changed to $100,000 in a 6/27/58 revision.

In a series of 10/36/61 changes, the purpose of the field fire protection surveys was expanded to include: "b. Evaluate the adequacy of the local fire protection and prevention programs for the protection of AEC property." This was the first indication that contractor sites would have programs and people dedicated to protection. The earlier versions had addressed the subject as if the AEC fire protection engineers were insurance company inspectors. The complete plant was inspected without regard to what the plant people did themselves although, like the insurance companies, AEC generally required self-inspections, equipment tests, fire brigades, impairment program, and all the other attributes of an "improved-risk" facility.

The 10/30/61 change also changed the property value trigger to $1,000,000 for annual surveys (the conditions requiring semi-annual surveys were unchanged), and facilities with values between $100,000 and $1,000,000 could be inspected at up to 5-year intervals if:

a. An initial survey had been made.

b. The facility would be surveyed by non-AEC fire protection engineering personnel.

c. A loss would not seriously affect the continuity of an AEC program.

d. Fire would not present an unusual hazard to the public, and:

e. An annual review was made to verify the above conditions.

A revision of 5/27/65 changed the qualifying conditions for facilities requiring semi-annual surveys to; "Facilities at which uninterrupted operation is vital to the mission of the AEC."

A 7/7/66 revision defined property in much the current terms, at the request of a number of field staff, and added an extensive paragraph clarifying that the intent was not to apply the Chapter to such regulatory activities as licensed power reactors.[83] It did, of course, apply to Naval Reactors and all other government-owned property, unlike the latest policies.

When AEC became ERDA, one of the usual first courses of business was to revise all the AEC Manual Chapters to become ERDA documents. This became effective 10/8/75. It was still Manual Chapter 0552, however.

This ERDA document was the first in which the post-Rocky Flats fire (see Chapter X, XI, and XII) insurance survey program was incorporated in the Manual Chapter as official policy.

The ERDA version also changed the survey requirements (still surveys of the contractors by the Operations Offices) to include semi-annual surveys at facilities where $25,000,000 or more was invested in a single installation and the permissible level for surveys at up to 5-year intervals was changed to a $250,000 to $1,000,000 range.

The first of "major" changes occurred when ERDA was transformed to DOE in 1977. This placed a greater variety of facilities, run by a greater assortment of operators, from all-government to multiple contractors, and performing widely disparate activities under one roof. Inevitably, the fight to maintain the superior fire protection program as a one-size-fits-all activity was to take some lumps. The results were incorporated in the now-infamous "Order" system adopted by DOE.

A "safety" Order was the first result of the new policy and fire protection became Chapter VII of Order 5480.

The most visible change was the deletion of the requirements for any inspection or appraisal at all. Only the requirement that the field organization maintain a list of facilities and designate the frequencies remained. This was not considered too destructive as the appraisal requirements, including frequencies, were to be incorporated in a new Order specifically addressing appraisals. Despite a long history of bad experiences "shoehorning" disparate activities into a single format[84], the author accepted the "intent." Unfortunately, the result was that the new appraisal Order did finally come out, but with no frequency requirements for anything other than a management appraisal every three years! Needless to say[85], the next few rounds of HQ appraisals of field offices uniformly found that the fire protection (and other discipline) appraisals had deteriorated (from 130+/year in the 1970's, to less than 30 in 1987). Since there were no frequency requirements in the Orders, the only

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[83]. Which the astute reader will recognize as the greatest failure in NRC history - - and nine years before there was an NRC!

[84]. The astute reader will recognize the first description of a Tiger Team.

[85]. Nobody complains when you don't come around to appraise them.

recommendation we could make was for a discipline-appraisal at least between the 3-year "management" appraisals.

Revisions were made to the Order on many occasions, with "final" versions being presented to field fire protection conferences in 1982, 1984, and 1985; the revisions always being "imminent." There was a period when the "nuclear" Orders had to be revised first, and then a period when we were waiting to revise all the "non-nuclear" Orders as a package. When the final decision to go for the revisions was made, (a panic move as usual), we handed over the last "ready-to-go" package, already "ready." This made the coordinator happy until he had to return it some days later, saying that it was a revision. Of course, that's what it was supposed to be, but in the rush to get a new package out, only changes in references were made. The only real change was for the worse, as explained later. Thus the 1980 Order became a "Reprinted 1987" Order with accumulated deficiencies still in place.

Dauntlessly, the author plodded on with additional Order changes until our retirement in 1989. The last great change actually got sent to the Assistant Secretary for Administration, for review and publishing, until wiser heads prevailed. As the cover letter with this revision stated, some of the changes included:

1. Headquarters safety was reduced to a "life saving and regulatory" role, assigning all property protection functions to the Assistant Secretary for Administration.[86] (MA)

2. The "loss preventive appraisal program" would also go to MA.

3. The "independent appraisal program" (Factory Mutual) would also go to MA.

4. The inspection frequencies that had been eliminated, were restored to the Order, basically requiring the field to make appraisals at the same frequency as the pre-1980 Orders.

Nothing came of the proposed revision and results in obtaining a needed revision had to await the recruitment of a new staff and a new philosophy. The final red-letter day came in December of 1992, as the efforts of Dennis Kubicki, a small HQ group, and a field ad hoc committee, paid off in a new Order. The inspection requirements were restored in a modified form, but requirements were included for appraisals by not only the field office, but for self-appraisals, at stated frequencies, by the contractors, a first.

Unfortunately the 23-year old independent appraisal program (the Factory Mutual program) was dead, but then, you can't have everything.

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86. Who had no fire protection staff and who was not consulted on his great new responsibility.

In 1996, the fire protection Order was eliminated and fire protection requirements were included in a "Worker Safety" Rule and a facilities design rule. A Fire Protection Guide contained the meat of the program, although it was no longer mandatory.

GOALS

The "Purpose" section of the AEC Manual Chapter stated that it applied to industrial installations, "as distinct from municipal fire protection or construction". This was deleted by a "pen-and-ink" change on 5/10/64, as it was felt that the industrial protection philosophy applied equally well to construction. The "pen-and-ink" change was formalized in the printed revisions of 7/23/58, along with deletion of the reference to the 1945 version of the Federal Fire Council's manual.

A number of changes in a 10/30/61 revision included expanding the definition of "improved risk" (since the references to the FFC Manual had been deleted) and criteria for evaluating an "improved risk" were added.

The first addition of an "Objectives" section, stating fire protection goals, appeared in the first ERDA Manual Chapter 0552, which was issued on 10/8/75. The goals were first stated as:

a. There is no undue hazard to life from fire.

b. No significant offsite pollution or contamination would occur because of fire.

c. Automatic extinguishing systems would be provided to limit the credible loss from fire to less than $1,000,000.

d. Areas or values would be limited to the extent that failure of an automatic system would not result in a loss greater than $25,000,000.

e. No vital programs would be curtailed as the result of fire.

An Appendix to the manual Chapters existed, which included general information distinct from the "Thou shalt" approach in the Chapters, themselves. The 0552 Appendix was modified in the ERDA issuance to further define the conditions under which the "goals"would be considered as being met. This included the phrase that the life safety goal was considered to be met when the "intent" of the NFPA Life Safety Code was met. This originated from the fact that a number of Life Safety Code requirements could not be literally met at a nuclear facility when containment for supposed "public safety" precluded some LSC provisions.

While a number of changes were suggested, and several "draft" Orders existed, this remained the statement of goals until the years of rewrite efforts were finally completed with the approval of the revised Order in December of 1993. The additions to the goals in this last Order included:

a. Minimize the potential for the occurrence of a fire. (Note that this became the first goal).

d. Ensure that process control and safety systems are not damaged by fire or related perils.

The other goals were substantially as originally stated, although slightly reworded. The section on meeting the goals was no longer present, but was replaced by a number of specific requirements for protection and additional requirements for analysis.

ANNUAL SUMMARY

The subject of annual summary reports and their contents is the meat of Chapter XVII. Some of the Order considerations date back to the first GM Bulletin. The requirement for an annual summary became effective on 5/1/50 with the list of items noted under the paragraphs on the first "Order", above.

The first change was the issuance of AEC 0552 Appendix on 1/16/56. This included a suggested format for the annual report, including reporting all incidents where total property damage exceeded $50. Another "pen-and-ink" change was made to section 6 of 0552 to read: "See Appendix 0552-06 for suggested format."

A major change in the requirement included adding a section on "Property Damage Vulnerability of AEC Projects" and was to include a list, with brief remarks, of locations where upwards of $100,000 in loss or serious interruption to important operations could reasonably be anticipated. This was a valuable addition as the mere fact of the listing resulted in efforts, frequently successful, to eliminate buildings from the list. Although never utilized by AEC/ERDA/DOE as the tool it could have been[87], it was of valuable assistance to fire analysis and appraisals.

A second addition was to include a section for "Observations, Conclusions, and Recommendations." It was intended to include suggestions for basic changes in AEC regulations or to point out especially important risks, as well as summarizing any conclusions the field organizations wished to present to Headquarters. As such, it became a valuable tool for planning conferences, new "AEC Guide" needs, and feeding back compliments to the field.[88]

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[87]. We heard a number of "How does Maybee know these things?" remarks over the years from people who never bothered to find out what was going on or what was routinely reported. They thought everything was done as "secretly" as they acted.

[88]. Of course, some things, such as Nevada's frequent comments on valuation problems, never did get corrected.

The 6/27/58 revisions required copies of the annual report to be furnished to the Operating Division Directors, with copies to the Division of Organization and Personnel, instead of to the General manager. This was an early attempt to involve the operating groups more directly in safety, but without a great deal of success.

The 10/30/61 revisions made March 15 the submittal date.

With the ERDA issuance of 1/12/76, the summary format was removed from the 0502 Appendix and placed in Appendix 0552, with other report forms. This eventually resulted in the requirement for the summary being in one Manual Chapter (and later Order), the format in another, and the due date in a third location. HQ eventually realized that a new memo stating the requirement was needed every year. This proved advantageous, since it also offered the opportunity to request any special information desired.

The latest December, 1992 revision places he requirement for submitting the summary on the field offices, with the format listed in the 5484.1 Order that covers reporting requirements. A special letter to remind the field and specify additional specific subjects for the summary is still sent out, however.

EXEMPTIONS

The subject of exemptions has been a problem since the 1969 Rocky Flats fire and the "Fire, Safety and Adequacy of Operating Conditions" emphasized the need for handling deviations. In fire protection, the "exemptions" had been from code requirements, not the codes themselves, so the "Authority Having Jurisdiction" (the field fire protection engineer as usually defined) was the solution to any perceived fire problems. Unfortunately, as usually happens in the "one size fits all" mentality, the subject of exemptions became a significant problem, and worthy of a Chapter of its own in this history. From the standpoint of the Orders, though, the fire part is rather simple.

The exemptions procedures were established after the Rocky Flats fire and went through a number of modifications in practice. It was not until the ERDA Manual Chapter 0552 was issued on 10/8/75 that the duties of headquarters and field staffs relating to exemptions and exemption requests were defined in the Chapter. These were a reiteration of the post-Rocky Flats policies.

The 1993 version of the Fire Protection Order lays down extensive requirements on all contractor, field, program, and HQ offices for exemptions of temporary and permanent nature and from different levels of standards. As was the case a few years back, the problems became so intransigent that HQ people were making strong efforts to avoid "exemptions" by defining "equivalences." This is a significant part of the latest Order, but the requirements are more appropriately discussed in a chapter on the subject.[89]

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89. Suffice to say, an inventory some years back revealed that, of several hundred exemption requests in the early 1970's, all but three were from fire protection.

CHANGES

Every safety manager since AEC became the political agency, ERDA, in 1975, has claimed they were going to initiate a "fast track" system for issuing directives, orders, requirements, or what-have-you. As exemplified by the fire order history, the situation has never improved, it has only gotten worse. The time span involved with the first GM requirements is cited above. In total, AEC issued changes to the 3/15/50 original Fire Protection Manual Chapter on;

2/9/54, 5/6/54, 1/19/55, 1/16/56, 6/27/58, 10/30/61, 5/27/65, and 7/7/66.

The ERDA fire protection document was issued on 10/18/75 and revised once on 1/12/76, in the brief 3-year life of ERDA.

The DOE Order was issued in 1980 and reprinted in 1987. It was finally issued in revised form in December of 1992, although revisions were always "imminent" under one "fast-track" system or another. To wit:

The October, 1981 Fire Protection Conference of DOE reviewed the Order and concluded that restoring the former Chapter on Mutual Aid[90] was the only significant revision needed.

The October, 1982 Fire Protection Conference discussed a complete revision, including updating dollar losses to account for inflation and incorporating new DOE policies.

The February, 1984 Fire Protection Conference included a review of the changes included in the revision to be issued "shortly."

Due to organizational changes[91], a number of editorial changes had to be made and a revised mat was finally ready for processing on 1/14/85.

At the contractor and DOE Fire Protection Conference in March, 1985, almost an entire day was spent on a detailed review of the "imminent" changes.

Although ready, the revision was placed on hold as it was "necessary" to get the revised "nuclear" Orders out first. When some finally got issued, we inquired again, and found that it was necessary to wait until all the "non-nuclear" were ready to go as a package. When the package was ready, it was discovered that the process couldn't accommodate changes, it could only reissue with

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90. Omitted by "accident" when the great ERDA consolidation and revision was underway.

91. One of the most common reasons Orders always have to be changed at the last minute.

updates on the references, dates of other documents, etc. Accordingly, the 1980 Order was reissued in 1987, supposedly with no changes.

Unfortunately, the 1987 "reprint" changed an allowed loss-limit escalation factor from using the January, 1980 Factory Mutual data list to the January, 1987 Factory Mutual data list. The 1980 to 1987 escalation was about 1.7, making a considerable difference in the levels at which protection was required.[92]

The new Headquarters fire protection engineers reinstated the effort for revisions in 1990, forming a DOE Fire Protection Committee to assist and support the revision effort. Unfortunately, the number of additional offices in the review and approval chain, each with some delegated fire protection authority, resulted in additional delays. Thus the last (first?) revision of December, 1992.

THE MISSING MUTUAL AID

Congress enacted Public Law 46 (Title 42 USC, Section 1856) in the 84th Congress. Like many motherhood laws, it merely codified existing practices and encouraged government fire departments to formalize mutual aid arrangements as long as there was no specified cost or liability incurred. The result was AEC Manual Chapter 0555, Mutual Aid Firefighting Agreements, approved 5/21/63.

The short Manual Chapter merely stated that it was the policy of AEC fire departments to enter into mutual aid agreements with other fire departments, in accordance with the law. In the absence of such agreements, AEC departments could provide emergency assistance in the vicinity of AEC installations where such assistance was in the government interest and did not excessively endanger the firefighting capability for emergencies at AEC plants.[93]

When the Orders were rewritten with the formation of ERDA, and subsequently DOE, the one on mutual aid was overlooked and disappeared from the system. It was the intent, since about 1977, to restore it to the system. It finally made it in the 1992 revision where Section 9.b.(7) on Fire Departments says that fire departments (DOE or contractor-operated) may enter into mutual aid agreements per the cited law. (Phew!)

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92. But no major field problems resulted. Apparently, it was "close enough for government work."

93. When the final agreement for Livermore was ready at the SAN office after a year of legal work, we couldn't figure out what was different from the "non-legal" working arrangements already in force!

THE NON-INDUSTRIAL CHAPTER

During, and for some years after WW II, the AEC owned and operated the municipalities of Oak Ridge, TN; Los Alamos, NM; and Richland, WA. GM Bulletin 138 was established on 8/1/49 to provide requirements for municipal fire protection. The Bulletin was subsequently reprinted, unchanged, as AEC Manual Chapter 0551, Municipal Fire Protection, on 2/4/54.

The provisions of the Chapter were to:

1. Provide a level of protection equal to the upper quartile for municipalities of similar size.

2. Establish the standard of the National Board of Fire Underwriters (NBFU) municipal grading system. Oak Ridge and Richland were to achieve a Grade 3 rank and Los Alamos a Grade 5.[94]

3. Each Operations Office was charged with making annual municipal surveys.

4. Each community was to request NBFU grading at 5-year intervals,

5. The Safety and Fire Protection Branch of AEC Headquarters was to make annual appraisals of the overall fire protection in each community.

6. An annual fire summary would be submitted for each community, similar to the requirements for the industrial facilities.

The Manual Chapter was cancelled on 3/1/63 as control of Oak Ridge and Richland had been relinquished and similar action had been initiated for Los Alamos.

THE CODED CODES

The reference to mandatory codes and standards was treated very simply. The first AEC regulation, Safety No. 3, of 1947, simply stated that the NFPA codes were the basic standard.

Bulletin GM-133 was adopted on 6/10/49, replacing the above and citing the National Fire Codes (all 5 volumes), the 1949 Uniform Building Code,[95] and the Underwriters Laboratories List of Inspected Appliances, Equipment, and Materials, as the basic AEC standards.

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[94]. When researching the subject for the "Caves Report", we affirmed that all had achieved the goal.

[95]. And 1989 Tigers were zinging 1944 buildings for not complying with the 1991 Uniform Building Code!

The Manual Chapter system resulted in establishing AEC Manual Chapter 0550, Codes and Standards. It was a reprint of the above, without substantive changes, and was itself revised on 8/29/57 without changing the fire protection portion.

It was the 8/20/62 revisions to 0550 that resulted in the first changes in fire protection requirements. Listed as mandatory standards were he National Fire Codes, Uniform Building Code, and AEC Manual Chapter 0552. A list of "guidelines" was added for the first time, and this included, the Factory Mutual Handbook (later to become the Data Sheets), the NFPA Handbook, and two since lost to obscurity, the Federal Fire Council's Manual of Loss Prevention and a book be Charles W. Baume titled "Fire Protection for Chemicals."

The UL lists were still included in the 8/20/62 revisions, but they were listed under the general safety provisions.

All editions had carried the now-familiar proviso that where there was a conflict in requirements, the one providing the higher level of protection would apply.

A number of revisions were made as AEC became ERDA and ERDA became DOE and additional safety and environmental topics were added to the standards lists. All, however, retained the basic reference to the NFPA codes as the mandatory requirement. The 5/15/84 revision listed the NFPA codes, UL listings, two DOE-developed standards. Reference standards were FM, the old FFC'c RP-1 computer recommended practice, and the NFPA Handbook.

There is a current drive by DOE to place the standards references in the Orders, rather than in an Order of their own, and the 12/92 revision of 5480.7A does just that.

GENERAL DESIGN CRITERIA

For many years, the AEC maintained an engineering division in headquarters that was one of the larger units, as was also true of a number of field organizations. (The SAN Engineering Division was the largest San Francisco Operations Office group in 1962). A design manual was developed over the years, with building limitations, such as 5,000 sq. ft. for unsprinklered, combustible construction, that added to the fire requirements. Most of the document, however, simply repeated the guidance given in the fire protection documents.

Engineering became more "management" oriented, and less "engineering" oriented and by the 1980's was heavily into contracts, procedures, and reports. One of the projects was a contract with an A/E group to rewrite the design criteria in the same format, numbers, headings, etc. as the standard set of A/E specifications. This took several years and was complicated by a desire to add sections on special facilities, while the people in the safety organization were reluctant to contribute.

The fire protection subjects in the new Order, 6430.1A, General Design Criteria, were developed by the author initially. After several field review versions were distributed, the comments were so voluminous that a "coordinator" was assigned for the safety organization and people who weren't "coordinators" gratefully left the resolution of comments to them. The result was somewhat less than adequate review by some organizations.

Since this author had the initial fire protection effort for a renewed 6430.1A, we wrote the sections based on the draft of the fire Order, 5480.7, which was "imminent" after all. Unfortunately, when the 6430.1A was finally approved on 4/6/89, it contained a number of conflicts with 5480, which was not to be issued for another 3-1/2 years. Since this author left within six months, there are still some conflicts and a major current effort is resolving new comments on a to-be revised 6430.1A Good luck to all.

XXIII

TINY BUBBLES

..... in which we learn that AEC was once again installing unapproved fire protection systems, but it was alright; the AEC was installing complete protection systems before there even was anything to approve, or a standard to approve them by.

[AUTHOR'S NOTE: One of the recurring themes of AEC/ERDA/DOE fire protection was the introduction of new fire protection systems and equipment, often before there was an accepted standard for the installation. The support of Frank Brannigan for high-expansion foam, Pat Phillips for a number of detection systems and devices, Bob DeMombrun for cooling tower sprinklers, and Tom Franck for halon, were all instrumental in advancing the art. Many systems were installed in DOE facilities before the NFPA standards were developed, a cause of some amusement when subsequent appraisers would ask why some system "didn't meet the standard."]

In the early 1960's, the great new light on the fire protection systems horizon was high-expansion foam. Essentially a soap bubble-like material, it could be produced rapidly in such great quantities that it was practical to flood an entire building in a short period of time. In addition, the actual water content was so slight that the old bugaboo of "water damage" was practically eliminated. Potential applications ranged from the basement-flooding to high-piled roll paper storage; from electronics protection to criticality concerns. Applications were made in each area. As usual, the Atomic Energy Commission was a leader in adopting systems to new applications, developing test modules for unusual situations, and demonstrating potential uses to the public. Each of which had been demonstrated in AEC facilities before the first NFPA Standard on the subject was even a draft.

The development of high-expansion foam (up to 1000 times the concentrate volume) was begun by the Safety in Mines Research Establishment of Buxton England, in coal mine fire studies. The initial U. S work and first systems were under the auspices of the Safety Development Corporation. Factory Mutual approved the first use of a hi-ex foam system in 1962 and a truck-mounted unit was Safety Development's first demonstrator, touring the country in 1963. We saw our first demonstration at Rodeo, California in December of 1963. Other demonstrations were conducted with Livermore and Berkeley laboratory participants at Camp Parks California. This first truck was intended for a Firestone plant, but was subsequently acquired by the AEC's Idaho Operations Office Fire Department and served for over 20 years there.

A number of AEC tests were conducted at numerous sites and the first documented result was a report: "High Expansion Foam Test on Simulated Nuclear Fuels and on Scrap Zirconium", issued as Health and Safety Information Bulletin No. 175, from AEC Headquarters in 1963. In the same year, the Lawrence Livermore Laboratory had developed a small high expansion foam generator for possible use in glove boxes and a number of tests and demonstrations were run on the unit. The Factory Mutual glove box protection project for AEC was just beginning at that time and we accompanied numerous visitors on demonstration tours, including **George Weldon** from Factory Mutual, **Fred Pancner** of ANL, **Don Keigher** of RL, and **Humphrey Gilbert** of HQ. All witnessed tests in the July-August 1963 time frame. The Livermore system was written up in Fire Technology in the first 1965 issue as "High Expansion Foam Fire Control System For Gloveboxes", by Lindeken and Taylor, Vol. 1, pp 211-215. It was an interesting potential application, but was never applied to an actual installation, to the best of our knowledge.

By 1964, applications were being pursued at such a rate that an NFPA standards committee was formed under the foam committee to specifically develop a standard for high-expansion foam. Although the committee was formed in 1964, their first draft was not ready until 1968 and did not become official until 1970. By that time, a number of AEC applications had been demonstrated, a number of portable units had been acquired, many potential applications reviewed and some tested, and at least one major system was in service -- protecting a nuclear reactor.

The LPTR, or Livermore Pool Type Reactor was an experimental unit at the Lawrence Livermore Laboratory. Housed in a containment vessel and with the usual concerns about water on electrical equipment (particularly research instrumentation), it seemed like a good candidate for a system. Summer fire protection intern **Mike Magee** proposed a total-flooding hi-ex foam system. A system suspended just below the ceiling of the dome and taking the supply air from the building interior[96] was designed and installed in February of 1965, with a full-scale operational test conducted on 3/15/65. The usual stunt of walking through the foam was performed by many people and was a great source of inspiration for photographers. The annual tests each year always drew a larger crowd than any other fire equipment test.[97]

Although the glovebox design did not see further application in AEC/ERDA/DOE, note that the reactor design was in service a full three years before the first NFPA standard was ready in even the draft version. Fortunately, the system had been removed before the first of the "Tiger Team" type of appraisals or the Laboratory may have been cited for not having a system in conformance with NFPA standards! Unfortunately, that's the type of standards' application that was being used later on, but that's another story.

A somewhat similar installation was made at Brookhaven National Laboratory where an automatic foam system was installed to protect the 7' Bubble Chamber. It tripped at least once, accidentally, and did what had been observed in a number of tests. Namely, it does a remarkably good job of cleaning the walls! With the demise of liquid hydrogen bubble chambers (replaced by spark

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[96] The idea of using combustion air as the bubble-maker seemed like a good way of achieving a double benefit in one application.

[97] Except for when the Laboratory acquired the first Snorkel in California. The foam was discharged outside later, giving more photo opportunities, even if somewhat less impressive than flooding the building.

chambers and other detection devices) as an accelerator research tool, the foam system was no longer needed and eventually was removed.

Also at Brookhaven, a system was installed to protect a concrete polymer operation where a high-strength material was produced by radiation treatment after mixing the concrete with the polymer material. This was in service a few years in the 70's, during the life of the experimental process.

In the meantime, Idaho had played with a number of potential applications for their truck and were able to flood a records storage building with foam, then observing the effect on records and storage boxes. Except for dissolving the glue on some boxes, allowing some records to spill, the effect was nil. **Dick Beers** published the report, "High Expansion Foam Fire Control for Records Storage Centers" as IDO 12050 in 1966 and it has received periodic revivals of interest ever since. Again, no actual installations of a record protection system were ever made in DOE, the good record of sprinkler protection and the ease of installation of sprinklers having alleviated any remaining water concerns.

Argonne National Laboratory had a truck-mounted unit with which they performed a number of tests, including use in making "fire-breaks: to contain brush fires. A film of this use was made and included in the old AEC film library.[98]

Several sites acquired portable and trailer-mounted units (RL had 3 trailer units) up to about 5,000 cfm and many tests were made, including tunnels and stacks at RL and ID. At Stanford Linear Accelerator Center, a 1965 demonstration included the potential for filling portions of the two-mile accelerator or the beam switchyard building with foam injected through surface-level vents. While the unit capacity was too small for large-scale use, it showed that almost any volume could be filled as long as the air ahead of the foam had ample means of being exhausted.

By the time the NFPA standard was first adopted, the effects of smoke and combustion products on the capability of producing foam was being evaluated. A paper by Livermore's **Norm Alvares** and **Ann Lipska** was published by SRI in 1971, titled: "The Effect of Smoke on the Production and Stability of High Expansion Foam." The effects were found to seriously impair the capacity to produce acceptable foam. This had serious implications for units purposely intended to draw their air from the fire building, such as the LPTR reactor. Since the reactor building was tall and the experiments and combustibles of concern were within a few feet of the floor, it was felt that at least some depth of foam could be laid down on the fire before it might become ineffective, so no changes were made to the system. When the LPTR ceased operation in the 70's, the foam system became superfluous and no other applications succeeded it.

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[98] It's interesting that the AEC had an extensive lending library of safety films from both HQ and the contractors. In an age of videotapes, DOE has nothing.

Like the Halon story, discussed in a later chapter, the high-expansion foam story was one in which the AEC was one of the first organizations to experiment and develop uses for the new agent, and one of the first to find practical application. Although the story is almost a foot-note in the DOE fire protection history, it is a notable one.

The original chapter included two illustrations; the "Firestone" truck that toured the country and was photographed by the author at the Camp Parks demonstration near Livermore, Calif., and the unit that was tested at the Stanford Linear Accelerator's Beam Switchyard.

IT'S STILL TEMPORARY

....in which we learn that some of the most permanent things in AEC/ERDA/DOE history are the temporary buildings.

In the history of the agency, beginning with the first days of the Manhattan Engineering District, the temporary building was the most prevalent type of structure built. Given the war-time conditions, it would have been extremely surprising[99] to have been any other way. Unfortunately, the most prevalent type of structure also became some of the most enduring.

The claim to the "earliest" or "oldest" is not entirely settled, in this authors opinion. A log cabin at Los Alamos, used as living quarters by a scientist for awhile in the 1960's, was believed to pre-date the Pajarito Club, a pre-WW I facility that occupied the general area of TA-18, the Criticality facility. While now unused, it still stands.

Second place in longevity is probably a multi-place tie. When the State of Illinois bought up the land around the small residential area called Weston, Illinois,and gave it to the AEC for the Fermi National Accelerator Laboratory, it contained a small town and a number of farm houses dating from around the turn of the century. One may even be the oldest building in DOE. One is definitely the oldest still-used building in DOE.

The farm houses at Fermilab were transposed to an area adjoining the town site and converted to temporary housing for visiting scientists. Utilities were upgraded, as well as the structures, and residential smoke detectors provided in each[100] of the houses. Some of the first visitors were a group of Russians and the fire department stories of checking the detectors made you sure some of the Russians were convinced they were much more likely to be talk detectors than smoke detectors!

The town itself was mostly post WW-II structures of the small retirement-home size. It was used as construction offices and support facilities. If it had remained a "town", it would have had the distinction of being the town with the highest percentage of sprinklered buildings in the country.[101]

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99. Not to say extremely expensive and extremely "wasteful."

100. This was before the days of the residential sprinkler. Besides, the inhabitants were just guests, not employees.

101. It does have the distinction of having what is probably the strangest fire wall in DOE, but that's in another chapter.

The town became number 51 in the author's paper: "So You Think You've Heard It All" on AEC, ERDA, and DOE oddities.

A Sandia National Laboratory, Albuquerque structure may have the dubious third-place "honors." A small frame structure, it was used for various purposes until it was finally removed. It lacked fire protection for the same reason that it lacked heat and lights; - - the roof wouldn't support it! A 1930s Civilian Conservation Corps structure, it had been moved down from the mountains in somebody's undoubtedly money-saving mood. It was long our personal favorite and constituted number 63 in our "So You Think You've Heard It All" list. We followed its existence for some time until it was finally torn down after sufficient new space had been built in the 1970's.

A number of facilities probably share honors with Sandia's structure. The Bonneville Power Administration still uses the first headquarters building they had. Built in the 1930s, (of wood frame, naturally), it was still in use in the 1980's. It also may have been the oldest structure to experience a sprinkler fire in DOE. The 9/23/87 fire breached a conference room wall, but a single pre-action sprinkler controlled the fire until manually extinguished.

The WW-II program naturally built the largest number of temporary facilities. Almost everything about the project was "temporary" and it was only natural that the bulk of the structures would reflect this.[102] However, a number of structures had existed on the land-acquisition sites and pictures of old farm-houses, country stores, schools, and barns exist in histories of Oak Ridge, Hanford, and Los Alamos. Most of these have long since been abandoned or razed. Some, like the original Los Alamos Boys School, are now civic buildings. All, however, pre-date the WW-II construction and form a vast block in the "temporary, but still-here" category. Of course, most of them, when they were originally built, were not considered "temporary' and our story is mainly concerned with the ones that were fully intended to be temporary, but still struggle along.

The "who's first" game ends with WW-II. Not only did the MED build its "temporary" facilities then, and on a vast scale, but many "temporary" facilities built for others at the same time later became DOE facilities. Many are still in use and the story is so wide-spread that we must switch from individual buildings to whole sites to tell it.

Leading off the story of "temporary" sites would be he Lawrence Berkeley Laboratory. The original structure was a fine, but wood-framed, wood-domed structure built to house the monstrous 184" cyclotron in the late 1930s. Though it has many permanent buildings now, it wasn't until WW-II that numerous structures other than support facilities for the 184" cyclotron were built. The cyclotron was being used to help develop the magnetic separation process for enriching uranium and a number of GI barracks-type structures were built as offices and supporting shops. Most of these soldiered on well into the 1980s and some still exist, albeit considerably upgraded in fire protection, as well as other features.

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102. It was not so natural that a large number of buildings were also of massive, fire-resistive construction, and/or sprinklered.

The Berkeley facility originated a number of the oddities in our history. Sprinklers installed only in women's restrooms were one oddity, as well as an accelerator generator building (of wood-frame) that was also sprinklered; - - with sprinklers and sprinkler piping laid along the roof, only!

Although it didn't come into existence until after WW-II, the Brookhaven National Laboratory had a number of pre-war temporary buildings. Pre WW-I, that is! Aficionados of trivia history, or Irving Berlin songs, might recognize that the Brookhaven site, at Upton, New York was the site of Camp Yaphank, the inspiration for an early Irving Berlin review, Yip, Yip, Yaphank![103] Since Camps, as opposed to Forts, were supposedly temporary, and WW-I camps especially so, the warehouses, barracks, and everything else, were "temporary." When Brookhaven was established after WW-II the temporary buildings were still there, and were still in use; - - and many still are 40+ years later. As usual in these cases, almost the only thing original about some of these structures is he foundations. Certainly, protection changes have kept up with the times. Only the "Tiger Team" appraisers, who seem to think that a temporary building should comply with the DOE standards on buildings, are confused.

Of course, the early AEC was in no position to complain too loud about using temporary buildings. The first AEC headquarters structures were temporary war-time buildings[104] on the Mall, in the heart of the Capitol. It wasn't until the new building in Germantown was built in the mid-1950s that the downtime frame buildings were finally vacated (and finally torn down some years later). The Germantown building was probably the largest building built after the mid-1950s without sprinklers. Unlike the 1950s Gaseous Diffusion Plant expansions, which were later sprinklered (see the Paducah Chapter), the HQ building has not been so fortunate.

Two of the largest sites with continuing "temporary" problems are the result of another basic AEC/ERDA/DOE failing[105] ; doing things cheaply. The Kansas City Plant was of a very good fire-resistive, concrete-arch construction of over 2,000,000 square feet on a single floor. The building was a large, open-area, aircraft engine plant built by the government. After the war was over[106] the War Assets Administration had surplus property on its hands which it was only too glad to turn over to the new Atomic Energy Commission when the government got serious about nuclear weapons production after the start of the Korean War in 1950. The basic problem with the building was that a large, open machine shop became a machine shop,--and a plastics shop, and an electronics shop, and assembly rooms, and high-value parts storage, and about a dozen other things that aren't exactly compatible with a single area building. To top it off, only half the building was originally required by AEC. The other half housed a General Services Administration warehouse, with rubber tires, wood

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103. Source of the immortal: "Oh, How I Hate To get Up In The Morning."

104. WW-I, again!

105. OK, it's really a government-wide failing.

106. WW-II, this time.

pallets, and motor oils stored next to the wall separating the Atomic Energy Plant.[107] The discrepancy in occupancies and the difficulty of essentially building a new plant in the middle of existing plants every time a change was needed, caused no ends of problems.[108] On the author's first visit, he was amazed to find that, after getting lost riding a small cart through various areas, to come upon a bulldozer and backhoe digging new foundations in what he thought was the middle of the plant, - - and was!

The Lawrence Livermore National Laboratory is another example of a "cheap" acquisition coming with not-so-cheap problems. The site had been a WW-II naval air training station, flying several squadrons of Corsairs in advanced training programs.[109]The extra land became a convenient spot for a Standard Oil Company subsidiary, California Research and Development Co., to build an accelerator for an experimental isotopes enrichment program in 1950. The operation lasted until 1954 when the AEC took over the experiment and also decided to make the site the location of the second weapons laboratory. All the GI barracks, mess hall, infirmary, hangers, and swimming pool structures became the first Lab buildings. All temporary and all staying far beyond their planned life.

The author began a data source book for the San Francisco Operations Office in 1962. Among the tables was a list of temporary buildings and planned demolition dates. We religiously up-dated the list each time a new one was issued and finally gave it up when the first building scheduled to be torn down on the original list was still in existence past the date at which the last building on the original list would have been demolished! But perserverence gets results and things did get torn down. The 1943 infirmary, which became the first headquarters and first computer building, was finally torn down in 1973, several years after a new central headquarters building had been built.

The Livermore swimming pool illustrated one of the problems of "temporary" structures. It had been built for Navy training and contained a number of support and dressing rooms, all under an arched roof. The Lab's employees club wanted to use it for their recreation programs and a simple fence alignment would make it available to the families for summer use. Since it was all wood and had never been sprinklered, the use by families, including children resulted in a SAN-AEC decision that it should be sprinklered before use. The club couldn't afford that and finally tore down the building. It was still a great swimming pool[110], but with no protection from the summer sun or rain. (It was also more exposed to 5-lb. explosives storage magazettes less than 100 yards away).

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107. Needless to say, upgrading of the fire wall was one of the first projects in the early 1970s upgrades throughout AEC.

108. If you think the AEC was nervous, the Marines had a personnel computer operation in the basement on the GSA side!

109. And leaving behind lots of oil and solvent drippings for the future environmentalists to love.

110. It was also connected to a draft hydrant for fire department pumper suction use.

Some sites were built from scratch, with good construction, and still had temporary buildings. At most major projects, some construction trailers, tool shacks, and "transportainers" always seemed to be left behind to be acquired for use as "temporary" storage facilities. There were a few cases of good structures being built as temporary construction facilities. One of the more remarkable was at Stanford Linear Accelerator Center. A temporary metal building was built for storage of high-value parts during the construction phase. It was remarkable for two reasons. Although temporary, it was provided with automatic sprinkler protection because of the value. Second, and most amazing, it was temporary. When the accelerator was completed, it was torn down. Unfortunately, it was moved to the pad outside the End Stations and reassembled as a shop building. More unfortunately, it was sitting on a couple of acres of concrete several feet thick and it took a number of years before water mains could be extended through the pad to service the building.

Some sites were originally built of light "temporary" types of construction. This was the original 1956 Control Point for Livermore's Site 300, an HE test site east of Livermore. They were temporary. Better structures were built as the site expanded.

The Nevada Test Site was typical of "temporary", light-weight construction. The problems were compounded by the fact that many buildings, including some fairly sizeable ones, were built with "Operating" funds, rather than regular construction project funds. Thus, buildings were being "Discovered" that weren't on anybody's list! Confusing at times, needless to say.

Nevada was also the major trailer or "transportable" buildings user. From living quarters to million-dollar instrumentation facilities, trailers were prolific at NTS. The problems of trying to accommodate the expanding use, multiple occupancies, and difficult protection problems, lead to the formation of an AEC Portable Structures Committee in 1975. Some of the actions of this committee will be covered in a future chapter.

IT WAS A GAS

.....in which we learn of yet another fire protection system in which AEC/ERDA/DOE was installing systems before there was a standard, contributed to the existence and continuation of the standard, installed some of the largest systems, and some unique systems, and finally helped abolish the system. Halon was the name.

[AUTHOR'S NOTE: Although Halon is being phased out of DOE, its story is typical of many of the agency's fire protection programs. We were among the very earliest (and probably the first) users, we developed the standards, both internally and nationally, we installed far more systems than most organizations, and we maintained and published records of their performance.]

In April of 1966, the annual AEC safety conference was held in the Federal Building auditorium in Richland, Washington. One of the presentations was by Tom Franck[111] of Argonne National Laboratory. He described a new extinguishing system that he had designed for a hot cell application at Argonne National Laboratory, West (at what was then called the national Reactor Test Site in Idaho). We remember discussing it with several other fire protection engineer attenders and none of us was quite sure why good old, reliable, CO_2 wasn't being used instead of this new gas, called Halon 1301. Suffice it to say, we all came to learn much more about the subject.

Prior to the publication of the first tentative NFPA standard (NFPA 12AT, 1968), Argonne had already installed manual systems in three computer room underfloor spaces, totaling 6,860 sq. ft. (with smoke detection). Another fixed-pipe system was being engineered for a 40-inch propane bubble chamber at the Zero Gradient Synchrotron accelerator, where a 5,000 cfm exhaust rate would have a 6.5% Halon 1301 inhibitor. Ten, 75-lb. CO_2 cylinders, containing 135 pounds of Halon at an average pressure of 430 psi would discharge in 24 seconds. Operation would be manual or automatic by ultra-violet flame detectors. (The propane-filled chamber could also be dumped to an outside underground tank in three minutes).

ANL had also installed systems in nine electronics trailers used for control and computer rooms at the ZGS. Smoke detectors would alarm and summon the fire department, while actuation was manual.

To illustrate how advanced AEC was in installing systems, a letter from the Director of the Advisory Center on Toxicology of the National Research Council, dated 22 September, 1967, and

[111] See Chapter VI, page 6.

addressed to the Director of a DuPont laboratory, thanked them for their assistance and noted that they were about to send a letter to NASA stating:

> "Personnel can be exposed without significant hazard for a maximum of five minutes to normal air at one atmosphere admixed with up to 6% mean concentration by volume of bromotrifluromethane as a fire extinguishing agent. This assumes appropriate engineering design to sense the fire and to deliver the agent so as to extinguish the fire promptly in order that the pyrolysis products are minimized."

Dr. Bryan's book: "Fire Suppression and Detection Systems", notes some Halon history, beginning with some 1950's research papers, principally from the Air Force. Outside of these papers, the earliest listing in the selected bibliography accompanying his chapter on Halons, is a toxicology literature review published as NRTS Health and Safety Information Number 55, by the AEC Idaho Operations Office, in 1969. Note that this was several years after the first AEC system had been installed and a full year before the final adoption of the first NFPA standard. (In fact, four of the 29 papers in the selected bibliography are from AEC site work).

The gas had the advantage of a very small volume needed to extinguish a fire and a lack of toxicity at the concentrations required to extinguish the majority of fires. This meant that a relatively small volume could handle a fairly large room in a total-flooding type of application (the easiest to design) and yet people could exist in the flooded space. This meant that the suffocation effect, as results from the volumes needed for CO_2 did not exist for Halon 1301. Thus, instant discharge could be allowed in occupied spaces such as computer and control rooms. This fast application possibility further contributed to extinguishing the fire at the earliest moment. This further assured minimal damage. Almost too good to be true, as later proved to be the case.

The applications seemed unlimited and there were a large number of systems, and studies, before the NFPA standard was finalized. Bryan's book includes three from the 1971-1972 period when most AEC sites were experimenting with systems for remote sites, electronics, trailers, etc. The first was Jim Gaskill's work at Lawrence Livermore Laboratory[112] titled: Engineering Tests of Halon 1301 Fire Extinguishing Systems for Field Assembly Buildings" (UCRL-51021). The Field Assembly Building was the multi-story, open tower from which the nuclear device and its instrumentation canister were lowered into the shot hole at the Nevada Test Site underground test facility. Since these were stacked, modular units, 17'x 17'x 17' per cell, and generally made of wood, they qualified for protection from the value, life hazard, contamination, and program aspects all together. The fact that they were located where water was unlikely to be provided made them a natural candidate for Halon. In fact, the first large use of Halon was at the Nevada Test Site, where the Nevada Operations Office

[112].If the names seem to change for different sites in different chapters, it's because they did change. From "Radiation Laboratory", to "Lawrence Radiation Laboratory-Livermore", to "Lawrence Livermore Laboratory", to Lawrence Livermore National Laboratory", in this example. Politicians can't keep their hands off anything.

procured a number of the "suitcase" type portable units (originally developed for aircraft interiors in construction or overhaul) in 1970 and 1971. Actual fires were used in the test series.

One of the first conferences we attended while at AEC headquarters, circa 1970, was at the National Academy of Science, where one day was spent on toxicology of Halon and its decomposition products. After a day of papers, anyone would have been convinced it could never be used. Fortunately, the second day was on applications. The life-saving films of systems installed in armored personnel carriers when struck by rockets igniting the internal fuel tanks more than justified its use. Needless to say, the demonstrated effectiveness, combined with the life studies already conducted by NAS, convinced the attenders that concern with decomposition products was over-rated. (Ordinary fires produce very undesirable decomposition products. When the fire is promptly extinguished, they are negligible).

Tom Frank, at Argonne, had continued work and his 1971 paper, "Clean Room Fire Protection Using Halon 1301" was one of the first on this application.[113]

In 1971, DuPont issued DP-1261, "Automatic Fire Extinguishing Systems For Glove Boxes and Shielded Cells at the Savannah River Laboratory." It illustrated Halon extinguishers installed as manual and automatic systems, and the tests made to confirm the adequacy. Extinguishers were supplied near the boxes or wall-mounted in the labs. Manual units were installed on the boxes when gamma levels were less than 100R/hr at three inches and systems were automatic when gamma levels exceeded that. Detectors and junction boxes were provided so that manual systems could readily be converted to automatic. As usual, the report was another unclassified AEC document available from the NTIS for $3.00.

The remaining AEC citation by Bryan was the 1972 paper titled: "Preliminary Report, Halon 1301 Fire Tests", by Brookhaven National Laboratory's John Dietz (BNL 16942). It covered a number of AEC potential applications, such as trailers, and with effects results on electronic equipment.

Another paper was published in "Fire and Flammability" for July, 1972. Titled: "A Portable Halon Fire Extinguishing System for Trailers", it was an account of the Gaskill, Kadi, and Taylor work at Livermore in developing a Halon package that could readily be installed or removed from trailers. A typical AEC application was the field instrument trailer. When outfitted, they could have very high values, but were often empty for much of the year. A system that could readily be transferred from one unit to another was a decided advantage. A number of sites developed somewhat similar systems and the "suitcase" units obtained by Nevada Operations Office served the same purpose.

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[113]. See Chapter XX, page 10.

THE STANDARDS

NFPA

The Halons became found applications more rapidly and more extensively than any other fire protection system, especially in DOE. Nationwide, the NFPA formed a Halogenated Fire Extinguishing Systems Committee in 1966. The four subcommittees had a draft ready for adoption at the 1968 NFPA meeting, where it was adopted as a tentative standard. the committee determined more work was necessary and it was renewed as a tentative standard and the first version as an official document was the 1970 edition. Note that AEC had quite a few systems installed by this time, so later Tiger concerns about complying with standards were a little difficult to reconcile in some cases.[114]

From the start, AEC involvement with the NFPA committee was significant, and has remained so until this day.

About the time the first version of the Standard was adopted in 1970, **DON KEIGHER**, formerly of AEC, Richland and then with NASA, was appointed to the committee. Leaving for Los Alamos National Laboratory later that year, he was reappointed to the committee from LANL. In 1975, he became the Chairman of the Halon Committee and remained so for the next five years. Nevada Operations Office's **PAT PHILLIPS** was appointed to the committee and serves on it through 1992, although he has retired from government and now represents his own consultant fire, Anti-Fire. Other members from DOE facilities have included **E. McCARTHY**, of REECO, Nevada, and **KEN PHILLIPS**, of EG&G, Idaho.

DOE

The Federal Fire Council developed its first "Recommended Practices" document, RP-1, "Fire Protection For Essential Electronic Equipment", in 1962. By the time the document was revised in 1969, experience had led them to the conclusion that automatic sprinkler protection was a must and its provision was the major new requirement in the document. By the late 1960s, with Halon an increasingly viable system, and computers assuming ever-greater roles in AEC, the need for a specific AEC standard was realized. Arnold Weintraub of HQ[115] and Tom O'Conner of Oak Ridge[116] authored a document specific to AEC and based on the Federal Fire Council's RP-1. This was WASH 1245-1, issued in July, 1973.

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114. Fortunately, these were usually the trailer systems, where, if not based on a non-existent standard, they did have considerable documentation from the original tests.

115. See Chapter VI, page 5.

116. See Chapter VI, page 3.

The AEC document was the first to recognize Halon and accepted total flooding systems in lieu of sprinklers. This was largely intended to recognize the existence of the many trailer and portable structure systems in wide use in AEC. Unfortunately, with the prevailing fear of water among computer people, Halon soon came to be the only system that many users wanted and was in danger of becoming the only protection system. For the same reason that the RP-1 revision demanded full sprinkler protection, ordinary combustibles in large quantities in every computer facility, the AEC standard was also changed.

The revised DOE standard, now numbered DOE/EP-0108 (Formerly WASH 1245-1), was issued in January, 1984. The major change was in the Fire Protection System Requirements Section 403, where sprinklers became the prime requirement, with Halon allowable in lieu of sprinklers only if an adequate water supply was not available. Halon was still an alternative in concealed spaces.

One requirement repeated in several DOE standards was the allowance for single-shot systems if a sprinkler system was also provided or if on-site refill capacity was available.

When the original Factory Insurance Association and Factory Mutual surveys began in 1969, it soon became apparent that there was no consensus on Halon in computer applications. There was a difference in survey recommendations between companies, between sites, and between earlier and later surveys. Recommendations to "do" something at first, tended to become recommendations to do a "study" of the subject. Accordingly, before the AEC 1973 standard was adopted, HQ had issued a blanket exemption to five generic computer protection items. These included underfloor Halon and interlocks of Halon (and other) protection with HVAC systems. These were supposed to be resolved by the issuance of the AEC computer standard. Unfortunately, the final version did not resolve the issue and further surveys, and Tiger Team surveys, were left to make facility-specific recommendations.

SIGNIFICANT INSTALLATIONS

The AEC applications were second in quantity only to sprinklers. We began to record the numbers from the annual fire protection program reports submitted by the field and, beginning with 1970, the AEC/ERDA/DOE had procured and installed at least 1600 systems between 1970 and 1989. The numbers are conservative since the reports did not generally account for systems by numbers, but only by building or area protected. Thus, a number of multiple systems in a single facility may have been counted as only one or two. In that 30-year period, the number of new installations varied from a low of 12 in 1970, to about 100 in 1987, the most active year.

In 1984, Fermilab conducted experiments to determine the capability of both ionization and photoelectric detectors to detect electrical component failure in electronic equipment racks. A 120v control transformer and a 1/2 watt resistor were both overloaded to destruction with each type of detector on the ceiling of the rack. The ionization detector detected both failures while the photoelectric detected only the transformer. A small plastic insulation fire in the racks was then easily extinguished with less than 1 pound of Halon 1211 discharged from a portable extinguisher. As a result Fermilab planned to provide automatic extinguishing systems in 23 high value and critical equipment racks.

COMPUTERS

The trailer or portable building was a major user, as was the computer and electronics facility. A 1982 survey of DOE computer facilities revealed that the computer value was about 1% of the total value of all DOE buildings, equipment, and facilities. A total of 207 high-value facilities were in the survey and nearly half had Halon protection. The Halon systems were protecting about 62% of the total are and about 70% of the total value. There was considerable overlap as 87% of the area and 84% of the value was also protected by sprinklers. The use of Halo-only was confined to 59 facilities, representing 12% of the area and 15% of the values.

Of 101 computer Halon facilities, 63 were activated by cross-zoned smoke detectors and most of the rest by heat detectors. Design concentrations were almost universally 5%, with up to 10% in underfloor spaces. There was some difference between costs for computer rooms and for control rooms, but the combined cost for the 68 facilities where good data was available was $1.43/cu. ft.

Maintenance costs were also reviewed and maintenance and inspection costs for alarm systems were about twice that of sprinklers and halon systems about t-1/2 times that for sprinklers.

WEEKS ISLAND

At the Strategic Petroleum Reserve's Weeks Island Site, a former salt mine became an oil storage reservoir. A shaft to a pump room, with oil, wiring, and motor hazards, had a "ceiling height" of 450'. A 6,000 lb Halon system was installed for protection, (one of the world's 10-largest at the time). The corrosive atmosphere resulted in a number of problems, and some expensive accidental trips. Major modifications were made in 1983, including cross-zoning actuation by ultraviolet detectors, additional halo to compensate for unenclosable openings, and special anti-corrosion coatings and enclosures. It was certainly one of the largest systems ever installed in a single occupancy and undoubtedly holds the record for high-ceilings!

SCYLLAC

Los Alamos National Laboratory had built a major magnetic fusion research machine, dubbed the SCYLLAC. This had its own building with office and support areas around a machine bay of 100' x 100' area and about 85' high. A large, circular machine with multiple decks filled the interior. The building had been sprinklered and a multi-ton CO_2 system provided for the high-bay. The system was manual due to the maze of walkways and machine access points and the time it could take someone to escape from the center of the maze. Since the machine had a vast number of oil-filled capacitors and oil coated almost everything, the fire potential was real.

A survey by Factory Mutual in 1977 recognized the hazard and recommended sprinkler protection be extended to the high-bay. Since the life safety problem still remained, (and there was a water-electrical interface problem for this machine), a number of studies were performed and several consultant reviews made. The final installation was a manual roof-sprinkler system and an automatic halon 1301 system. The final installation consisted of 65 Fenwal cylinders containing 12, 610 pounds of Halon, plus another 113 pounds in one room. The system was finally completed and tested by 1984, when the project began to wind down and was abandoned by 1987.

The Halon cylinders were then transferred as back-up manual systems to 5 areas of the CCF computer facility, with 1,500 pounds in each system and also to the newer, LDCC computer facility, where 3-2,000 pound systems were installed (Ironically, one was tripped accidentally in 1992, despite the fact that it was a manual system specifically to reduce the probability of accidental trips. Even more ironically, after the machine had been removed by 1991, a conversion of the empty high-bay to a Tiger conference area and the use of the office wings by the Tigers resulted in a Tiger calling the building "unsafe" despite being fully sprinklered. An elevator opened into a hallway, rather than a vestibule, a 1991 code change that hadn't been considered!)

NEVADA

At the Nevada Test Site, REECO acquired 44 of the portable "suitcase" units, originally developed for aircraft fuselage ground protection. This was in addition to the 13 fixed systems installed that year throughout AEC (the first year for which we began to accumulate records). Another 39 of the portable units were acquired in 1971, a year which saw 12 fixed systems installed in AEC. The Nevada usage was accompanied by a number of sites conducting research and tests on small systems, both portable and fixed, for use in trailers and similar part-time high value or importance occupancies.

The Fenwal "Firepac" units were self-contained, with a detector on a telescoping mast and a plug-in power cord. They were just-barley portable by one man and thus came to be called "suitcase" units. They formed an early and effective solution to the problem of providing protection in high-value, but temporary, occupancies.

1986 SUMMARY

By 1986, the increasing concern over CFC's and the environment had extended to Halon. The EPA was to promulgate rules by 1987 and a number of agencies, including DOE were surveying their Halon applications and discharges. I n the meantime, the NFPA committee revised the standard to not require discharge testing. The DOE also surveyed its applications and found that, in 1986:

> There were 160 Halon 1301 portable extinguishers in use, containing a total of 1,060.5 pounds of agent. Only 5 pounds had been discharged in 1986, all on a single fire.

There were 13,439 Halon 1211 extinguishers, containing 180,854.75 pounds of agent. Some 8.218 pounds, or 4.5% of the total was expended in 1986. Firefighting used 1,051 pounds, or about 12% of that consumed.

There were 1,275 fixed extinguishing systems, all Halon 1301. Total agent contained was 368,826.75 pounds. Total usage was 92,563.5 pounds. Of the total expended 0.8% was in firefighting, 3.9% in training and demonstrations, 25% in accidental discharges, and 70.3% in testing. (Du Pont routinely made discharge concentration tests in their program. As a result, while they had about 1/4 of the systems in DOE, they discharged about 1/2 of the total agent expended).

Toxicity

Toxicity had been a concern from the start, due to the decomposition products. Noticeable effects were observed in the BNL tests reported by Dietz in 1972. A two-day symposium in Washington, hosted by the National Academy of Sciences spent the first day on medical potentials. The second day was actual application tests and the consensus was that the fire extinguishing action was so effective that decomposition was extremely limited and the value far outweighed the possible drawback. This was the experience until a 1987 DOE experience at a Savannah River facility.

The author was visiting the site when word of a number of construction workers "keeling over" at the Waste Facility was received and discovered to be due to Halon trip tests, -- about a thousand feet away! It resulted from a Halon system in a rad-waste incinerator being tripped for a concentration test. Numerous openings allowed the gas to escape, requiring retests. Finally, gas seeping into the incinerator, which was in a burner-on shutdown condition, allowed some gas to be decomposed, pass through the filters and stack, and blow to the construction site. A number of people on the roof smelled the acrid odor, the building was evacuated, and several people were sent to the hospital. At least one was an overnight stay but no actual physical effects were observed. This was our only record of adverse effects.

Ironically, the incinerator system was inappropriate. The storage room had cardboard boxes of low-level waste stored one or two high. In addition to the incinerator, there were a number of door and ventilation openings that made it difficult to hold a design concentration. The nature of the material made a deep-seated fire a likelihood, which is the worst to protect with Halon. At the same time, a small room with low-piled cardboard boxes is ideal for sprinkler protection. Actually, sprinklers had been provided, but were disconnected in lieu of the Halon. Although there were drains in the floor and a holding tank, environmental concerns about spread of low-level contamination if the sprinklers went off, was the controlling factor, one of the earlier instances of what was to become a bigger impact on fire protection than the traditional fire vs, security concerns.

THE HALON RECORD

The Systems Safety Development Center, run by EG&G, Idaho, took over the accident recording function and began publishing summaries in 1979. From 1982 on, each quarterly and annual report included a one-line summary of each property loss over $1,000. The Halon incidents from these summaries are repeated below. In addition, a number of incidents were reported from earlier sources, especially the annual summary reports. Where this was the source, an [AS] so indicates.

Fire incidents, as distinguished from accidental discharges, are indicated by "**FIRE**' in bold letters after the date. One of the problems with halon statistics is the fast action of the system. A number of "false" trips were from smoke or overheated items that quite probably have progressed to a flaming fire if the system had not activated so fast.

Another problem, common to any reporting system, is that the establishment of a threshold level for reporting means that some data will be lost. This effect is more pronounced for Halon systems than sprinklers, since the Halon usually protects a much smaller volume. Where halon was being obtained at costs as low as $1/lb., and 1,000 lbs was a large system, an accidental trip would not be reportable in many cases Even small fires with successful system extinguishment might not reach the reportable level. This effects both the overall dollar loss data and the overall reliability data.

1977

07/26/77. $1,400. Welding gasses at an Idaho site (TAN) tripped an underfloor system.

1978

01/04/78. $2,941. A Westinghouse Hanford Halon system accidentally discharged when a manual pull box was being dismantled. [AS]

1979

In its annual summary, Nevada Operations Office noted that it had begun some cylinder refilling operations for other sites. Nevada had purchased Halon by the largest available size, a 2,000 lb. container. A HQ survey of costs about this time showed that NV had obtained the cheapest rate, about $1/lb. due to bulk purchase.

1980

06/15/80. **FIRE** $16,400. (No.31 in order of the amount of loss that year). At Lawrence Berkeley Laboratory, a circuit board, valued at $85,000, caught fire and was extinguished by the Halon system. [AS]

04/24/80. $5,940. (No. 52). A petroleum reserve system was discharged by a short or faulty control panel. [AS]

02/28/80. **FIRE** $2,000. (No. 104). A trash can fire in a trailer at the Carbondale Mining Technology Center was extinguished by a Halon system. No damage to the trailer was incurred. [AS]

05/21/80. $1,246. (No. 127). A Halon system at Argonne National Laboratory was discharged by smoke from a fan motor. [AS]

A power outage at the Solar Energy research Center resulted in the accidental discharge of $5,940 worth of Halon. The cost was absorbed by the installation contractor. As a result of the failure, SERI evaluated the equipment, including the replacement control panel and found the system substandard. They refused to entertain any bid by that contractor for any future systems. [AS]

One of the 1980 accomplishments reported by Richland Operations Office was the establishment of a sit-wide contract for inspection and recharge of all Halon cylinders at all contractor facilities. The contract was administered by the site fire department. [AS]

<u>1981</u>

Undated. **FIRE**. $890. The 1981 Annual Summary contained a note of a plate shop fire in which a 30 gallon alcohol tank fire was extinguished by a small system of 2-5# cylinders for a loss of $890.

05/29/81. $30,500. The highest-cost accidental trip resulted from a 6,000 pound system trip at the Weeks Island Salt Mine oil facility of SPRO.

11/04/81. $2,900. Another SPRO trip. Cause unknown.

12/12/81. $2,800. The third SPRO loss of the year, due to a shorted panel module.

<u>1982</u>

08/23/82. $8,075. (No. 63). Lightning destroyed control panel circuitry at EG&G, Los Alamos, causing discharge of Halon.

10/13/82. $1,445 (No. 153). At Du Pont Research, Savannah River plant, 516 pounds of Halon was discharged when an actuator was being reinstalled and the system tripped.

10/29/82. $1,300. (No. 156). At a Strategic Petroleum Reserve site, smoke from dirty heating system coils tripped a Halon system.
Unknown. **FIRE**. $300. Savannah River reported a fire from a transformer loss in a computer cabinet. 102# of Halon discharged.

1983

04/22/83. **EXPLOSION**. $11,000. A suppression system on a mill at Fernald successfully quenched an explosion.

02/10/83. **FIRE**. $2,500. (No. 125). A 350# Strategic Petroleum Reserve system was activated by smoke from overheated test equipment leads. Burning rubber on the alligator clamps was extinguished before the flaming combustion stage was reached. (This was typical of Halon. Fires were extinguished so fast that most of the "loss" was the value of the Halon. Other incidents of "accidental trips" may have become fires, if the system actuation had been delayed a few minutes. Compiling accidental trip statistics on Halon was a difficult thing to do. [AS]

02/10/83. $2,500. An Oak Ridge facility reported an accidental trip, due to electrical faults. [AS]

12/27/83. $1,909. A mechanical trip occurred at an Oak Ridge facility. [AS]

02/16/83. $1,700. (No. 147). A Halon system at Battelle Memorial Institute was discharged by an "unnecessary fire alarm".

Undated. **FIRE**. $1,000 (plus $40,000 medical). Two electrical technicians were inspecting a motor control center with the safety interlock bypassed when an electrical arc occurred that started a small fire which shocked and burned both technicians. A 144# Halon system operated via its smoke detectors and extinguished the fire. The equipment cost, including recharge, was not quite $1,000, but medical costs for the two technicians exceeded $40,000. This was another example of the value of the annual fire protection summary. The loss was just under $1,000, so it was not on the SSDC list. The two injuries were occupational safety cases, so could easily be overlooked in the fire data. The old AEC requirement for an annual summary allowed a great many items of interest to be recorded that otherwise would have been lost forever.[117] Unfortunately, other safety programs have still not learned the lesson. [AS]

Undated. **FIRE** $500. A wastebasket fire at a National Laboratory power supply building activated a rate-compensated detector which discharges a 25# (5% concentration) Halon system, extinguishing the fire. Damage was negligible and the "loss" was the Halon replacement cost. Note that this was less than the #1,000 trigger level for reportable losses, so it is not included in the DOE loss statistics. This is typical of many Halon actuations, so fire performance data before 1982, when reports of all automatic system actuations were requested, is not complete. [AS]

Undated. A failure in a control room panel at the same laboratory tripped a circuit breaker and released smoke in the motor generator set building. An ionization smoke detector activated and summoned the fire department. In the meantime, an operator had extinguished the fire with a portable CO_2 extinguisher before the separate detection zone could activate to discharge the automatic Halon

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[117]. See Chapter XVII.

system. No visible flames were noted and total damage was negligible. While not a Halon "fire' or "accidental discharge", it does illustrate the value of the detection systems installed as part of the Halon system. They often allowed for effective action before the Halon was needed. [AS]

Undated. **FIRE**. At another laboratory, a fire in a decontamination and disassembly facility was started by a welding operation. The fire was extinguished by the operator manually tripping the Halon system before it could automatically operate. Damage was negligible. [AS]

Although the annual summaries did not generally detail the type of occupancies in which systems were installed, at least 21 of the 43 or more systems installed in 1983 were in computer and electronics occupancies. At least one of the new installations was in a glove box at Richland, another type of application peculiar to DOE.

1984

07/11/84. $5,806. (No. 64). A Halon system was accidentally tripped at the Portsmouth Gaseous Diffusion Plant, while troubleshooting.

07/27/84. **FIRE** $5,481. (No. 67). Flames were observed coming from a small pump in a glovebox during a non-destructive assay at Richland. The fire was successfully extinguished by manual discharge of the Halon system. When the pump was replaced, the same accident recurred.

08/07/84. **FIRE** $5,481. (No. 68). An identical fire resulted, after which it was found that improper overload switches had been installed in the system.

12/23/82. $2,750. (No. 102). An air conditioner received smoke from an outdoor demolition operation at the Pinellas Plant, activating a Halon system.

06/14/84. $2,100. (No. 112). A malfunctioning ionization detector discharged a Halon system at a Strategic Petroleum Reserve site.

07/16/84. $2,028. (No. 113). An operator error in following procedures allowed another SPRO accidental discharge.

07/12/84. $1,690. (No. 122). At Rockwell Hanford, a power transformer on a crane overheated, releasing fumes and discharging a Halon system. [Note that this might be considered a successful fire extinguishment, if the overheating had continued for a few seconds more. This is typical of a number of Halon discharge incidents, making statistical interpretations doubtful. In the HQ-issued list of incidents in the 1986 annual summary, this was carried as a fire].

01/31/84. **FIRE** $1,243. (No. 133). Oil-soaked insulation ignited during a welding operation, successfully discharging a Halon system. Discharge was 330# of Halon.

Undated. Bonneville Power Administration noted that overly sensitive heat detectors tripped a small Halo system (<100lbs.) twice. The detectors had been adjusted after the first incident and were replaced after the second. The system protected a control panel in a computer room.

Undated. BPA also noted an incident where portable radio transmissions had caused a Halon panel to go into a trouble mode. The annual summary noted that a number of other DOE sites and other agencies had reported a similar problem and that the best solution seemed to be that of specifying in-house frequencies and requiring installers to protect against trip or trouble modes at those frequencies.

The individual Field Office reports for 1984 noted a total of 68 new Halon system additions. While most were not identified, included were at least 12 computer, 14 trailer, and one rector cable spreading room application.

The 1984 summaries also included a number of portable extinguisher upgrades. Most extinguishers at the Pinellas Plant were being replaced with Halon 1211 units and the Inhalation Toxicology Research Institute was replacing CO_2 with Halon. More Halon replacements were major programs at the Knolls laboratory of Schenectady Naval Reactors Office and at the Portsmouth Gaseous Diffusion Plant.

Fire department equipment also included a number of Halon items. The major one, at Richland, was the acquisition of a new foam, Halon, and Purple K multi-purpose truck by the Hanford Fire Department.

<u>1985</u>

09/13/85. $1,097. (No. 158). A Halon system was manually discharged at United Nuclear Industries, Richland. Lack of authorization resulted in disciplinary action.

07/25/85. **FIRE**. $0. Kansas City Plant reported alcohol vapors ignited on a production part of depleted uranium and was instantly extinguished by a 10# Halon system. (Recharge costs not noted) [AS]

08/09/85. **FIRE**. $0. A similar incident occurred at the same site when a tygon tube, used to distribute the alcohol, contacted an electrode and arced.

07/19/85. $2,850. A computer system power outage at Ross Aviation dumped a 10# system for an overall, contributing slightly to the loss.

The annual summary reports also noted the successful operation of a Halon explosion suppression system at the Fernald Plant (not included in our fire data) and an undated $2,247 loss at Portsmouth GDP when a gauge leaked. [AS]

At least 42 additional Halon systems were installed in 1985.

1986

05/01/86. $3,150. (No. 96). At Westinghouse, Idaho, off-gas from a denitrator activated a Halon system. [AS]

09/12/86. $2,155. (No. 112). At United Nuclear Industries, Richland, a gauge nipple broke, spraying water on a wall and activating a Halon control panel. [AS]

07/28/86. $1,870. (No. 119) At the Oak Ridge Gaseous Diffusion Plant, welding smoke activated a system. [AS]

04/21/86. **FIRE**. $1,575. (No. 125). At Westinghouse, Idaho, smoke from a CAM monitor fire activated a system.

05/29/86. $1,200. (No. 136). During repair work at United Nuclear, Richland, smoke detector circuits were tripped, activating a system. [AS]

10/23/86. $1,150. (No. 138). At United Nuclear, an employee accidentally bumped a manual station, discharging a system. [AS]

10/24/86. $1,150. (No. 139). Again at United Nuclear, a reserve cylinder was discharged while refilling a main bottle. [AS]

01/01/86. $1,600. At the SPRO Weeks Island site, a truck exhaust dumped a 160# system. [AS]

03/28/86. At the Y-12 Plant, a 336# system was dumped when the fire department was resetting a panel. [AS]

Unknown. #791. An overheated power supply dumped a system at REECO-NV (Note that this is not a reportable loss under the dollar criteria). [AS]

Unknown. $1,100. A freon refrigerant leak at United Nuclear, Richland, activated a detector, tripping a system.

1987

09/17/87. $10,890. (No. 45). At Princeton Plasma Physics Laboratory, a vacuum pump line separated and emitted oil vapors, discharging several Halon systems. [AS]

09/30/87. $4,000. (No. 82). At WHC Services, Richland, a system was activated when a switch was tripped while repairing a fire alarm system. [AS]

11/18/87. $1,157. (No. 134). At SPRO, a switch on an unsecured pull station was activated, discharging a Halon system.

10/??/87. $0. A 25# system on power supply cabinet at SLAC was discharged by welding fumes activating the cross-zoned detectors. No loss "other than refill of the system." [AS]

12/??/87. $0. At ANL, two-125# cylinders discharged when a severe drop in atmospheric pressure during a thunderstorm activated the "Atmo Pneumatic Tube Fire Detection System". [AS]

Unknown. $0. At ANL-West, a system protecting a reactor rod drive hydraulic system tripped when dust from concrete core drilling activated the cross-zoned smoke detectors. An inhibit switch was available, but not used. When the preprogrammed time delay expired, 275# of Halon discharged. [AS]

Unknown. 0$. Also at ANL-W, a 30# system was dumped when a control panel fault tripped the system. [AS]

Unknown. $1,500. At Fermilab, a new 428# system discharged during test. Investigation established that the Pyrotronics System 3 "Time Cycle" module could send uninitiated signals to the release modules. With RM-30 modules, false actuations were possible. All "Time Cycle" RM-30 units were replaced with RM-30U units. [AS]

07/27/87. **FIRE**. $30,265. At SNL-Livermore, a fan motor in an air handling system single-phased, overheated, and smoldered. The cross-zoned Halon system was activated and extinguished the motor. While the fire loss was only $544, the Halon recharge was $29,721. As is typical of Halon system, the extinguishment was so fast that the loss appears contradictory. What is not evident is how much the loss might have been if the Halon system was not present, or how big the fire would have been if it had to actuate sprinklers. It's somewhat like having a sprinkler system so sensitive that it extinguishes any fire with the first five gallons of discharge. The fire damage/water damage ratios would be misleading. [AS].

Unknown. $0. At SPRO, the St. James Terminal site control room system tripped due to an improperly secured manual release station. [AS]

04/??/87. 0$. At Bonneville Power Administration's Ross Complex, a 125# system discharged when a service contractor forgot the timer delay was still activated when he finished servicing the system. After completing the cycle, it discharged. The system was refilled at no cost to BPA. [AS]

10/06/87. **FAILURE**. <$1,000. At Richland, a small fire of less than $1,000, occurred in a filter test unit. Corrosion of contacts in the actuation system prevented the Halon system from operating. [AS]

1988

04/03/88. $4,080. (No. 82). At the Kansas City Plant, extreme room heat caused a system actuation during a utility shutdown. [AS]

09/15/88. $1,784. (No. 120). At REECO, Nevada, a technician accidentally activated a system, discharging four Halon bottles. [AS]

12/24/88. $1,696. (No. 122). At WHC Services, Richland, a power outage "caused dirty smoke detectors to discharge the Halon. [AS]

10/22/88. $1,584. (No. 123). At the same site, a power short burned out the ventilation blower of a crane, the resulting smoke activating a Halon system. [Another "almost" fire?]. [AS]

06/28/88. $1,502. (No. 124) At Sandia National Laboratory, an employee accidentally pulled a toggle switch, discharging a Halon system. [AS]

01/11/88. $1,500. (No. 127). An employee tripped at Fermilab, hitting a fire alarm pull box and activating the first zone of the Halon activation circuit, as well as the building alarms and the alarm to the fire department. When the fire department attempted to reset the box, they accidentally actuated a second set of contacts, discharging a 245# system. The pull station had not been marked to indicate that it could discharge the system.[AS]

Undated. A $700 loss of Halon occurred at Portsmouth Gaseous Diffusion Plant, due to a gasket failure.

Undated, **FAILURE**. A manual station at BNL failed to activate the Halon system when operated during a small fire. The Kidde RS-48 manual release has two circuits, one for alarms and one for system activation. Five other boxes were found to have faulty discharge circuits. The problem was to have been resolved by Kidde. [AS]

Undated. Another possible "fire" classification occurred at Savannah River when a 33# system discharged due to an electrical short in a motor. Due to the low cost, the incident was not in the reporting system and the records are thus incorrect by one more fire or one more accidental discharge. [AS]

Undated. A Halon system at a BNL project accidentally discharged 339#. The fire/rescue group had responded to an alarm and tripped the box while attempting to reset it. Several modifications had been recommended. [AS]

Undated. During maintenance work at PPPL, a technician had turned off the power to a panel, but not pulled the fuses. A wire was bumped and grounded the panel, discharging 40# of Halon. A number of non-compliances with the NFPA standard were found on reexamination and corrections were made to a number of systems, including adding the Halon to the change control system. [AS]

All told, Savannah River stated that there had been 13 trips in 1988, losing 4,603# of Halon 1301, total. The combined DOE report for CY1988-CY1989 stated that there had been a total of 48 discharges throughout DOE.

1989

06/06/89. $10,912. (No. 41). Lightning activated a power supply at a SPRO site, discharging a system.

03/18/89. $5,775. (No. 69). A Halon system was discharged during testing of a fire alarm system at the Princeton Plasma Physics lab.

08/02/89. $5,500. (No. 71). A newly-installed air conditioner at Fermilab began to smoke, discharging a Halon system.

01/03/89. $5,453. (No. 72). At Westinghouse, Savannah River, a circuit board connector shorted, discharging a Halon system.

06/24/89. $4,950. (No. 83). At Westinghouse, Savannah River, a heat detector failure resulted in Halon discharge.

07/03/89. **FIRE**. $4,300. At the Waste Isolation Pilot Plant, a 60# Halon system extinguished a fire in an underground shed. [AS]
12/17/89. $2,432. (No. 122). Smoking dust on a heating unit at a SPRO site discharged a system.

11/06/89. $3,070. An electrical short activated a system at Westinghouse Hanford Co. [AS]

12/17/89. $2,432. Heated dust on a SPRO site heater discharged a Halon system. [AS]

12/06/89. $1,875. (No. 138). At WHC Services, Richland, dust on a heating system also activated a Halon system.

04/28/89. $1,800. (No. 142). At Mound Laboratory, the fire department activated a system during a smoke detector test.

02/06/89. $1,250). (No. 157). At Argonne National Laboratory, a brass screw in an alarm panel tripped a contact, releasing Halon.

Undated. **FIRE**. A 70# Halon system was reported to have extinguished a fire in a vacuum pump motor at Savannah River for a non-reportable loss of only $100. [AS]

Undated. A communications technician, working on a system at ANL tripped a 300# system in a hot cell cave area. [AS]

Most of the incidents did not detail the weight of Halon in each system. The report to Headquarters, though, noted that there were 34 incidents in 1989, 4 of each were fires and all successfully extinguished. A further notation was that 27 incidents had occurred at Savannah River, with a total discharge of 10,775# of Halon. Fermilab reported several discharges, totalling about 1,240# when startups of HVAC equipment discharged a number of systems.[AS]

As a result of increasing concerns over Halon and the atmosphere, the Kesselring Site of Schenectady Naval Reactors Office installed a Halon recovery system for portable extinguisher servicing.

1990

01/20/90. $2,520. (No. 82). At Westinghouse, Savannah River Plant, 840# of Halon were lost in an accidental discharge. [AS]

01/13/90. $2,369. (No. 88). A Halon system was accidentally tripped during transformer maintenance at the Y-12 Plant. [AS]

02/08/90. $1,600. (No. 103). At Sandia National Laboratory, a resistor in an alarm panel failed, discharging Halon. [AS]

01/03/90. $1,500. (No. 104). At Fermilab, burnt particles in a furnace tripped a smoke detector, discharging a Halon system. [AS]

1991

08/05/91. $6,836. (No. 38). At Westinghouse, Savannah River, a lightning strike damaged an alarm system, discharging a Halon system.

03/28/91. $2,966. (No. 59). At the Kansas City Plant, a "Humidbar" injected steam into a room, activating a Halon system.

01/29/91. $2,500. (No. 66). At WHC Services, Richland, the fire department activated a Halon system during test.

09/08/91. $2,346. (No. 68). Again at WHC, an electrical short circuit discharged a system.

11/25/91. $1,500. (No. 85). Smoke from a SPRO site grinding operation activated a system.

The original issue of this chapter ended with the 1991 data. Since then, the following has been added:

1992

There were 45 discharge incidents from fixed systems; 44 Halon 1301, and one Halon 1211. There were no failures in a fire event. Seven were directly fire-related, all of which were successfully extinguished. All losses were "none-reported" except for a Fermilab fire of $11,600 and a SPRO fire of $2,500. Accidental discharges were not reported as losses except for a $550 discharge of 430 pounds at Portsmouth GDP, a $16,645 discharge of 1,360 pounds at SSPRO, and another $2,500 discharge of 600 pounds at SPRO. A total of 7,800 pounds were discharged in the non-fire events.

1993

A total of 10,772 pounds was reported discharged in 24 incidents, all non-fire.

The 1993 report summarized the Halon status. No new systems were being installed, per DOE policy. There were 1,235 Halon 1301 systems containing approx. 335,362 pounds. About 330 were considered essential applications. Inventory was 85,551 pounds. There was also 180,593 pounds of operational Halon 1211 and 24,949 pounds in inventory. There were 106 "non-essential" systems disconnected during the year.

Adding the seven new Halon fire actions to the previous record:

THE RELIABILITY OF HALON IN FIRES IS 24/26 OR 92.3%

This may be contrasted with the AEC/ERDA/DOE sprinkler record which is 99.1% successful.

For fires, the average loss was about $3,700. The maximum was $30,265, and seven of the 26 total incidents were listed as "no loss' or "negligible" (although the cost of the refill should have been included in the loss).

For the non-fire incidents, the average loss was only about $400 less than the fire loss (indicating the effect of prompt extinguishment), and the maximum loss was $30,500.

All of the above figures are affected by the $1,000 reporting trigger. Perhaps a majority of the systems had less than $1,000 of Halon in them so that trips would not be reportable. Similarly, fires under $1,000 were not reportable for most of the years and the number would probably increase considerably while the average loss per incident would also decrease.

With the number of halon systems in DOE, it is obvious that the performance and reliability statistics will continue to be accumulated. However, the subject is somewhat moot, except insofar as it may be relative to replacement gaseous agent systems. On September 27, 1990, the DOE established an interim position on new Halo systems, namely:

No new systems would be proposed.

No new portable Halon fire extinguishers would be purchased.

Unless design had reached 30% completion, plans and specifications for new systems should be cancelled.

Where contracts for installation exist and substantial pre-installation costs incurred, the systems may be completed, but where consensus cannot be reached on this issue, they should be cancelled.

Existing system may be maintained, pending further advice.

Subsequently, a new inventory was developed, prioritization of systems was requested, and HQ was urging sites to eliminate as many Halon systems as seem feasible. The existing bank of Halon would be maintained for those systems deemed most essential. By 1996, a inventory depot had been established at Savannah River and surplus stores could be sent there for redistribution or disposition.

PROBABLY

.....in which we learn that probabalistic data studies, statistics, charts, and every other kind of analysis, are wonderful things to work with, as long as you don't fall into the trap of believing them.

[AUTHOR'S NOTE: The annual summaries have consistently reprinted analysis techniques and results, whether informative or inclusive. The fire protection program utilized, and published, more analyses than any other safety program in DOE. A review of some is included here.]

Throughout our AEC/ERDA/DOE career, from 1962 through 1989, and on into our period of writing this history while serving with Los Alamos National Laboratory since 1990 to 1996, we have tried to compile every sort of loss-predictive or loss-analysis data that we could accumulate. Many provided useful insight into the fire protection story. Many others were of historical interest only, and a few were frustratingly useless. All had one common factor, however, they were fun to play with; but only so long as you didn't take them seriously. Herewith, some of the stories.

The field offices had been submitting annual summary reports to Headquarters since 1950. It wasn't until we went to Headquarters in 1970 that we began to try and get more information out of them than a simple compilation of loss data and stories of improvements. In 1976, for the first time, a report was prepared for field distribution, using the 1975 summaries submitted by the field, together with the cumulative loss studies we had been preparing. Thus, in the very first feedback to the field, some statistical studies and attempts at analysis were made. These, and later studies, are summarized under the subject headings below:

THE DOMINANT 10%

A common exercise in elementary analysis tactics is to look at the influence of a selected 10% on the whole, as in the well-know statement that "10% of the____ causes 90% of the ______." We found this to be true in a number of areas. The very first 1976 annual summary presented the results of a brief analysis related to ERDA changing the fire loss reporting level from $50 to $1,000, the same as other property damage losses. While every fire protection engineer agreed that some of the most informative losses were going to be lost[118] from the records, we found that the fire loss ratios, themselves, would only be slightly affected.

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118. The whole subject of "Unusual Incident Reporting" can be considered as just a complicated attempt to recapture what was lost when the reporting thresholds were raised.

From 1970 to 1974, inclusive, only 35% of the number of fire losses would have been reported if the threshold had been $1,000 instead of $50. This is of value if your objective is to reduce the amount of reports you read. At the same time, over 92% of the actual dollar fire loss would still be reported. Thus, the effect on the loss ratios would be small. The effect on overall losses would have been smaller still since the fire losses were only accounting for 13% of all losses in this period. The change to the $1,000 level was thus justified, if you're goal was to reduce the volume of paper required, which, at that time it was.

While the above data shows the importance of the "significant few", it could also be a misleading result of the same factor. After all, if there are only ten losses, all of $10 except for one of just over $1,000,000, then 10% of the number of losses are accounting for about 99.99% of the total loss.[119] The cited example was significant as the five-year period represented the best five years in AEC history. There were no large losses to distort the picture. Therefore, it is true that you can retain most of the dollar loss data and still throw away most of the losses! It's a useful thing to know when you're dealing with large numbers that include a few large figures and many small ones. If, however, you're looking for insight, some of the small ones you threw away may be the ones you really wanted.

PORTABLE EXTINGUISHERS

One of the things we lost when the reporting threshold was raised was most of our data on portable extinguishers. That first summary of 1975 did contain extinguisher data. In 91 fires that were extinguished by portable extinguishers in the five year period[120], the mean loss was only $1,416, just a little over the new reporting level so that many portable extinguisher fires could be expected to disappear from the future reporting system. The data from that report is of interest in several other ways and is reprinted as the following page.

This page also includes the first summary of the "water damage" studies that were a frequent Headquarters exercise. No matter when done, the results were about the same; both the frequency of non-fire system losses and the mean dollar loss involving non-fire systems was about twice that of a fire protection systems (the sprinkler study also showed the same).

The "self-extinguished" fire figure was surprising. The number of incidents was fairly high, but why the highest mean dollar loss?

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119. And the mean loss would be over $100,000. True but misleading.

120. Remember, any fire with a loss under $50 was not included; probably a fair number with portable fire extinguishers.

HOW GOOD CAN YOU GET?

The 1977 annual report had a brief appendix exploring the results of the "Fire, Safety and Adequacy of Operating Conditions" improvements program instituted after the Rocky Flats fire in 1969. As Appendix G, illustrated, you can get very good indeed. All the more so, since the goal had been stated to be a part of the new program. Considering that the program was good before, an extra-good improvement to an already-good program is a doubly good achievement.

THE TERRIBLE SURVEYS (BUT COMPARED TO WHAT?)

When the first round of surveys by Factory Mutual and Factory Insurance Association started in late 1969, a common response from many people not used to the idea of the insurance survey, was sheer horror at the large number of recommendations. [121] By the 1977 report, the total had reached some 4,820 recommendations. A very large number. We managed to ease some concerns, including at least one newspapers[122], by comparing the numbers to something they could understand. The 3,989 recommendations resulting from the first complete round of surveys averaged out to one for every $8.9 million in value of the facilities inspected, or one for every inspector-day of inspection time. (We later did the same thing and threw in numbers per building). Unfortunately, there were always some people, including supposed safety managers back in DOE Headquarters, who could only see the size of the recommendation number. Others, particularly the reporter, could figure out what might happen if the same inspector spent two days in their $17.8 million plant; - only two recommendations? It's always wise to multiply and divide any numbers you have by any others you can think of. Sometimes the results can throw a different light on a subject, - or get you out of a jam. Anyway, they're always interesting as long as you don't put too much faith in them. They are especially worth saving for the times you run into people who think big numbers mean big problems.

MORE EFFECTIVENESS COMPARISONS

By the 1978 report, the annual summary had become an official DOE publication and we expanded the analysis sections. One of the concerns in 1978 was the introduction of many facilities in the three-year ERDA history and now in the new DOE organization. We did a comparison of where the losses occurred and found that the former AEC sites accounted for 85% of the total property value in DOE, but were suffering only 21% of the total loss. In fact, the loss ratio for the last 5 years of AEC had been 0.6 cents/$100, while for the first four years of ERDA/DOE, it was 1.86 cents/$100. Obviously, the AEC safety system was not yet in affect DOE-wide.

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121. They were used to the "management concern" type of broad-brush surveys, not detailed inspections of every building at a site.

122. By offering to have one of the companies survey their printing plant and editorial offices and see how many recommendations they came up with on the same basis.

"ALL COSTS AND NO LOSSES"

Some people seem to think a no-loss program is no program. At least we often had trouble explaining why we spent all that money on fire departments, inspections, and protection systems, when we didn't have any losses. Didn't that mean we were just wasting money?[123] It was when somebody said: "Why don't we just insure everything?" that we found a solution. We were able to extract enough data on loss ratios, costs, deductibles, and protection requirements to show that our protection costs, plus our losses, and plus the firefighting costs were cheaper than insurance would be at even the best rates. An example was a 1976 IRI report of $320 billion in liability and $260 million in premium income for an effective rate of 8.1 cents/$100, overall. When you add in the municipal fire protection costs included in the taxes paid by private plants, DOE, if not all of the federal government, was more than "cost effective", but you have to keep proving it.

By the end of the 1970's, the fire loss ratio was around 1 cent/$100 and the recurring costs of fire protection, which included fire protection engineering and support services as well as the major component of fire department costs, was around 4 cents/$100. Thus the total cost of fire protection to DOE was about equal to the insurance cost of the best class of private industry.

FIRE FATALITIES

The 1978 annual summary contained a short summary of fire and firefighter fatalities. In the history of MED and AEC, there were 321 fatalities. Sixteen were the result of burns (and two firefighters died in accidents not the result of fire). Eight of the burn fatalities were the result of explosive origins, three from the ignition of combustible-saturated clothing, and five from flash-fires. In none of the cases would a building sprinkler system have been a credible safeguard. The fire-related fatalities constituted 5% of the total.

While there were no fire fatalities in the three year ERDA history, there had been 11 more in DOE through 1978, five of which were fire-caused. All of these were flash-fire type accidents in the petroleum facilities. Again, a building suppression system was not involved in any (most were outdoors). The 1978 summary noted that the last fire death had occurred in 1966. Since the 1978 summary, a perusal of the DOE fatality data shows only two more deaths, an explosion-fire fatality in 1981 at a petroleum facility and a 1987 case in which an electrician was burned over 60% of his body in an electrical clothing ignition accident. (see also the "Odds and Ends" chapter).

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123. Former AEC Safety & Fire Protection Branch Chief Dan Hayes always said they wouldn't let him hire the one type he really needed, an experienced arsonist. One who could set a fire that didn't do much, but would really set people to thinking: "What if...?"

As of 1993, the MED/AEC/ERDA/DOE record shows a 50-year period of no fire fatalities in a sprinklered building from other than an electrical ignition and shock to the victim. Overall, fire is a negligible component of all accidental deaths.

FREQUENCY-SEVERITY

In 1978, a frequency/severity list of fires was prepared. This was updated on several occasions and last published in the 1984 summary. A frequency/severity table is of some value in predicting the probable loss picture in future years, depending on two big ifs. If the data is sufficiently voluminous to be statistically reliable and if the system you are looking at does not change. For instance, the number of fires per year and the number of years you are considering may be statistically significant, but if all those warehouses that comprised your data base were changed from unsprinklered to sprinklered at the mid-point of the study ? To the fire professional, the expected difference is obvious. The trap is in knowing where the "change" points are. We had considerable success in using such data to support various arguments over time. Of course, sometimes the answers seemed ambiguous, so we just waited until "more data was available", or so we said.

A look at the 1984 summary is illustrative. While the fire loss per year was over twice the next largest loss category, mechanical damage accidents, the mean loss per incident was only the third highest of the eight listed. This anomaly is due to the fact that fire was accounting for about 50% of the total number of losses. Also, the second-largest loss in AEC/ERDA/DOE history had occurred, the $12M SPRO loss at the West Hackberry site. The effect of the single large loss was again demonstrated by the fact that the mean loss from fire (total $ loss divided by total incidents) was an order-of-magnitude greater than the median (half the number of incidents over and half under) $ loss!

In each of the $ targets chosen, fire accounted for a nearly uniform 25% of the number of incidents that equaled or exceeded that number. Taking into account the relative numbers of losses in each loss category yields the final table. One out of 11.5 fires exceeded $50K, the 4th rank in frequency. One out of 17.2 exceeded $100K, the 4th rank again. One out of 34.4 exceeded $250K, the 3rd most-frequent. One out of 68.8 exceeded $500K, the 3rd again. Finally, one fire out of 137.5 exceeded $1M, the <u>lowest</u> of the five remaining causes.[124]

HOW BIG IS BIG?

Soon after we started collecting and comparing all the data we could compute, we realized that one of the most essential elements for an adequate analysis was missing. All too often the "compared to what?" was unknown. If you don't know the property values, for instance, you can't compute a loss ration. If you can't compute a loss ratio, you can't tell if a "trend" is decreasing losses,

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[124]. Electrical losses dropped out at the $250K level and no transportation loss made the list at the $50K start point.

increasing inflation, or changes in the amount of property assigned. One of the more valuable indicators, now that DOE has 50 years of records to draw on, is the simple comparisons of fire loss frequency against total loss frequency. If we have been doing so much in fire protection additions, is fire becoming less frequent in the total loss picture?

The two graphs in the 1987 annual summary illustrate that the improvements programs did, indeed, work. As with most of the data we collected, we found it most informative to plot both annual and cumulative records. For dollar figures, it was also informative to include charts using inflation-adjusted figures.

The annual report graphs illustrate several other problems that are the consequences of the nature of the calculations. These are often misleading in data analysis and have been a trap for people in the past. In the first instance, annual fluctuations (are extreme, as would be expected for a subject heavily dependent on large but rare losses. In no single year can the ratio be explained without reference to the actual losses. For instance, a year with $50K in fire losses and $50K in assorted losses in all other categories would have a fire ratio of 50%. If the next year has $1M in fire losses and no other losses of any category except for a $2M tornado, the ratio is now 33% The data plot may fool you into thinking fire has improved or other losses have gotten worse, or both. Actually, fire was much worse and other losses were non-existent (except for mother nature). Similarly, the next year might have a single $5K fire loss and a few other losses with a $5K total. Now we're back to 50%, seemingly the same as two years ago, but both loss categories are actually major improvements.

A second problem is illustrated by the annual vs cumulative losses graphs, covering the post-Rocky Flats period. While the cumulative percent has a fairly consistent, and definite, downward slope, the trend of the yearly, dotted line curve, seems to be increasing. This is due to a variation of the preceding paragraph's discussion. Only five individual years were below 20% and nine were above 40%. In the post-Rocky Flats period, six years are below 20% (and there are four years less in the post-Rocky Flats period), while only two years are above 40%. Drawn on a continuous, same-scale graph, it is apparent that the ratios may be increasing for the post period, but the majority are so far below the cumulative curve, that the cumulative plot is continuing its downward trend. This is emphasized by the fact that only one year in the post RF period had a ratio exceeding the cumulative up to that point. It is possible to have sharply rising annual curves that still contribute to a lowering of the cumulative record.

A final problem is the nature of cumulative data. In the early years, a little change makes a big difference. In the later years, it takes a big change to make even a little difference.

GOING TO EXTREMES

The single most useful predictive tool was the EXTREME VALUE PROJECTION technique. The technique was developed for DOE applications by the System Safety Development Center run by EG&G, Idaho in the early 1970's. It was detailed in SAN 821-2, "MORT - The Management

Oversight and Risk Tree" and in various other publications from EG&G. Examples are often found in the quarterly summaries of accident statistics published by the SSDC and has been used extensively by them in various studies done for DOE Headquarters.

The first example we saw was an all-fire plot which clearly showed the return period for a fire of the magnitude of the $26M Rocky Flats loss was on the order of 19 years. The fact that the 1969 Rocky Flats fire occurred 23 years after the organization of AEC certainly added to the impressions of a first-time viewer. We don't know what might have happened if everyone was aware that the loss was "overdue" in those last few years, but it would have been interesting to find out.

Basically, the technique uses the maximum accident (or any measurable item) in any selected time period to calculate (in a t + 1 time period) on probability paper, the expected return period for a loss of any given magnitude.[125] We first used it in comparing various loss categories and in comparing pre-and post-Rocky Flats data. The plot was printed in the 1978 annual summary. The dollar losses were normalized for inflation by using the Factory Mutual Index. The basis was the maximum fire loss each year, giving the return period for any chose value as years.

The plot clearly showed the improvements, and a disturbing trend. The new plots again demonstrated that an order-of-magnitude improvement had been made. Whereas the return period for a $1M fire in AEC had a return period of about 3.3 years, the post-RF system had a return period of about 19 years. Further, the plots were sharply diverging to the point that losses much above that level soon became incredible in the revised system.

A number of interesting variations can be played with Extreme Value Projections. A lesson of this technique is that to change the slope of the curve, the <u>system</u> must be changed. Sprinklered vs non-sprinklered buildings are two different fire protection systems. An interesting exercise is to plot the AEC/ERDA/DOE return periods for the two systems. We'll leave it to the reader to determine at how low a value a given loss expectancy can become incredible in a sprinklered property.

IT'S ALL CUMULATIVE

Any collection of data amassed over time can be calculated on a cumulative basis. Quality control techniques often use a running five-year average as a trend analyzer. In all cases where single items can vary widely from the norm, the occurrence of such an item will distort the graph and make it difficult to interpret. In the preceding example, a collection of varying data seemed to be illustrating a worsening situation, while comparison with the long-term cumulative curve showed that the situation was actually improving.

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125. With lots of caveats, such as not projecting too far off the data points, accounting for "bends: in the straight-line plots, and discovering when a datum is "off-normal."

A number of things have continuously been plotted on both a year-to-year basis and on a cumulative basis. Most notably loss ratios and actual dollar losses have been presented as a continuing story with data points starting in 1947. In some cases, over such a period of time, the data must be adjusted by some inflation factor. We generally used the Factory Mutual data because we could find correction factors going back to 1947 and because it did relate closer to buildings and equipment than some others. However, in one annual report, we printed several published data sets, including FM and two Engineering News Record indexes. They all were close enough that any choice should be adequate. (These are also the two traditionally recommended by DOE for updating replacement values each year). One of the more useful exercises was to reverse the base point, or even take the middle. For example, when the change from 1947 to 1985 was a factor of four, you could upgrade the $1K loss of 1947 to $4K on the plots, or downgrade the $4K loss of 1990 to a $1K loss in 1947 terms. Sometimes, as with Rocky Flats in 1969, it was more useful to use that as a base year and adjust the other years up on one side and down on the other. Since most editions of the FM and ENR data do not go back as far as 1947 on a year-by-year basis, the 1985 annual summary included the graph illustrating the effect.

One set of data that was continually collected, published as both currant and cumulative data, but seldom used, was the "recurring cost of fire protection" data reported by each office each year. This was supposed to include all data, including fire protection engineering costs. However, yearly perusals of the field reports revealed considerable differences in calculating the costs. Finally, it was evident that the totals were so small in the overall picture that it wasn't worth while trying to fine tune the methods of acquiring the data. As long as each office was consistent, we accepted the data as evidence of the year-to-year trends, if not the exact dollars.

The trouble with the recurring cost figure was that it was almost all fire department costs. Comparisons, therefore, had to differentiate between sites with and without departments (and between AEC-facilities, and DOE as a whole). Most managers saw only the cost and not the cumulative ratio, and knew nothing of the facilities involved so we published it last in 1985. The figures are still published in the annual summaries, but not emphasized.

The principal problem was the bulk of the recurring cost figure, which was fire department costs. These increased considerably over the years, particularly when a new department was added, but the cost ratio kept going down. This was understandable when you realize that the initial cost is large when the decision is made to have a department (you need at least four people for every position if it operates around-the-clock). But once established, the site can add a considerable number of buildings before it becomes necessary to add to the department.

A missing part of the fire department cost picture was the department functions. Besides the firefighting function (actually negligible for most AEC sites, most of the time), a true comparison would have to take into account departmental activities that would still have to be performed, frequently at greater cost, if the department was not doing them. This included at various sites such things as building inspections, fire system inspections and acceptance tests, impairment supervision, extinguisher inspections and servicing or recharging, employee training, and non-fire emergency support. Consider the almost universal provision of medical emergency and hazardous material control and the bulk of the service may not even be "fire protection" related! Of course, any attempt at comparing sites was impossible if you did not differentiate between sites that covered a square mile or a hundred square miles; between departments that provided medical response and those that did not; and between those that were instituting major hazardous materials response activities and those who had not yet started. Even mutual aid arrangements imposed significantly different costs on individual departments. In short, not even individual departments could be compared.

In the 1979 annual report, a section describing the different fire departments in DOE was inserted in a (if you'll pardon our using our most detested "buzz word") proactive effort to have some written material available for the next person to discover the subject of fire department costs. The problem was never satisfactorily resolved, however, and we simply stopped including it in the annual summary after publication of the last chart (see preceding page) in 1985. That was never commented on, either.[126]

ANOTHER EXTREME

The 1980 annual summary took another look at an extreme value projection with two added years of data. The all-DOE and former AEC-only records were compared. Below a $1M level, both were straight lines to about the $1M level, with a "dog-leg" at that point. The "flyers" were more interesting and illustrated the soundness of the concept (see the discussions in the texts on the method, previously cited). The largest fire loss of 1977 was a forest fire. When the next largest, an oil fire, was substituted, the point was right on the curve. The maximum point on the AEC-facilities line was a $700,000 contamination fire in which the fire loss was negligible without the contamination effect. Both illustrated an increasing return time for losses above $1M. For AEC-facilities, the projected return rate for a $10M loss was about 30 years.[127] A variation, using a straight frequency-severity analysis was done on the added data (the $12M West Hackberry fire was included). This illustrated that, if that fire was within the "system", there should have been about 3 fires in the $1M to $10M range and there were none.

MONTH OF OCCURRENCE

For a few years, we accumulated the data by month of occurrence and added a yearly update to the time-chart. A May and November low and June high seemed to be significant and we speculated on possible causes in the 1980 report. Later analyses showed that the statistical significance was very marginal, so no further attempts were made along these lines.

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126. Although in 1989, one of the only two federal-employee departments, Los Alamos, began a tortuous conversion to a County Fire Department, at greatly increased cost of course.

127. The largest fire loss from 1979 through 1991 was a 1987 Fermilab loss of just over $1M - successfully handled by sprinklers.

One of the problems of data analysis is often forgotten in the midst of trying to determine the validity and meaning of the analysis. Namely; the use that can be made of the results. In this case, it is easy to validate that range and forest fires are more frequent in summer, while heating fires show a winter rise. Unfortunately, it is hard to determine what use this could be beyond validating common sense. One management problem in the modern "formality of operations", "trend analysis" and "root cause" [128] environment is deciding which things you are not going to do. Too many organizations are being told what they should be doing and then are not given assistance in doing it. In a budget-cutting age, high-level management should be concerned with things they are not going to do.

THE LOST LOSS RATIO

The 1979 annual report contained an addition to the reporting of loss ratios by Operations Office. In order of loss ratios, the (former) Grand Junction Office led the field with a zero rate. The addition to the annual report listing calculated the amount of loss that would be necessary the next year to "worsen" the better-than-average offices to the DOE cumulative fire loss ratio. For Grand Junction, it would have been $20,000! Only one of the nine best offices would have had to have total losses exceeding $1.7M. It is not difficult to dream up a scenario for a several-million dollar single fire loss at any field office's many contractor sites, let alone total losses of that amount. Thus, even the best site cannot rest on its laurels just because it has a good record. A very useful exercise was calculating just what it took to change "good" to "bad." It offers the safety staff the opportunity to rebut the oft-stated argument that "things are so good we can relax and save some money."

The same argument can be applied to improving data. In the 1981 annual summary, we made a point of stressing that the slight upturn being shown in the recurring cost data was still below such things as the cost of private insurance. More important, if the cost ratio had not been going down for nearly 20 years, we would have spent over $50 million extra than the actual costs for that period.

The "savings" of a program is a useful figure and should be prepared for every program that costs money. Sooner or later, somebody, like Frank Brannigan's oft-cited accountant, a person who knows the cost of everything and the value of nothing, is going to question some program's cost. Any astute safety person should be able to say that "compared to the cost of..., we have save $X". Unfortunately, all too often, the fire protection program is the only one that has collected the costs to begin with.

If the AEC/ERDA/DOE fire protection program had suffered fire losses at the rate of private industry, losses would have been about a **half-a-billion-dollars** more than they actually were over 50 years!

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[128]. What is the "root cause" of a forest fire and what are you going to do about it?

BOXED IN

One of the better ways of comparing data that has large ranges is the Box Plot. A heavy line is the median and the areas above and below are the 25 and 75, percentile ranges. Usually, an arrow will extend to the point that marks the maximum and minimum values. The 1984 annual summary contained several pages of plots.

The first plot (not shown) illustrated the pre and post-Rocky Flats upgrade loss ratios. The size of the box illustrates a key control element. In this case, the mean had not only been depressed, but the 50%-75% range had dropped from ($0.4M to $1.45M) to ($$0.12M to ($0.25M).

Other plots illustrated a problem that must be realized (or taken advantage of!) with this method. The charts covered a period from 1960 through 1985, so the data should be thorough, but the two appeared contradictory. On a dollar loss basis, the Naval Reactors Offices and Albuquerque seemed the "worst", while San Francisco and Nevada seemed good. On the plot of ratios, however, we saw that the situation was basically reversed. Again, the system can be confusing to those who look at loss data without a firm understanding of the base. Property values are so different that the ratio is the proper figure to compare with this technique. (Although actual dollar losses over various periods are useful comparisons for the same site).

LESSONS LEARNED

The fire protection program, as pointed out in earlier chapters, was almost unique in having 50 years of data to work with. In many ways, it was unique in that it was the only safety discipline that could not only compare it's loss record to national statistics, but could compare it's "cost of doing business". It was unique in that it was the only program that compared the effectiveness of its major tool, the automatic sprinkler systems (see Chapter XV) with international records. Indeed, fire protection is the only safety discipline that can make such comparisons.

The modern safety world emphasizes the use of sophisticated prediction techniques, trend analysis, probabalistic risk analysis, quality assurance, failure analysis, fault trees, and all the other "analysis" techniques that can be dreamed up. In fire protection, all have been found to have some application and many are "old hat." For fire protection, however, the "data base" is so broad and so complete, that analyses do not have to be based on suppositions, "trees", "roots", or failure guesses, let alone probability predictions. The probability of a fire has always been "one" in the fire protection hazards analysis scheme. The bottom line has been known for many years and many times reconfirmed:

THE DOE FIRE PROTECTION PROGRAM HAS BEEN, AND IS, SUPERB

PROBABILITY DATA

By the early 1990's, we were increasingly asked if we had any data relating to the probability of building fires, so we created this new table:

YEAR	FIRES	BLDG. FIRES	PROBABILITY	FREQUENCY
1975	10	10	1.0×10^{-3}	1 per 1,000 yrs.
1976	13	10	1.0 "	1 per 1,000 yrs.
1977	27	18	1.8 "	1 per 556 yrs.
1978	33	21	2.1 "	1 per 476 yrs.
1979	21	17	1.7 "	1 per 588 yrs.
1980	23	15	1.5 "	1 per 667 yrs.
1981	35	22	2.2 "	1 per 455 yrs.
1982	23	15	1.5 "	1 per 667 yrs.
1983	44	36	3.6 "	1 per 278 yrs.
1984	33	19	1.9 "	1 per 526 yrs.
1985	37	23	2.3 "	1 per 435 yrs.
1986	40	14	1.4 "	1 per 714 yrs.
1987	27	17	1.7 "	1 per 588 yrs.
1988	22	12	1.2 "	1 per 833 yrs.
1989	30	17	1.7 "	1 per 588 yrs.
1990	22	14	1.4 "	1 per 714 yrs.
CUMULATIVE		280	1.75 "	1 per 571 yrs.

All data is based on a mid-1980's survey counting 10,000 buildings in DOE. This did not include the Power Administrations or Oil Reserves, although their losses are included. The frequency is extremely conservative as a result since a number of fires in these facilities are included.

The increase over the years is more apparent than real as the number of buildings obviously increased by a considerable amount, especially as AEC became ERDA and then DOE and a number of new facilities, each with numerous buildings, were added. Most striking, the change from 1975 to 1990, an increase of only 4 fires, is remarkable considering all the buildings that are part of the power administrations and oil facilities, energy research centers, and the many pilot plants that existed and were added during the ERDA and early DOE years.

The fire losses counted are those over $1,000, the minimal reporting level for property damage incidents. The inflation factor is also masked. The $1,000 reportable fire of 1990 was little more than half of that in 1975. If we added the unknown number $500 fires, and up, beginning in 1975, the 1990 probability is probably more correct for a cumulative figure, but still remarkable.

BY THE NUMBERS

.....In which we learn that the AEC was not only a great innovator in a new world of computers, it was a great innovator in protecting the new world, even when it involved a return to one of the oldest worlds of protection.

[AUTHOR'S NOTE: Computers have been a major part of the agency since the earliest days. Not only does DOE lead in new systems and number of systems, it has always been a leader in fire protection programs for computer facilities. No history would be complete without a significant chapter on computer protection.]

THE FEDERAL FIRE COUNCIL

At the Annual Meeting of the Federal Fire Council on 1/26/60, a panel of four representatives from federal agencies and Underwriters Laboratories discussed the topic of fire protection for electronic data processing installations. A subsequent meeting on Feb. 16 saw three representatives from the computer industry meeting to discuss fire protection for such installations. As a result of these sessions, the Design Standards Committee set up a subcommittee to draft "Recommended Practices for Fire Protection for Essential Electronic Equipment." This became Recommended Practices No.1" of March, 1962.

The FFC task group developing the recommended Practice was composed of R.G. Bright of the Veterans Administration as Chairman, and H.E. "Bud" Nelson, of GSA, as ex. officio. A cables and machines group of four included people from NASA, Navy, HEW, and Army. A six-person group on environment included people from Treasury, GSA, Navy, Veterans Administration, and the Post Office Department. A four-person group on records included people from GSA, Interior, and Treasury. A final group of "special consultants" included three people from the Navy, GSA, and Commerce.

The March, 1962 first edition included four classifications of combustibility interlocked with four classifications of importance. This was deleted as unworkable by the 1969 edition. As an example of the problems, the second edition noted that UL had published a standard for "electronic data processing units" that included a classification for a unit in which a fire could not spread beyond the source unit (when deenergized). The FFC felt this was an excessive module of risk and posed a tighter definition. UL also had a class defined for a system where an internal fire could not propagate. No systems were ever classified under this category.

Carbon dioxide extinguishing systems were covered in some detail.

Automatic shutdown of air conditioning systems was considered desirable.

The second edition was published seven years later, in July, 1969. It was remarkable in several categories. As the preface stated:

1. The four combustibility classifications were eliminated.

2. Cable construction was an identified problem, covered by new requirements.

3. The revised edition "requires that all essential electronic equipment areas involving computers and other low energy devices shall be completely protected by automatic sprinkler systems." They added: "Extensive review of fire control and potential damage from both fire and fire extinguishing actions has convinced the committee of the need for this requirement." This was the first dramatic endorsement of sprinklers in computer areas and placed the Federal fire Council years ahead of the private sector and private standards-making bodies.

4. Ionization detectors were selected as the choice for early warning.

5. The carbon dioxide recommendations were eliminated.

6. The requirements for automatic shutdown of air handling systems was revised to encourage smoke removal systems wherever practical.

7. The Federal Fire Council second edition was unique in that it included the information on the remarkably effective decontamination procedures that had been developed by the Navy Research Laboratory and used to decontaminate equipment left sitting on cold docks after being exposed to smoke and flames and flooded with salt water in the middle of winter as an aftermath of the aircraft carrier "Constellation" fire. The RP-1 document even gave the trade names and manufacturers of the materials used. This was considered so valuable that, when the AEC standard was updated for the 1984 edition, the authors exerted considerable effort verifying the correctness of the information and reprinting it as part of the AEC document.

Although the AEC was in the forefront of most computer applications, (and remains so to this day), neither of the two AEC-HQ fire protection engineers were represented on the FFC. (Contractors were few in numbers in those days and not represented on any AEC committee).

THE AEC STANDARD

In September of 1962, the AEC issued a 24-page booklet as "Safety and Fire Protection Technical Bulletin No. 8", titled "Fire Protection of AEC Electronic Data Processing Systems." It reviewed the results of a survey by Don Keigher of AEC facilities and which was used as input to NFPA and FFC standards. It included notes on the utilization of computers, findings, significant fires, NFPA activities, and recommendations for an AEC computer standard.

A similar 46 page report was published in 1966, classified as Official Use only.

In 1966 and 1967, Donald J. Keigher, then Chief of the Industrial Safety Branch of the Health and Safety Division at the AEC's Richland Operations Office and a member of the NFPA committee, made a survey of AEC computer facilities to evaluate them against the requirements of the 1964 edition of NFPA 75, "Standard for the Protection of Electronic Computer Systems." Each Operations Office had its computer facilities described in a separate Appendix which was issued only to the concerned field office. For instance, Appendix C of his report, marked "Official Use Only", covered SAN facilities and included details of his visits to Lawrence Radiation Laboratory, Berkeley (four locations); Lawrence Radiation Laboratory, Livermore (three locations); and the Stanford Linear Accelerator Center (one location).

Part II of the Keigher Report was a summary of AEC computer utilization. Evan at that date (end of FY 1967), AEC had 274 computer systems, 250 directly owned. Operating costs for FY 66 were $56 million and replacement value of all units was estimated to be over $150 million. Only 10% of AEC computers at that time were valued over $3 million, each.

All of the sites visited in 1966 - 1967 had improved since the 1962 tour. General new concerns were: increased AEC ownership, increased congestion, more values in smaller units and more units in newly enlarged areas, increased combustibles in the form of tapes and carbon-backed paper printouts, vastly increased records storage, poor emergency plans (only one site having a good system(, and many sites with ADP committees but none with and FPE on the committee. Overall, despite the expressed concerns, the AEC was deemed to be better than any other agency, with the possible exception of the Navy. However, while the Navy had a good program, they were less successful in getting it applied at numerous shore installations.

After the 1967 review, a survey report was published by the AEC as "Safety and Fire Protection Bulletin No. 12", titled "Fire Protection of AEC Electronic Data Processing systems." This covered the background to the AEC computer protection program, survey findings, a possible AEC supplement to NFPA 75, the NFPA standard, an update of significant fires, and additional protection considerations.

In 1968, Don Keigher had completed a number of tours of all AEC computer facilities. He prepared reports on their protection, both for AEC and as background for his role as a memebr of the NFPA Computer Protection Committee. On 6/26/68, Acting AEC Safety Brabch Chief Dick Smith (one of the original AEC fire protection engineers) wrote a memo to Keigher, Safety Branch Chief at Richland. It contained the following:

> "Several months ago, Harvard advised NY (New York Operations Office - ed) of the 6-months interim need for using a small SDS computer within an existing building. NY requested interim fire protection and suggested high expansion foam consideration. Harvard agreed to provide protection, but objected to using foam and proposed Freon as a substitute. We understand that, when DuPont was contacted to handle design and installation of the fire detection and protection system, John

Dowling (DuPont expert on Freon fire protection) was called off of vacation to initiate the work. The apparent strong DuPont interest is probably attributal to the fact that this is the first known specific application of Freon use for computer fire protection."

After several paragraphs noting that the protection would be moved, with the computer, to its permanent home, and cautioning about the decomposition products of freon, the memo concludes with the reason it was written:

"It is my understanding that you concur in the direction of the proposed effort for protecting the subject Harvard computer and that NFPA 75 requirements do not prohibit computer facility fire protection with Freon."

From the above, it is obvious that an AEC facility was certainly among the first Halon users, if not the very first. Note also that it was a computer facility being protected, and a temporary installation at that. (It's a good thing the year was 1968. Thirty years later, Freons were prohibited from just about any use!

After the 1969 revision of RP-1, with its strong insistence on sprinklers, the AEC felt that a specific AEC standard would be desirable. The NFPA standard was not strongly pro-sprinkler and even though most AEC fire people supported sprinklers, many felt that recognition should be given to the new Halon agents, particularly as a means of providing protection in trailers and other facilities remote from water supplies.

The story of the AEC internal computer standards effort must be expanded by noting that Dick Glover, then with Albuquerque Operations Office, had been appointed to the NFPA computer committee and was requested by AEC Headquarters on 5/22/70 to arrange for a new round of computer tours, to be completed by early 1971. Dick had already expressed his preference for what has become the "standard" for computer protection. His 1/3/68 letter to Bill Hanbury, then head of the Federal Fire Council, commented on previous discussions of protection and strongly supported wet-pipe sprinkler protection throughout, with an early warning smoke detection system supplementing the protection.

At this time, we wrote the first of several "Different Viewpoint" articles. The first, distributed on 6/20/70, argued that all codes and standards required sprinklers throughout all buildings. The basis was that you could omit sprinklers, but only when you complied with all the other requirements for unsprinklered buildings. In other words, we treated the exemptions allowed for sprinklers as the requirement and the non-sprinklered requirements as what had to be done if sprinklers were omitted. It was an early demonstration of cost savings in construction if sprinklers were provided. At the same time, we also completed "The Computer Fire Problem, Its Causes Effects, and Cure". It has been a much - requested document, particularly for its irreverent approach to the subject. It was an early advocate on in - unit Halon systems. Unfortunately, a workable Air Force unit was developed in the early 1990's, hust as Halon was being phased out. It also contained the major statistical analysis of computer losses to that date.

When the AEC standard, WASH 1245-1, was issued in July 1973, largely based on RP-1, with the additions from AEC experience and the Keigher surveys, it established several criteria unique to AEC facilities. These were:

1. Halon became an allowable fire extinguishing agent.

2. Halon 1301 total flooding systems were acceptable in lieu of sprinkler systems.

3. CO_2 was reintroduced as recommended protection for underfloor and in-cabinet use.

4. A limit of $25M in computer values was established for any one area.

5. Requirements for records protection were simplified in view of the ease of providing duplicate and remote system records storage.

6. Smoking prohibitions were added. (This was considerably in advance of its time and the direct result of an AEC-Headquarters administrative manager who didn't like smoking. An ash tray sitting on the control console had been a fixture in most installations up until then).

7. Finally, the standard was designated as mandatory for computers with a value of $1M or more and "strongly recommended" for those with a value under $1M.

The AEC was in the midst of its appraisal program by FIA and FM (see Chapter XII, "Independence") and a number of new recommendations were being made relative to computers. These included underfloor protection, ventilation interlocks, power interlocks, wet pipe or pre-action or no sprinklers at all, and acceptance of Halon in total-flooding, under-floor, or in-cabinet. Headquarters issued what was to be the first of a series of "exemptions" (this without field requests) stating that every site was exempted from the recommendations of FIA and FM, as they pertained to these elements, until a HQ-developed computer standard could be issued which would settle AEC policy.[129]

A computer committee, consisting of Arnold Weintraub, newly moved to DOE HQ from the Brookhaven Office, and Thomas O'Connor of Oak Ridge[130] was formed to prepare the standard. The

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[129] The standard, as issued, did not resolve the policy and still has not in 1994. Fortunately (?), the majority of DOE sites have long since forgotten what the controversy was or what the HQ action was.

[130] Soon to move to Savannah river and then to leave AEC. see Chapter IV.

basic decisions were made at a meeting at the author's house in Bethesda, MD. The document was signed by the AEC Controller, the Director of the Division of Management Information & Telecommunications Systems, and the Director of the Division of Operational Safety. (Getting computer management and computer money people on board gave the standard much more authority and credibility than it would otherwise have had).

The 1973 AEC standard continued the practice established by the Federal Fire Council of including an appendix listing computer and computer-related fires known to the authors. The 1973 edition contained 17 examples of fires originating within electronic equipment, 9 cases of fires originating within other electronic equipment, 16 cases of fires outside of the equipment but directly related to the equipment or its special environment, 22 examples of fires originating from causes not directly involving electronic equipment, 15 wire and cable fires, and 12 miscellaneous incidents involving computers.

One of the more interesting developments from the Keigher reviews was the result of the author's survey of Lawrence Berkeley Laboratory in the mid-1960's. Fire Chief Elmer Silva, when asked about possible water damage incidents to computers took us to a 184" cyclotron support building. The 1930's building housing the cyclotron was extremely dusty and the accumulation of grime was obvious. The electronics shop across the alley had numerous electronic assemblies that they were cleaning by spraying with soap and water (And drying in ovens). The difference between wetting unplugged equipment and hot vacuum tubes is obvious, but the idea that water could be applied to electronic equipment under any conditions was almost revolutionary. We acquired several pictures of the process, which were also used in an article in the laboratory bulletin. The subject became and often-quoted item in a number of fire publications and the photograph of a water nozzle spraying a bare oscilloscope assembly was used in AEC and other publications.

In addition to the AEC's early involvement in the most sophisticated of computer equipment, a 1982 survey (published in the 1982 Annual Summary of Fire Protection programs) showed the importance of computers to AEC (now DOE). Some of the more remarkable figures are:

1. The total value of computers (and basically including only those over $1M in value) was just under one billion dollars. This represented 1.7% of the total value of DOE buildings, equipment, and stock.

2. There were 155 computer rooms (again, primarily in the over-$1M category), and 52 control rooms. There were also 84 separate tape or records storage vaults.

3. The mean value of all occupancies was $1,686/sq. ft.

4. The maximum value located in a single fire area was $65M.

5. Over 70% of the dollar value was in areas with separate alarm systems in addition to any extinguishing system actuating alarms.

6. The alarm systems were 99% smoke detection, although 5% of the computer values had both smoke and heat detection systems.

7. About 1% of the values or areas had only fire detection (mostly small trailer units) and only 0.1% had no protection.

8. Over 99% of computer and control rooms were protected by automatic fire extinguishing systems, with sprinklers constituting nearly 90% of either the value or area protected.

9. Halon systems also were protecting nearly 62% of the areas and 70% of the values.

10. For the total of computer and control rooms, the sprinkler system was the only protection for 30% of the values and a total flooding Halon system the only protection for 15% of the combined values.

11. By numbers, total flooding Halon was installed in nearly half the total of 207 facilities. Again, trailers and portable test-site facilities are the principal reason for the differences between numbers of facilities and areas or values of facilities.

12. The wet-pipe sprinkler system was the most common. The early history of computer protection is replete with examples of selling sprinklers by using preaction systems as a safer system, but the survey showed over 50% of he floor areas protected by wet-pipe systems, while about 1/3 of the floor area was protected by preaction systems.

13. Another seller for sprinklers was the use of high-temperature heads to reduce the possibility of accidental discharge. Despite the popularity of this move, the survey revealed that the number of facilities with ordinary heads exceeded the high-temperature by 2-1/2 times. On an area basis, the ordinary heads were twice as prevalent and on a dollar-protected basis, the ordinary heads were 1.2 times as prevalent.

14. For portable extinguishers, Halon was the obvious choice. Surprisingly, almost 1% of the areas were protected with dry chemical extinguishers!

15. Cost data was requested, but little was available. The mean cost for protection in computer rooms was \$1.31/sq. ft. and \$2.01/sq. ft. was the mean cost for control rooms.

16. Maintenance costs were also evaluated, although there were a number of problems due to lack of precise definitions. However, overall maintenance

costs for detection systems were twice that of sprinklers and Halon system costs were 2-1/2 times that of sprinklers.

17. Maintenance/inspection times were 2.7 hours per 1,000 sq. ft. for sprinklers 5.3 hours for detection systems, and 6.6 hours for Halon systems.

The 1982 computer survey had been conducted as part of a program to update the computer standard. Arnold Weintraub, now in Headquarters, with contributions from the author and a number of field people, produced the second edition of the AEC (now DOE) standard. It was issued as DOE/EP-0108 in January, 1984 and labeled "Formerly WASH 1245-1."

The new standard reemphasized sprinklers as the basic protection system with Halon as a backup or redundant system or as a primary system only where a water supply had not been practical. The staff had become concerned with the massive acceptance of Halon as the only system in installations where sprinklers were not only practicable but where considerable quantities of ordinary combustibles were present. Doubts about the adequacy of limited-supply systems also played a major role. In addition, the revision introduced a carpet flame spread limitation, clarified ceiling fire resistance ratings, increased the dollar limit per fire area to $50M, clarified detection requirements, and modified the Appendix to include all fire since 1966 (through 1983).

One of the principal efforts involved investigating the FFC and Naval Research Laboratory material on reconditioning flooded and smoke-contaminated equipment. The DOE document included as Appendix B, an updated version of the NRL procedures, including the addresses of equipment and chemical suppliers and references to the original NRL reports.

THE NFPA COMPUTER STANDARD

After a number of notable computer fires, particularly the 7/2/59 Pentagon computer facility fire,[131] resulting in a $6.669M loss, the NFPA formed a Committee on Electronic Computer Systems in January of 1960. A number of companies, subject to differing recommendations, had petitioned for a uniform standard. The first draft of the "Standard for the Protection of Electronic Computer Systems" was tentatively adopted in 1961 and officially adopted at the 1962 annual meeting. Subsequent revisions were issued in 1963, 1964, 1968, 1972, 1976, 1981, 1987, and 1989. The 1992 edition was a complete rewrite.

The AEC was represented on the committee from the start. The interest was obvious from the number, value, importance, and advanced technology represented by AEC computers. Don Keigher, Branch Chief for safety at the Richland Operations Office was a charter member. The membership lists in the 70's and early 80's included Keigher; Arnold Weintraub, with New York

[131] ironically, the fire was the common light bulb and combustible ceiling tile. The occupancy just happened to be a computer system.

Operations Office, Brookhaven Area office, and ERDA-Headquarters by 1976; Thomas O'Connor, with Oak ridge and then Savannah River Operations Offices, and John Hoogesteger, Chief of Fire Protection at the Union Carbide's Oak Ridge Gaseous Diffusion Plant. Upon Arnold Weintraub's retirement in 1985, he was replaced by the author until the author's retirement in 1989.

DuPont had conducted tests on Halon for computers in October of 1970. Results were sent to the NFPA committee in January of 1971. The proposed amendments allowing Halon protection were not accepted by the committee at that time. This again illustrates how AEC was in advance of industry practice. (A final draft, 9/70, British Standard for computer protection recommended only smoke detection for unoccupied areas, carbon dioxide portable extinguishers, and no sprinklers).

With retirements and the passage of time, the membership changed, but even in 1994, the DOE was represented by Carl Caves, of Headquarters, Stephen Leeds of Lawrence Livermore National Laboratory, and Don Keigher, now a member Emeritus and the corporate memory of the committee.

When the author was on the committee in the 1980's, a perennial subject at each meeting was the history of underfloor fires. Basically, there were none. We remember one session where the IRI representative mentioned two underfloor fires, but we were never able to pin them down. Checks of military records, DOE, and published NFPA accounts showed none. Several lists were compiled by the author covering all the published data we could find, but the underfloor fire remained elusive.

LOSS RECORD

One of the best features of the FFC document, RP-1, was the inclusion of the computer fire record. The data was used in this author's first paper on computer protection to establish the desirability of sprinklers, and argue for a compact halon system, applicable to individual main frames. A problem with studying computer losses in the early 1960's was the scarcity of examples. Computers were large main frames. the idea of a personal computer was considered far-out. Indeed, an early IBM executive had stated the future market for major computers was limited to a few hundred potential examples world-wide. RP-1 contained incidents from 1957 to 1962 (and to 1968 in the revised edition). In order to provide a wider range of examples, RP-1 contained a number of categories. These included; fires originating in computer equipment, fires originating outside the equipment but directly involved with the equipment, other electronic equipment fires, cable fires, telephone system cable fires, fires propagating to cables, and a number of miscellaneous incidents.

One of the early computer fires was at the University of Illinois in early 1967. Fortunately, while the AEC had invested several million dollars in the total program, title to the unprotected computers and the facility had been transferred to the university. the fire, while resulting in about $150,000 in damage, was not a chargeable AEC loss. (See AEC Serious Accidents Bulletin #281).

The current problem with collecting computer loss data is a plethora of incidents. Not that the old-concept computers have proliﬁgated so much, but that the quantity and types of computer-related equipment have increased tremendously. Now almost everything is computerized, from the personal computer to electronic controls, switchgear that has been miniaturized to the appearance of computers, and everything from temperature controllers to fire detectors containing more computer circuits than was imagined only 20 years ago.

Another problem, related to the above, is the difficulty of identifying whether or not something is computer-related if it is not specifically identified as such. At one time, a Halon release could almost be assured of being in a computer room. Now Halon protects so much that, unless the occupancy is specifically identified as a computer room, it can not be included with computer accidents. Now, a water leak in any office can damage several thousand dollars of computer equipment and not even be identified as such. Recognizing that such difficulties are inherent to any modern study, it may still be informative to add to the losses (from 1966 to 1983) contained in DOE/EP-0108 and see what the recent history shows. The second edition contained data on 61 incidents. From 1984 to 1991 (the last year for which we have obtained data) another 32 losses can be added. These are as follows:

1984

In the non-sprinkler water damage category, a 10/17 roof leak at LLNL damaged a Cray computer to the extent of $91,119.

Another pipe freeze and rupture at RL on 12/23 resulted in a $70,000 loss.

A heating coil froze in a Rockwell, RL, facility on 2/18, releasing water onto computing equipment for a $161,270 loss.

At Fermilab on 12/14, a sprinkler system discharged water onto computer components when an elbow froze. loss was $4,000.

The above example is typical of the problems of classifying DOE losses. In this case, the cause was identified as "natural' because freezing weather was the initial incident. Reviewing the record shows that similar incidents are described as "mechanical' because nothing was damaged until the pipe or valve broke, "electrical" because the water didn't do anything until it shorted out something, or "miscellaneous" because they weren't sure what category it should be in.

1985

Freezing weather at Los Alamos on 2/3 ruptured sprinkler piping in a ZIA facility, doing $23,000 damage to assorted electronic equipments.

At ANL, a disc drive fire was extinguished by the room occupant with a portable extinguisher for a $2,750 loss.

At BNL, a fire in a 200 watt anode power supply wire-wound resistor was extinguished by a small portable extinguisher in a $2,500 loss.

At LLNL, a VG Micromass Spectrometer unit was fire damaged in an unsprinklered room. loss was $100,000.

1986

On 2/25 at United Nuclear, an IBM copier fell from a truck for a $6,000 mechanical damage loss. (There were at least five such incidents in these years. They certainly damaged the "computer" equipment but hardly represented the traditional computer problem.

On 1/3, at BNL, an unattended computer was damaged by fire when a non-regulated voltage supply overheated in a $3,300 electrical fire loss.

1987

The largest loss was a $1,253,250 fire at FNAL when an experimenter-built instrumentation box ignited from a misplaced connection and spread to cables and experimental shielding. The high-bay fire was controlled by five sprinkler heads. While the box was no larger than a lap-top computer it represents a generic
problem in electronic equipment. if classed as "computer" it distorts the loss data. However, it is certainly typical of modern
electronic equipment problems.

On 3/11, a Pantex computer was damaged from a leak in a ceiling water line to the extent of $21,000.

Another copier fell from another lift truck at RL for a $6,680 loss.

At Rockwell, ID, a $1,500 loss resulted when computer-operated equipment damaged other equipment through a software error. This doesn't fit in the categories established for the last DOE standard, but it may represent a future "root cause."

On 12/25, fire damaged computer hardware and software for a $150,000 loss at the Central training academy in Albuquerque. (Note that this is on the SSDC Annual Summary of accident board investigations in their fourth quarter report, but is not included in Table S-10 list of property damage ranked by cost).

1988

On 12/4, a computer Halon discharge at Westinghouse, RL, resulted in a $1,696 loss.

On 10/29, at PPPL, tapes in a vault were damaged when an underground water main leaked. loss was $26,000.

On 6/24, a Du Pont computer was damaged by lightning for an $18,550 loss.

On 5/15, a water coil at LANL froze and thawed, doing $5,041 damage.

On 2/13, at PPPL, a sprinkler head flooded a computer center when "a check valve assembly clogged." The loss was $1,460.

Copiers at RL were damaged during transport when a restraining strap released on a WHC-RL shipment for a loss of $1,400.

1989

On 10/16, a BNL loss of $10,000 was suffered when electronic equipment was damaged by water "pouring from open sprinkler piping."

At Allied-Signal on 2/28, 20 gallons of water from cracked sprinkler piping damaged TV equipment.

At Kaiser Engineering, Rl on 6/14, computer equipment was damaged when water leaked from a ceiling valve for a $1,000 loss.

1990

On 12/22, a sprinkler system froze/broke at the Pantex Plant, flooding a building and damaging a computer for a $43,600 loss.

On 9/10 an Apple computer and software were stolen from an unsecured room over a weekend at the Rocky Flats Plant. Loss was $20,000. (This doesn't fit into the category of losses previously considered, and shouldn't, since it is security more than safety. However, it does illustrate a prime problem with modern computers. The capabilities have increased so much that the theft of a lap-top is roughly equivalent to the theft of a main-frame 30 years ago. As the author frequently joked, the computer safety problem is becoming more industrial safety than fire protection. The million dollar loss is not so apt to come from a fire as from somebody dropping a computer module and then stepping on it).

At Sandia, an electrical failure and overheating of a computer module resulted in a $34,318 loss. (This is also an illustration of another of the author's pet peeves over the years. Which Sandia? Albuquerque, New Mexico or Livermore, California? They may have been run by the same corporate headquarters, but information by site would have been much more informative).

On 6/13, a faulty toilet valve caused water damage to carpet, computer, and modems, at the Albuquerque Operations Office in a $7,600 loss.

One 3/26, a $7,000 loss at Rocky Flats resulted from an electrical malfunction in a work station during the installation of a PC. (Another example of the modern "computer" problem. Is this a computer loss? Or a wiring loss? or an "electrical damage-no fire" loss?)

On 2/13 a Mound Laboratory power outage caused the failure of a computer and network interface units. Loss was $5,423.

A Battelle, PNL, loss of $3,300 on 4/2 resulted from a corroded pipe leaking onto an electronic balance and personal computers.

<u>1991</u>

An unattended portable space heater ignited computer equipment and furniture at the Y-12 plant on 1/9 for a $14,690 loss.

Adding the above data to the previous standards produces the page 13 table. The percentage changes or relative rankings changes are surprisingly small, given the few incidents in the earlier data base. One of the problems of continuing the earlier data is illustrated by the item about fires not extinguished by sprinklers. The only million dollar loss was in an occupancy by no means similar to a computer room and originated in a piece of equipment not considered traditional computer equipment. Since computers have proliferated, the peripheral considerations can probably be eliminated. On the other hand, the nature of computers and the occupancy of computer rooms has changed so much that perhaps even the traditional computer room definition is no longer valid.

If the Fermilab fire is omitted, the mean loss for all fires becomes about $36,000 and the order of the nine items is unchanged, with a minor exception of number nine, mechanical damage, displacing number seven, fire extinguished by a sprinkler system,.

The mechanical damage incident growth was due to three incidents of dropping equipment while in transit. It's not a fire protection problem, or even much in terms of relative dollar loss, but six incidents and $20,000 is worth at least a footnote.

The most dramatic figure is fires extinguished by sprinkler systems. The mean loss puts this category number seven of nine and less than $3,000 per incident. Surprisingly, fires extinguished by Halon systems had twice the mean loss (due mainly to the cost of Halon). Further, while the average sprinkler water damage incident resulted in four times as much damage as the average sprinkler-extinguished fire, the average non-sprinkler water damage was just over three times as costly as the sprinkler water damage incident.

The computer fire protection story in DOE history is another example of DOE contributions to the national standards systems and leadership in several aspects. While the three standards were developed in the same era, the DOE standard was the first to recognize Halon as an alternative, and the only one to reemphasize sprinklers after the demise of the federal fire council. The DOE standard was also the only readily available source for the Naval Research Laboratory's historic work on reconditioning equipment, the source of almost all of the many salvage organizations success stories in this area.

DOE COMPUTER LOSS RECORD

	Through 1983			**Through 1992**		
Cause	Total Loss	No.	Mean Loss	Total Loss	No.	Mean Loss
1. Flood or nonspklr water damage	$49,300	2	$29,650	$435,630	11	$39,602
2. Fires-no auto ext. syst.	$368,427	14	$26,316	$713,122	19	$37,753
3. Fire-all causes	$398,678	21	$18,993	$2,013,257	29	$69,423
4. Spklr. dmge.	$15,000	2	$7,500	$105,375	8	$13,172
5. Fires-ext. by Halon syst.	$18,492	3	$6,164	$18,492	3	$6,164
6. Elect. dmge. no fire	$18,504	4	$4,626	$83,795	8	$10,474
7. Fire-ect. by spklr. syst.	$11,949	4	$2,987	$11,949	4	$2,987
8. Accidental Halon dischg.	$21,027	8	$2,628	$22,723	9	$2,525
9. Mech. dmge.	$5,700	3	$1,900	$19,780	6	$3,297

XXVIII

SPREADING THE WORD

.....In which we learn that eight of the eighteen items in Chapter II that made the fire protection program unique can simply be described as "spreading the word", and are still a key to the success of the program.

[AUTHOR'S NOTE: Information exchange is one of the most important aspects of any safety program. It is particularly important in fire protection where so much of program is determined by history. This publication is the history of the DOE programs, AS the only safety program for which a history has been maintained, it is another of the reasons the fire protection program in DOE is superior to other programs.]

From the earliest days of the AEC, a principal feature of the fire protection program was the various means used to "spread the word" of what was going on to all the field and contractor fire protection professionals. No other safety discipline conducted so many similar programs, did it so extensively, or for as long. None have yet realized that this is a key element of any real safety program and that it cannot be maintained by publishing an occasional safety bulletin or hosting a one-size-fits-all safety conference that tries to address all disciplines at once. Without regards to any priority, some of the key elements in the AEC/ERDA/DOE historical programs are discussed below.

HISTORY

In any endeavor, the log of what is being done, or has been done, becomes the history. As Item 11 of Chapter II states, the fire protection program is the only one that has consistently published a record of its programs on an annual and cumulative basis. As noted in Chapter XXII, the requirement for an annual summary of the programs at each field office was a requirement of the very first requirements document in fire protection, the General Manager's Bulletin of May 1, 1950. In 1956, the requirement was formalized in the Appendix to the Fire Protection Order by including an outline of the submittal format.

All of the field offices passed on the requirement for the annual summaries to their contractor organizations. These were then consolidated into a single document and submitted to HQ by each field office. (Some contractors also sent their own submittals directly to HQ. While not required, it often provided an informative check on what was being omitted, if anything, in the field's consolidated reports). When the author went to HQ at the start of 1970, all of the reports since 1966 (and a few earlier) were maintained in the small HQ safety office's library in yearly binders. The author maintained the collection through his retirement in 1989 and used them on many occasions to compile historical summary data on a number of issues.

The missing part of the annual summary story was the lack of feedback to the field. A number of offices had complained that data was being sent to HQ each year but nothing was returned. Accordingly, the author started a summary program with the 1975 reports and continued it through the years. As time progressed, the document was expanded to include other data than that received from the field. DOE-wide data, such as the sprinkler survey and the computer protection survey results, were summarized and included in the annual summaries, as well as analyses of the loss data submitted. Since a major problem with any printed information is the fact that it tends to get thrown out in periodic housekeeping programs, including worthwhile data in a historical summary helped to ensure that it would survive. People tend to keep bound and dated summaries longer than loose papers.

The annual summary reports improved from the first 20 unbound pages of 1975. The first issued included what became perennial features, such as a listing of all AEC people on NFPA standards committees, cumulative program costs and accidental losses, and HQ interpretations. The report of 1978 became an official document of the now Department of Energy, DOE EV-0053, and was available from the National Technical Information Service at a printed copy cost of $6.00, or $3.00 for a microfiche copy.

With some delays in publication dates, the official editions continued through 1981. (On one occasion, we received a large package from the CIA. With some trepidation, and a number of observers, we opened it to find it was the publishing proofs and film pages of that year's annual report. DOE publications had farmed the report out to the CIA for printing without our knowledge).

The 1982 report does not officially exist. We had just finished a two-day review by two people from the HQ administrative offices and had been notified that it had been reaffirmed as an official DOE publication when a DOE "safety manager" decided that it was not a technically impressive document of the caliber that should be issued by HQ. That year, we simply sent a single copy to each field office with a cover memo stating that it was not being published and the copy was forwarded "...to enable your staff to use the comparative loss data, values, etc. for the overall program and to help you prepare your summary report for CY 1983, as required by DOE Order...." Most offices took the hint and prepared their own copies for distribution to the contractors. Ironically, this became one of the most-used annual reports as it contained the summary paper and charts on computer protection in DOE. This has been used on a number of occasions every year since then to provide data to non-DOE parties.

The following year, we discovered that the copy shop in Germantown could produce a fair number of copies, with a bound cover, without special authorization. Accordingly, from that date forward, we had copies prepared and sent a number to each field office each year, under a very mild cover memo referring to the Order as the justification. Copies were never distributed to the HQ safety organizations, especially management, until the field copies were already distributed. The "unsuitable" remarks never arose again until after the author's retirement. Unfortunately, another new "safety manager" made the same evaluation and 1993 was the last year for which a HQ summary was issued (although individual pages of that summary are labeled 1992). It is hoped that HQ will find another way to issue the report. Unfortunately, with the disintegration of the fire protection program among a number of entities, it is difficult to find a single person to compile a document that can cover all of DOE.

IN PERSON

One of the most valuable methods of "spreading the word" is simply getting the people together who need to be informed. As noted under item 10 of Chapter III, this is another unique program helping to make fire protection the best safety program in DOE. Regardless of, or in spite of, an official agenda, the interactions of professionals in the same field will ensure that worthy information is disseminated. The annual meeting of the AEC fire protection engineers was another example of a program that no other safety discipline has done as well or as long as has fire protection.

Unfortunately, many of the agendas and records of the early conferences are lost. There was never a stated requirement for holding a distinctly fire-only conference, or any safety conference. It was the result of having few people involved and a single, small safety office in AEC HQ that handled all safety matters. It was easy to organize an annual all-safety conference when HQ, the contractors, and the AEC field offices were all small in number. From the earliest, it was obvious that fire had some special interests and the handful of professionals throughout the agency made it even easier to arrange meetings. (Livermore did not have a fire protection engineer until 1961, Los Alamos until 1970, and few sites or field offices had more than one. HQ had two through most of the agency's history).

The earliest fire protection conference we have recovered data on was a December, 1953 meeting in Washington, D.C. attended by Don Keigher, then newly transferred to Richland from Chicago. The agenda topics were to be repeated many times throughout the years, including such items as filter protection, computers, and fire department staffing. As a perusal of the Chapter III tables reveals, there were only about six fire protection engineers in the field offices, greatly facilitating information exchange by any method. Notes also discuss a 1953 session at Richland, involving about 12-14 people and another 1954 or 1955 meeting at Richland involving about 20 people.

When the author started at AEC's San Francisco Operations Office at the start of 1962, the annual meeting minutes already filled a file cabinet drawer, even though the meetings were confined to AEC staff only. (Contractor FPE's were even rarer than AEC FPE's). We missed the 1962 conference and attended our first at Chicago Operations Office in February of 1963. A feature of this conference was the attendance of Don Keigher with a detailed model of the Richland Aquatic Laboratory which had suffered a major loss when the intricate roof construction burned away over the heads of firefighters and researchers salvaging records.

This same year, we attended the annual AEC safety conference which was held in Las Vegas in July. This illustrated a difficulty that always persists with this type of conference. The subject of safety is so broad, from criticality to cranes; and so deep, from step dimension limitations to management philosophy; and involves such a wide range of people, from apprentice inspectors to general managers; that any conference will have problems. Almost any subject will be of interest to only a few of the participants and there is small chance that those who are most involved with any particular topic will be in attendance. Las Vegas, for some reason, was heavily attended by managers whose interest in the more technical topics was limited, to say the least. While we continued to attend a few of the all-AEC safety conferences (SAN had no safety engineer in those days and fire protection assumed industrial safety oversight by default) we concentrated on the always-good fire protection conferences.

The fire conferences continued with a 1964 conference at the Youngstown, OH site of Automatic Sprinkler Corporation of America. Two days consisted of demonstrations of "Automatic" systems in their test yard, followed by a one-day, AEC-only meeting. Each participant received a self-extinguishing ash tray (a eutectic metal spring cigarette rest elevated when the hot ash hit it and slid the butt into the tray) and the proverbial comic graduation certificate "suitable for framing." This was one of the most memorable meetings and would serve as an excellent model if the number of topics to be covered could ever again be reduced to a single-day agenda.

Although our records are not complete, conferences continued with an April, 1965 meeting at Albuquerque, a 1966 meeting in San Francisco (which, for the first time, included bus trips to Berkeley and SLAC accelerator sites), and a 1968 meeting at Oak Ridge.

The Rocky Flats fire of 1969 kept everyone busy on a number of topics. By 1970, we were in HQ and attended the FPE conference at Las Vegas. In 1970, Albuquerque Operations Office held their own conference, one of a number over the years, for fire protection engineers and fire chiefs at Albuquerque, which we attended. (Several offices held their own contractor conferences, including San Francisco, Oak Ridge, and Albuquerque. At sites such as Richland and Idaho, get-togethers were easier and more numerous).

By 1971, we were heavily involved in travelling with the insurance team surveys (see Chapter XII) but attended a 1973 conference in Albuquerque. This was unique in being the first conference in which both contractor and DOE people attended. A highlight was the demonstration of a remote-control midget tractor pulling two squirting hoses about the Sandia Yard. By this time, the FPE staffs had grown sufficiently at all sites that the conference, at the Kirtland AFB Nuclear Weapons School, had nearly 100 in attendance. The sessions alternated for a few years between AEC-only and AEC and contractors before attendance became unlimited.

We presided at a special conference on alarm systems at Las Vegas in October of 1974 and the next Albuquerque conference held at the Kansas City Plant in October of 1975. This was highlighted by the introduction of the Factory Mutual role-playing games relating to a fire and an impairment exercise.

In 1976, the agency had become ERDA and the fire protection conference was held at Oak Ridge in Knoxville. In 1977, AL held another of their conferences in Los Alamos. In 1978 and 1979 we were heavily involved in touring with Schirmer Engineering with their part of the independent appraisal program, but a (DOE now) fire protection conference was held at Las Vegas in February.

In April of 1980, the conference was held at Las Vegas again. (Besides the obvious attractions, Las Vegas was one of the few places where people could still obtain meals and lodging within the government per diem allowances of that time). This was another unique conference in that, for the first time, a tour of a formerly restricted site was available to all participants, including spouses and children over 18. To avoid the inference of requiring travel on weekends, the Monday tour was listed as optional. The tour included the Sedan Crater, Frenchman's Flat test site, Mercury, Control Center, and even a train into the Area 12 test tunnels where military personnel from DASA gave a fascinating briefing. The tour was so popular, and so well done, that it became a feature of future conferences. (At the 1971 Kirtland conference, we had taken a survey of familiarity with major DOE sites. The knowledge of other facilities among the AEC fraternity was surprisingly low).

The October, 1981 FPE conference at Albuquerque was another DOE-only conference and attendance was only 20. (We had a number of meetings at Albuquerque since the AL office had the most FPE's in DOE. Despite the proximity, it was usually impossible to get attendance from more than two or three people at a time.

In October of 1982, the conference was extended to include contractors and was held at Augusta, GA, with an "optional" tour of the Savannah River Site included. Again allowing spouses, the tour included reactor refuelling control rooms and hot basins, as well as firehouses and laboratories. Another of the more successful tours and a tribute to Dupont.

1983 conference data is lacking, (we believe this was one of the skipped years), but it was back to Las Vegas in February of 1984 for a DOE-only conference. A notable lack of attendees from fire departments (except at Albuquerque's self-conferences) was a feature prompting the March, 1985 conference at Los Alamos to hold split sessions with topics specifically addressed to fire chiefs. This "broke the ice" and subsequent conferences always managed to contain a strong firefighting contingent.

In 1986, with one FPE in HQ, we believe the conference was omitted. It was resumed in August of 1987 with a contractor-DOE conference held at Argonne National Lab, with tours of Argonne and Fermilab.

Subsequent years were marked by management turmoil, staff shortages, the author's 1989 retirement, and delays in restaffing at HQ. The acquisition of Dennis Kubicki revived the program and conferences in the 1990's were held at Las Vegas in 1992, New Orleans in 1993, Albuquerque in 1994, and Gatlinsburg, TN in 1995. In addition to the now-traditional site tours, all of these conferences included contractors. Strong attendance from other interested parties and several other safety disciplines greatly expanded the information obtained from participation at each conference and increased the attendance from the former 100 maximum to about 200 normal. In the current budget climate, future conferences may be forced into the demonstratedly unsatisfactory mode of one-conference-fits-all, but we hope for the best.

LIVING WITH RADIATION

In addition to the extremely popular text of that name by Frank Brannigan (The number-two best-seller at the GPO for some years) Frank conducted a number of courses by that name from his earliest connections with the AEC in the late 1940's until his retirement in 1972. They continued for some years after by contract with DOE HQ and even into the late 1980's through contracts with individual sites.

The radiation-fire interface was always a perceived problem and Frank was the first to approach the subject from the firefighter's standpoint. He developed a number of short training courses and spent the majority of his days on the road, conducting the course at almost every AEC facility, and usually on multiple occasions. He expanded the course to include presentations for municipal firefighters and the demand for his services always far exceeded the possible supply. He was such an entertaining and informative speaker that he was asked to be the principal speaker at every kind of event, and requested by everybody from governors on down. (One of our proudest moments was when Frank was slated to address a large civic group at San Jose, CA, and D.C. weather cancelled the trip. We had to fill in for him and gave a performance that was very warmly received. Only we knew what they had missed, - until a later occasion when he was able to address the group in person).

Getting the word to the non-DOE audience was another of Frank's radiation missions. This has already been discussed in Chapter XIII under the heading of "The Public Safety Newsletter." Until internal bickering destroyed the incentive for producing it, the newsletter was becoming a bible of the haz-mat efforts of public fire departments. Although only five issues were produced, ending in 1967, it remains the only real effort to furnish an ongoing support effort to outside people. That it was done by the one person best qualified in the nation to do it was icing on the cake. That it was done by the AEC fire protection people is another testimony to the uniqueness and excellence of the program.

CONTINUING FIRE PROTECTION EDUCATION

There were two programs in continuing education where more was done and for a longer time by the fire protection people than by any other safety discipline. In fact, most disciplines have never attempted either.

The first program was an outgrowth of Frank Brannigan's natural education mission. With an evangelism unique to his persona, Frank developed, preached, and taught, a number of short (typically three-day) courses in "Fire Loss management." They covered AEC requirements and, above all, Frank's philosophy of loss management. Namely; while no category of loss can be prevented forever, it is possible to manage losses to acceptable levels. This was the AEC philosophy in setting dollar loss limits that would trigger certain types of protection. In fact, the philosophy was so ingrown that the fire protection basic Manual Chapter (later Order) never even mentioned "fire prevention" as a goal, but just defined acceptable loss levels for various categories (life safety, dollar loss, program interruption, etc.).

As conducted by Frank, guest speakers were provided at each session. We gave short talks on AEC improved risk philosophy and agency requirements, an Underwriters Laboratories official defined the UL programs, Pat Phillips discussed the latest developments in alarm and extinguishing system technology and other guests would be added in various courses. Basically however, the course was three days of Brannigan and probably the most popular offered by AEC.

In the 1970's, alone, we participated in Brannigan courses at Chicago, Las Vegas, Pinellas FL, Berkeley, Las Vegas, Richland, Pittsburgh, and Stanford CA. At least four other courses were given at the University of Maryland at College Park. Earlier courses made use of the Navy Structural Firefighting Schools at Norfolk, VA and Treasure Island, CA. These courses regularly included demonstrations of sprinkler operation, filter fires, duct flashbacks, portable extinguishers, and various detection systems. A principal feature of the radiation-oriented courses was the use of a short-lived iodine isotope to demonstrate actual contamination spread and radiation detection instrumentation. Our first experience in AEC was at such a Treasure Island course in early 1962. Andy Pryor, then with Richland Operations Office, was an instructor on water tests, we participated on inspections, and Naval instructors covered some firefighting aspects. As usual, the real star and inspiration to the 20 attendees was Frank Brannigan.

The second fire protection training offered by AEC arose from the aftermath of the Rocky Flats fire, as described in Chapters X and XI. Mentioned briefly in Chapter XII on the independent survey program, it was the Factory Mutual training course. The need arose from the fact that a number of people were being "appointed" to fire protection positions as safety staffs in general, and fire protection in particular, grew as an aftermath of the fire. While HQ was able to incorporate the requirement for a professional fire protection engineer at each major contract site, and define what the term included, we were not able to require everybody in a fire protection position to meet the definition. Indeed, it was not considered necessary. What was necessary was some means of providing people a basic knowledge of the subject of fire protection. The improved risk insurance companies were believed to be the solution.

Since AEC (following Federal Fire Council recommendations for the federal government) had adopted the "improved risk" (or the essentially synonymous term "highly protected risk") concept of fire protection, it was a natural choice when looking for an independent appraisal, to pick the companies that were in the business. Since the majority of AEC fire protection engineers had come from "improved risk" insuring and rating organizations (as did the majority of all FPE's in those days) it seemed natural to request them to provide a training program, especially since they conducted such programs for their own people. While the two major companies in those days, Factory Mutual and Factory Insurance Association (now Improved Risk Insurers) were willing to take on the appraisal program, both were reluctant to provide the training as they felt that many of their member companies or insureds would want to take advantage of the training also, and they weren't prepared to expand their offerings. (Ironically, both companies, plus Kemper and other later organizations, have found it good business to offer courses to others).

After some negotiation, Factory Mutual offered to present a course specifically for AEC. We tailored the courses they offered their own people by omitting FM-specific subjects and concentrating remaining subjects into a three week intensified course. This was done and the first of three estimated courses was offered in 1971. To ensure the maximum participation, HQ paid not only for the tuition, but per diem and lodging costs by arranging for the motel rental at Norwood and allowing unlimited access to the menu. Thus, the parent organization had only the travel cost and a very minimal reduced per diem.

The course reception was uniformly good. One participant described it as the perfect compromise between the point at which the most work was obtained and the point at which everyone rebels. Unfortunately, no matter how good the motel, everyone had eaten their way through the menu in the first week and it got rather monotonous after that. Since this was one of the few periods when fire protection had a budget that allowed it, we expanded the program so that the next course took everybody out to dinner several times a week, took bus tours on weekends or attended ball games or other attractions. Needless to say, the course became even more popular after that. (Attending a graduating session in Norwood in April of 1976, we found some people eschewing the special of the house, lobsters, because they had just eaten too many that week!)

While control of attendees was never achieved to the extent HQ desired, it soon became obvious that there were some advantages in mixed participants. Intended for new appointees, many veteran people attended as a refresher or whatever justification they could deliver. They proved to be invaluable in relating site practices and personal experiences as well as explaining AEC policy more fully. The courses were received so well that a number of attenders suggested establishing a course specifically for veteran fire protection people, to concentrate on specific problems, new developments, etc. This was a goal of HQ, but after a few years, the funding was insufficient to allow additional courses and none were offered for some years.

The replacement HQ fire protection staff of the 1990's, largely through the inspiration of Dennis Kubicki, were able to reestablish the FM program. Shortened to the two week course that had eventually been adopted, it was not so much for totally new people or even fire protection people. HQ continued to participate and FM continued to stress basics, but the course had been modified to be more DOE-specific. Ample use, for instance, was made of the slide collection of accidents and facilities built up over the years by the author. DOE experience and data was enhanced by incorporating the items FM considered pertinent from their long experience in the independent appraisal program. The program is continuing and is still the only safety course in DOE that has been offered on a continuing basis and over some 20 years. As such, it is another of the programs unique to fire protection. (Chapter III, item 17).

NO EXCUSE FOR IGNORANCE

At the retirement program for Dr. Liverman, Director of AEC safety, just as AEC had become ERDA in 1975, he remarked that things would be a lot different since the agency had become a political agency now. We thought we understood his meaning until several years of appointments of unlearned people to high positions convinced us that turnover and change were a way of life. We became reconciled to the fact that organizations and people would change with each administration and that each would bring a new policy and a great new inspirational management system. What we couldn't become reconciled to was the constant need to explain the simplest subject or the most elemental history and do it time and time again. After the first dozen briefings, we decided to put together some briefing papers that would answer everything. The result was a ten-section and two-appendix document that proved to be a useful adjunct of the program and one that none of the other safety disciplines were able to do. The result was that fire protection had fewer questions to answer and less follow-up briefings than any other discipline for the next few administrations.

Section one was a short seven pages that gave a quick overview, including total and cumulative people, sites, values, losses, fire departments, loss ratios, fatalities, a paragraph on what each field organization was and did, a few paragraphs on fire protection engineers, and then short paragraphs on the independent survey program, fire research programs, publications, meetings and training. While we frequently received questions from many sources in subsequent years, we were most often able to refer them to "page x, paragraph y," of the briefing book.

The second section was a list of organization charts--with a twist unique to the fire protection program. Where the usual chart is a group of boxes of group titles, equal in size for each group or function, we drew five charts. Each showed HQ and a line with each field organization under that line and then each contractor organization as a box under the appropriate field organization. What was unique was the scale. The "Replacement value DOE" chart had the size of each box proportional to the replacement value of the facility. (Thus, it was obvious that the values were in the contractors, not the DOE offices, and a glance told you which contractors were the really big ones). A "People DOE" chart did the same thing with each box proportional to the number of people in the organization. (Again, a glance told you where the workers you should worry about were located). The third was "The Area DOE" with each box proportional to the square feet of structures. (Oak Ridge was immediately obvious as about half the total DOE structure). The next chart was (The Major Loss DOE" in which each box was proportional to the total amount of losses (over $50K) suffered by that entity. (Rocky Flats and SPRO demonstrated that the historical loss picture could essentially be described by the two largest losses). The final chart was "Fatalities by Field Office." This was a little different since many contractor organizations had come and gone and a number had been located under different field offices. It was possible, however, to show them by the field office they were under at the time of the event.

The third section was 18 pages of loss data, individual by year and cumulative since 1947. It was started with a page of the more dramatic loss photos and a page of notes on each. Charts included fire and non-fire on an annual and cumulative basis, and on an adjusted to inflation basis

Section four was a short introductory paragraph (on a single page as was done for each section) that briefly described the contents. The remaining pages gave a narrative, charts, and costs of the independent appraisal, program. This included number of recommendations, number of surveys, completion status of recommendations, and costs of the surveys and the corrective actions.

Section five consisted of two pages and a historical project-by-project chart of the fire research program conducted at Lawrence Livermore Lab.

Section six was three pages listing the five principal problems in the fire protection program, with three to thirteen explanatory bullets under each.

Section seven was the three page resume of the fire protection engineering staff in HQ (one person at the time).

Section eight was a two page summary of fire departments in DOE, emphasizing the varying conditions and nature of each department.

Section nine consisted of the usual single paragraph describing the HQ fire appraisal program, followed by a single page denoting the percent of time spent on appraisals over the previous 15 years by the only remaining HQ fire protection engineer, and the percent of travel days as opposed to working days. (Explanatory notes included). The remaining 17 pages consisted of the blank appraisal form developed for use at each appraisal of a DOE field office (which is what HQ appraised. Although HQ visited individual sites for both appraisal and special purposes, the field appraised the contractors). Again, at that time, fire protection was the only program that had such an appraisal format, with the form topics being derived from the requirements in the Order.

Section ten was a five page list of answers to "embarrassing" questions, such as: "Why is fire protection so important?"; "Isn't the record terrible?"; "Is the record really that good?"; "How can we believe your figures?"; Wasn't Rocky Flats the worst (or worst industrial fire) in U.S. history?"; "How can you provide good protection when you set your own standards?"; "How can we believe you're good when you're the only judge?"; "Why shouldn't you be under NRC or OSHA?"; "How do you justify spending $40M per year on fire departments?"; and finally, "If you're as good as you think you are, why?"

To add to the document and provide a little spice for those readers who had progressed that far, we included four pages of a speech regarding how far the program had come in twenty years. This was followed by the twenty-four page history of the fire protection program that we had written for Nuclear Safety magazine of May-June, 1979.

The final document was the "So You Think You've Heard The One About?" list of 74 items treated in a vein similar to the "Did You Hear The One About?" in the author's "804" newsletter. Surprisingly, a number of readers got that far and found it their favorite part. They may not have remembered how many fire departments we had or what our total losses were, but they remembered the one(s) about the fires starting inside the sprinkler pipes.

KEEPING THE WORD

By the 1980's, it became obvious that maintaining a record of DOE was going to be a problem. Management turnover had reached the point where any document over three years of age was considered ancient history and not applicable. At the same time, field fire protection people were losing their records of why they were doing things and facing the same problems of "Why?", "Who said so?", and "What's the justification?" that were hitting the HQ program. Unfortunately, some of the same people asking the questions were the major obstacle to preserving the reasons behind many of the actions and programs. The solution to these multiple problems came in the form of the "Fire Protection Resource manual."

THE RESOURCE MANUAL

By the early 1980's, the AEC had been converted to ERDA and less than two years later, to DOE. The agency was now a political agency, with many Presidential appointees. The agency was always experiencing changes in personnel, procedures, Orders, the basic organization, and even operating philosophies, with each change in Administration. Although the requirement for professional staff fire protection engineers at contractor sites had been formalized in a letter from the General Manager of the AEC on Jan. 29, 1971, the document was disappearing from the field and each new administration did not feel bound to any requirements left over from previous organizations.

At the same time as previous operating standards were being lost or diluted, the first stirring of the "formality of operations" mentality were becoming evident. Whereas once the AEC had updated documents by a "pen-and-ink-change" procedure, it was now taking years to make even simple changes to the Fire Protection Order. (See "That's an Order", Chapter XXII).

Exemptions were another problem. After the 1969 Rocky Flats fire (Chapter X), all exemptions to AEC criteria were supposed to be evaluated and formal exemptions recorded by Headquarters. In actuality, while numerous items were submitted, all except one crane and one pressure vessel items were fire protection criteria. New management did not even know of the existence of the program, let alone what individual exemptions had been granted, and there was no pressure to eliminate any exemptions by corrective actions. By 1988, it was obvious that some means of recording the past, facilitating the future, and documenting decisions, was necessary. Unfortunately, initiating any new program at that time was something no one had any interest in.

The opportunity to establish a new system came with the creation of the Standard on Fire Department Safety, NFPA 1500, by the National Fire Protection Association in 1987. Since the potential impact on the many sizes and types of fire departments could be dramatic, the first edition recommended that any jurisdiction adopting the standard should establish an implementation program and guide. Since NFPA standards were the DOE requirement, a panel was organized, chaired by Argonne's Chief Gordon Veerman. An interpretation was established by DOE and issued for comment in May of 1988. At that time, the distribution memo noted that the final version would become part of a "DOE Fire Protection Resource Manual" and should be inserted therein. Note that there was no mention of developing or approving such a manual or of what the contents would be).

When the NFPA 1500 implementation plan was issued to the field, the cover memo ended with the note that "A Fire Protection Resource Manual is being developed. This document will be included with the manual, when issued." When the first package of material was distributed, we included a binder cover and a table of contents. A glance would indicate that it contained copies of

Orders, official AEC/ERDA/DOE fire standards, records of exemptions granted by HQ, and "Background Material" and "Interpretations." When several packages were distributed, the cover memo always said, in effect, "Here's some more material for the reference manual", not indicating that any may have been new requirements. In this manner, we formalized the previous documents, such as the General Manager's letter requiring contractor fire protection engineers. The exemptions list put together those granted by HQ and implied the exemptions extended to all of DOE. Most importantly, interpretations, such as the prohibition of "light-hazard" pipe schedule sprinkler systems and the "AEC Guides to..." watchman service, valve supervision, etc. were resurrected and supplied as "additions to the Resource Manual." Whether management ever recognized that an efficient and timely system for establishing fire protection policies had been created is unknown. Suffice to say, the fire protection program is still the only safety program in DOE that has such a system in place.

After the author retired in 1989, more organizational and operating revisions produced a plethora of new documents and new requirements. Several additional materials were added and, through the efforts of Dennis Kubicki, a revised edition, with more official graphics and more comprehensive enclosures was issued. The need for a major revision was evident, however, and a new and revised Manual was a goal for the 1990's.

804

Having served on several Federal Fire Council committees before it's "defunding" by Congress in 1975, the author was well aware of the informational services provided by the Council and also of the difficulty of communicating the commonality of interests among federal fire protection engineers. We found a federal personnel publication listing all federal job categories by number (fire protection engineering is 0804) and noting the number of people in each pay grade, men and women, U.S. and overseas, total by agency, etc. There were only 85 listed. Using this with our D.C.-area knowledge and the Society of Fire Protection Engineers membership lists (company affiliations were listed then), we sent a 4-page memo to each, calling it Issue No. 1, and noting items of interest to all federal people. The response was so good that we expanded to eight pages in a few months. Where we thought we might have enough information for three or four issues per year, it soon became evident that we could produce an 8-page issue almost monthly, especially when we started adding humorous running features, such as : "Said The Wise Old Fire Protection Engineer", "Did You Hear The One About", "Fire Protection Trivia", "Safety Syndromes", "Unasked Questions", "Gems From The Media", and "Excerpts From The Cynic's Dictionary." The publication was so well received that it was distributed monthly to all DOE Field Offices, with copies for each contractor site, as well as to the regular federal list. After retirement, the issues continued, but at a lesser frequency. Issue No. 100 was distributed in August of 1995. The new fire protection group distributes it with another publication, while the author continues the distribution to others at his expense.

The "804" newsletter is the only one of its kind in the federal government, official or unofficial, and is a direct descendent of the DOE fire protection program.

HOT DOE-Nuts

When the author "un-retired" and accepted a position at Los Alamos National Laboratory in January of 1990, it soon became evident that communication with, and between, field organizations was still a problem. Even more so since he had not yet been replaced at HQ. Accordingly, in July of 1990, we distributed an 8-page newsletter to the DOE field offices that we dubbed "HOT DOE-Nuts." It contained some of the same items as the "804" newsletter, which now did not go to all of DOE, but was more specific with DOE-oriented items.

When the new fire protection staff was established at HQ, Dennis Kubicki occupied the position formerly held by the author (although numerous prior and subsequent organizational changes made comparisons inappropriate, particularly as there are now a number of fire protection professionals in various offices). Dennis found the DOE-Nuts to be just the thing for spreading the word without the restrictions placed on every other program. Accordingly, with issue number 11, in October 1991, the compilation was shared with HQ and the document distributed by them, after input by the author and Dennis. By issue number 12, in January 1992, the publication had a new life and a professional format, and had grown to 17 pages. It had also become a quarterly and a norm of about 18 pages. The distribution routinely includes new material, drafts of DOE documents, the "804" issues since the previous distribution, and news items of interest to the fire protection community that were not covered as fully (or as frankly) in any other DOE publication. This addition to the history saga is expected to be distributed with HOT DOE-Nuts #27 in January 1996.

Again, fire protection is the only program in DOE that has such an established and informative program. No other safety discipline produces any similar document.

THE FIRE PROTECTION COMMITTEE

From time to time, there have been special groups functioning on a continuing basis within AEC/ERDA/DOE. One of the best is the High Explosives Safety Committee, formed of the DOE field office and contractor safety people directly concerned with, and users of, high explosives. This committee has existed since about 1960 and has provided an exemplary function for the handful of people directly involved. A High Explosives Safety Manual resulted from their efforts, but was only a by-product of the committee. Twice-yearly meetings were held at rotating sites and included a typical two days of talks and a one-day tour of the explosives operations at the site visited. The author participated when he was the safety and fire protection professional at the AEC's San Francisco Operations Office. The format was considered ideal (no official reports followed any meeting) and were applied on several occasions to fire protection. This included the Accelerator Safety Committee (see Chapter XIV), and the NFPA 1500 Implementation Committee (see above).

The explosives committee was the prototype for a standing DOE Fire Protection Committee. Composed of one or more members from each field office and the major contractor sites, the committee has been active in writing new standards, guides, and other documents applicable to the program. While current standards (January 1996) are in a state of flux, the efforts of the committee have assured that documents originating from HQ have field and contractor support and development assistance. Committee members assure their site people have a chance to review and input. Semi-annual meetings (one coinciding with the annual fire protection conference) allow for frank discussions of all activities and documents applicable to fire protection in DOE. Again, this is one more activity contributing to the superiority of the DOE fire protection program and one more system of excellence that most of DOE has not yet discovered.

THE INTERNATIONAL ASPECT

The fire protection program has always had an international flavor. Federal and contractor people have attended and participated in most international conferences. One of the most notable was the series of International Fire Protection Engineering Institute conferences. The first one was held at College Park, MD, and featured Frank Brannigan and Don Keigher on the program. Attendees included Carl Caves from CH, Ray Gockley from Kansas City Area Office, James Blackmon from Y-12, Pat Phillips from NV, and Andy Pryor from AL. In view of the limited total attendance and the strong international representation, the proportion of AEC participation was extraordinary. Subsequent conferences, in both the U.S. and abroad also had strong participation.

Other international conferences were attended by many people who also presented key papers. Livermore fire researchers presented a number of papers on their filter programs, Andy Pryor presented his Browns ferry paper at one and Dick Smith, of HQ, presented a paper on the history of the AEC program at another. The overall result was to increase the knowledge of, and respect for, the DOE program throughout the world's fire protection community.

ODDS AND ENDS

..... in which we throw in a few subjects, none of which were big enough to fill a chapter of their own, but all of which contribute to the fire protection history.

WHO"S ON FIRST?

Chapter XXVI discusses a number of the problems inherent in trying to compile data, especially of a comparative nature. Despite the often-expressed difficulties, there were a number of occasions when some new safety "manager" wanted to know "who's best." Since most safety disciplines could only give anecdotal evidence after citing the more obvious accident statistics, we made a number of efforts to compile such data in the fire protection area. The post-Rocky Flats fire effort has already been mentioned. Since the only data set we have maintained is the 1981 effort, we shall discuss that here.

Up until 1987, HQ had maintained the policy of appraising the field organizations. The field organizations, as contract managers, appraised the contractors for everything, including safety. HQ often accompanied the field people on their appraisals and frequently participated in special appraisals of specific topics at individual contractor sites, but it was the field office that was the subject of HQ appraisals.

A major effort was made in 1969 to obtain comparative data (see Chapter XII) but were not very useful. In 1981, we did another major data comparison of the ten field offices (just the AEC-originated organizations) to satisfy our own interests. These were Albuquerque (AL), Chicago (CH), Idaho (ID), Nevada (NV), Oak Ridge (OR), Pittsburgh Naval Reactors (PNR), Richland (RL), San Francisco (SAN), Schenectady Naval Reactors (SNR), and Savannah River (SR).

The basis of the data set was to compile everything possibly related to a fire protection program and that could be quantified, and then to compare every number against every other for the ten offices. The result was 16 numbers for each office that yielded 120 comparison ratios. The data includes: the number of fire protection engineers (adjusted for full-time, part-time, branch chief with FPE origins, and division directors with FPE origins); the cumulative value of the site for a number of years (average would have been just as useable if there were no major changes in a year or two); the number of sites valued at over \$25M (the Fire Protection Order required differing actions at different value levels); the total fire loss for a number of years (total, not average since a single years' good or bad record distort the averages); total losses on the same basis; total contractor employees; fires over \$50K since 1947 (since the record was already available and a goal of the program was to control looses, not prevent all losses); the construction budget (the longest period possible total would have been best as individual field totals vary greatly from year-to-year); the number of construction projects (since the FP effort depends on numbers as well as magnitude); the total reportable fires over the longest period that could be accumulated (seven years in this study); the same for non-fire incidents; the fire protection Line Item budget (again, the more years, the better); the number of field and contractor Society of Fire Protection Engineers members); the recurring fire protection costs accumulated over a number of years (seven in this study); the number of recommendations made by the FM/FIA/Kemper/PLC appraisals, and the total number of safety professionals in the field organization (assuming there was some level of mutual support with numbers).

Each number was charted and each data divided by each of the others for each field office and recorded in ascending or descending order. The mean was then drawn on the list for each item. Two things became obvious at the start. While serving to lessen the value of the "who's on first?" exercise (we already knew that), it serves a useful lesson for those trying to do the same for any subject.

The first problem was the very meaningful one of: "What's best? - big or little?" For instance, it is easy to rank the number of FPE's (adjusted scale) for each office. In this case, a range from 0.6 at PNR to 9.1 at AL and a mean of 2.4 Before we even begin to use this to compute ratios, using the other data, we see that there are actually two problems with our first problem. The obvious question relates to the pure number. Is more better? Not necessarily and we shall try to correct it in the ratio rankings. For instance, the absolute number is better for fire protection as it gets larger. But for two offices, one with half the fire losses but not as many FPE's, the ratio is in their favor. The order in which data are ranked may thus change from item to item; bigger is best for one, less is best for another.

Another difficulty in our first problem area is illustrated by our initial effort with averages. In the number of FPE's example, the mean is 2.4, but only two of the ten offices are better than "average." This shows in a number of data sets. One or two offices are so far outside the norm that the mean is distorted. (When everybody is "worse than average", it takes a little explaining).
In the 120 ratios calculated for each field office, there were eleven where three or less of the ten offices were better than average. There were also sixteen cases where only three or less offices were below average.

The second problem might be called "How best is best?" We tried several systems in this study; the number of times above average; the number above minus the number below; the number of times more than x% above average; the number of first places minus the number of last; and weighting the categories (FPE ratios count more than construction budget ratios).

Without further details, some of the results were:

(*,** = Tie)	1	2	3	4	5	6	7	8	9	10
Most firsts:	PNR	ID	SNR	NV	OR	RL	SAN	SR	AL	CH
Least lasts:	AL	CH	PNR	RL	ID	NV	SR	SNR*	SAN*	OR
Best net:		PNR	ID	AL	RL	SNR	CH*	NV*	OR	SAN**SR**
>Average		AL*	PNR*	ID	SNR	NV	CH	OR	RL**	SAN**SR
>Avg. +50%	PNR	SNR*	ID*	NV	OR	AL	SAN	RL	SR	CH
<Avg. -50%	AL	CH	ID*	PNR*	RL	NV	SNR	OR	SR	SAN
Weighted		PNR	ID	AL	SNR	NV	RL	CH	OR	SAN SR

To attempt the same thing today would be even less meaningful. There are far more field organizations, some of which have no contractor sites or only one and the discrepancy in size and variety of sites in the field offices is far greater. A simple sensitivity analysis also reveals how little change it takes in some factors in order to make a sizeable change in comparative rankings. Within an individual field office, it might still be possible to group a few fairly similar sites and perform the exercise on them. We leave such games to our descendants.

TRANSPORTATION

Few transportation accidents involved fire and most are included in the AEC document recording the 1943-1975 record if they involved over $50K in losses. Less well-known is the fact that AEC published Quartery and annual booklets on transportation accidents. These were graded into a number of categories with low damage, no injury, no loss of material being the least category and by far the most numerous. Essentially, they proved the packaging was sufficient to prevent release of hazardous materials under all circumstances. Unfortunately, when waste shipments are now the great bugaboo, the reports have been long since discontinued. One that could go in the early losses chapter, but is worth a separate topic is noted here. This is from a speech by D, Keigher, delivered about 1978.

One of the most significant of the "radioactive = no water" syndrome events was a 2-ton rack bed truck accident outside Kansas City in the summer of 1952. The truck was carrying machined uranium to Kansas City when it was side-swiped, overturned, and the 42-gallon outrigger gas tank burst into flame. The escorts kept everybody back and wouldn't even allow the local fire department to attack it until the entire truck had burnt to ashes, leaving only the engine block and axles. All the uranium burned, too. The monitors, HP's, and decon people came within hours and cleaned up everything within 50 meters in two days. Obviously, the fire could have been extinguished in minutes. Since the NFPA Quarterly had already published two AEC articles on fire and uranium in 1950, some people might have thought this wouldn't happen. As too often occurs, one discipline (fire protection) wasn't getting through to another (transportation couriers). The situation is common among many disciplines and agencies.

When the AEC FPE's met in Washington later that year, this event was much discussed. The decision to stress that such fires could and would be fought was the subject of early tests and training. It has now been so long since that incident that the subject is ripe for a repeat, especially since Brannigan's "Public Safety Newsletter" is no longer a public fire department staple and DOE no longer offers any training or information to public fire departments. (DOE fire departments do, but that only affects the other departments in their mutual-aid areas. A department a long ways from DOE and a short distance from a highway is out of luck, but that's a subject for the "Pets and Peeves" chapter). The incident is No. 33 in WASH 1192. The bulk of the $200K loss is attribited to the "self-sustaining combustion of massive uranium."

DRY CHEMICAL

Dry chemical and dry powder (for combustible metals) extinguishers also are important in DOE history. For many years, the only fixed-pipe dry powder extinguishing system in the U.S. was a 32-nozzle array fed by two-2,000 pound Met-L-X units protecting sodium storage tanks in a building at the SBR-II reactor in Idaho. Design coverage was 3#/sq. ft.

Sodium fire extinguishing was a major effort with early evaluations at Knolls Atomic Power Laboratory and MSA Research Corp., both in support of Naval Reactors in the 1950's. Work for the FERMI reactor was done by Detroit Edison and Atomic Power Development Associates in the same period.

Atomics International performed tests with 50 different agents in the late 1960's. These, and tests performed by ANL on the fixed-pipe Met-L-X system are described in the 1979 Liquid Metals Fire Control Engineering Handbook, HEDL-TME-79-17. The AI site (which became the Liquid Metals Engineering Center, (LMEC), and then Energy Technology Engineering Center, (ETEC), developed, and tested with Ansul, the sodium carbonate agent, NAX (For no salt, important to reactor piping). The agent proved more effective than Met-L-X and became a UL-listed agent.

HEDL was doing large-scale testing for sodium reactors by the 1980's, involving mostly inerting and self-extinguishing sumps. ORNL became involved with testing carbon-microspheres, an asphalt manufacturing by-product, and found them effective both sodium and lithium.

Many earlier reports covered liquid metals fire technologies. In addition to the cited HEDL document, there were an ANL 1970 sodium guidelines, an AEC-Navy 1971 handbook, a 1969 AI study, and a number of published papers internationally in the same period.

The use of dry chemical portable extinguishers in glove box protection goes back to the earliest AEC days. Many published reports describe penetrating nozzles for portable extinguishers to be used to penetrate the gloves to introduce an agent. Many boxes were provided with an extinguisher on the outside, piped to a distribution nozzle on the inside. These could be activated manually in all cases and many were also automatic, usually activated by rate-of-rise heat detection.