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Preliminary Report on Evaluating Alternatives for Reducing Upholstered Furniture Fire Losses

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Preliminary Report

U.S. DEPARTMENT OF COMMERCE

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U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary*

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PRELIMINARY REPORT ON EVALUATING ALTERNATIVES FOR REDUCING UPHOLSTERED FURNITURE FIRE LOSSES[1]

Benjamin Buchbinder, Susan Godby Helzer and
Fred L. Offensend[2]

Abstract

This paper presents preliminary results from a pilot project designed to test the utility of applying decision analysis to fire hazard problems. To test the methodology, an analysis is being performed to determine the effectiveness and economic consequences of alternative intervention strategies for reducing upholstered furniture fire losses in residences. A probabilistic model has been developed to assess quantitatively the expected fire losses under each alternative. This paper describes the analysis on one alternative: the proposed upholstered furniture standard currently under consideration by the Consumer Product Safety Commission. The loss model for this alternative is described in some detail. Preliminary results on costs, losses, and cost plus loss to society and the present value of these quantities are presented.

A subsequent report will update this analysis with revised data, and present a comparison of the proposed standard with other alternative strategies.

Key words: Cost plus loss; decision analysis; fire; furniture fire; losses; residential fire; standard; upholstered furniture.

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[1] This paper was originally presented as a talk at the Society of Fire Protection Engineers Seminar, National Fire Protection Association Annual Meeting held on May 18, 1977 in Washington, D.C. and will be published by NFPA as a Technical Note.

[2] Fred Offensend works for SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025.

1. INTRODUCTION

Policy makers in areas of public safety, including fire safety, are continually confronted with the need to select among several courses of action in setting policy to reduce accidental losses. Such decisions should be based on a systematic consideration of all benefits, risks, and costs. However, because of the complexity of safety problems and the uncertainties inherent in the evaluation of strategies for reducing accidental losses, the choice among strategies is difficult. To assist in this regard we are developing an analytical technique for use in assessing the risks and avoided damages associated with different fire safety alternatives. A comprehensive technique for assessing the total economic costs of the different alternatives must also be developed. These loss and cost assessments will then be combined in an analytical framework to provide a systematic basis for choosing the most cost effective strategy for addressing a particular fire problem.

This paper outlines an analytical framework for evaluating alternative intervention strategies for reducing upholstered furniture fire losses. Although work on this project is continuing, enough progress has been made to allow us to outline the basic structure of the model and to demonstrate its potential for analyzing the consequences of alternative strategies for reducing such losses. We illustrate the use of the model by evaluating one possible intervention strategy: the proposed upholstered furniture standard currently under consideration by the Consumer Product Safety Commission. More complete documentation of the model and the results of this analysis will be presented in a forthcoming report [1][3].

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[3] Numbers in brackets refer to references listed at the end of this paper.

2. APPROACH

The analytic framework is being developed using decision analysis. Decision analysis is a formal methodology for analyzing complex decision problems under uncertainty. The methodology employs quantitative models developed expressly for each decision problem. These models are used to assess systematically the costs and losses that would occur under the decision alternatives in question. Uncertainty on key factors affecting future losses is addressed with probabilistic methods.

The first step in the analysis is the development of a model of current fire losses. Parameters are included in the loss model if they are important determinants of the overall losses, or if they are important in evaluating the change in losses expected under a particular intervention strategy. Comparing the output of this model with current loss statistics provides a useful consistency check on the logic and data of the basic model. To estimate the losses under a particular strategy, the model of current losses is modified to reflect the losses expected under that strategy.

A separate model is developed to estimate the cost of each intervention strategy. The cost and losses under each strategy are then assessed over time. All future values of cost and loss are then discounted to obtain the present value of the cost plus loss under the alternative in question. From an economic viewpoint, the most attractive strategy is that which minimizes the cost plus loss to society.

3. MODEL OVERVIEW

Figure 1 gives a schematic of the fire loss model, expressed in the form of a probability tree. The model is used to calculate the expected fire losses associated with a single upholstered furniture

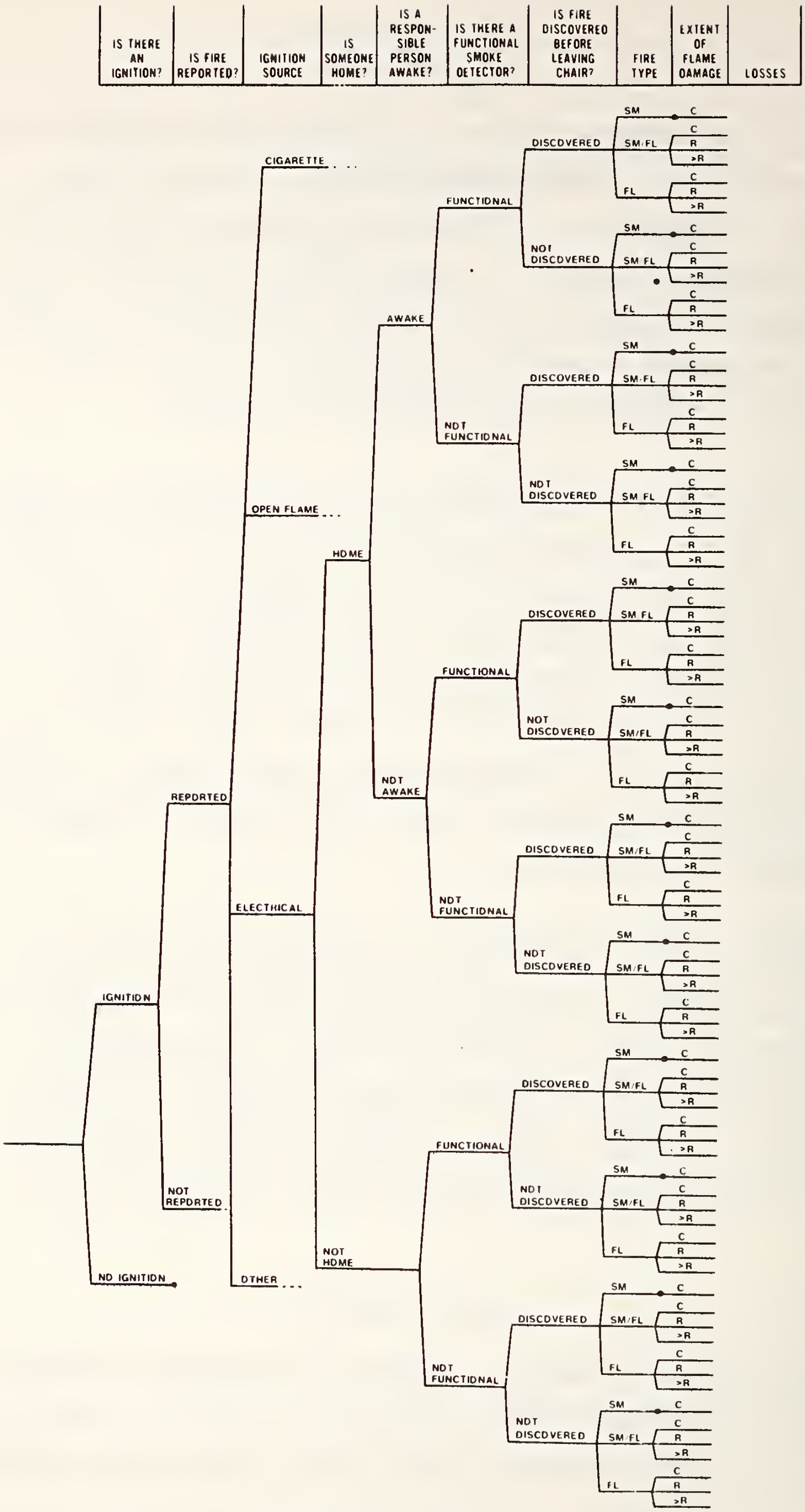

Figure 1. Probability tree for assessing upholstered furniture fire losses.

fire (sometimes referred to in the following text as "chair fire" for brevity). The principal model parameters are listed across the top of figure 1. The first nine parameters, from "is there an ignition?" to "extent of flame damage," are the independent or causal variables in the model. The last parameter listed, "losses" is the dependent or output variable of the model. Losses are characterized in terms of loss of life, injury, property loss, and intangible losses. The logical and computation flow of the model is from left to right.

The different branches under each of the parameters give the possible values that the parameter in question might take on. For example, the possible values of the ignition source parameter are "cigarette," "open flame," "electrical," and "other." The branch values are defined so that they encompass all possible values for the particular parameter.

Probabilities are assigned to the different branches to indicate the likelihood of the particular parameter taking on the designated value. The probability of a particular path through the tree is calculated by multiplying the probabilities of the branches making up that path. The losses associated with each path are derived from fire incident data, adjusted by expert judgment where necessary. These are average or expected losses. By combining the probability of each path with its corresponding losses and tracing all the paths of the tree, we construct a probability distribution on the expected losses per fire that would occur under the particular intervention strategy. We then combine this distribution with the annual number of upholstered furniture fires in the United States to obtain the probability distribution of total upholstered furniture fire losses.

First, current losses are modeled. Next, losses under each alternative strategy are modeled at a future time when that strategy has become fully implemented. The losses for each alternative are then modeled for each intervening year by combining the current losses with the losses under the fully implemented strategy in the appropriate way.

A cost model is used to calculate the total cost of each alternative. The model encompasses all direct and indirect costs including costs of development, implementation, compliance and enforcement. Costs for a given alternative are modeled for each year of interest. Expected costs and losses for each alternative are then combined, with appropriate discounting, and accumulated over time. When this has been done for each strategy, the cost plus loss comparison is made.

4. MODELING THE PROPOSED UPHOLSTERED FURNITURE STANDARD

To illustrate the methodology for evaluating alternatives, we now use the model to assess losses and costs under one alternative: the upholstered furniture standard currently under consideration by the Consumer Product Safety Commission. The proposed standard is aimed at reducing smoldering ignitions of upholstered furniture, primarily those caused by cigarettes. Combinations of upholstery and furniture construction which can be ignited by cigarettes are not permitted under the proposed standard.

Using the current loss model as a basis, new probability assignments are made for certain parameters on the probability tree shown in figure 1 to reflect expected losses under the fully implemented proposed standard. Probability assignments for the model of both current losses and losses under the proposed standard are developed using a combination of fire loss data and expert judgment. The data on current fire losses come primarily from the National Fire Incident Reporting System (NFIRS) at the National Fire Prevention and Control Administration. The judgment comes primarily from fire technology experts at the Center for Fire Research at the National Bureau of Standards. This judgment is then encoded into probabilities and combined with fire loss data as input to the fire loss model shown in figure 1.

We must emphasize that the primary purpose of this project has been to develop and demonstrate methodology. The probability and loss assignments, whether from data or judgment, are strictly preliminary and will be revised as more extensive information becomes available. The reader is thus cautioned against drawing any firm conclusions from this presentation as to the actual costs or benefits of the proposed upholstered furniture standard.

4.1. Model Parameters and Probability Assignments

We now model the fire losses for the case in which the current upholstered furniture population is replaced by a new furniture population fully compliant with the proposed standard. We show how the probability assignments for current losses (values to be documented in our full report) are adjusted to obtain new probability assignments for the fully implemented proposed standard. We consider each model parameter displayed in figure 1, determine if it is affected, and if so how. We first discuss those model parameters, affected by changes in the furniture population: "is there an ignition?," "ignition source," "fire type," and "extent of flame damage."

The column of table 1 gives the current number of ignitions by ignition source and ignition type (smoldering or flaming). Using a 1974 household fire survey [2], we estimate that there are currently 110 000 fires annually in which upholstered furniture was the first item ignited. This is the total of column 1, table 1. Based on NFIRS fire incident data from over 2700 upholstered furniture fires[4], we set the current ignition source probabilities to the following: cigarette - 0.70, open flame - 0.13, electrical - 0.05, and other - 0.12. We

[4] Fires in one and two family homes and apartments in which upholstered furniture was the first item ignited from Ohio (1976) and California (1975). Incendiary and suspicious fires were excluded.

Table 1. Number of Fires for Current Conditions and Under Fully Implemented Proposed Standard

Ignition Source	Ignition Type	Current Number of Ignitions	Estimated Reduction Factor	Estimated Number Under Standard	Estimated Number for Each Ignition Source Under Standard	Probability fcr Each Ignition Source Under Standard
Cigarette	Smolder	88 117	0.0	0	0	0
	Flame	0	---	0		
Open Flame	Smolder	2 613	0.0	0	4 269	0.533
	Flame	6 098	0.7	4 269		
Electrical	Smolder	2 447	0.2	489	1 223	0.153
	Flame	1 049	0.7	734		
Other	Smolder	8 709	0.2	1 742	2 516	0.314
	Flame	968	0.8	774		
TOTAL		110 000		8 008	8 008	1.000

then apply expert judgment to estimate the proportion of smoldering and flaming ignitions for each ignition source. Combining the 110 000 ignitions with the ignition source probabilities, and the judgment on ignition type, we obtain the numbers shown in column 1.

The principal effect of the proposed standard would be to reduce the number of ignitions, particularly smoldering ignitions. The second column of table 2 gives the proportion of current smoldering and flaming ignitions for each ignition source anticipated under the proposed standard, as determined by expert judgment. For example, with a fully compliant furniture population the experts predict essentially no cigarette ignitions, an 80% decrease in smoldering electrical ignitions and a 30% decrease in flaming electrical ignitions. The entries in the third column are the estimated number of ignitions under the standard by ignition source and type. They are obtained by taking the products of the entries in columns 1 and 2. The total of this column, 8008, is the expected number of ignitions under the fully implemented standard. Dividing 8008 by 110 000, the current number of ignitions, we find that the probability of ignition occurring under the fully implemented standard is 0.0728 times the current ignition probability.

Column 4 of table 1 displays the estimated number of ignitions for each ignition source, which is the sum over both ignition types for that source. Normalizing, the new probability distribution on ignition source shown in colume 5 is obtained.

The next model parameter affected by the changing furniture population is the "fire type," a combination of both ignition type and fire development. Three fire types are considered: initially smoldering (SM), initially smoldering and later flaming (SM/FL), and directly flaming (FL). The numbers in column 3 of table 1 are used

Table 2. Probability Distributions on Extent of Flame Damage for Current Conditions and Fully Implemented Proposed Standard

Is Fire Discovered Before Leaving Chair?	Extent Flame Damage	Probability	
		Current Conditions	Proposed Standard (Fully Implemented)
Discovered	C	0.833	0.458
	R	0.068	0.122
	>R	0.099	0.420
Not Discovered	C	0.000	0.000
	R	0.605	0.333
	>R	0.395	0.667

to obtain the proportion of smoldering and flaming ignitions for each ignition source. These proportions are then used, in combination with fire development data, to obtain revised distributions on fire type for the proposed standard.

The final model parameter directly influenced by the changing furniture population is the "extent of flame damage." This parameter can take on three values: confined to the chair (C), beyond the chair but confined to the room (R) and beyond the room (>R). The probability assignments for current conditions, shown in table 2, are based on NFIRS data adjusted by judgment to make the assignments conditional on the parameter "is fire discovered before leaving chair?" Under the fully implemented proposed standard, somewhat larger fires are likely to result once an ignition has occurred. This effect is primarily the result of the natural evolution of the furniture population toward greater use of urethane foam. To model this effect expert judgment is used to adjust the current flame extent probabilities to obtain the new probability assignments shown in table 2.

It is useful to digress here to emphasize that as we move from left to right through the probability tree, the probability assignment on each branch is conditional on the values of the parameters on the preceeding branches. Thus the details on some of the probability assignments are too lengthy for this report. Note that from the "ignition source" parameter on, the tree is in reality four times as large as it appears because only the "electrical" ignition source branch is continued on figure 1. We now return to our discussion of the fully implemented proposed standard, to look at the other model parameters affected.

The increasing voluntary installation of smoke detectors is expected to reduce fire losses significantly. We assume that 5% of the households in the United States currently have a functional smoke detector. Eventually about 60% of U.S. households are expected to have smoke detectors through voluntary installation or code requirements for new construction. We assume this level will be reached by 1980. We further assume that 90% of these will be working at a particular time. Thus to model the fully implemented proposed standard, the parameter "is there a functional smoke detector?" is set to 0.60 x 0.90 = 0.54.

Finally, the probability assignment on "is fire reported?" is adjusted. A separate inference structure has been developed to compute that the probability that an upholstered furniture fire is reported to the fire department is 0.29 under current conditions and 0.51 under the fully implemented standard.[5] Only reported fires are explicitly considered by the model at present because even though many fires are not reported to the fire department, reported fires account for the great majority of the losses. In addition most statistical data are based on reported fires. Losses from unreported fires will be added to the model later on for completeness, although this refinement is not expected to be of great significance.

The other model parameters "is someone home?", "is a responsible person awake?" and "is fire discovered before leaving chair?" are not affected by the proposed standard. Thus the current probability assignments are used.

Loss estimates are made for each path through the tree. Four categories of loss are considered: fatality, injury, tangible property and intangible property. The loss assignments are made dependent on

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[5] For the details on this calculation, and on others not fully explained, the reader is referred to the forthcoming complete report on the analysis.

the extent of flame damage, and whether or not the fire was discovered before it left the chair. In addition human losses are also made dependent on whether or not someone was home at the time of ignition. Loss assignments for deaths, injuries and tangible property loss for each extent of flame damage category are initially derived from NFIRS data. These assignments are then modified by expert judgment to reflect the dependencies discussed above. Estimates, based on expert judgment, are also introduced to reflect intangible fire losses such as disruption of lifestyle and loss of family heirlooms.

Loss assignments are given in terms of number of deaths and injuries and dollars of property loss. Alternatives can be compared by separately considering each loss category. However, since it is difficult to compare several outcome factors at one time, value assignments are introduced to aggregate all losses using a common monetary scale. For the purpose of this analysis we use nominal assignments of $300 000 as the amount society is willing to pay to save a single life and $10 000 for the economic loss due to an average fire injury. The current loss assignments are also used to model each alternative including the fully implemented proposed standard.[6]

4.2. Results for the Proposed Standard

Thus far we have presented input data for the case of 100% compliance with the proposed standard; however, we assume that in practice only 90% of the furniture produced under the proposed standard will be fully compliant. Ten percent of the furniture is assumed to be non-compliant because of such factors as the use of slip covers, poor quality control in the manufacturing process and loss of ignition resistance due to soil and wear. To model this compliance level, we

[6] For simplicity, all calculations are performed using 1977 dollars.

take a weighted average of the above losses for the fully compliant case and the losses expected for upholstered furniture which does not meet the proposed standard. Losses for the case of 90 percent compliance with the proposed standard are given in figure 2.

Figure 2 gives the cumulative probability distribution on the aggregate losses associated with a single reported upholstered furniture fire. Aggregate losses include deaths, injuries, tangible and intangible property loss, all measured in dollars. The probability distribution is constructed by first following the ignition and reported branches, and from that point the probability of each path through the tree is calculated. Associating each path probability with its corresponding aggregate loss figure, we obtain the dollar loss distribution shown. The expected value of the probability distribution is calculated by multiplying the aggregate loss for each path by its probability and then summing. This calculation gives an expected aggregate loss of $13 500 per reported fire, under the proposed upholstered furniture standard.

Total annual expected U.S. losses are found by multiplying the expected losses per reported fire by the expected number of reported fires. Assuming 90 percent compliance with the proposed standard the total number of ignitions is found to be 14 800 of which 5 800 are reported. (These numbers are appropriately weighted averages of the corresponding numbers for the fully compliant proposed standard case and the case in which no standard has been imposed.) Multiplying the number of reported fires per year by the expected total loss per reported fire gives an expected total annual loss of $78 million for the case of 90 percent compliance with the proposed standard.

The fire loss model can also be used to develop probability distributions and loss statistics on individual categories of loss. The calculations are carried out exactly as in the case of aggregate loss, except that instead of using aggregate loss values for each path on the tree, we use the losses for the particular loss category.

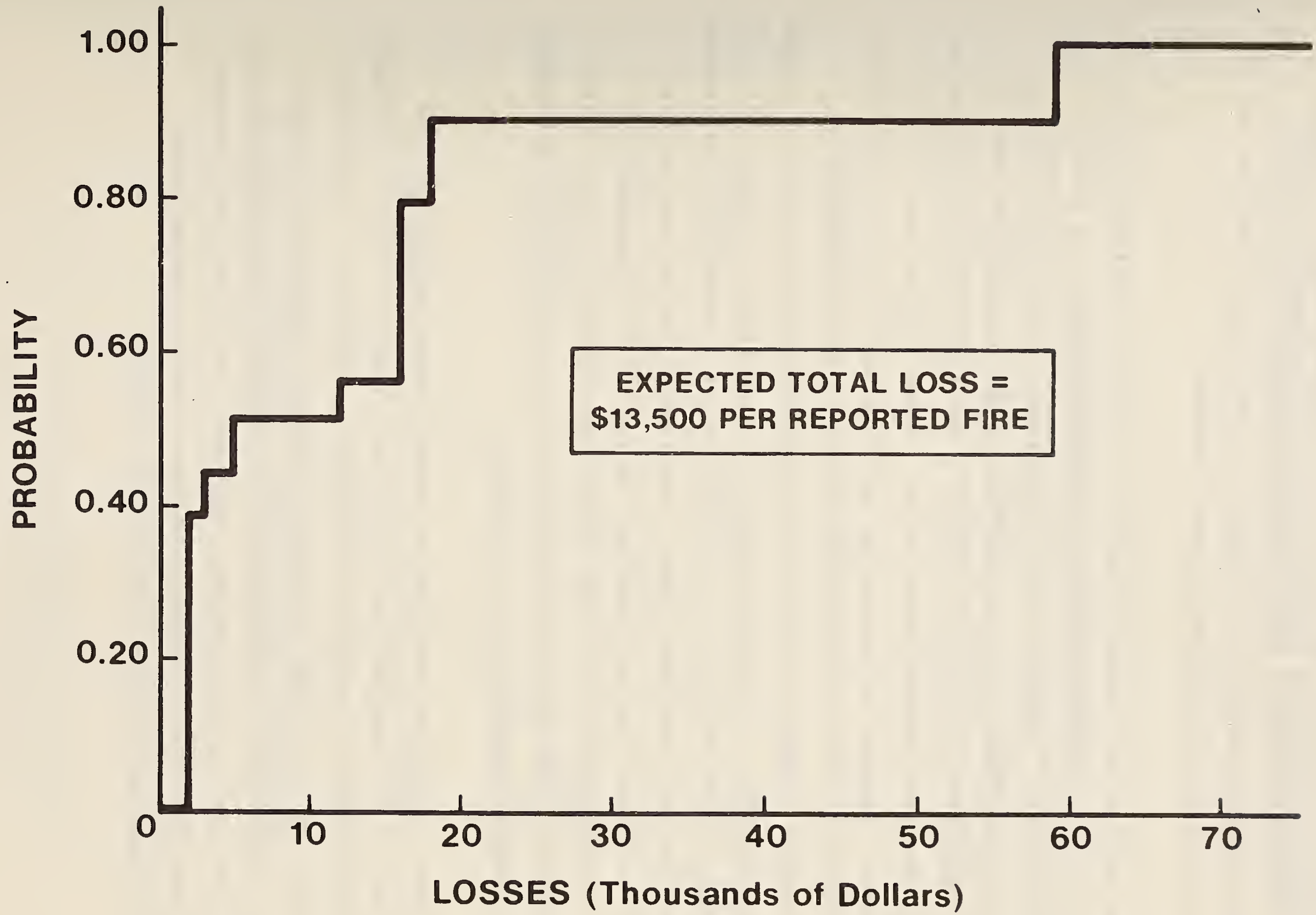

Figure 2. Cumulative probability distribution on aggregate losses per reported fire under proposed upholstered furniture standard with 90 percent compliance.

Table 3 gives the expected losses per reported fire for each of the four categories of loss. Multiplying the expected numbers of fatalities and injuries per fire by 5 800, the annual number of reported fires, gives an expected annual number of 120 deaths and 760 injuries for the case of 90 percent compliance with the proposed standard.

The results just presented reflect a furniture population all of which has been manufactured under the proposed standard (at a 90% compliance level). However, it will take years to completely replace the current furniture population with this newly manufactured furniture. Figure 3 shows the percentage of chairs in the total furniture population produced after the standard takes effect. Using 1980 as year in which the proposed standard is implemented, we calculate that by the year 2010 essentially all of the "pre-standard" furniture will be replaced by "post-standard" furniture thus achieving the 90% compliance level. Losses for the years 1980 to 2010 are found by interpolation. The interpolation is accomplished by obtaining the fraction of pre-standard and post-standard furniture for each year from figure 3 and then taking the appropriate weighted average of the corresponding losses. To calculate expected losses for the years 1975 to 1980, before the standard goes into effect, both increased smoke detector installation and naturally evolving changes in the furniture population are considered.

Figure 4 shows that relative to current losses substantial loss reductions may be expected from the proposed standard. Current aggregate losses (for 1975) are estimated at $455 million annually. The decline in annual loss, prior to 1980, is primarily due to voluntary and locally mandated installation of smoke detectors. After 1980 the losses decrease as more and more furniture becomes compliant with the proposed standard. By the year 2010, the 90 percent compliance level is reached with resulting aggregate losses of $78 million annually.

Table 3. Expected Losses from Reported Fires Under Proposed Standard (90% Compliance) in the Year 2010

	Expected Loss Per Reported Fire*	
Category	Number	Dollar Value
Fatalities	0.0208	$ 6 240
Injuries	0.131	1 310
Property		
Tangible		5 120
Intangible		840
Aggregate		$13 500

*5 800 of the Estimated 14 800 Fires Under the Proposed Standard Would be Reported in the Year 2010

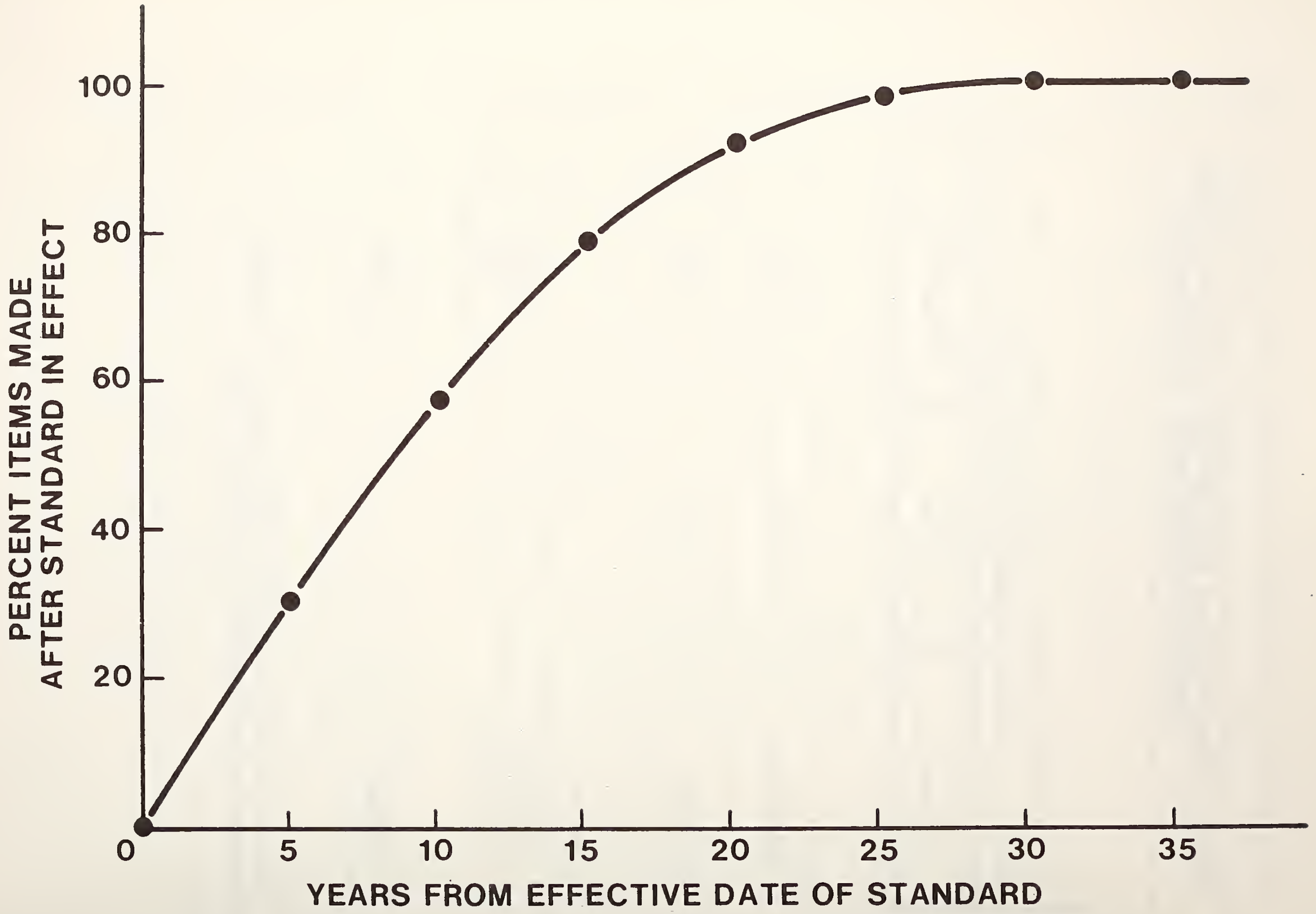

Figure 3. Percentage of furniture population manufactured after proposed standard becomes effective.

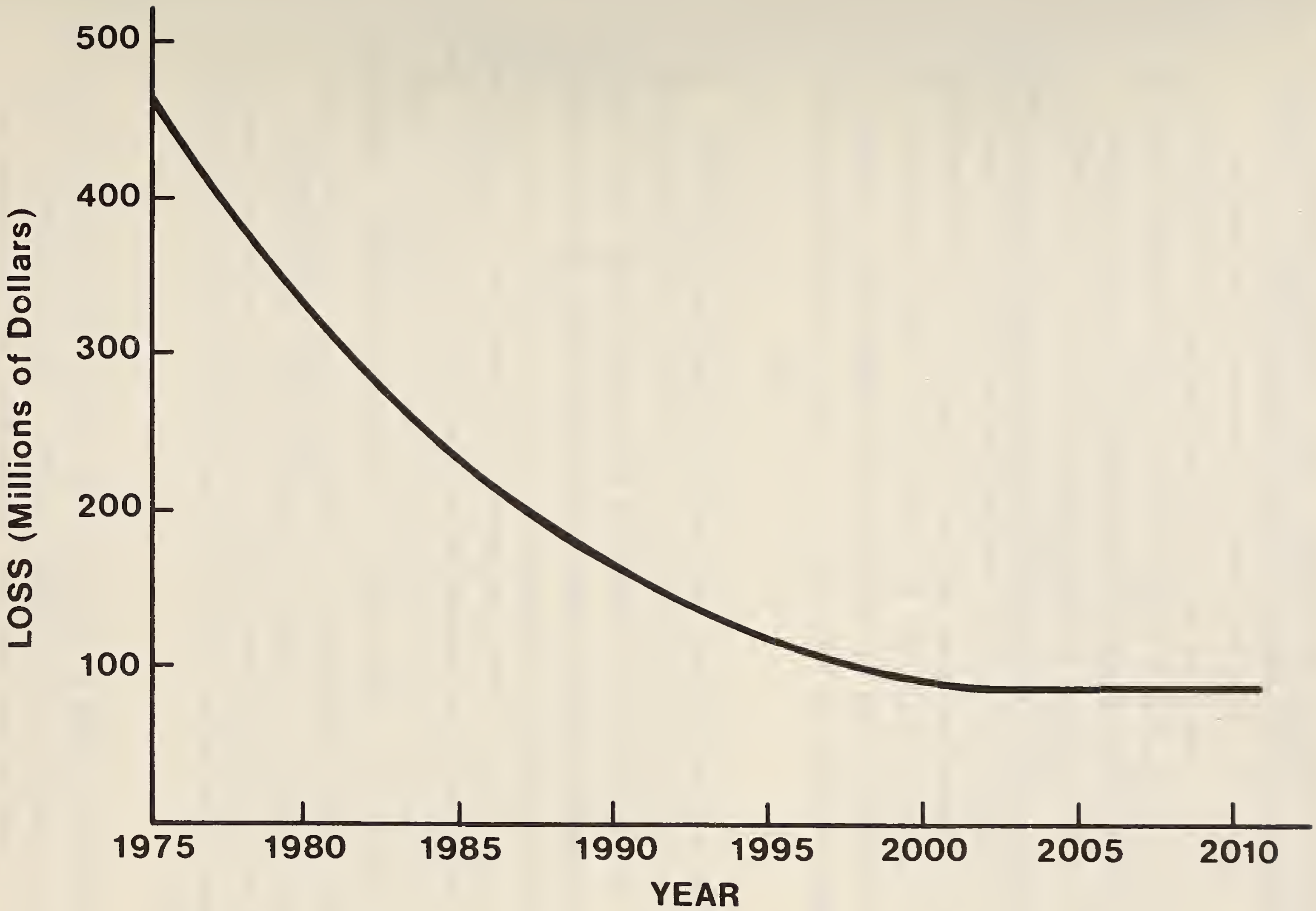

Figure 4. Total annual aggregate dollar loss under proposed upholstered furniture standard with 90 percent compliance.

Our major modeling effort thus far has been directed towards assessing fire losses. Nevertheless, our criterion of minimum cost plus loss requires that we include the expected costs as well, and finally that we compare cost plus loss among all alternative strategies. Work is currently under way at the National Bureau of Standards to develop a comprehensive cost model for the proposed standard [3]. To obtain a preliminary estimate of the annual cost of the proposed standard we use a Center for Fire Research estimate of $256 million annually [4]. This figure includes the cost increase at retail, in 1977 dollars of upholstery fabrics, construction materials and flammability testing. This estimate does not include the costs of record keeping, research and development, and enforcement. To account for these additional costs we add $25 million to the $256 million to obtain a preliminary estimate of $281 million for each year the standard is in effect.

Table 4 gives the cost plus loss of the proposed upholstered furniture standard for selected years. The total cost plus loss to society is calculated from the losses and costs outlined above. The reader is again cautioned, however, that these losses and costs depend upon nominal probability assignments, as well as nominal costs and loss assumptions. Many of these assignments and assumptions are preliminary, and are currently being refined and updated. Others are, and will remain, largely subjective. These considerations make the decision analysis methodology used here most useful in comparing alternatives, rather than obtaining absolute estimates of the cost plus loss. Thus the results presented in table 4, as well as figure 4, should be interpreted as illustrative of the decision analysis methodology rather than absolute estimates of the losses, costs, and cost plus loss under the proposed standard.

As shown in table 4, the cost plus loss of the proposed upholstered furniture standard is $455 million in 1975. When the standard takes effect in 1980 the cost plus loss reaches $608 million because the

Table 4. Estimated Cost, Loss, and Cost Plus Loss of the Proposed Upholstered Furniture Standard (90% Compliance)

Year	Cost	Loss	Cost Plus Loss
	(Millions of Dollars)		
1975	$ 0 M	$ 455 M	$ 455 M
1980	281	327	608
1990	281	175	456
2000	281	85	366
2010	281	78	359
Present Value*	$1990 M	$2925 M	$4915 M

*Discounted at 10% to 1977

first year's cost of implementing the proposed standard are included. The cost plus loss then decreases due to the decreasing losses (shown in figure 4). A constant annual level of $359 million cost plus loss is attained by 2010 when the 90% compliance level is reached.

Also given in table 4 is the present value of the cost plus loss discounted at a 10 percent rate to 1977. The present value is an accumulation of the costs and losses over the entire period, 1977-2010, obtained by discounting the costs and losses of future years at a 10 percent compound interest rate and then summing. The table shows that the present value of the expected cost plus loss at a 10 percent discount rate is $4.9 billion.

5. ADDITIONAL ALTERNATIVES

Work is currently underway on modeling two other alternative strategies. One is called the "no action" alternative under which we assume that no formal intervention strategy will be implemented, but that voluntary purchases of smoke detectors will also reach a 60 percent installation rate in 1980. This alternative also assumes that the furniture population will evolve toward the mix that is currently being produced, as opposed to that which is currently in our homes. The second alternative involves a mandatory requirement for the installation of smoke detectors in all U.S. residences. The evaluation of this alternative is based on the same furniture population as the no action alternative. Other alternatives such as a voluntary upholstered furniture standard, modifying the burning behavior of cigarettes, specially targeted public education programs, or combination of alternatives may also be considered. In each case the costs and losses will be computed over time in a manner similar to that for the proposed standard. At this point no comparison of alternatives has been made pending the completion of the initial analysis of the other alternatives.

6. UNCERTAINTIES IN CALCULATED OUTPUT VALUES

The results just presented were based on nominal estimates for the various input data assignments. We carry out an analysis on the sensitivity of the calculated output variables to uncertainties in the input estimates. In performing a sensitivity analysis, we use the model to generate cost-plus-loss values, assuming different values for the various input data. In this manner we bound our uncertainties on parameter assignments and examine the effect of changing given parameters to extreme values which they might take on. Initial sensitivity analyses serve to screen the parameters, and identify those for which our degree of uncertainty is too great to permit a clear choice among alternatives. In these instances we weigh the cost of obtaining better data against the improvement in our ability to distinguish between alternatives.

The forthcoming report on the complete analysis contains considerable sensitivity analysis. It should be stressed that the methodology is designed to measure differences among alternatives rather than to estimate exact values of cost and loss.

7. CONCLUSIONS

The purpose of this paper has been to provide preliminary documentation of a decision analytic approach for evaluating alternative intervention strategies for reducing upholstered furniture fire losses. We have not attempted to document the detailed calculations and assumptions for the fire problem involved, but rather to illustrate how it is possible to address systematically the uncertainties that combine to affect fire losses.

A comprehensive evaluation of alternatives requires the incorporation of value judgments as a fundamental step. To evaluate alternatives directed toward reducing injuries and fatalities, values are assigned to the amount that society is willing to pay to avoid an average fire injury or save a single life. There is a large body of literature and substantial difference of opinion regarding these value assignments. Our pilot analysis uses nominal values for injury and loss of life, as well as nominal discount rate, to illustrate the cost plus loss computation. Hard conclusions, based on these nominal assignments, should not be drawn from the results presented at this time. Our methodology, and the orderly structured analysis it provides, should provide significant input to the decision makers ultimately responsible for reducing fire losses in the public interest.

The emphasis of the project to data has been on methodology development and on the pilot application of that methodology to a sample problem. We are currently in the process of completing the analysis of the upholstered furniture fire problem, and we will document that work in a complete final report. We regard decision analysis as an important tool in fire hazard analysis, and we plan to apply this approach to other problems of fire safety, including mobile home fires.

8. REFERENCES

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15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This paper presents preliminary results from a pilot project designed to test the utility of applying decision analysis to fire hazard problems. To test the methodology, an analysis is being performed to determine the effectiveness and economic consequences of alternative intervention strategies for reducing upholstered furniture fire losses in residences. A probabilistic model has been developed to assess quantitatively the expected fire losses under each alternative. This paper describes the analysis on one alternative: the proposed upholstered furniture standard currently under consideration by the Consumer Product Safety Commission. The loss model for this alternative is described in some detail. Preliminary results on costs, losses, and cost plus loss to society and the present value of these quantities are presented.

A subsequent report will update this analysis with revised data, and present a comparison of the proposed standard with other alternative strategies.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Cost plus loss; decision analysis; fire; furniture fire; losses; residential fire; standard; upholstered furniture.

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