# The Costs and Benefits of Smoking Restrictions

## An Assessment of the Smoke-Free Environment Act of 1993 (H.R. 3434)

## Executive Summary

**Prepared at the request of:**

**Congressman Henry Waxman**
**Chairman, Subcommittee on Health and The Environment**
**Committee on Energy and Commerce**
**U.S. House of Representatives**

**Indoor Air division 6607J**
**Office of Radiation and Indoor Air**
**U.S. Environmental Protection Agency**
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### Introduction

In August 1993, H.R. 3434, the Smoke-Free Environment Act of 1993, was introduced in the House of Representatives by Congressman Henry Waxman (Chairman of the Subcommittee on Health and the Environment of the Committee on Energy and Commerce) with more than 40 co-sponsors. This Bill would require that all nonresidential buildings regularly entered by 10 or more persons in the course of a week adopt a policy that bans smoking inside the building or restricts it to separately ventilated and exhausted smoking rooms. The Bill would allow enforcement actions in the United States District Courts by an individual, government, or other aggrieved entity, with allowable fines of up to $5,000 per day.

H.R. 3434 would effectively ban or restrict smoking in most indoor environments. As written, these environments would include such diverse establishments as office buildings, schools and other educational establishments, theaters, restaurants, hotels, hospitals and other health care facilities, sports arenas, retail establishments, and manufacturing plants.

In a recent letter to Carol Browner, Administrator of the United States Environmental Protection Agency (EPA), Congressman Waxman requested that EPA analyze (quantitatively where possible) the compliance costs and the health and economic benefits of H.R. 3434. Specifically, he asked that EPA assess the cost of compliance including provisions for smoking lounges; the value of benefits resulting from reduced exposure to environmental tobacco smoke and changes in smoking behavior; the value of increased productivity and reduced absenteeism; savings from reduced operation and maintenance costs; and savings in fire related injuries and property damage.

#### Role and Limits of Cost-Benefit Analysis

In principle, cost-benefit analysis can be a useful tool for helping to identify those government actions which leave society as a whole better off. It can contribute to such assessments by providing a systematic framework for measuring and comparing the net economic benefits of policy alternatives. Cost-benefit analysis does not by itself, however, provide definitive answers regarding the merits of public health and environmental policy alternatives. Rather, net benefit estimates must be combined with other information, and weighed with other policy considerations, to formulate effective public policy. Pursuant to this, and consistent with Executive Order 12866, EPA routinely weighs the full range of

relevant policy considerations, such as distributional effects, legal issues, and institutional issues in making regulatory decisions. In keeping with this approach, EPA presents the current analysis, which the Agency believes provides useful insights regarding many of the potential costs and benefits of H.R. 3434.

**Summary Results**

This analysis indicates that passage of H.R. 3434, or similar restrictions, could achieve net benefits (i.e., benefits minus costs) ranging from $39 to $72 billion per year, excluding some potentially significant costs and benefits to smokers. For various reasons these and other potentially significant effects of H.R. 3434 could not be characterized in terms of economic value. Major costs reflected in these estimates include the costs of compliance and enforcement. Major benefits include those associated with reduced exposure to environmental tobacco smoke (ETS) and reduced operating and maintenance expenses. Benefits are also achieved from reduced absenteeism and reduced smoking-related fires, but these are not significant relative to other benefits. The net effect is that estimated benefits exceed estimated costs by $39 billion to $72 billion.

As noted above, the current analysis leaves open the question of whether smokers themselves gain or lose due to H.R. 3434. Clearly, smoking restrictions impose a burden on smokers. The losses in terms of time and inconvenience associated with forcing smokers to shift the location and/or timing of their cigarette consumption, and the potential burden associated with quitting, may be substantial. However, these losses would be offset to some unknown extent by the benefits of improved health among smokers who quit, cut back, or fail to start smoking in the first place. The net economic valuation of these and other costs and benefits of smoking to smokers themselves is beyond the scope of this analysis for reasons discussed in more detail below.

Nevertheless, it is important to emphasize that this analysis found that, of those effects which could be quantified, the estimated benefits exceeded the estimated costs by $39 billion to $72 billion. In order to reach a finding that H.R. 3434 would impose a net economic loss to society, the net effect of all unquantified costs and benefits - including some important costs and benefits to smokers themselves - would have to be additional costs of at least $39 billion per year.

**Document Review**

While EPA makes no commitment to revise and reissue the present study, this document has been developed and submitted to Congress in a form intended for review by outside experts, interested parties, and the public.

The principal author of the study is Dr. David H. Mudarri, an economist in the Indoor Air Division of EPA's Office of Air and Radiation. This version of the study reflects extensive review by other EPA offices, the Office of Management and Budget, the Council of Economic Advisors, and the Department of Health and Human Services. In addition, a previous version of this report was reviewed by several economists in the public and private sectors.

## General Methodology

### Assessing Annual Costs and Benefit

This analysis assesses the costs and benefits that would occur each year into the future for present and future generations. All estimates are represented as annual costs or benefits. That is, all costs are converted to an annual equivalent that would occur every year into the future based on 1990 population characteristics. Varying time streams of costs or benefits are converted to equivalent annual values using a 3% social discount rate. Sensitivity analyses using 5% and 7% discount rates are also provided.

Throughout this analysis it is assumed that H.R. 3434 would apply to all the previously stated buildings, at all times, without exception. It is also assumed that full compliance would be achieved within the first year of implementation.

### Choice of Baseline for Assessing Costs and Benefits

Per capita cigarette consumption has been steadily falling over the past several years. In addition, recent survey data suggest that many establishments already have some form of smoking policy, and the percent of establishments which report having such policies has been increasing in the past few years (DHHS, 1992; BNA 1991). Therefore, it was necessary to establish a baseline from which to measure the effects of H.R. 3434 from enactment forward. This was accomplished by a three step procedure.

In the first step, the net costs and benefits are computed assuming current cigarette consumption levels, and assuming that there are currently no restrictions. This is an artificial baseline used for analytic convenience, but may be interpreted as a reflection of the cost and benefit differences in a society with and without smoking restrictions comparable to H.R. 3434.

Second, survey data were examined concerning the prevalence of smoking policies already in place, and using assumptions about the nature of those policies as well as policies in small establishments not covered in those surveys, an estimate was derived that 23% of the population is covered by smoking restrictions comparable to the requirements of H.R. 3434. Current cigarette consumption levels, and 23% coverage by existing policies are therefore used as the baseline for this study. As a result, this study concludes that 23% of the previously calculated cost and benefits are attributable to existing policies, and 77% are attributable to H.R. 3434, or other future restriction policies, including private initiatives.[1]

Finally, sensitivity analyses to the baseline assumptions are conducted by calculating the changes to the costs and benefits that would result from alternative assumptions about

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[1]As this report was being prepared, the President signed into law the Goals 2000: Educate America Act. This legislation restricts smoking in all federally funded primary and secondary schools and in day care centers. Because a sensitivity analysis is presented of the alternative baseline assumptions, no specific adjustments to account for this new law were made to the 23% baseline calculations used to assess the effect of H.R. 3434.

future trends. The specific variables tested include future trends in cigarette consumption, and future trends in the development of public and private smoking restriction policies which could take place in the absence of national legislation. These alternative scenarios of potential future trends are intended to demonstrate how the absolute levels of incremental costs and benefits attributable to H.R. 3434 are sensitive to assumptions about the future prevalence of smoking restrictions enacted by other public and private entities, and to future trends in cigarette consumption.

### Other Economic Impacts

Economic considerations which legislators may wish to consider go beyond just costs and benefits assessed in this analysis. Where information from this analysis sheds light on some of these considerations, they are briefly described.

## Summary Comparison of Costs and Benefits

Exhibit ES-1 summarizes the estimated costs and benefits of implementing national legislation such as H.R. 3434, using a baseline estimate that 23% of the population is already subject to such restrictions. The following sections provide additional detail on these results.

### Costs of Implementing Smoking Restrictions

#### *Policy Implementation*

In implementing the restrictions of H.R. 3434, establishments would incur the costs of establishing a policy, communicating the policy to employees or clientele, posting signs, assuring compliance, and possibly offering smoking cessation services. The current study estimates that these activities would cost between $0.2 billion and $0.5 billion per year.

#### *Smoking Lounges*

The main determinant of cost is the expenditure associated with the construction and maintenance of smoking lounges. Smoking lounges meeting the requirements of H.R. 3434 would be required to meet stringent standards concerning ventilation and other provisions to insure that the air in the lounge does not enter other parts of the building. In addition, smoking policies involving smoking lounges are generally associated with greater complaints and with lower reported satisfaction than smoking bans, and smoking bans are becoming increasingly popular (Sorensen. et al. 1991; 1991a, 1992; Stillman. et al. 1991). Finally, the structural features of many existing buildings make it infeasible or cost prohibitive to construct a smoking lounge which would meet the requirements of H.R. 3434. While the extent to which smoking lounges will be relied upon to comply with this legislation is uncertain, this analysis is based on the assumption that, for the reasons mentioned above, only 10% to 20% of establishments would opt for smoking lounges. For the 10% to 20% of establishments which opt to build smoking lounges, the cost of those

lounges is estimated to be between $0.3 billion (10% lounges) and $0.7 billion (20% lounges) per year.

The current analysis estimates that the total cost of implementation by the public and private sector, including the cost of smoking lounges, would be approximately $0.5 billion per year (10% smoking lounge) to $1.4 billion per year (20% smoking lounge).[2]

**Enforcement Costs**

The cost to building owners for ensuring compliance in their buildings is included as part of the cost of establishing and maintaining a policy. With respect to enforcement, H.R. 3434 provides no specific requirements for enforcement of its provisions, other than through citizen suits in federal court. Therefore, enforcement costs are difficult to quantify. However, in a proposed rule concerning the sale or distribution of tobacco products to individuals under 18 years of age, the Department of Health and Human Services[3] estimated that sting-type operations used by state governments would cost between $0.1 billion and $0.2 billion per year. Recognizing that these two issues are not strictly comparable, an estimate of between $0.1 billion and $0.5 billion per year appears plausible for a society with no current restrictions, and is used in this analysis. This would translate into an estimated enforcement cost of between $0.1 billion and $0.4 billion per year under current baseline (23% coverage) conditions. Some expenditures by the Federal government and by state and local governments can be expected for information dissemination, though they may well be less than the value of current resources devoted to passing controversial state and local legislation.[4] These expenditures were not quantified.

## The Effects of Reduced ETS Exposure

### *The Health Consequences of ETS*

A major component of the benefits that could be achieved from national legislation that restricts smoking in public places is from reduced exposure of building occupants to ETS.

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2 Includes a higher cost per lounge.

3 Department of Health and Human Services, Substance Abuse and Mental Health Administration, 45 CFR Part 96, Substance Abuse Prevention and Treatment Block Grants: Sale or Distribution of Tobacco Products to Individuals Under 18 Years of Age: Proposed Rule.

4 Even when smoking restrictions are passed at the state or local level, campaigns to nullify the legislation or to preempt local legislation with weaker state legislation can involve the expenditure of significant resources on both sides of the issue. No attempt was made to quantify current costs to state and local entities, though national legislation would be expected to reduce many of these costs. For an excellent analysis of this issue as it is manifested in California, see Macdonald and Glantz (1994).

Exhibits ES-2a and ES-2b present information on the health consequences of ETS. For the purpose of valuing the benefits resulting from reduced exposure to ETS due to smoking restrictions, several conservative adjustments to these figures were made. First, all deaths and illnesses associated with maternal smoking were excluded because the primary route of exposure is not expected to be through ETS in public buildings.[5] Therefore, the deaths associated with spontaneous abortions, sudden infant death syndrome, respiratory conditions in newborns, and short gestation/low birth weight newborns were also excluded, as were the morbidity consequences of low birth weight and neonatal intensive care.

The second conservative adjustment relates to heart disease. The American Heart Association estimates that between 35,000 and 40,000 heart disease deaths occur every year because of ETS (Taylor, 1992). This is based on studies in which estimates of the effect of ETS on heart disease fall in the range of 32,000 to 40,000 deaths per year as presented in Exhibit ES-2a. Because these estimates are substantial, and because EPA did not formally assess heart disease risks in its ETS risk assessment (EPA, 1992), two conservative adjustments to these figures were made.

- First, the low end of the range (32,000) was used as the high estimate, and this was reduced by 50% (16,000) to obtain the low estimate.

- Second, an arbitrary additional conservative adjustment factor of 75% to this range was applied, resulting in a base estimate of 12,000 to 24,000 heart disease deaths per year.[6]

The same proportional breakdown between home (27%) and nonhome (73%) exposure related deaths that was reported by EPA for lung cancers also applied here. Therefore, 3,240 to 6,480 heart disease deaths per year are estimated for home exposures, and 8,760 to 17,520 heart disease deaths per year are assumed to be associated with exposure outside the home.

### *The Value of Benefits from Reduced ETS Exposures*

The reduction in exposure resulting from smoking restrictions will result in avoiding an estimated annual average of 7,000 to 12,900 premature deaths over the first 50

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5 While the primary route of exposure is maternal smoking, it is estimated that smoking restrictions comparable to H.R. 3434 would reduce the size of the smoking population because some smokers would quit, and some future smokers would refrain from initiating the habit. In addition, it is estimated that the rate of consumption of remaining smokers would be reduced. To the extent that these changes in behavior will affect maternal smoking, some reductions in these excluded effects would also likely occur, resulting in benefits. The current study did not, however, quantify these potential benefits in our calculations.

6 Some adjustment may be appropriate also because there appears to have been an increase in the survival rate of heart disease patients over the past several years due to advances in medical technology.

years, and approximately 7,500 to 13,000 annually thereafter.[7] The value of these reductions, when using a "willingness to pay" measure[8], and discounting future reductions at a rate of 3%, would range between $33 billion and $60 billion per year.[9]

To this has been added benefits to be achieved from improved health, mostly to children, including reduced incidence of lower respiratory tract infections, ear infections, and asthma. These benefits are estimated at between $2 billion and $5 billion per year, most of which is associated with reduced asthma induction among children. For asthma, this analysis reflects an estimated reduction of between 1,200 and 3,000 cases annually. To value the benefits from reduced asthma induction, a willingness to pay measure associated with chronic bronchitis,[10] which is also a chronic respiratory disease was used.

The total benefit from reduced ETS exposure includes both the benefits of premature deaths avoided plus the benefits of reduced illness. The total benefits due to reduced ETS exposure is thus estimated to be $35 billion to $66 billion per year.

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7 The 7,500 to 13,000 annual premature deaths avoided is achieved gradually over a period of about 20 years. It is based on the assumption that the gradual reduction in mortality risk from reduced ETS exposure would follow the same time pattern as the reduction in mortality risk for smokers who quit smoking. Available data suggests that the reduction of lung cancer mortality risks for smokers who quit is gradually reduced over a 20 year period (DHHS, 1989). The decrease in mortality risk for heart disease is known to occur much more quickly (e.g. Taylor, 1992). Therefore, this analysis assumed that the decrease in mortality risk for heart disease takes place twice as quickly as for lung cancer.

8 Willingness to pay measures in this case reflect the value that persons assign to reducing their risk of premature death. The willingness to pay measure used for reduced exposures to ETS is $4.8 million per premature death avoided. See Appendix A-1 for a discussion of this estimate.

Where possible, willingness to pay measures as opposed to medical cost savings and savings in lost earnings are used as the value of avoiding premature death. Using medical costs and lost earnings alone would represent an incomplete measure of the economic value individuals and society assign to avoiding mortal risk. For example, using only medical costs and lost earnings would imply that social well being is improved when individuals die just after retirement–before medical costs are high and just after salary income ceases.

9 It is estimated that smoking restrictions would induce 3% to 6% of current smokers to quit, and would decrease by 5% to 10% the number of persons who each year become regular smokers. The smokers who quit would eventually die of old age, so this effect would be transitory. In addition, it would take about 50 years for the reduction in smoking initiation rates to fully reduce the smoking population by 5% to 10%.

It is estimated that smoking restrictions would reduce, by 10% to 15%, the number of cigarettes smoked by the remaining smokers in a 24 hour period. It has been suggested that some smokers may increase their consumption at home in order to make up for lost consumption outside the home. No attempt was made to account for this possible effect on ETS exposures because this does not appear to be the general case, and because the estimate of reduced consumption is a net reduction over the full day.

10 Based on willingness to pay measure for reducing the incidence of chronic bronchitis (Neumann. et al. 1994), the estimated value of avoiding chronic asthma is assumed to be $1.5 million per case.

*Increased Comfort of Building Occupants*

This analysis assumes that, all else being equal, no building occupant would prefer being exposed to environmental tobacco smoke, and that most derive benefits from a smoke free environment. With the exception of the health, productivity, and safety effects discussed elsewhere, these benefits are largely intangible, and include such factors as reduced irritation and reduced environmental odor, and less annoyance with tobacco smoke residuals left on hair and clothing. These effects are more bothersome to some than others, but may be of considerable importance to some persons.[11] In the present study, no attempt was made to quantify these benefits. However, because the overall results do not include the benefits of increased comfort, and because of the pervasive use of conservative assumptions in this analysis, it is expected that the estimate of total benefits from reduced ETS exposure is conservative.

**Savings in the Operation and Maintenance of Buildings**

Smoking in a building involves implicit operational and maintenance expenses. In addition to emptying and cleaning ashtrays, the smoke, ashes, and accidental burns on furniture and carpets create an additional housekeeping and general maintenance burden. For example, the Building Owners and Managers Association (BOMA) International reports that in a tightly monitored program, a member firm experienced a 15% reduction in housekeeping costs when a non-smoking policy was introduced. Maintenance costs were not covered in the monitoring program. Changes that were observed included elimination of the need to empty or clean ashtrays; reduction in high surface dusting and the dusting of desks and tabletops; reduced detailed vacuuming around desks of smokers; and reductions in the cleaning of venetian blinds and heating, ventilation, and air conditioning (HVAC ) vents. In addition, cleaning personnel found that they spent less time moving articles on desks in order to remove ashes. BOMA cautions that this was a tightly monitored program, and that actual experience may only produce an average of 10 % in overall cleaning costs.[12] Maintenance cost savings include less frequent replacement of furniture, reduced cost of carpet repair, savings in the repair of computer equipment operated by smokers, and sometimes less frequent painting.

The actual savings in both housekeeping and maintenance expenses are expected to vary from building to building depending upon use (e.g., offices versus retail stores). A separate estimate was therefore developed for different uses: offices, mercantile and services (retail), food service, health care, assembly, education, lodging, and warehouse/industry.

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[11] See for example letters to the editor in the Journal of the Medical Association of Georgia, Vol. 79, March 1990, page 273.

[12] Personal correspondence from James Dinegar, BOMA International to David Mudarri, EPA. January 1994.

The cost saving estimates were then allocated just to the portions of those buildings for which they would apply.[13]

Finally, it was recognized that the computed savings would not be realized in many buildings for several reasons. First, some buildings already have partial smoking restrictions, even though they do not comply with the requirements of H.R. 3434, so that these buildings would have already experienced some savings from smoking restrictions. Second, it was recognized that buildings for which permanent housekeeping and maintenance personnel are fixed may not experience savings in the short term. Using survey data to indicate proportions of establishments that experience maintenance savings, the square feet to which savings would apply was decreased by about 40% in most cases.

For maintenance expenses, the high estimate is distinguished from the low estimate primarily by the inclusion of items for which there was considerable uncertainty. Reduced computer repair costs are applied only to the high estimate for offices. Savings in the replacement of furniture are applied only to the high estimate for offices, health care and educational facilities, and to the high and low estimates for lodging and food service establishments. Carpet repair savings are included in the high estimate for offices and health care, and in the high and low estimates for lodging and food service establishments.

Taking these factors into account, this analysis estimates that the operation and maintenance savings would amount to about $4 billion to $8 billion per year.[14]

**Effects on Productivity**

*On-the-Job Productivity Improvements from Reduced ETS*

It is generally agreed that exposure to ETS reduces the productivity of "individual" building occupants, probably more for nonsmokers than smokers, though no reliable basis for quantifying this effect could be found. It is also likely that clearly defined and implemented smoking policies will increase "organizational" productivity by reducing potential conflicts between smokers and nonsmokers. Evidence suggests that well-run smoking restrictions are popular among both employees and management, and that when they are well managed and tailored to the social norms of individual worksites, they are effective (Andrews,1983; Hocking. et al. 1991; Hudzinski, 1990; Peterson. et al. 1988; Sorensen. et al. 1986; Sorensen. et al. 1991; Stave. et al. 1991). Nevertheless, no basis for quantifying effects on organizational productivity could be found.

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13 For example, university classrooms do not generally allow smoking anyway, so that a smoking restriction would result in savings only in the office spaces or other common areas in classroom buildings.

14 The housekeeping and maintenance cost savings, when compared to the cost of implementing smoking restrictions, including smoking lounges, suggest that some building owners may be induced to consider implementing smoking restrictions in order to increase profits, even in the absence of smoking restriction legislation.

*Losses in Productivity from Restrictions to Smokers.*

While reduced ETS exposure would likely have some positive impact on smoker's productivity, the inability to smoke at their work stations would likely have the opposite effect. This could occur for two reasons. First, depending on their level of addiction, some smokers who want to smoke, but are restricted, may become uncomfortable, and less able to work effectively. Second, in order to smoke, smokers would have to leave the work station and go either to a designated smoking lounge or outside to smoke. The resulting effect on productivity would be limited because taking occasional breaks is already a normal part of the workday for most persons. Thus, while it is likely that some decrement in productivity would result from these two effects, it is not likely to be large relative to the productivity gains from reduced ETS exposure, and it would be difficult to quantify.

*Net Effect on Productivity*

There are both positive and negative influences on productivity. The ETS effect would *increase* productivity and apply to all employees. However, some smokers would work less effectively and some would spend more time going to and from an allowable smoking area. This may *decrease* productivity, but would apply only to smokers, and only to some portion of the smoking population. Quantitative estimates of these effects could not be developed for this study.

**Benefits from Reduced Absenteeism**

In addition to considerations of on-the-job productivity, smoking restrictions would yield productivity gains by reducing absenteeism. After accounting for differences in socioeconomic characteristics between smokers and persons who have never smoked, smokers are estimated to have about 50% more workdays lost than persons who have never smoked, and former smokers are estimated to have about 30% more workdays lost than never smokers (Manning. et al. 1991).

There is a plausible presumption that an institutional environment that restricts smoking and that supports abstinence will reduce cigarette consumption among smokers, increase attempts to quit and quitting success rates, and reduce the rates at which nonsmokers take up smoking. However, in 1989, the Surgeon General found that evidence of the effect of smoking restrictions on actual smoking behavior was considered to be inconclusive (DHHS, 1989). Since that time, a number of studies appear to support the conclusion that such restrictions have some of the postulated effects on smoking behavior (see Appendix A).

Based on a review of these recent studies, it is estimated that between 3% and 6% of current smokers would quit as a result of national legislation that restricts smoking. This would result in an immediate decrease in the number of smokers and an equivalent increase in former smokers. We also estimate that the initiation rate for new smokers would decrease by 5% to 10%. This would ultimately result in an equivalent proportional reduction in the number of smokers, and an equivalent absolute increase in the number of persons who have never smoked. However, the effect of the reduced initiation rate would

occur gradually over a 50 to 60 year period. The average daily earnings including fringe benefits of smokers is about $104, and discounting all future effects by 3% yields an estimated savings of under $0.5 billion per year. This is quite insignificant when compared with other effects.

### Savings in Smoking-Related Fires

Most smoking-related fire injuries and property losses are in residential environments, which would not be subject to smoking restrictions. For example, between 1988 and 1990, there was an annual average of some 1,328 smoking related fire fatalities in residences compared to an annual average of 38 fatalities in nonresidential buildings (Miller, 1993). Likewise, property damage due to smoking-related fires over the same period averaged some $316 million annually for residences, compared to $115 million annually in nonresidential buildings (Miller, 1993). As a result, the savings from smoking restrictions would be minimal, and is estimated to be approximately $0.5 to $0.7 billion per year. This estimate includes the effect of an estimated reduction in cigarette consumption at home because of quitting and reduced initiation.

## Benefits or Losses Regarding Smokers

Smoking restrictions comparable to those in H.R. 3434 would be expected to result in some reduction in overall cigarette consumption. Faced with restrictions on where they may smoke, some current smokers may quit and some may reduce overall consumption. In addition, these restrictions would also tend to discourage many nonsmokers, mostly teenagers,[15] from becoming smokers.

These changes in behavior would result in significant improvements to the health of smokers themselves, as well as other benefits such as increased safety and reduced property damage from smoking-related fires. Based on the assumptions used in this analysis, EPA estimates changes in smoking behavior would result in an average of 27,000 to 54,000 fewer premature deaths per year among smokers during the first 50 years, and 47,000 to 92,000 fewer premature deaths per year thereafter.[16] On average, smokers who quit or cut back would add back an average of 5 to 8 years of life otherwise lost to smoking-

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[15] CDC (1991).

[16] The difference in death rates each year results from the different time patterns of the effects of quitting and cutting back on consumption, and because the analysis assumed that it would take 60 years reduced annual initiation to complete its affect on the size of the smoking population. Therefore, the 54,000 to 92,000 premature deaths reflect annual rates after 60 years for reduced initiation, In addition, this analysis assumed H.R. 3434 would have only a "one time" effect on decisions to quit, rather than an ongoing effect. Therefore, the H.R. 3434-related quitting eventually disappears as the cohort of smokers motivated to quit by H.R. 3434 dies from old age or other causes.

related premature death. For those nonsmokers who avoid becoming smokers, life is extended by an average of about 15 years.[17]

Clearly, these health benefits to smokers are highly significant, and, as a matter of public policy, may be viewed as a benefit to society. However, there remain 45 million smokers who purchase approximately 25 million packs of cigarettes per year, and about 1 million persons become regular smokers annually. Since persons smoke despite the risks and costs, one would presume that, provided these persons are rational, fully knowledgeable, and are able to accurately assess the consequences of smoking, including potential addiction, the benefits of smoking to them outweigh the risks and the costs. However, for a number of reasons, this study does not attempt to estimate the economic value of the benefits or losses regarding smokers.

First, the economic measures traditionally applied to the health consequences of pollution may not be appropriate to use in estimating the economic value of physical effects of smoking that occur to smokers themselves. Exposure to pollution, such as ETS, is essentially involuntary and uncompensated. Addiction arguments aside, smoking is a voluntary activity that results in other consequences for smokers, some positive and some negative. These other consequences are not reflected in measures of value for health risk reductions sometimes used by EPA. Applying such health risk valuation factors to health consequences for smokers would therefore inappropriately omit the value of all these other costs and benefits to smokers, resulting in potentially biased measures of the welfare change to society.

Second, analysts disagree whether the traditional economic models one might use to measure the welfare change to smokers can be reasonably applied, particularly given limits on available data. To obtain reasonable estimates of the change in net benefits to smokers, these traditional models require that the subjects -- smokers in this case -- are acting rationally in response to a free and open marketplace. Furthermore, these consumption decisions must either be devoid of significant price distortions such as taxes and subsidies, or analytical corrections must be made to take account of these distortions. With respect to the rationality requirement, questions have been raised whether the rational consumer choice model applies given the apparent addictive nature of smoking, or to the delicate question of smoking initiation by teenagers.[18] Questions have also been raised whether the consequences of taxes (e.g., cigarette tax) and subsidies (e.g., tobacco farm subsidies, subsidized health care) significantly distort consumer decision-making in this case.

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17 See Exhibit 6-8 of the main text.

18 Note, however, that some analysts subscribe to models of "rational addiction" which have been developed and empirically tested (Becker and Murphy,1988);(Chaloupka,1991). However, these models do not take account of those who underestimate the strength of the addiction, or, who, for whatever reason, fail to appreciate the magnitude of the adverse consequences.

Nor do the models appropriately confront the difficult question of the consequences from teenage smoking. These models demonstrate that teenagers tend to disregard the future consequences of smoking more so than do adults (Chaloupka, 1991). Reducing teenage smoking is generally regarded as a benefit, and legislation in most States prohibits the sale of tobacco products to teenagers.

Third, EPA is concerned that currently available data are insufficient to support using a traditional economic model to estimate the change in net benefit to smokers caused by H.R. 3434. The reason for this is H.R. 3434 does not prohibit smoking outright, nor does it change the purchase price or quantity of cigarettes available. Instead, H.R. 3434 only compels changes in the location and/or time pattern of cigarette consumption. This would be expressed in economic terms as an increase in the transaction cost of smoking, and the transaction cost would vary widely among smokers. Since it is unclear how the slope of the demand curve for cigarettes might shift in response to a nonuniform increase in transaction costs to smokers, a reliable measure of the change in net benefits to smokers cannot be decided.

Based on the foregoing, this study makes no attempt at this time to quantify the economic value of the consequences of H.R. 3434 to smokers themselves.

## Comparing Costs and Benefits

While several elements of costs and benefits were not quantified, and bearing in mind the limitations presented by the current analysis, two principal findings emerge. First, it is clear that the benefits of smoking restrictions comparable to H.R. 3434 substantially outweigh the costs for those items quantified in our analysis. Second, comparing the high estimate of costs with the low estimate of benefits does not change the fundamental conclusions that benefits significantly exceed costs.

It should be noted that no attempt was made in the current analysis to evaluate the costs and benefits of altering provisions of the legislation. Throughout the analysis, no exception in scope or timing of the provisions of H.R. 3434 were assumed. Clearly, changing provisions such as the scope or timing of the restrictions would affect both costs and benefits.

### Comparisons with Alternative Baselines

Given the rapid increase in public and private smoking restrictions in the last few years, it is likely that the future will bring additional restrictions without passage of H.R. 3434. Of course, the future is always uncertain, and tobacco consumption and smoking restrictions will be influenced in part by campaigns of tobacco and anti-smoking interests (Samuels and Glantz, 1991, Macdonald and Glantz, 1994).

Three different baseline scenarios for the prevalence of present and future public and private sector smoking restrictions were developed and compared. Each one assumes that current levels of cigarette consumption are maintained into the future. The first baseline scenario for smoking restrictions assumes that there are no current restrictions. This is the artificial baseline used in the main text for analytic convenience. The second scenario assumes that 23% of the population are currently covered by restrictions comparable to H.R. 3434, and is the scenario used to characterize the costs and benefits of H.R. 3434. The third scenario assumes that the recent increase in public and private

restrictions would continue reaching a maximum level in which 75% of the population is covered by smoking restrictions, in 10 years.

Alternative scenarios were also constructed which varied the assumption about future baseline consumption of cigarettes, assuming that per capita consumption would continue to decline for 10 years and 20 years, before levelling off. Similar to other major influences such as the national educational campaigns about smoking, national legislation restricting smoking in public buildings may contribute to continued downward trends in cigarette consumption. Alternatively, these downward trends may continue or level off regardless of the advent of such legislation. However, while recognizing that several issues were not quantified in this study, sensitivity analysis indicates that, as in the case of alternative public and private restriction policies, varying the assumed baseline trend of future cigarette consumption has no significant effect on the result the benefits would be expected to exceed costs by a substantial margin.

Results using alternative baseline scenarios are summarized in Exhibit ES-3. The first scenario presents results under an assumption that there are no restrictions currently in place and that per capita consumption of cigarettes remains at current levels. This is the base scenario used to calculate benefits and costs of smoking restrictions. The second scenario differs from the first in that it assumes that 23% of the population is covered by policies which already comply with H.R. 3434. This is the baseline we use to assess the impact of H.R. 3434. The third scenario assumes that restrictive smoking policies will continue to be adopted in the public and private sector without the passage of H.R. 3434, and that these will continue and achieve a level of 75% compliance in 10 years and remain at that level thereafter. The fourth scenario combines an assumption of 23% existing compliance with an assumption that per capita cigarette consumption will continue to fall for ten years into the future at 3% per year, and then remain constant after that. The last scenario is the same as the fourth except that per capita cigarette consumption is assumed to fall for 20 years before it levels off.

Under all of the alternative scenarios presented in this analysis, assumptions about the pervasiveness of future restrictions in the absence of H.R. 3434 have virtually no effect on the findings that the benefits would exceed the costs.

A 3% discount rate is used for all scenarios. While the absolute level of estimated costs and benefits are different under each scenario, our qualitative conclusions remain unchanged.

## Other Economic Considerations

The estimates of costs and benefits covered in this analysis are a subset of potential economic consequences that policy makers may wish to consider.

*Restoration of Lost Income*

Implementing smoking restrictive legislation nationally would result in the restoration of approximately $31,000[19] for each pre-retirement year of premature death which is avoided because of smokers who quit, cut back, or fail to become smokers because of H.R. 3434. On average, we estimate that each premature death avoided because of quitting and reduced consumption would add approximately 1.4 to 4 salary earning years, and each premature death avoided from persons who refrain from becoming smokers would add approximately 11 salary earning years of life.[20] When future values are discounted at 3%, this analysis estimates that between $3 billion and $6 billion of lost income would be restored. A similar estimate was not possible for persons exposed to ETS, though this effect should be considered. The importance of this impact is enhanced to the extent that some children, spouses, the elderly or disabled may be dependent on such income.

*Reduced Burden on the Medical Service Industry*

Every year, the average expenditure for medical services for smokers and former smokers exceeds that of nonsmokers. However, this is partially offset by the fact that nonsmokers live longer, and continue to consume medical services during the extra years of life. When both of these factors are taken into account, the result is a net excess burden on the medical service industry of about $35 billion per year due to smoking.[21] Assuming that changes in the excess medical expenditures due to smoking restrictions would be proportional to changes smoking related premature deaths, this analysis estimates that every reduction in annual premature death would represent an annual reduction of $85,000 for medical services. Accordingly, when future savings are discounted at 3%, H.R. 3434 would reduce annual expenditures for medical services by $2.3 billion to $4.7 billion per year. It is not clear from our analysis what net impact reduced exposure to ETS would have on the medical service industry.

*Potential Cost to Social Security and other Pension Funds*

Persons who would otherwise have died prematurely would live longer under smoking restrictions and collect pensions and social security during those extended years. Each premature death avoided for smokers who quit, cut back, or fail to initiate smoking represents an extension of life of about 5 to 7 years beyond the age of 65, during which time

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[19] The estimated annual earnings of smokers is inflated by 20% to account for earnings after the age of 65, based on OTA (1993).

[20] Salary earning years are assumed to be years prior to the age of 65.

[21] This is estimated from information provided by Hodgson (1992) who compares excess medical costs over the lifetime of persons who have ever smoked , and persons who have never smoked. Similar data and procedures were also used by Manning. et al. (1991).

they would be eligible to collect a pension annuity. Data are not currently available to support a similar estimate for ETS exposed individuals.

*Reduced Revenues from Cigarette Sales and Excise Taxes*

Implementation of national legislation to restrict smoking in public buildings would reduce overall cigarette consumption by approximately 11% to 17%, and this impact would occur within the first few years of implementation. This would result in a corresponding reduction in cigarette tax revenues.[22] However, these could be offset, to some extent, by the social benefits of alternative agricultural production or other taxable uses of farmland.

*Employment Dislocations*

Reductions in demand for cigarettes and medical services would involve some temporary dislocations of persons employed in these industries.

## Conclusions

Given data limitations, and the uncertainties inherent in cost-benefit analysis of public health and environmental policies, this analysis does not purport to provide definitive conclusions about the overall merits of national smoking restriction legislation. Nevertheless, while recognizing that several effects of H.R. 3434 including effects on productivity, comfort from reduced exposure to ETS, and the net losses or gains regarding smokers, were not quantified, this analysis demonstrates that, for those items that were quantified, the estimated benefits of H.R. 3434 exceed the estimated costs by a substantial amount. This analysis suggests that the net effect of these excluded items would have to represent a loss of $39 billion to $72 billion per year for costs to exceed benefits.

As suggested in Exhibit ES-4, the overall findings of substantial net benefits is not altered by comparing high costs to low benefits, or by alternative discount rates. Furthermore, while the magnitude of the net benefits specifically allocated to H.R. 3434 is dependent on one's assumptions about baseline conditions, these assumptions go more to the question of whether or not to capture these net benefits through national legislation or by other public and/or private initiatives.

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[22] For an excellent comparison of what smokers pay in excise taxes, medical expenditures, and contribution to retirement funds, relative to the value of the services they receive for those payments, see Manning, et al. (1991). However, the net monetary payments made by or to smokers is not a useful index for measuring the overall social benefits or costs of smoking restrictions. As previously described, willingness to pay measures are more appropriate. Also, our costs and benefits do not count transfers of costs or benefits from one group in society to others.

## Exhibit ES-1: Summary of Costs and Benefits*

**Base=23% Restrictions**

| | ****3% Discount Rate**** | | ***5% Discount Rate*** | | **7% Discount Rate** | |
|---|---|---|---|---|---|---|
| | Low Estimate | High Estimate | Low Estimate | High Estimate | Low Estimate | High Estimate |
| | (Millions of Dollars) | | (Millions of Dollars) | | (Millions of Dollars) | |
| **Cost of Implementing the Legislation** | 470 | 1,437 | 475 | 1,451 | 480 | 1,464 |
| Smoking Bans | 123 | 350 | 123 | 350 | 123 | 350 |
| Smoking Lounge | 270 | 703 | 275 | 716 | 280 | 729 |
| National Enforcement | 77 | 385 | 77 | 385 | 77 | 385 |
| **Benefits from Reduced Exposure the ETS** | 34,884 | 65,041 | 33,188 | 61,924 | 31,956 | 59,683 |
| Value of Premature Deaths Avoided | | | | | | |
| Home Exposure | 559 | 2,016 | 530 | 1,911 | 509 | 1,836 |
| NonHome Exposure | 32,229 | 57,988 | 30,555 | 54,976 | 29,351 | 52,810 |
| Improved Health [1] | 2,095 | 5,037 | 2,095 | 5,037 | 2,095 | 5,037 |
| Increased Occupant Comfort | # | # | # | # | # | # |
| **Savings in Operating and Maintenance Expenses** | 3,969 | 7,714 | 3,969 | 7,714 | 3,969 | 7,714 |
| Housekeeping | 2,983 | 3,388 | 2,983 | 3,388 | 2,983 | 3,388 |
| Maintenance | 986 | 4,327 | 986 | 4,327 | 986 | 4,327 |
| **Net Change in Productivity** | # | # | # | # | # | # |
| **Savings in Reduced Smoker Absenteeism** | 172 | 344 | 144 | 289 | 126 | 256 |
| **Savings in Smoking Related Fires** | 469 | 694 | 469 | 694 | 469 | 694 |
| Value of Injuries and Deaths Avoided | | | | | | |
| Residential | 226 | 452 | 226 | 452 | 226 | 452 |
| NonResidential | 157 | 149 | 157 | 149 | 157 | 149 |
| Property Damage Avoided | 86 | 93 | 86 | 93 | 86 | 93 |
| **Benefits Without Regard to Smokers [2]** | 39,023 | 72,356 | 37,287 | 69,170 | 36,041 | 66,884 |

### Benefits or Losses Regarding Smokers

| | Annual Average over 60 Year Period | | Annual Rate After 60 Years | |
|---|---|---|---|---|
| | Low Estimate | High Estimate | Low Estimate | High Estimate |
| **Premature Deaths Avoided (Smokers)** | | | | |
| Quit Smoking | 4,198 | 8,391 | 0 | 0 |
| Reduced Consumption | 20,176 | 39,431 | 30,582 | 59,768 [1] |
| Reduced Initiation | 2,934 | 5,869 [3] | 15,968 | 31,936 [3] |
| Total | 27,306 | 53,691 | 46,550 | 91,703 |
| **Benefit Losses to Smokers** | # | # | # | # |

*Totals may appear to be greater than the sum of individual items due to rounding.

# Not quantified. See text for discussion.

1. Most of this estimate is due to the estimated value of reduced asthma induction in children. The high estimate in Exhibit ES-1 is reduced by 50% because of uncertainty of its magnitude.
2. Considers just the above costs and benifits.
3. *Annual premature deaths avoided after 60 years. Annual reduction in premature deaths gradually increases over the first 60 years before it reaches a constant value.*

**Exhibit ES-2a: Estimates of U.S. Nonsmoker Annual Mortality Associated With Exposure to Other People's Smoke**

| MORTALITY | U.S. EPA[1,a] | CENTERS FOR DISEASE CONTROL[2] | OTHERS | COMMENTS |
|---|---|---|---|---|
| Lung Cancer (ICD 162-163) | 3,000 Total | 3,800[3] | 12[4], 240 to 2000[5] | ETS a Group A carcinogen. ETS concentrations similar in smoking homes and offices. Generally higher in restaurants. |
| Home ETS sources | 800 | -- | 300[6], 3000[7], 5000[8] | |
| Other ETS sources | 2,200 | -- | 4000[9] | |
| Other Cancers | *b* | | 11,000-12,000[7,10] | Limited evidence for cancers other than lung |
| Heart Disease (410-414) | | | 32,000-40,000[7,10,11] | Evidence continues to mount on ETS and heart disease |
| Burn Deaths | | 1,300[12] | 1200[13], 150[13b] | Due to fires initiated by smoking materials |
| Spontaneous Abortions | | | 145,000[14] | |
| Sudden Infant Death Syndrome | c | 700 | 1,900[14] | |
| Respiratory Conditions, newborn (769-780) | | 2,000 | 4,400[14,d] | Estimates are based on maternal smoking |
| Short Gestation, Low Birthweight (765) | | 900 | 4,400[14,d] | |

[a]EPA[1] evaluated only the respiratory hazards of ETS; also, was the only source to breakdown home vs. nonhome risks.
[b]Deaths to children under age 18.
[c]EPA[1] concluded that maternal smoking is a strong risk factor for SIDS. ETS exposure to the newborn is also considered to be a risk factor for SIDS.
[d]Defined by DiFranza as perinatal deaths, which includes stillborns.

**References**


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4. Arundel (1987)
5. Vutuc (1984)
6. Wigle (1987)
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12. Adapted by CDC from Federal Emergency Management Agency, 1990
13. Miller, A.L. (1993). The U.S. smoking-material fire problem through 1990. The role of lighted tobacco products in fire. National Fire Protection Association, Quincy, Mass, March 1993
14. DiFranza, J.R. (1993). Tobacco Abuse: Morbidity and Mortality in the Pediatric Population due to the Use of Tobacco Products by Other People. Submitted to JAMA

**Exhibit ES-2b: Estimates of ETS-Attributable Morbidity in Children Due to Home and Nonhome Sources**

| MORBIDITY[a] | HOME | | NONHOME |
|---|---|---|---|
| | U.S. EPA[1] | DiFranza[14] | |
| Low Birth Weight (≤2500g) | | 59,000[b] | |
| Admission to Neonatal Intensive Care Units | | 25,000[b,c] | |
| Operations on Tonsils or Adenoids | | 27,000[d] | 30,000[e] |
| Tympanotomy Operations[f] | | 139,000 | 160,000[e] |
| Episodes of Otitis Media | | 2,366,000 | 2,800,000[e] |
| Asthma Exacerbation | 300,000 - 700,000 | 536,000[f] | 100,000 - 300,000[g] |
| Asthma Induction | 12,000 - 40,000[h] | | 1,000 - 5,000[g,h] |
| Physician Visits for Cough | | 2,176,000[d] | 3,400,000[e] |
| Lower Respiratory Tract Infections (Pneumonia, Bronchitis, Bronchiolitis) | 135,000 - 270,000[i] | 885,000 - 1,138,000[i] | 15,000 - 30,000[g,i] |
| Fire-Related Injuries | | 359[k] | |

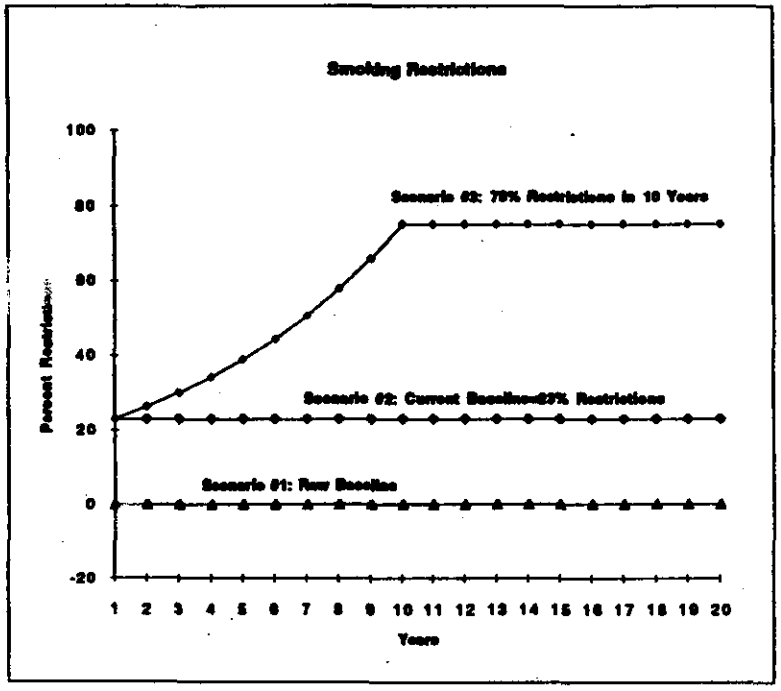
[a]Age < 18 years, unless noted otherwise
[b]From maternal smoking during pregnancy
[c]DiFranza provides cost estimates of 302 m - 773 m $
[d]Age < 15 years
[e]As estimated by U.S. EPA based on results from DiFranza[14]
[f]Physician visits
[g]As estimated by U.S. EPA based on results from U.S. EPA[1]
[h]Nonthreshold model, Z=10
[i]Under 18 months of age only
[j]Bronchitis in children under 18 years plus pneumonia in children under 5 years
[k]From all sources of smoking materials

## Exhibit ES-3: Analysis of Alternative Baselines*

| | Low Estimates [1] | | | | |
|---|---|---|---|---|---|
| | Scenario #1 Raw Baseline No Restrictions (1988 Cig. Cons) [2] | Scenario #2 Current Baseline 23% Restrictions (1988 Cig. Cons.) [3] | Scenario #3 75% Restrictions in 10 Years (1988 Cig. Cons.) [4] | Scenario #4 Current Baseline 23% Restrictions Contin Cons Decl 10 Years [5] | Scenario #5 Current Baseline 23% Restrictions Contin. Cons. Decl. 20 Years [6] |
| | (Millions of Dollars) | | | | |
| Cost of Implementing the Legislation | 810 | 470 | 209 | 456 | 382 |
| Savings in Reduced Exposure to ETS | 39,303 | 34,884 | 15,521 | 33,664 | 28,364 |
| Savings in Operating and Maintenance Expenses | 5,154 | 3,969 | 1,766 | 3,853 | 3,227 |
| Net Change in Productivity | 0 | 0 | 0 | 0 | 0 |
| Savings in Reduced Smoker Absenteeism | 223 | 172 | 77 | 167 | 140 |
| Savings in Smoking Related Fires | 609 | 469 | 209 | 455 | 381 |
| Net Benefits | 39,079 | 39,023 | 17,383 | 37,883 | 31,736 |

*Totals may appear to be greater than the sum of individual items due to rounding.

1. All estimates use 3% discount rate, and assume the same enforcement cost of $100 million.
2. This is the basic scenario used in the main text.
3. The principal estimates in the text for assessing the effects of H.R. 3434 are based on this scenario.
4. Assumes no additional compliance after 10 years.
5. Per capita consumption has declined by about 3% per year from 1980 to 1990 (DHHS, 1994). Assumes the rate of decline will continue for 10 years, and then level off.
6. Assumes the rate of decline in per capita consumption over the past 10 years will continue for the next 20 years and then level off.



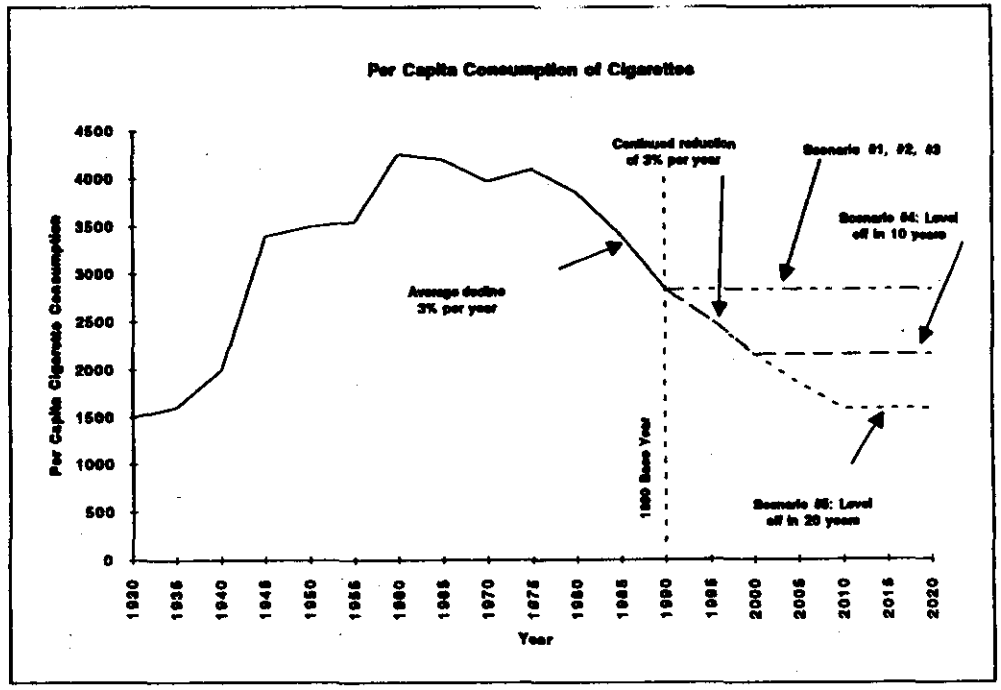



**Exhibit ES-4: Benefits Minus Costs**

**Base=23% Restrictions**

| | $ million | | |
|---|---|---|---|
| | 3% Disc. Rate | 5% Disc. rate | 7% Disc. Rate |
| Low Estimate | 39,023 | 37,287 | 36,041 |
| High Estimate | 72,356 | 69,170 | 66,884 |
| Low Benefits Minus High Costs | 36,056 | 36,311 | 35,057 |

# The Costs and Benefits of Smoking Restrictions

## An Assessment of the Smoke-Free Environment Act of 1993 (H.R. 3434)

## Introduction

In August 1993, H.R. 3434, the Smoke-Free Environment Act of 1993, was introduced in the House of Representatives by Congressman Henry Waxman (Chairman of the Subcommittee on Health and the Environment of the Committee on Energy and Commerce) with more than 40 co-sponsors. This bill would require that all nonresidential buildings regularly entered by 10 or more persons in the course of a week adopt a policy that bans smoking inside the building or restricts it to separately ventilated and exhausted smoking rooms. The bill would allow enforcement actions in the United States District Courts by an individual, government, or other aggrieved entity, with allowable fines of up to $5,000 per day.

H.R. 3434 would effectively ban or restrict smoking in most indoor environments. As written, these environments would include such diverse establishments as office buildings, schools and other educational establishments, theaters, restaurants, hotels, hospitals and other health care facilities, sports arenas, retail establishments, and manufacturing plants.

In a recent letter to Carol Browner, Administrator of the United States Environmental Protection Agency (EPA), Congressman Waxman requested that EPA analyze (quantitatively where possible) the compliance costs and the health and economic benefits of H.R. 3434. Specifically, he asked that EPA assess the cost of compliance including provisions for smoking lounges; the value of benefits resulting from reduced exposure to environmental tobacco smoke and changes in smoking behavior; the value of increased productivity and reduced absenteeism; savings from reduced operation and maintenance costs; and savings in fire related injuries and property damage.

### Role and Limits of Cost-Benefit Analysis

In principle, cost-benefit analysis can be a useful tool for helping to identify those government actions which leave society as a whole better off. It can contribute to such assessments by providing a systematic framework for measuring and comparing the net economic benefits of policy alternatives. Cost-benefit analysis does not by itself, however, provide definitive answers regarding the merits of public health and environmental policy alternatives. Rather, net benefit estimates must be combined with other information, and weighed with other policy considerations, to formulate effective public policy. Pursuant to this, and consistent with Executive Order 12866, EPA routinely weighs the full range of relevant policy considerations, such as distributional effects, legal issues, and institutional issues in making regulatory decisions. In keeping with this approach, EPA presents the current analysis, which the Agency believes provides useful insights regarding many of the potential costs and benefits of H.R. 3434.

**Summary Results**

This analysis indicates that passage of H.R. 3434, or similar restrictions, could achieve net benefits (i.e., benefits minus costs) ranging from $39 to $72 billion per year, excluding some potentially significant costs and benefits to smokers. For various reasons these and other potentially significant effects of H.R. 3434 could not be characterized in terms of economic value. Major costs reflected in these estimates include the costs of compliance and enforcement. Major benefits include those associated with reduced exposure to environmental tobacco smoke (ETS) and reduced operating and maintenance expenses. Benefits are also achieved from reduced absenteeism and reduced smoking-related fires, but these are not significant relative to other benefits. The net effect is that estimated benefits exceed estimated costs by $39 billion to $72 billion.

As noted above, the current analysis leaves open the question of whether smokers themselves gain or lose due to H.R. 3434. Clearly, smoking restrictions impose a burden on smokers. The losses in terms of time and inconvenience associated with forcing smokers to shift the location and/or timing of their cigarette consumption, and the potential burden associated with quitting, may be substantial. However, these losses would be offset to some unknown extent by the benefits of improved health among smokers who quit, cut back, or fail to start smoking in the first place. The net economic valuation of these and other costs and benefits of smoking to smokers themselves is beyond the scope of this analysis for reasons discussed in more detail below.

Nevertheless, it is important to emphasize that this analysis found that, of those effects which could be quantified, the estimated benefits exceeded the estimated costs by $39 billion to $72 billion. In order to reach a finding that H.R. 3434 would impose a net economic loss to society, the net effect of all unquantified costs and benefits -- including some important costs and benefits to smokers themselves -- would have to be additional costs of at least $39 billion per year.

**Document Review**

While EPA makes no commitment to revise and reissue the present study, this document has been developed and submitted to Congress in a form intended for review by outside experts, interested parties, and the public.

The principal author of the study is Dr. David H. Mudarri, an economist in the Indoor Air Division of EPA's Office of Air and Radiation. This version of the study reflects extensive review by other EPA offices, the Office of Management and Budget, the Council of Economic Advisors, and the Department of Health and Human Services. In addition, a previous version of this report was reviewed by several economists in the public and private sectors.

## General Methodology

### Assessing Annual Costs and Benefits

This analysis assesses the costs and benefits that would occur each year into the future for present and future generations. All estimates are represented as annual cost or benefits. That is, all costs are converted to an annual equivalent that would occur every year into the future based on 1990 population characteristics. Varying time streams of costs or benefits are converted to equivalent annual values using a 3% social discount rate. Sensitivity analyses using 5% and 7% discount rates are also provided.

Throughout this analysis it is assumed that H.R. 3434 would apply to all the previously stated buildings, at all times, without exception. It was also assumed that full compliance would be achieved within the first year of implementation.

### Choice of Baseline for Assessing Costs and Benefits

Per capita cigarette consumption has been falling steadily over the past several years. In addition, recent survey data suggest that many establishments already have some form of smoking policy, and the percent of establishments that report having such policies has been increasing in the past few years (DHHS, 1992; BNA 1991). Therefore, it was necessary to establish a baseline from which to measure the effects of H.R. 3434 from enactment forward. This was accomplished by a three step procedure.

In the first step, the net costs and benefits are computed assuming current cigarette consumption levels, and assuming that there are currently no restrictions. This is an artificial baseline used for analytic convenience, but may be interpreted as a reflection of the cost and benefit differences in a society with and without smoking restrictions comparable to H.R. 3434.

Second, survey data were examined concerning the prevalence of smoking policies already in place. Using assumptions about the nature of those policies as well as policies in small establishments not covered in those surveys, an estimate was derived that 23% of the population is covered by smoking restrictions comparable to the requirements of H.R. 3434. Current cigarette consumption levels, and 23% coverage by existing policies are therefore used as the baseline for assessing the effects of H.R. 3434. As a result, this study concludes that 23% of the previously calculated cost and benefits are attributable to existing policies, and 77% are attributable to H.R. 3434, or other future restriction policies, including private initiatives.[1]

Finally, sensitivity analyses to the baseline assumptions are conducted by calculating the changes to the costs and benefits that would result from alternative assumptions about

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[1] As this report was being prepared, the President signed into law the Goals 2000: Educate America Act. This legislation restricts smoking in all federally funded primary and secondary schools and in day care centers. Because a sensitivity analysis is presented of the alternative baseline assumptions, no specific adjustments to account for this new law were made to the 23% baseline calculations used to assess the effect of H.R. 3434.

future trends. The specific variables tested include future trends in cigarette consumption, and future trends in the development of public and private smoking restriction policies which could take place in the absence of national legislation. These alternative scenarios of potential future trends are intended to demonstrate how the absolute levels of incremental costs and benefits attributable to H.R. 3434 are sensitive to assumptions about the future prevalence of smoking restrictions enacted by other public and private entities, and to future trends in cigarette consumption.

**Other Economic Impacts**

Economic considerations which legislators may wish to consider go beyond just costs and benefits assessed in this analysis. Where information from this analysis sheds light on some of these considerations, they are briefly described.

# Assessment of Costs and Benefits
# In A Society With No Smoking Restrictions

In this section,the costs and benefits associated with smoking restrictions are assessed from a hypothetical baseline in which we assume that no restrictions in the public or private sector are currently in place. The results in this section may be interpreted as measuring the cost and benefit differences between a society with smoking restrictions versus a society without such restrictions. After completing the analysis using this hypothetical baseline, the costs and benefits of H.R. 3434 are assessed under estimates of current baseline conditions, and the sensitivity of these results is evaluated using alternative baseline assumptions.

## Section 1. Cost of Implementing Smoking Restrictions

### Cost of Implementing Smoking Bans

Despite the apparent wide use of some forms of smoking restrictions, there are no published data on the cost of compliance. While many establishments have smoking policies, it is not common for them to develop compliance cost information. Some preliminary data on compliance costs for worksites may be published soon as part of the Community Intervention Trial (COMMIT) project sponsored by the National Cancer Institute (Lewit, 1993). In the absence of specific data, estimates are developed for start-up costs which would occur initially, and for recurrent costs associated with maintaining the policy once it was established.

In establishing smoking bans nationally, responsible entities would incur initial costs to develop the policy, assign responsibilities, print and distribute information, print and post signs, remove ashtrays and cigarette vending machines, provide outdoor receptacles, and develop compliance procedures. Initial costs include a one time increase in participation in smoking cessation programs. Subsequent to these initial start-up costs, establishments will incur annual costs for policy maintenance. The estimates used in this analysis are provided in Exhibit 1-1. For simplicity, the estimates were developed for a prototype company with 1,000 employees.

According to Bureau of Labor Statistics (BLS) data, in 1990 there were approximately 118 million people in the employed civilian labor force (excludes military). Subtracting approximately 8 million for those who work in farming and the construction trades leaves 110 million persons employed indoors. The 110 million figure is used as the basis for calculating national costs of implementing smoking bans nationally.

The national cost estimate is presented in Exhibit 1-2. Initial costs are annualized in two ways. First, all the initial costs will be experienced in the first year or so that the policy is initiated. The annual equivalent of that initial cost is the interest cost at the appropriate interest rate.[2] In our analysis, we use a 3% social discount rate for our calculations.

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[2] Since the relevant quantity is the equivalent annual cost that would occur every year, in perpetuity, this is equivalent to borrowing the money and paying interest but no principal every year.

Second, the initial costs will recur when new establishments are formed. We assume a 15% turnover rate every year, so that 15% of the initial cost will be experienced every year by these new establishments.[3]

*Outdoor Shelters with Smoking Bans*

A few firms that have thus far established smoking bans now provide some form of outdoor smoking shelter for smoking employees. We assume that 10% of firms that ban smoking will provide this feature, so we included an estimate in our calculations.

A 9' x 12' free standing shelter (similar to a bus shelter) of aluminum frame with acrylic glazing would cost about $4,800 or $44 per square foot (Means,1991). Less elaborate structures, such as a bench under available shelter would cost considerably less. The cost of outdoor shelters is assumed to be, on average, about the same as the cost of indoor shelters, or about $25 per square foot. Maintenance costs are included in the cost of establishing a smoking ban.

**Costs of Smoking Lounges**

*Smoking Lounge Requirements*

H.R. 3434 requires that specifically designated smoking lounges meet appropriate standards for ventilation. To be properly ventilated, a smoking lounge should meet the following requirements (EPA 1993, ASHRAE 1989).

- Air from the smoking lounge should be directly exhausted to the outside by an exhaust fan. Air from the smoking lounge should not be recirculated to other parts of the building. This may require that the plenum (the space between the ceiling tiles and the next floor) be sealed and isolated from the remainder of the building.

- More air should be exhausted from the lounge than is supplied at all times. This insures that the area is under negative pressure, so that smoke does not drift to surrounding spaces.

- The ventilation system should provide the smoking room with 60 cubic feet per minute (cfm) of supply air per smoker. Smoker densities of 7 persons per 100 square feet are often assumed. This air may be supplied by air transferred from other parts of the building such as corridors.

- Nonsmokers should not have to enter the smoking room for any purpose.

Construction of separately ventilated lounges in existing buildings may require modification of the building ventilation system to isolate return air and establish the exhaust system. Because of the requirement that air be exhausted directly to the outside,

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[3] An establishment here is any new business, as distinguished from a new building. It is assumed that any new establishment would experience the initial costs of establishing a policy.

rooms with an outside wall or on the top floor are preferred. On the outside, exhaust vents must be adequately separated from the air intake vents which supply outside air to the building's ventilation system. The exhaust air may have to be filtered to avoid soiling on windows and on the outside surface.

There are three options for supplying ventilation air to the smoking area. The first is to transfer air from surrounding spaces. This may enter through grills in the door or through a separately constructed supply duct. The second option is to supply air from the main ventilation system, and the third option is to provide a dedicated supply air system for the smoking area. The first option is the cheapest but also the most susceptible to creating ventilation imbalances that compromise the integrity of the building's ventilation system and may generate complaints. The second option requires that the ventilation system have sufficient capacity to satisfy the supply air requirement for the room and still meet the demands of the rest of the system. While most systems are built with excess capacity, a recent increase in ASHRAE requirements for outdoor ventilation (ASHRAE 1989), or higher than designed occupant densities, may reduce that excess. The last option is the most expensive, but will offer the best guarantee that the system operates without complaint.

*Number and Size of Lounges*

It remains to estimate the lounge area that would normally be supplied to satisfy the smoking population in those establishments that choose this option. There are no published guides to help make this estimate. Therefore, the analysis derives an estimate by formulating an example of a site with 100 smokers. Each smoker is assumed to smoke before work and during lunch which will be outside of the building, and will take a 15 minute break once in the morning and once in the afternoon. Each break will take 3 minutes in transit, and 12 minutes in the smoking lounge. Smokers will visit the lounge over a two hour period, averaging 50 smokers an hour. If evenly distributed over the hour, there would be 10 smokers in the lounge all the time. Assuming a 50 percent variance for peak use gives an estimate of 15 smokers in peak use. Smoking lounges may be designed for 7 smokers per 100 square feet (ASHRAE 1989). This means that about 200 square feet of smoking lounge would be needed to satisfy a peak demand of 15 smokers. The design parameter then is to build 200 square feet of smoking lounge for every 100 smokers to be accommodated, or 2 square feet of lounge per smoking occupant. Exhibit 1-3 provides an estimate of the lounge construction requirements.

Each smoker may count as a smoking occupant in different buildings. For example, a smoker spends some time at work, some time in a restaurant, in a sports facility, etc. Therefore, the number of potential smoking occupants rather than numbers of smokers is a better measure for estimating the number of smoking lounges that may be built. In 1990, there were approximately 46 million smokers in the United States, and about 65% of the adult population was employed. Assuming the same employment rate for smokers would give us an employed smoking population of about 30 million persons who are the smoking occupants for the nation's workplaces. In addition, there were approximately 117 million seat or bed accommodations in educational facilities, restaurant facilities and hospitals (DOE 1991). Assuming a capacity utilization rate of 80%, gives us approximately 100 million

accommodations, of which 25% (25 million) will be used by smokers (About 25% of the population are smokers.). Thus, the total smoking occupant base for our calculations is taken to be 30 million plus 25 million or 55 million smoking occupants.

*Cost of Construction and Maintenance of Smoking Lounges*

A significant cost element for smoking areas inside buildings is the potential cost of ductwork. Since the area must be exhausted directly to the outside, rooms in the interior portion of the building will require horizontal and/or vertical ducts. Vertical ducts would be used to carry exhaust air from lower floors to the roof of the building through the central core of the building. Horizontal ducts would be used to reach the central core, or to exhaust the air through an outside wall. The building structure can make vertical duct construction prohibitive in existing buildings. Exhausting through the exterior wall can create films of exhaust materials on windows unless the exhaust air is properly filtered, or the exhaust air may infiltrate back into the building under certain conditions.

The Building Owners and Managers Association International (BOMA) reports that retrofitting ventilation systems to accommodate smoking room ventilation requirements is very costly, if not impossible in some cases. In new buildings, the design and installation of separate ventilation systems is reported to cost $30 - $50 per square foot (Hurwitz 1993).

Based on conversations with Digital Equipment Corporation and Connecticut Mutual Life Insurance, Environmental Health & Engineering (EH&E) (1992) suggests that lounges cost on the order of $40 - $50 per square foot, but could be as low as $20 per square foot if the room is already adequately enclosed, furnishings exist, and the room can be exhausted to a nearby exterior wall with minimum difficulty.

A firm in Dallas, Texas has made a business of providing smoking lounges to commercial establishments (Poynter 1993). The firm avoids vertical ducts, filters the exhaust air to avoid filming on windows, and provides a service contract to building owners which allows them to pass on the expense to tenants. According to its advertising literature, the firm would charge approximately $30 per square foot up-front costs plus an annual cost of about $25 per square foot to completely maintain the space and the ventilation equipment. This includes the rental fee for the space.

*National Cost of Compliance under the Smoking Lounge Option*

The Poynter 1993 estimate for indoor lounges is somewhat lower than the other estimates. However, it falls within the EH&E range, and is based on real market experience. Further, it is reasonable to assume that the indoor smoking lounge option will be used only when the costs are sufficiently low to make this option attractive. The Poynter estimate is used to calculate compliance cost. It is then increased by 30% to provide a high estimate. Calculations are provided in Exhibit 1-4. An initial average cost of $25 per square foot would be experienced by all establishments that choose to provide interior smoking lounges to accommodate smokers. This is translated into an annual equivalent cost using a 3% discount rate, to which is added a recurrent portion which would be experienced when

old structures are torn down and new ones built. We assume an average life of 20 years (or a turnover rate of 5% per year), so that 5% of this cost would recur annually.

The total annual cost estimates represent the national cost if every establishment elected to comply with smoking restriction requirements using the smoking lounge option.

***Proportion of Establishments Which May Choose to Provide Smoking Lounges***

Once fully implemented, only 10% (low estimate) to 20% (high estimate) of employees are expected to be serviced by smoking lounges (see Exhibit 7-3b for justification of this assumption). There are several reasons that most entities are not expected to provide a smoking lounge.

- Smoking lounges would have to meet stringent ventilation requirements and could not be spaces in which nonsmokers would have reason to enter. Most existing rooms with available outside exhaust such as rest rooms would not be allowed.

- Smoking lounges are more expensive and more complicated than smoking bans. It is likely that smoking lounges will be chosen only when they are relatively inexpensive and convenient.

- Smoking lounges may require exceptional diligence to insure that exhaust is adequate, that the space is under negative pressure, and that the building's ventilation system is balanced. Smoking lounges are generally associated with greater complaints and with lower reported satisfaction with the smoking policy than smoking bans, and smoking bans are becoming increasingly popular (Sorensen. et al. 1991, 1991a, 1992; Stillman. et al. 1992)

- Smoking lounges compete for space with other potential uses and could result in foregone rental revenue.

**Enforcement**

Costs to building owners for ensuring compliance in their building is included in the cost of implementing smoking bans. With respect to enforcement by governmental jurisdictions, H.R. 3434 provides no specific requirements for enforcement of its provisions, other than through citizen suits in Federal court. Therefore, enforcement costs are difficult to quantify. Some expenditures by the Federal government and by state and local governments can be expected for information dissemination, though they may well be less than the value of current resources devoted to passing controversial state and local legislation.[4] These expenditures were not quantified. Information dissemination on a

[4] Even when smoking restrictions are passed at the state or local level, campaigns to nullify the legislation or to preempt local legislation with weaker state legislation can involve the expenditure of significant resources on both sides of the issue. No attempt was made to quantify current costs to state and local entities, though national legislation would be expected to reduce many of these costs. For an excellent analysis of this issue as it is manifested in California, see Macdonald and Glantz (1994).

uniform requirement at a national level would likely enjoy greater efficiencies, and some reductions in resources currently devoted to passing and maintaining controversial state and local legislation, and in litigating private sector policies, would likely occur.

In a proposed rule concerning the sale or distribution of tobacco products to individuals under eighteen years of age, the Department of Health and Human Services [5] estimated that sting-type operations used by state governments would cost between $0.1 billion and $0.2 billion per year. Recognizing that these two issues are not strictly comparable, an estimate of between $0.1 billion and $0.5 billion per year appears plausible, and is used in this analysis as the cost of enforcement in a society with no current compliance with standards comparable to H. R. 3434. *(See Exhibit S-2 for estimates of H.R. 3434 under current baseline conditions.)*

## Section 2: Benefits from Reduced Exposure to Environmental Tobacco Smoke (ETS)

### Morbidity and Mortality Effects of Environmental Tobacco Smoke

#### *Lung Cancer and Other Respiratory Disorders*

The Environmental Protection Agency conducted a risk assessment of the respiratory health effects of environmental tobacco smoke (EPA 1992). The EPA report reviewed available evidence on the health consequences and estimated lung cancer population risks from exposure to ETS. Included in the EPA report is a summary of the conclusions from other major reports. This summary is paraphrased below.

> **National Research Council (NRC).** At the request of the U.S. Environmental Protection Agency and the U.S. Department of Health and Human Services, the National Research Council (NRC) formed a committee in 1986 to evaluate the methods for assessing exposure to ETS and to review the literature on all of the potential health consequences of exposure. The NRC's report concluded that "considering the evidence as a whole, exposure to ETS increases the incidence of lung cancer in nonsmokers." Correcting for smoker misclassification and background ETS exposure, the NRC calculated an overall adjusted relative risk estimate of 1.42 for lung cancer in nonsmokers from exposure to ETS from spousal smoking plus background sources. The NRC report also suggested a link between ETS exposure and an increase in pulmonary symptoms and respiratory infections in children, chronic ear infections and middle ear effusions in young children, and an increased risk of low-birth weight babies for pregnant women exposed to prolonged exposure to ETS (NRC, 1986).
>
> **Surgeon General.** Also in 1986, a report by the Surgeon General concluded that *available evidence leads to the conclusion that involuntary smoking is a cause of*

[5] Department of Health and Human Services, Substance Abuse and Mental Health Administration, 45 CFR Part 96, Substance Abuse Prevention and Treatment Block Grants: Sale or Distribution of Tobacco Products to Individuals Under 18 Years of Age: Proposed Rule.

lung cancer, and that the children of parents who smoke have an increased frequency of respiratory infections, increased respiratory symptoms, and a slightly diminished rate of increase in lung function as the lung matures (DHHS 1986).

**Other Reports.** Other major reports provide similar conclusions about various health effects from ETS exposure. The International Agency for Research on Cancer (IARC, 1986) concluded that there was some link between environmental tobacco smoke exposure and lung cancer. In a report supported by R.J. Reynolds, an independent international panel of scientists (Spitzer. et al. 1990) concluded that evidence supported a positive association between residential exposure to ETS and the risk of lung cancer. Spitzer. et al. also concluded that there is strong evidence that children exposed in the home to ETS have higher rates of hospitalization for severe respiratory illness, and that exposure to ETS is related to asthma in children. Finally, the National Institute for Occupational Safety and Health (NIOSH) (1991) concluded that ETS meets the criteria of the Occupational Safety and Health Administration for classification as a potential occupational carcinogen.

*Heart Disease*

EPA did not include an assessment of heart disease in its 1992 risk assessment of ETS exposure. However, NIOSH (1991) reviewed recent epidemiological evidence on the link between exposure to ETS and both lung cancer and heart disease. NIOSH (1991) concluded that the recent epidemiological studies "point to a pattern of health effects that is similar for both smokers and nonsmokers exposed to ETS. " With respect to heart disease, NIOSH (1991) reviewed the evidence from several studies and concluded that the evidence suggested a possible link between exposure to ETS and an increased risk for heart disease of nonsmokers. The NIOSH (1991) review of the evidence is summarized in Exhibit 2-1c.

Studies reported by Hole. et al. (1989), Helsing. et al. (1988), and Humble. et al. (1990) associated ETS exposure with an increase of heart disease among persons who never smoked. The studies by Hole. et al. (1989) and Helsing. et al. (1988) are large cohort studies of men and women who live in the same household. Studies of these cohorts demonstrated an excess of heart disease in persons who lived with smokers and never smoked compared with persons who lived with nonsmokers and who never smoked. Furthermore, Hole. et al. (1989) and Humble. et al. (1990) show an increasing risk for heart disease mortality with increasing exposure to ETS at home. Helsing. et al. (1988) found a similar trend in women but not men.

Experimental studies support the hypothesis that ETS exposure has deleterious effects on platelets and the endothelium and can decrease the time to onset of angina pectoris in patients with coronary artery disease.

The evidence suggests a possible association between exposure to ETS and an increased risk for heart disease of smokers.

Several studies have estimated the population risk of heart disease from ETS exposure. Using a relative risk of 1.30 for ETS-exposed nonsmokers relative to unexposed

nonsmokers, Wells (1988) estimated that 32,000 deaths occur each year to nonsmokers from exposure to ETS. Glantz and Parmley (1991) reviewed the epidemiological studies since 1984, including the studies reviewed by NIOSH. They estimated a 30% increase in risk of death from ischemic heart disease or myocardial infarction in nonsmokers exposed to ETS at home, resulting in an estimated 37,000 heart disease deaths per year. They also noted a positive dose response relation between the amount of smoking by the spouse and the risk of heart disease in the nonsmoking spouse. Steenland (1992) analyzed available literature and predicted that exposure to ETS solely from the one's smoking spouse could cause 15,000 to 19,000 ischemic heart disease deaths per year, and estimated overall that 35,000 to 40,000 cardiovascular disease deaths per year were due to ETS exposure.

In a recent position paper, the American Heart Association reviewed the available evidence reported above, including evidence on the mechanisms for inducing heart disease (Taylor, A.E. et al. 1992). They concluded that the risk of heart disease is increased by about 30% among those exposed to ETS at home and could be much higher in those exposed at the workplace, where higher levels of ETS may be present. In its position paper, the American Heart Association adopts the Steenland estimate of 35,000 to 40,000 ETS-related cardiovascular disease deaths per year (Taylor. et al. 1992).

**Base Estimates of Population Risk Used for Calculating Impacts**

Restrictions akin to those in H.R. 3434 eliminate almost all nonresidential exposure to ETS. Various time-activity pattern studies suggest people spend about 28% of their time out of the home. About 18% of people's time is spent at work, about 2% outdoors, 4% in transit and 4% in other indoor environments (EPA, 1989). H.R. 3434 would apply to work and other indoor environments, but would only partially affect in-transit exposures. Assuming that between half and three quarters of in-transit exposures are already controlled, and that outdoor exposures are insignificant, this study concludes that H.R. 3434 would apply to approximately 90% of nonresidential exposure to ETS.

Exhibit 2-1a and Exhibit 2-1b summarize estimates of U.S. mortality and morbidity associated with ETS exposure. Using this table as the basis for discussion, the mortality and morbidity estimates to be used in the national cost calculations are summarized below.

**Lung Cancer.** EPA estimates that 3,000 deaths occur each year from lung cancer due to ETS exposure. Of that number, 73% or 2,200 deaths per year are due to exposure outside of the home.

**Other (Nonlung) Cancers.** There is insufficient evidence to support inclusion of nonlung cancers in this estimate.

**Heart Disease.** Reported estimates for the effect of ETS on heart disease fall in the range of 32,000 to 40,000 heart disease deaths per year. Because these estimates are substantial, and because EPA (1992) did not specifically address heart disease in its risk assessment, two conservative adjustments are made to these figures.

- First, the low end of the range (32,000) is used as the high estimate, and this is reduced by 50% (16,000) to obtain the low estimate.

- Second, an arbitrary additional conservative adjustment of 75% is made to this range, providing a base estimate of 12,000 to 24,000 heart disease deaths per year[6].

The same proportional breakdown between home (27%) and nonhome (73%) exposure-related deaths as was reported by EPA for lung cancer is also used for heart disease. Therefore, 3,240 to 6,480 deaths per year are estimated for home exposures, and 8,760 to 17,520 are assumed to be associated with exposure outside the home.

**Burn Deaths.** Burn injuries and deaths are estimated elsewhere in this report.

**Other Mortality.** Studies of the mortality due to ETS exposure from spontaneous abortion and sudden infant death syndrome respiratory conditions in infants, and short gestation and low birth weight are based on maternal smoking. These effects are not included in the estimates presented in this study.

**Morbidity.** Studies of low birth weight and admission to neonatal intensive care units are based on maternal smoking and are also not included in the current estimates, however, the remaining morbidity effects are included.

**Estimated Mortality and Morbidity Effects Of Reduced Exposure to ETS**

***Home Versus Nonhome Exposures***

While smoking restrictions would apply only to nonhome environments, it is estimated in Section 6 below that between 3% and 6% of the smoking population would quit smoking as a result of comprehensive smoking restrictions. It is expected that this will result in an immediate reduction of 3% to 6% of home exposures, and result in a commensurate reduction in premature deaths due to ETS exposures in the home. However, those who quit will eventually die of old age or other causes, so this effect is transitory and will gradually dissipate over a period of some 50 years. Offsetting this is an estimated reduction in the number of persons who take up smoking each year. In Section 6, a reduction of 5% to 10% in the rate at which new smokers enter the smoking population is assumed. As fewer persons enter the smoking population each year, the size of the population decreases, reaching a maximum reduction of 5% to 10% in about 60 years. The net effect of quitting and reduced initiation is an average annual reduction of between 4.2%

[6] Some adjustment may be appropriate also because there appears to have been an increase in the survival rate of heart disease patients over the past several years due to advances in medical technology.

and 8.5% in the smoking population (Exhibit 2-3). This is assumed to translate into an equivalent reduction in home exposure to ETS.[7]

The greatest reduction in exposure to ETS will come as a direct result of smoking restrictions in nonresidential buildings. Such smoking restrictions in non-residential buildings are expected to reduce nonhome exposures by 90%.

*Proportional Reductions in Mortality Risk*

The impact of reduced exposure on mortality will not be immediate. It is assumed that the mortality risk for persons will fall over time in the same proportion as the reduction in the mortality risks of former smokers which gradually fall from the time they quit smoking. Exhibit 2-2 presents the proportional reductions in mortality risk (PRMR) from the time of reduced exposure. Calculations are based on the reduction of cancer mortality risk for male smokers since the time of quitting. Heart disease risks are assumed to fall twice as fast. Accordingly, it is assumed that full recovery from excess mortality risk of persons exposed to ETS is accomplished in 20 years.

**Estimated Annual Benefits from Mortality and Morbidity Effects**

*Value of Premature Deaths Avoided From Reduced Exposure to ETS*

Based on the proportional reductions in mortality risks and the assumption that home exposures would decrease by 4.2% to 8.5%, and that nonhome exposures would be reduced by 90%, the number of premature deaths avoided due to reduced exposure to ETS is calculated. Exhibit 2-4 provides estimates of premature deaths avoided in ten year increments, and for 50 year totals. The largest benefits in terms of premature deaths avoided occurs as a result of reductions in nonhome exposures.

"Willingness to pay" measures are used to value the premature deaths avoided due to reduced ETS exposure. Willingness to pay measures assess the value that persons assign to reducing their risk of premature death. The willingness to pay measure used for reduced exposures to ETS is $4.8 million per premature death avoided.[8] (See Appendix A-1 for a discussion of this estimate.)

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[7] Estimates are also presented in Section 6 that smoking restrictions will reduce, by 10% to 15%, the number of cigarettes smoked per smoker in a 24 hour period. It has been suggested that some smokers may increase their consumption at home in order to make up for lost consumption outside the home. No attempt was made to account for this possible effect on ETS exposures because this does not appear to be the general case, and because the estimate of reduced consumption used herein is a net reduction over the full day.

[8] Where possible, we rely on willingness to pay measures as opposed to medical cost savings and savings in lost earnings as the value of avoiding premature death. Using medical costs and lost earnings alone would represent an incomplete measure of the economic value that individuals, and society, assign to avoiding mortal risk. For example, using only medical costs and lost earnings would imply that social welfare is improved when individuals die just after retirement – before medical costs are high and just after salary earnings cease.

As shown in Exhibit 2-4, the reduction in home and nonhome exposures to ETS due to the introduction of smoking restrictions in a society with no restrictions would result in avoiding an average 9,000 to 17,000 premature deaths per year (Exhibit 2-4). The value of these reductions, when using a willingness to pay measure, and discounting future reductions at a rate of 3%, would range from $39 billion to $71 billion per year (Exhibit 2-6). *(See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)*

*Value of Morbidity Effects from Reduced Exposure to ETS*

The estimated reductions in home and nonhome exposures result in reduced morbidity as well as mortality. Morbidity effects from smoking restrictions are shown in Exhibit 2-6. Reductions in the incidence of these effects are assumed to be immediate, with no significant time delay, and are proportional to the reductions in exposure previously discussed. In a society with no current restrictions, the value of reduced morbidity from smoking restrictions would be between $2.7 billion and $6.5 billion per year. *(See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)* This value is dominated by the value of reduced cases of asthma induction, which is a chronic illness. For this illness, a reduction of between 1,400 and 4,000 cases annually is estimated. To value the benefits from reduced asthma induction, a willingness to pay measure associated with chronic bronchitis[9] was used.

## Section 3. Savings in Operating and Maintenance Expenses

Smoking in a building involves implicit operational and maintenance expenses. In addition to emptying and cleaning ashtrays, the smoke, ashes, and accidental burns on furniture and carpets create an additional housekeeping and general maintenance burden. For example, BOMA reports that in a tightly monitored program, a member firm experienced a 15% reduction in housekeeping costs when a non-smoking policy was introduced. Maintenance costs were not covered in the monitoring program. Changes that were observed included elimination of emptying or cleaning ashtrays; reduction in high dusting and the dusting of desks and tabletops; reduced detailed vacuuming around desks of smokers; and reductions in cleaning of venetian blinds and heating, ventilating and air-conditioning (HVAC) vents. In addition, cleaning personnel found that they spent less time moving articles on desks in order to remove ashes. BOMA cautions that this was a tightly monitored program, and that actual experience may only produce an average of 10% in overall housekeeping costs.[10] Unit cost estimates for smoking and nonsmoking interior spaces cleaning and maintenance are provided in Exhibit 3-1.

Maintenance cost savings include less frequent replacement of furniture, and repair of carpets, fewer repairs of computer equipment operated by smokers, and sometimes less frequent painting. For maintenance expenses, the high estimate is distinguished from the

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[9] Based on willingness to pay measure for reducing incidence of chronic bronchitis (Neumann, et al. 1994), we estimated the value of avoiding chronic asthma to be $1.5 million per case.

[10] Personal correspondence from James Dinegar, BOMA International to David Mudarri, EPA. January 1994.

low estimate mostly by the inclusion of items for which there was considerable uncertainty. Reduced computer repair costs are applied only to the high estimate for offices. Savings in the replacement of furniture are applied only to the high estimate for offices, health care and educational facilities, and to the high estimate for lodging and food service establishments. Carpet repair savings are included in the high estimate for offices, mercantile and service, health care, assembly, and education, and in the low estimates for lodging and food service establishments. Detailed estimates for maintenance are provided in Appendix B-1.

The actual savings in both housekeeping and maintenance expenses would vary from building to building depending upon use (e.g., offices versus retail stores). To provide an estimate of the impact of smoking restrictions on housekeeping and maintenance operations, we developed separate prototype cleaning and maintenance savings estimates for establishments representing different building uses: office, mercantile and service, food service, health care, assembly, education, lodging, and warehouse and industrial buildings.

The analysis reflects the assumption that the computed savings would not be realized in many buildings. For example, only 43% to 60% of firms with smoking bans report such savings (Carroll, 1990). There are many reasons for this. Firms differ in their needs for cleanliness (e.g. hotels may be more sensitive than offices), some establishments already have partial restrictions, and some establishments have rapidly changing personnel needs, calling for frequent refurbishing activities not related to smoking. Of course, many establishments may experience savings, but may not notice. Finally, and perhaps most importantly, many establishments have permanent cleaning and maintenance personnel are paid fixed salaries, while others may have contractual arrangements that would need to be renegotiated in order for the savings to be realized.

To estimate the square feet of floor area to which estimated savings would apply, two downward adjustments were made. First, these estimates are based only on that portion of the spaces for which the items would apply. For example, persons normally do not smoke in university classrooms, even in the absence of formal smoking restrictions, so savings would result only in the office spaces or other common areas in classroom buildings. Second, using survey data the total commercial square feet for each building use was reduced by about 40% in most cases. These two adjustments were used to arrive at an estimate of the applicable square feet to which estimated savings would apply. The results of these adjustments and the associated savings for each building use category are presented in Exhibit 3-2.

Using the above described procedures, total savings shown in Exhibit 3-2 suggest that a society with no prior restrictions would experience a national savings of between $3.9 billion and $4.4 billion per year in housekeeping, and $1.3 billion to $5.6 billion in maintenance, resulting in a total savings of between $5 billion and $10 billion per year. (*See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.*)

## Section 4. Increased Productivity and Decreased Absenteeism Resulting from Smoking Restrictions

### Effects on Productivity

**On-the-Job Productivity Improvements from Reduced ETS.** It is generally agreed that exposure to ETS reduces the productivity of "individual" building occupants, probably more for nonsmokers than smokers, though no reliable basis for quantifying this effect could be found. It is also likely that clearly defined and fairly implemented smoking policies will increase "organizational" productivity by reducing potential conflicts between smokers and nonsmokers. Evidence suggests that well-run smoking restrictions are popular among both employees and management, and that when they are well managed and tailored to the social norms of individual worksites, they are effective (Andrews. 1983; Hocking. et al. 1991; Hudzinski, 1990; Peterson. et al. 1988; Sorensen. et al. 1986; Sorensen. et al. 1991; Stave. et al. 1991). Nevertheless, no basis for quantifying effects on organizational productivity could be found.

**Losses in Productivity from Restrictions to Smokers.** While reduced ETS exposure would likely have some positive impact on smokers' productivity, the inability to smoke at their workstations would likely have the opposite effect. This could occur for two reasons. First, depending on their level of addiction, some smokers who want to smoke, but are restricted, may become uncomfortable, and less able to work effectively. Second, in order to smoke, smokers would have to leave the workstation and go either to a designated smoking lounge or outside to smoke. The resulting effect on productivity would be limited because taking occasional breaks is already a normal part of the workday for most persons. Thus, while it is likely that some decrement in productivity would result from these two effects, it is not likely to be large relative to the productivity gains from reduced ETS exposure, and it would be difficult to quantify.

**Net Effect on Productivity.** There are both positive and negative influences on productivity. The ETS effect would *increase* productivity and apply to all employees. However, some smokers would work less effectively and some would spend more time going to and from an allowable smoking area. This may *decrease* productivity, but would apply only to smokers, and only to some portion of the smoking population. Quantitative estimates of these effects could not be developed for this study.

### Benefits from Reduced Absenteeism

Several studies suggest that smokers have a greater number of sick leave absences from work than nonsmokers or former smokers. Using data from the 1979 Report of the Surgeon General which estimated that 81 million working days were lost to smoking, and dividing by the number of smokers, Kristein (1983) estimated the excess days lost due to smokers to be 2 days per year. Rice. et al. (1986) presents data from the supplement to the 1979 National Health Interview Survey showing an average of 4.9 work-loss days per employed person per year. Non-smokers average 4.3 work-loss days while current smokers and former smokers combined average 5.4 work-loss days (or 25% more than non-smokers). Jackson. et al. (1989) also report on other studies which showed 1.5 - 2.2 excess

workdays lost per month for smokers compared with ex-smokers. Unpublished data from the 1991 National Health Interview Survey show a difference in the reported mean days lost of 1 day between smokers and former smokers, and 1.7 days between smokers and never smokers.

The difficulty in making direct comparisons between the absentee rates of smokers and nonsmokers is that smokers are generally less educated, have lower incomes, are more likely to be in blue collar jobs, and are more likely to be alcohol users. These factors could account for some or all of the differences. However, recent evidence suggests otherwise. Reporting on a study of an eastern North Carolina pharmaceutical company, and using a time-series control group design, Jackson. et al. (1989) report a significant difference between current smokers and ex-smokers, and between smokers before and after cessation. Likewise, Manning. et al. (1991) examined data from the 1983 National Health Interview Survey and concludes that after controlling for age, sex, race, and education, former smokers had 31% more work-loss days and current smokers had 52% more work days lost per year than never smokers.

The 1993 NHIS data show a mean value in days lost from work of 3 days for never smokers. We will use Manning. et al.'s results to compute days lost for smokers and former smokers since they controlled for confounding variables. Thus, there are associated 0.9 (3 x .31) absentee days per year saved for each smoker who has quit and 1.5 (3 x .52) absentee days per year for each potential smoker who has refrained from becoming a smoker. Results are shown in Exhibit 4-1.

In Section 6 below, it is estimated that between 3% and 6% of current smokers would quit as a result of national legislation that restricts smoking, resulting in an immediate decrease in the number of smokers and an equivalent increase in former smokers. It is also assumed that the initiation rate for new smokers would decrease by 5% to 10%, resulting ultimately in a proportional reduction in the number of smokers, and an equivalent absolute increase in the number of persons who have never smoked. However, the impact of the reduced initiation rate would gradually take place over a 60 year period.

Finally, the estimated value of excess absences per smoker or former smoker is presented in Exhibit 4-2. The average value of each day lost is taken to be approximately $104 per day. This is the weighted average of the median daily earnings of white collar, blue collar, and service workers (weighted by the proportion of the smoking population in each of these categories). The reported earnings are inflated by 24% to account for fringe benefits.[11]

Given that a smoker's average daily earnings including fringe benefits is about $104, and discounting all future effects by 3% yields an estimated savings of under $0.5 billion per year (Exhibit 4-3). This is quite insignificant when compared with other effects. (*See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.*)

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[11] The daily earnings are the BLS median weekly earnings divided by 5. The smoking prevalence rates by labor category are given in DHHS 1989.

## Section 5: Savings in Smoking-Related Fires

Smoking is the leading cause of fire deaths in the United States. According to the National Fire Protection Association (NFPA), smoking materials were the cause of more than 200,000 fires per year during the decade of the 1980s (Miller 1993). Smoking-related fires refer to those caused by lighted tobacco products, and not cigarette lighters or matches.

Most smoking-related fire injuries and property losses are in residential environments, which would not be subject to smoking restrictions. For example, between 1988 and 1990, there was an annual average of some 1,328 smoking-related fire fatalities in residences compared to an annual average of 38 fatalities in non-residential buildings (Exhibit 5-1). Likewise, property damage due to smoking-related fires over the same period averaged some $316 million annually for residences, compared to $115 million annually in non-residential buildings.

This study estimates that smoking restrictions comparable to H.R. 3434 would eliminate 90% of the smoking-related fires in the non-residential sector with smoking bans. A 50% reduction in the nonresidential sector with smoking lounges is assumed. Further, because smoking restrictions are postulated to reduce the smoking population through quitting and reduced initiation, a proportional decrease in residential smoking-related fires is also estimated. Estimated reductions in injuries, deaths, and property damage from smoking restrictions in a society having no such restrictions is presented in Exhibit 5-2. Because a large portion of smoking related fatalities is in residences, the annual benefits from smoking restrictions in public buildings is minimal, and would be on the order of $0.6 billion to $0.9 billion per year (Exhibit 5-3). *(See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)*

## Section 6: Impacts of Smoking Restrictions on Smokers

### The Health and Economic Consequences of Smoking

In 1990, smoking caused an estimated 419,000 deaths in the United States (CDC, 1993a). Of these, approximately 116,000 were caused by cancers of the lung, trachea, or bronchus; 134,000 were caused by heart disease; and 74,000 were caused by respiratory diseases. Significant morbidity consequences are also associated with smoking. Smoking is clearly a major cause of health impairment and death. However, about 25 billion packs of cigarettes are sold each year. This means that individuals, with some knowledge of the risks of smoking, make a conscious choice to smoke, despite the expense and the consequences. Therefore, evaluating the social costs and benefits related to smokers is significantly different from evaluating the social consequences of exposure to ETS or other pollutants.

This subject is approached first by estimating the effects which would result from smoking restrictions on the behavior of smokers and the resulting effects on health. Issues concerning the valuation of these effects are then discussed.

### The Impact of Smoking Restrictions on Smoking Behavior

Several parameters which describe the smoking population and its smoking behavior are relevant to assessing the health effects of smoking restrictions. Smoking restrictions may increase the rate at which individuals quit smoking and thereby reduce smoking prevalence, and it may reduce cigarette consumption by those who do smoke. Both of these factors will reduce the per capita consumption of cigarettes, but the impact on health will be less than proportional to this reduction. Those who quit smoking become former smokers. The relative risk of health impairment of former smokers is less than it is for smokers, but greater than it is for persons who have never smoked (never smokers). Similarly, the relative risk for smokers is reduced by their average consumption, but it is not eliminated. Those who quit or reduce consumption will enjoy a longer life expectancy, but the result in annual death rates will take time to develop as the population ages.

Smoking restrictions may also reduce the rate at which nonsmokers take up smoking. Since most persons who initiate smoking do so at a young age, the full impact of this will be manifested over the long term. However, it will have a greater impact on health because the risk of health impairment for persons who never smoked is less than it is for smokers or former smokers.

### The Effect of Smoking Restrictions on Smoking Prevalence

There is a plausible presumption that an institutional environment that restricts smoking and that supports abstinence will reduce cigarette consumption among smokers, increase attempts to quit improve quitting success rates, and reduce the rates at which nonsmokers take up smoking. However, in 1989, the Surgeon General found that evidence of the effect of smoking restrictions on actual smoking behavior was considered to be inconclusive (DHHS 1989). Since that time, a number of studies appear to support the

conclusion that such restrictions have some of the postulated effects on smoking behavior, and that these effects are potentially more powerful than other antismoking efforts. These studies are summarized in Appendix A-2 .

Almost all of these studies relate to smoking restrictions in the workplace where smoking behavior was compared before and after institution of a smoking policy. A few studies also compared worksites with smoking restrictions to worksites without smoking restrictions. Only two studies dealt substantively with the effect of smoking restrictions on the decision of nonsmokers to take up smoking (smoking initiation rates). Most studies examined changes in smoking prevalence and the proportion of smokers who quit (quit rates). A few studies also provide data on the extent to which smokers change their consumption habits.

*Effect of Smoking Restrictions on Quit Rates*[12]

A review of recent studies of the impact of smoking policies on smoking behavior reveals a wide range of potential effects on quitting behavior, including some studies that show no effect at all. Some authors have offered an explanation of this phenomenon (Sorensen and Pechacek, 1989; Stillman. et al. 1990; Woodruff. et al. 1993). Increased quit rates and decreased rates of smoking prevalence that appear to follow the introduction of restrictive smoking policies may reflect the acceleration of quitting behavior around the time the policies are introduced. Since the quit rates are highest among those who otherwise planned to quit and have in the past attempted to quit, it is possible that smoking restrictions result in a rapid increase in quitting followed by a leveling off. Depending upon the time frame in which the changes in behavior are measured, one could observe a wide range of quit rates all reflecting the same basic phenomenon. For example, if behavior was measured just before and then again after the policy, but smokers had already adjusted their behavior in anticipation of the policy was initiated, their reaction would not be measured and changes in behavior would appear to be minimal. Likewise, if behavior was measured just before smokers adjusted their behavior and then soon after, a rather substantial effect would be observed. However, if sufficient follow-up studies were not conducted, one could not tell whether the higher quit rates that were measured were actually maintained over the long term. This analysis adopts this as a plausible explanation of the wide range of behavioral changes observed to date, and incorporates the following derivation of the effect of H.R. 3434 on quitting.

The first step in deriving the quit rate effect of smoking restrictions is to review quit rates reported following implementation of existing workplace smoking restrictions. Recent studies suggest gross quit rates range from 9% to 17% (Exhibit 6-1). These gross quit rates must be adjusted, however, to take account of several factors.

Second, some smokers who quit eventually renew their habit. Historical data suggest this relapse rate is approximately 50% (CDC 1993b). Therefore, to develop an estimate of the quit rate effect of national legislation, the gross workplace quit rate must be

[12] The term quit rate refers to the proportion of smokers who become former smokers in a given time period.

adjusted to net out historical average quit rates observed in the absence of smoking restrictions. Data suggest this rate is approximately 2.5% (CDC, 1993b). Therefore, to develop an estimate of the quit rate effect of comprehensive national legislation, the estimated gross workplace quit rate must be adjusted to take account of relapse. For the current analysis, the relapse rate is lowered to 30% to reflect the characteristics of comprehensive nation-wide restrictions. Specifically, the pervasiveness of nationwide restrictions is expected to reduce overall relapse rates and their implementation is expected to lead to substantial increases in stop-smoking support services and other support programs which would further lower the relapse rate, particularly among workers. Quit rates and relapse rates for smokers not subject to workplace restrictions, however, are assumed herein to remain at long term historical average levels.

Third, an adjustment must be made to account for portions of the adult smoking population who are retired or not employed. This analysis assumes that the smoking behavior of these individuals would not be affected by national legislation. Since approximately, 60% of the adult population is employed, the quit rates estimated for employed persons is reduced by about 40%.

Finally, an assumption must be made regarding the persistence of the effect of national legislation on decisions to quit. Plausible arguments can be made that nation-wide restrictions would have an on-going influence on decisions to quit and on the success of attempts to quit. However, consistent with the preceding discussion of quit rate persistence, the current analysis adopts the conservative assumption that national legislation would lead to only a "one-time" increase in net quit rates among the current population of smokers.

As shown in Exhibit 6-1, the estimated net quit rates resulting from the above approach ranges from 4% to 8% for employed individuals, and from 3% to 6% of the total current adult smoking population. This net quit rate includes those individuals who are retired or otherwise not employed.

*Effect of Smoking Restrictions on Initiation Rates*

Most persons who become regular smokers do so as teenagers or young adults. About 75% of adults who have ever been regular cigarette smokers report that they tried their first cigarette before the age of 18 and about half of them had become regular smokers by that time. Cigarette smoking among U.S. youth appears to have declined sharply in the late 1970s and stabilized in the 1980s (CDC, 1991).

Wasserman, et al. (1991) estimated that legislation that substantially restricts smoking in the workplace would reduce cigarette consumption by teenagers by 41%, and he reports that most of this would result from the effects of reduced initiation among nonsmoking teenagers. If this is interpreted to mean about three fourths of the effect is due to reduced initiation, the 41% reduction would translate into roughly a 31% reduction in initiation. Likewise (Woodruff. et al. 1993), when comparing worksites having a few smoking restrictions with those having a smoking ban. reported a 43% difference (37% versus 21%) in the proportion of occasional smokers who become regular smokers.

EPA believes that these studies are not adequate to support the inclusion of a substantial reduction of initiation rates in this analysis. Consistent with the conservative approach to estimating the effect of smoking restrictions on smoking behavior, this analysis assumes that smoking restrictions comparable to H.R. 3434 would reduce initiation rates by only between 5% and 10%. However, unlike the temporary increase in quit rates which would have an immediate impact on smoking prevalence, the effect of reduced initiation would be to gradually reduce the size of the smoking population, and would take more than a generation to reach the majority of its impact. Nevertheless, those who fail to initiate smoking remain nonsmokers, rather than former smokers, so that the health impact of reduced initiation is greater.

*Effect of Smoking Restrictions on Cigarette Consumption*

With respect to reductions in consumption by smokers who continue to smoke after national legislation is enacted, this analysis relies on recent studies that estimate that workplace restrictions reduce consumption by 18% to 34% (Exhibit 6-1). These estimates are of reduced consumption by smokers who continue to smoke and do not reflect double-counting of reductions in aggregate consumption by smokers who quit. Consistent with the assumption that only the smoking behavior of employed persons would be affected by national legislation, this analysis estimates that the effect of national legislation would be to reduce consumption rates of smokers by about 10% to 15%.

*Net Effect of Smoking Restrictions*

Based on the assumptions of a one time increase in quit rates and of a reduction in the relapse rate for those who quit, this analysis projects a 3% to 6% decrease in the number of smokers, and a corresponding increase in the number of former smokers. This effect will influence health and death incidence rates, but they will be less than if this were a reduction in the number of persons who had ever smoked. The smokers who remain will be less able to quit, and it is assumed that quit rates and relapse rates for those who remain smokers will be no different than historic levels. However, smokers who continue to smoke will reduce their consumption of cigarettes by approximately 10% to 15%. If initiation rates were not affected, the population of smokers would gradually increase to the level they would be without the passage of smoking restriction legislation. However, the reduction in initiation rates will gradually reduce the population of smokers by about 5% to 10%, resulting in a corresponding increase in the number of those who never smoke.

*Health Effects of Smoking Restrictions on Smokers*

The reductions in smoking-related premature deaths result from the elevation of quit rates, and reductions in consumption and initiation. The effect on premature death rates depends on the disease, the age of the smoker, and the length of time this change of behavior has been in effect. While a completely rigorous treatment of these effects is beyond the scope of this assessment, simplified assumptions were used to account for these effects and the varying time stream in which these effects occur.

The influence of changing of quit rates on the number of annual deaths due to smoking is calculated in Exhibit 6-2 and Exhibit 6-3. The reductions in mortality ratio for smokers who quit rise with years of abstinence and are provided in DHHS 1990. From this, the percent reduction in mortality ratio (PRMR) for each ten year increment in the time of abstinence is calculated, as presented in Exhibit 6-2. The number of deaths due to smoking for each age group of the population is estimated using data from OTA (1985) and OTA (1993). This is used as a baseline, and the age distribution and the calculated death rates are assumed to remain constant over time in the absence of smoking restrictions. Given the PRMR, the proportion of smokers who quit, and the age of the smoking population, a time stream of premature deaths avoided from quitting is calculated (Exhibit 6-3). This analysis shows that in a society with no smoking restrictions, quitting due to the imposition of smoking restrictions would result in avoiding an annual average of between 5,000 and 11,000 premature deaths per year in the first 50 years. *((See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)* Beyond 50 years, however, the cohort of quitters would have succumbed to death from old age or other causes, resulting in no further effects.

We assume that all persons who initiate smoking are under the age of 35. We use this assumption to calculate the reduction in smoking prevalence over time, given our estimate of reduced initiation. Premature deaths avoided are assumed to be proportional to smoking prevalence in each age group. From this, we calculate the time stream of premature deaths avoided from reduced initiation (Exhibit 6-4). We estimate that, in a society with no smoking restrictions, reduced initiation from smoking legislation would result in an average decrease in premature deaths of between 4,000 and 8,000 per year in the first 50 years, approximately 18,000 per year between the 50th and 60th year, and approximately 20,000 every year thereafter. *((See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)*

Based on the data presented in DHHS (1989), and DHHS (1990), the mortality ratio for lung cancer appears to be approximately proportional to the number of cigarettes smoked. This proportional relationship is representative of other diseases also, and it is further assumed that the PRMR with years since the time of reduction follows the same pattern as that calculated for quitting (Exhibit 6-2). Using these assumptions, the PRMR for reduced consumption and the corresponding premature deaths avoided due to reduced consumption are calculated in Exhibit 6-5. Relative to a society with no smoking restrictions, reduced consumption from smoking legislation would be estimated to result in an annual average decrease in premature deaths of between 26,000 and 51,000 per year in the first 50 years, and approximately 40,000 every year thereafter. *((See Exhibit S-2 for estimates related to H.R. 3434 under current baseline conditions.)*

**Life Expectancies and Life Years Recovered from Smoking Restrictions**

Premature deaths of young or middle aged persons may be regarded differently than premature deaths of persons in their late 60s. Therefore, an important dimension of the effects of smoking restrictions is an assessment of the life years restored as a result of avoiding premature deaths.

In Exhibit 6-6 survival probabilities and probabilities of death are estimated for persons who have ever smoked and persons who have never smoked using data provided by Hodgson (1992), and using the age distribution of smokers and former smokers. The years lost by premature death to the age of 65 and to life expectancy are then calculated as shown in Exhibit 6-7.

In Exhibit 6-8, the life years extended to age 65 and to life expectancy are estimated and reported by type of smoking behavior impact. Accordingly, it is estimated that those who the average yearly expenditure for medical services for smokers and former smokers exceeds that of nonsmokers. However, this is partially offset by the fact that nonsmokers live longer, and continue to consume medical services during the extra years of life. When both of these factors are taken into account, the result is a net excess burden on the medical service industry of about $35 billion per year due to smoking.[13] Implementing smoking restrictive legislation would reduce this excess burden on the medical service industry by reducing the number of smokers and former smokers. Assuming that medical expenditures are proportional to smoking-related premature deaths, every reduction in annual premature deaths avoided by virtue of some smokers quitting, cutting back, or failing to initiate smoking, would represent a reduction of $85,000 per year for medical services.

### Net Effect of Smoking Restrictions on Premature Deaths and Medical Expenses

The results of this analysis suggest that smoking restrictions, relative to a society with no restrictions, would result in significant reductions in premature deaths per year from persons quitting, cutting back, or declining to initiate smoking. These reductions would both extend lives of those affected by 4 to 8 years for those who quit or reduce consumption, or by 15 years for those who decline to smoke. When future values are discounted by 3%, it is estimated that for a society with no current restrictions, this would result in a reduction of approximately $3 billion to $4 billion in expenditures for medical services per year. Comparable reductions related to implementation of H.R. 3434 would be about 77% of these values or $2.3 billion to $4.7 billion in reduced medical expenditures per year. (See summary of costs and benefits of H.R. 3434 below.).

## Value of Benefits or Losses Regarding Smokers

This analysis assumes that, faced with restrictions on where they may smoke, some current smokers would quit and some would reduce overall consumption. In addition, these restrictions would also tend to discourage many nonsmokers, such as teenagers, from becoming smokers.

These changes in behavior would result in significant improvements to the health of smokers themselves, extension of their life expectancy due to the avoidance of

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[13] This is estimated from information provided by Hodgson (1992) who compares excess medical costs over the lifetime of ever smokers and never smokers. Similar data and procedures were also used by Manning et al. (1991).

premature death, and reductions in medical expenses during their lifetime, as well as other benefits such as increased safety and reduced property damage from smoking-related fires.

Clearly, these health benefits to smokers are highly significant. However, there remain 46 million smokers who purchase approximately 25 billion packs of cigarettes annually, and about 1 million persons become regular smokers each year. Since smokers do this despite the risks and costs, one would presume that, provided these persons are rational, fully knowledgeable, and are able to accurately assess the consequences of smoking, including potential addiction, the benefits of smoking to them outweigh the risks and costs. However, for a number of reasons, this study does not attempt to estimate the economic value of the benefits or losses regarding smokers.

First, EPA is concerned that the economic measures traditionally applied to the health consequences of pollution may not be appropriate to use in estimating the social value of physical effects of smoking that occur to smokers themselves. Exposure to pollution, such as ETS, is essentially involuntary and uncompensated. Addiction arguments aside, smoking is a voluntary activity that results in other consequences for smokers, some positive and some negative. These other consequences are not reflected in measures of value for health risk reductions sometimes used by EPA. Applying traditional health risk valuation factors to health consequences for smokers would therefore inappropriately omit the value of all these other costs and benefits to smokers, resulting in potentially biased measures of the value change to society.

Second, analysts disagree whether the traditional economic models one might use to measure the welfare change to smokers can be reasonably applied, particularly given limits on available data. To obtain reasonable estimates of the change in net benefits to smokers, these traditional models require that the subjects, smokers in this case, are acting rationally in response to a free and open marketplace. Furthermore, these consumption decisions must either be devoid of significant price distortions such as taxes and subsidies, or analytical corrections must be made to take account of these distortions. With respect to the rationality requirement, questions have been raised whether the rational consumer choice model applies given the apparent addictive nature of smoking.[14] Questions have also been raised whether the consequences of taxes (e.g., cigarette tax) and subsidies (e.g., tobacco farm subsidies, subsidized health care) significantly distort consumer decision making in this case.

Third, EPA is concerned that currently available data are insufficient to support using a traditional economic model to estimate the change in net benefit to smokers caused by H.R. 3434. The reason for this is H.R. 3434 does not prohibit smoking outright, nor does it change the purchase price or quantity of cigarettes available. Instead, H.R. 3434 only compels changes in the location and/or time pattern of cigarette consumption. This would

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[14] Note, however, that some analysts subscribe to models of "rational addiction" which have been developed and empirically tested (Becker and Murphy,1988); (Chaloupka,1991). However, these models do not take account of those who underestimate the strength of the addiction or who, for whatever reason fail to appreciate the magnitude of the adverse consequences. Nor do they appropriately confront the difficult question of the social consequences from teenage smoking. These models demonstrate that teenagers tend to disregard the future consequences of smoking more so than adults (Chaloupka, 1991).

be expressed in economic terms as an increase in the transaction cost of smoking, and the transaction cost would vary widely among smokers. Since it is unclear how the slope of the demand curve for cigarettes might shift in response to a nonuniform increase in transaction costs to smokers, a reliable measure of the change in net benefits to smokers cannot be derived.

Based on the foregoing, this study makes no attempt at this time to express the health consequences of H.R. 3434 to smokers themselves in social value terms.

**Summary of Costs and Benefits With Reference To A Society With No Smoking Restrictions**

This completes the assessment of smoking restrictions using our analytic baseline of a society with no restrictions. The results of this analysis are summarized in Exhibit S-1, and may be interpreted as the costs and benefits of smoking restrictions in a society where no such restrictions exist. This summary analysis forms the basis for estimating the effects that H.R. 3434 would have on current society, which is the subject of the remaining portion of this report.

# Cost and Benefits of H.R. 3434
# Based on Current Conditions

S-1 summarizes the costs and benefits of smoking restrictions that would occur on a society with no current smoking restrictions. However, to assess the impact of H.R. 3434, the level at which current restrictions already exist must first be assessed.

**Baseline Estimate of Compliance**

***Establishments with Existing Smoking Policies.*** Many establishments already have some form of smoking policy. The National Survey of Worksite Health Promotion Activities collected information on worksite smoking policies. In 1992, 59% of worksites covering more than 50 employees had a formal smoking policy that either banned smoking, or restricted smoking to separately ventilated areas (DHHS, 1992). This represents a substantial increase since 1985 when only 27% of the worksites reported such policies. Exhibit 7-1 provides data from the 1992 survey (DHHS, 1992). In general, larger worksites were more likely to have such policies than smaller worksites. The 1992 survey covered a wide variety of establishments in the following categories: manufacturing; wholesale and retail; services; transportation, communications, and utilities; finance, insurance, and real estate; and agriculture, mining, and construction establishments.

The Bureau of National Affairs and the Society for Human Resource Management have conducted surveys since 1985 of members of the American Society for Personnel Administration concerning workplace smoking policies. Organizations spanned a wide range of manufacturing and commercial enterprises (BNA, 1986). In 1991, 85% of responding firms had smoking policies designed to address employee health and comfort, up from 5% in 1987 and 36% in 1986. Total bans on smoking existed in 34% of the firms, compared with 7% in 1987 and just 2% in 1986 (BNA, 1991).

Many state and local laws require some form of smoking restriction in different indoor environments, but for the most part, these are not very restrictive. Exhibit 7-2 summarizes 1993 data (unpublished) from the Centers for Disease Control, Office of Smoking and Health on the types of state laws restricting smoking. At the time the data were collected, no states had laws banning smoking in public places or restricting smoking to separately ventilated areas. Since that time, Vermont has passed such a law, and similar laws exist in some local jurisdictions. However, requirements for designated smoking areas (not separately ventilated) in public places exist in 40 of the 53 states and territories, and 31 states or territories have similar restrictions for restaurants.

It is clear from the above that not all entities subject to H.R. 3434 would suffer the full cost burden of compliance. Those that already comply would suffer no burden, and others that partially comply may suffer only a partial burden. These issues are incorporated into the assessment method described below.

***Current Compliance Estimates.*** DHHS (1992) estimated that 59% of working establishments with 50 or more employees have restrictive smoking policies which either ban smoking or restrict it to separately ventilated areas. The BNA survey suggests that 34%

completely ban smoking. Data from these surveys show a clear trend toward the establishment of smoking policies in general, and total smoking bans in particular, among American business enterprises. However, the figures may overstate the proportion of building spaces actually covered by such policies. Coverage is inversely correlated with the size of firms (Exhibit 7-1). The DHHS survey did not include firms under 50 employees. While the BNA survey did not apparently exclude such firms, smaller firms are unlikely to have personnel administrators as those who were surveyed.

DOE (1991) provides data which suggests that 55% of employees in commercial establishments are in buildings with less than 50 employees. Given this, the proportion of employees currently covered by various smoking restrictions under various assumptions about the policies of small firms are estimated. The results are presented in Exhibit 7-3a. For example, there is widespread opinion among those involved in the smoking issue that only a portion of small firms have a formal smoking policy. Lewit (1993) showed that the compliance rate by small establishments (under 50 employees) to a New Jersey law was less than half the compliance rate for larger establishments. If one assumes that 10% of small establishments have smoking policies of the type reported in the DHHS survey, there would be 32% (vs. 59%) of all employees covered with restrictive smoking policies, and 21% (vs. 34%) would be under a smoking ban. The difference (11%) would have smoking allowed in separately ventilated areas. The results only slightly change with alternative assumptions about small firms.

This study therefore assumes that about 32% of employees are covered by restrictive smoking policies that either ban or restrict smoking to a separately ventilated area. This is composed of 21% which completely ban smoking, and 11% which allow smoking only in separately ventilated areas. It is generally believed that most of the survey responses which indicate separate ventilated smoking areas do not meet the stringent separate ventilation requirement of H.R. 3434 (see discussion in Section 2). Assuming that the 10% of employees with ventilated smoking areas is composed of one fifth (2%) with adequate ventilation, 23% (21% + 2%) of all establishments are estimated to already be in compliance with standards comparable to the requirements of H.R. 3434 (Exhibit 7-3a). Using the same distribution of employees covered by bans and lounges, we estimate that about 80% to 90% will be covered by a ban, and 10% to 20% by a lounge after H.R. 3434 is implemented (Exhibit 7-2b). However, as indicated in Section 1, a small portion of those under a smoking ban are likely to be serviced by some form of outdoor smoking shelter. The actual degree of compliance may well be less than this estimate because of the way in which respondents answer questions about their policies. For example, Rigotti (1992) reports that when assessing compliance with a local smoking ordinance in Brookline, MA, self-reported prevalence of smoking policies greatly exceeded that directly observed.

## Summary Comparison of Costs and Benefits Of H.R. 3434 Based on Current Conditions

Exhibit S-2 summarizes the estimated costs and benefits of implementing national legislation such as H.R. 3434, using a baseline estimate that 23 percent of the population is already subject to such restrictions. Current levels of cigarette consumption are also used to

assess costs and benefits under this baseline. The following sections provide additional detail of these results.

## Costs of Implementing Smoking Restrictions

### *Policy Implementation and Smoking Lounges*

The analysis shows that costs of implementing legislation such as H.R. 3434 appear to be quite low relative to the benefits that would be achieved. Establishments would experience costs of establishing a policy, communicating the policy to employees or clientele, posting signs, assuring compliance, and sometimes offering smoking cessation services. These activities would cost between $0.1 billion and $0.4 billion.

The main determinant of cost is the expenditure associated with the construction and maintenance of smoking lounges. Smoking lounges meeting the strict requirements of H.R. 3434 would have to meet stringent standards concerning ventilation and other provisions to insure that the air in the lounge does not enter other parts of the building. In addition, smoking policies involving smoking lounges are generally associated with greater complaints and with lower reported satisfaction than smoking bans, and smoking bans are becoming increasingly popular (Sorensen. et al. 1991; 1991a, 1992; Stillman. et al. 1991). Finally, the structural features of many existing buildings make it infeasible or cost prohibitive to construct a smoking lounge which would meet the requirements of H.R. 3434.. While the extent to which smoking lounges will be relied upon to comply with this legislation is uncertain, for the reasons mentioned above, this analysis estimates that only 10% to 20% of establishments would opt for smoking lounges.

The total cost of implementation by the public and private sector is estimated to be approximately $0.4 billion (10% smoking lounge) to $1.4 billion[15] (20% smoking lounge) per year.

### *Enforcement Costs*

Some expenditures by the Federal government and by state and local governments can be expected for information dissemination, though they may well be less than the value of current resources devoted to passing controversial state and local legislation.[16] Costs to building owners for insuring compliance in their building is included in the cost of implementing smoking policies. With respect to enforcement by governmental jurisdictions, H.R. 3434 provides no specific requirements for enforcement of its provisions, other than through citizens suits in federal court. Therefore, enforcement costs are difficult

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[15] Includes a higher cost per lounge.

[16] Even when smoking restrictions are passed at the state or local level, campaigns to nullify the legislation or to preempt local legislation with weaker state legislation can involve the expenditure of significant resources on both sides of the issue. No attempt was made to quantify current costs to state and local entities, though national legislation would be expected to reduce many of these costs. For an excellent analysis of this issue as it is manifested in California, see Macdonald and Glantz (1994).

to quantify. Based on an estimate in a proposed rule concerning the distribution of tobacco products to individuals under the age of 18, an estimate of between $0.1 billion and $0.4 billion per year appears plausible, and is used in this analysis as the cost of enforcement of legislation comparable to H. R. 3434 under current baseline conditions.

**Health Benefits from Reductions in Environmental Tobacco Smoke (ETS)**

*The Health Consequences of ETS*

A major component of the benefits which could be achieved from national legislation that restricts smoking in public places is from reduced exposure of building occupants to ETS.

Exhibit 2-1 presented information on the health consequences of ETS. For the purpose of valuing the benefits resulting from reduced exposure to ETS due to smoking restrictions, several conservative adjustments to these figures were made before making an assessment of the value of benefits resulting from reduced ETS exposure. The reduction in exposure resulting from smoking restrictions comparable to H.R. 3434 is estimated to result in an average reduction of 7,000 to 12,900 premature deaths per year over the first 50 years, and approximately 7,500 to 13,000 per year thereafter. The value of these reductions, when using a "willingness to pay" measure, and discounting future reductions at a rate of 3%, would range between $33 billion and $60 billion per year.

To this has been added benefits to be achieved from improved health, mostly to children, including reduced incidence of lower respiratory tract infections, ear infections, and asthma. These benefits are estimated at between $2 billion and $5 billion per year, most of which is associated with reduced asthma induction among children.. For asthma, this analysis reflects an estimated reduction of between 1,200 and 3,000 cases annually. To value the benefits from reduced asthma induction, we used a willingness to pay measure associated with chronic bronchitis, which is also a chronic respiratory disease.

The total benefit from reduced ETS exposure includes both the benefits of premature deaths avoided plus the benefits of reduced illness. The total benefits due to reduced ETS exposure is thus estimated to be $35 billion to $66 billion per year.

**Increased Comfort of Building Occupants:** This analysis assumes that, all else being equal, no building occupant would prefer being exposed to environmental tobacco smoke, and that most derive benefits from a smoke free environment. With the exception of the health, productivity, and safety effects discussed elsewhere, these benefits are largely intangible, and include such factors as reduced irritation and reduced environmental odor, and less annoyance with tobacco smoke residuals left on hair and clothing. In the present study, no attempt was made to quantify these benefits. However, because the overall results do not include the benefits of increased comfort, and because of the pervasive use of conservative assumptions in this analysis, it is expected that the estimate of total benefits from reduced ETS exposure is conservative.

**Savings in the Operation and Maintenance of Buildings**

Smoking in a building involves implicit operational and maintenance expenses. In addition to emptying and cleaning ashtrays, the smoke, ashes, and accidental burns on furniture and carpets create an additional housekeeping and general maintenance burden. For example, the BOMA reports that in a tightly monitored program, a member firm experienced a 15% reduction in housekeeping costs when a non-smoking policy was introduced. Maintenance costs were not covered in the monitoring program.

The actual savings in both housekeeping and maintenance expenses are expected to vary from building to building depending upon use (e.g., offices versus retail stores). A separate estimate was therefore developed for different uses. The cost saving estimates were then allocated just to the portions of those buildings for which they would apply.

Finally, it was recognized that the computed savings would not be realized in many buildings. Using survey data to indicate proportions of establishments that experience maintenance savings, the square feet to which savings would apply was decreased by about 40% in most cases.

Taking these factors into account, this analysis estimates that the savings in operating and maintenance costs would amount to about $4 billion to $8 billion per year.[17]

**Effects on Productivity**

***On-the-Job Productivity Improvements from Reduced ETS.*** It is generally agreed that ETS reduces the productivity of "individual" building occupants, and that clearly defined and fairly implemented smoking policies will increase "organizational" productivity by reducing potential conflicts between smokers and nonsmokers. While reduced ETS would likely have some positive impact on smoker productivity, the inability to smoke at their work station would likely have the opposite effect.

The ETS effect would *increase* productivity and apply to all employees. However, some smokers would work less effectively and some would spend more time going to and from an allowable smoking area. This may *decrease* productivity, but would apply only to smokers, and only to some proportion of the smoking population. Quantitative estimates of these effects could not be developed for this study.

**Benefits from Reduced Absenteeism**

After accounting for differences in socioeconomic characteristics between smokers and persons who have never smoked, smokers are estimated to have about 50% more

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[17] The housekeeping and maintenance cost savings, when compared to the cost of implementing smoking restrictions, including smoking lounges, suggest that some building owners may be induced to consider implementing smoking restrictions in order to increase profits, even in the absence of smoking restriction legislation.

workdays lost than persons who have never smoked, and former smokers are estimated to have about 30% more workdays lost than never smokers (Manning. et al. 1991).

Based on a review of recent studies, it is estimated that between 3% and 6% of current smokers would quit as a result of national legislation that restricts smoking. This would result in an immediate decrease in the number of smokers and an equivalent increase in former smokers. The initiation rate for new smokers is also estimated to decrease by 5% to 10%. This would ultimately result in an equivalent proportional reduction in the number of smokers , and an equivalent absolute increase in the number of persons who have never smoked. The average daily earnings including fringe benefits of smokers is about $104, and discounting all future effects by 3% yields an estimated savings of under $0.5 billion per year.

**Savings in Smoking-Related Fires**

Most smoking-related fire injuries and property losses are in residential environments, which would not be subject to smoking restrictions. As a result, the savings from smoking restrictions would be minimal, and is estimated to be approximately $0.5 to $0.7 billion per year. This estimate includes the effect of an estimated reduction in cigarette consumption at home because of quitting and reduced initiation.

**Social Benefits or Losses Regarding Smokers**

Smoking restrictions comparable to those in H.R. 3434 would be expected to result in some reduction in overall cigarette consumption. Faced with restrictions on where they may smoke, some current smokers may quit and some may reduce overall consumption. In addition, these restrictions would also tend to discourage many nonsmokers, mostly teenagers),[18] from becoming smokers.

These changes in behavior would result in significant improvements to the health of smokers themselves, as well as other benefits such as increased safety and reduced property damage from smoking-related fires. Based on the assumptions used in this analysis, EPA estimates changes in smoking behavior would result in an average of 27,000 to 54,000 fewer premature deaths per year among smokers during the first 50 years, and 47,000 to 92,000 fewer premature deaths per year thereafter.[19] On average, smokers who quit or cut back would add back an average of 5 to 9 years of life otherwise lost to smoking-

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[18] CDC (1991).

[19] The difference in death rates each year results from the different time patterns of the effects of quitting and cutting back on consumption, and because the analysis assumed that it would take 60 years reduced annual initiation to complete its effect on the size of the smoking population. Therefore, the 54,000 to 92,000 premature deaths reflect annual rates after 60 years for reduced initiation, In addition, this analysis assumed H.R. 3434 would have only a "one time" effect on decisions to quit, rather than an ongoing effect. Therefore, the H.R. 3434-related quitting eventually disappears as the cohort of smokers motivated to quit by H.R. 3434 dies from old age or other causes.

related premature death. For those nonsmokers who avoid becoming smokers, life is extended by an average of about 15 years.

Clearly, these health benefits to smokers are highly significant. However, for a number of reasons this study does not attempt to interpret the social value of these changes. First, the economic measures traditionally applied to the health consequences of pollution may not be appropriate to use in estimating the social value of physical effects of smoking which occur to smokers themselves. Exposure to pollution, such as ETS, is essentially involuntary and uncompensated. Addiction arguments aside, smoking is a voluntary activity which results in other consequences for smokers, some positive and some negative. These other consequences are not reflected in measures of value for health risk reductions sometimes used by EPA. Applying such health risk valuation factors to health consequences for smokers would therefore inappropriately omit the value of all these other costs and benefits to smokers, resulting in potentially biased measures of the welfare change to society.

Second, analysts disagree whether the traditional economic models one might use to measure the welfare change to smokers can be reasonably applied, particularly given limits on available data. To obtain reasonable estimates of the change in net benefits to smokers, these traditional models require that the subjects, smokers in this case, are acting rationally in response to a free and open marketplace. Furthermore, these consumption decisions must either be devoid of significant price distortions such as taxes and subsidies, or analytical corrections must be made to take account of these distortions. With respect to the rationality requirement, questions have been raised whether the rational consumer choice model applies given the apparent addictive nature of smoking.[20] Questions have also been raised whether the consequences of taxes (e.g., cigarette tax) and subsidies (e.g., tobacco farm subsidies, subsidized health care) significantly distort consumer decision making in this case.

Third, EPA is concerned that currently available data are insufficient to support using a traditional economic model to estimate the change in net benefit to smokers caused by H.R. 3434. The reason for this is that H.R. 3434 does not prohibit smoking outright, nor does it change the purchase price or quantity of cigarettes available. Instead, H.R. 3434 only compels changes in the location and/or time pattern of cigarette consumption. This would be expressed in economic terms as an increase in the transaction cost of smoking, and the transaction cost would vary widely among smokers. Since it is unclear how the slope of the demand curve for cigarettes might shift in response to a nonuniform increase in transaction costs to smokers, a reliable measure of the change in net benefits to smokers cannot be decided.

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[20] Note, however, that some analysts subscribe to models of "rational addiction" which have been developed and empirically tested (Becker and Murphy,1988); (Chaloupka,1991). However, these models do not take account of those who underestimate the strength of the addiction or who, for whatever reason fail to appreciate the magnitude of the adverse consequences. Nor do the models appropriately confront the difficult question of the social consequences from teenage smoking. These models demonstrate that teenagers tend to disregard the future consequences of smoking more so than adults (Chaloupka, 1991).

Based on the foregoing, this study makes no attempt at this time to express the health consequences of H.R. 3434 to smokers themselves in social value terms. Future versions of this analysis may make such an attempt if these analytical problems and data limitations are resolved.

## Comparing Costs and Benefits of H.R. 3434

Bearing in mind the limitations presented by the current analysis two principal findings emerge from this analysis. First, it is clear that, for those items quantified in this study, the benefits of smoking restrictions comparable to H.R. 3434 substantially outweigh the costs. Second, comparing the high estimate of costs with the low estimate of benefits does not change the fundamental conclusions that benefits significantly exceed costs.

It should be noted that no attempt was made in the current analysis to evaluate the costs and benefits of altering provisions of the legislation. Throughout this analysis, no exception in scope or timing of the provisions of H.R. 3434 were assumed. Clearly, changing provisions such as the scope or timing of the restrictions would affect both costs and benefits.

### Comparisons with Alternative Baselines

Given the rapid increase in public and private smoking restrictions in the last few years, and the downward trend in cigarette consumption, it is likely that the future will bring additional restrictions, and consumption may continue to fall without passage of H.R. 3434. Of course, the future is always uncertain, and tobacco consumption and smoking restrictions will be influenced in part by campaigns of tobacco and anti- smoking interests (Samuels and Glantz, 1991, Macdonald and Glantz, 1994).

Alternative scenarios were also constructed which varied the assumption about future baseline consumption of cigarettes. Similar to other major influences such as the national educational campaigns about smoking, national legislation restricting smoking in public buildings may contribute to continued downward trends in cigarette consumption. Alternatively, these downward trends may continue or level off regardless of the advent of such legislation. However, sensitivity analysis indicates that, as in the case of alternative public and private restriction policies, varying the assumed baseline trend in future cigarette consumption has no significant effect on the result that social benefits would be expected to exceed costs by a substantial margin.

Results using alternative baseline scenarios are summarized in Exhibit S-3. A graphic display is presented in the exhibit. The first scenario presents results under an assumption that there are no restrictions currently in place and that per capita consumption of cigarettes remains at current levels. This is the base scenario used to calculate benefits and costs of smoking restrictions. The second scenario differs from the first in that it assumes that 23% of the population is covered by policies which are comparable to those in H.R. 3434. This is the baseline used to assess the impact of H.R. 3434. The third scenario assumes that restrictive smoking policies will continue to be adopted in the public and

private sector without the passage of H.R. 3434, and that these will continue and achieve a level of 75% compliance with standards comparable to requirements of H.R. 3434 in 10 years and remain at that level thereafter. The fourth scenario combines an assumption of 23% existing coverage with an assumption that per capita cigarette consumption will continue to fall for ten years into the future at a 3% per year, and then remain constant after that. The last scenario is the same as the fourth except that per capita cigarette consumption is assumed to fall for 20 years before it levels off.

Under all of the alternative scenarios presented in this analysis, assumptions about the pervasiveness of future restrictions in the absence of H.R. 3434 have virtually no effect on the findings that, for the items quantified in this study, the social benefits would exceed the costs.

A 3% discount rate is used for all scenarios. While the absolute level of estimated costs and benefits are different under each scenario, our qualitative conclusions remain unchanged.

## Other Economic Considerations

The estimates of costs and benefits covered in this analysis are a subset of potential economic consequences that policy makers may wish to consider.

**Restoration of Lost Income:** Implementing smoking restrictive legislation nationally would result in the restoration of approximately $31,000[21] for each pre-retirement year of premature death which is avoided because of smokers who quit, cut back, or fail to become smokers because of H.R. 3434. On average, we estimate that each premature death avoided because of quitting and reduced consumption would add approximately 1.4 to 4 salary earning years, and each premature death avoided from persons who refrain from becoming smokers would add approximately 11 salary earning years of life.[22] When future values are discounted at 3%, this analysis estimates that between $3 billion and $6 billion of lost income would be restored. A similar estimate was not possible for persons exposed to ETS, though this effect should be considered. The importance of this impact is enhanced to the extent that some children, spouses, the elderly or disabled may be dependent on such income.

**Reduced Burden on the Medical Service Industry:** Every year, the average expenditure for medical services for smokers and former smokers exceeds that of nonsmokers. However, this is partially offset by the fact that nonsmokers live longer, and continue to consume medical services during the extra years of life. When both of these factors are taken into account, the result is a net excess burden on the medical service

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[21] The estimated annual earnings of smokers is inflated by 20% to account for earnings after the age of 65, based on OTA (1993).

[22] Salary earning years are assumed to be years prior to the age of 65.

industry of about $35 billion per year due to smoking.[23] Assuming that changes in the excess medical expenditures due to smoking restrictions would be proportional to changes in smoking-related premature deaths, this analysis estimates that every reduction in annual premature death would represent an annual reduction of $85,000 for medical services. Accordingly, when future savings are discounted at 3%, H.R. 3434 would reduce annual expenditures for medical services by $2.3 billion to $4.7 billion per year. It is not clear from our analysis what net impact reduced exposure to ETS would have on the medical service industry.

**Potential Cost to Social Security and other Pension Funds:** Persons who would otherwise have died prematurely would live longer under smoking restrictions and collect pensions and social security during those extended years. Each premature death avoided for smokers who quit, cut back, or fail to initiate smoking represents an extension of life of about 5 to 7 years beyond the age of 65, during which time they would be eligible to collect a pension annuity. Data are not currently available to support a similar estimate for ETS exposed individuals.

**Reduced Revenues from Cigarette Sales and Excise Taxes:** Implementation of national legislation to restrict smoking in public buildings would reduce overall cigarette consumption by approximately 11% to 17%, and this impact would occur within the first few years of implementation. This would result in a corresponding reduction in cigarette tax revenues.[24] However, these could be offset, to some extent, by the social benefits of alternative agricultural production or other taxable uses of farmland.

**Employment Dislocations:** Reductions in demand for cigarettes and medical services would involve some temporary dislocations of persons employed in these industries.

## Conclusions

Given data limitations, and the uncertainties inherent in cost-benefit analysis of public health and environmental policies, this analysis does not purport to provide definitive conclusions about the overall merits of national smoking restriction legislation. Nevertheless, while recognizing that several effects of H.R. 3434 including effects on productivity, comfort from reduced exposure to ETS and the net losses or gains regarding smokers, were not quantified, this analysis demonstrates that, for those items that were quantified, the estimated benefits of H.R. 3434 exceed the estimated costs by a substantial

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[23] This is estimated from information provided by Hodgson (1992) who compares excess medical costs over the lifetime of persons who have ever smoked, and persons who have never smoked. Similar data and procedures were also used by Manning. et al. (1991).

[24] For an excellent comparison of what smokers pay in excise taxes, medical expenditures, and contribution to retirement funds, relative to the value of the services they receive for those payments, see Manning. et al. (1991). However, the net monetary payments made by or to smokers is not a useful index for measuring the overall social benefits or costs of smoking restrictions. As previously described, willingness to pay measures are more appropriate. Also, our costs and benefits do not count transfers of costs or benefits from one group in society to others.

amount. This analysis suggests that the net effect of these excluded items would have to represent a loss exceed $39 billion to $72 billion per year for costs to exceed benefits.

As suggested in Exhibit S-4, the overall findings of substantial net benefits are not altered by comparing high costs to low benefits, or by alternative discount rates. Furthermore, while the magnitude of the net benefits specifically allocated to H. R. 3434 is dependent on one's assumptions about baseline conditions, these assumptions go more to the question of whether or not to capture these net benefits through national legislation or by other public and/or private initiatives.

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## Exhibit 1-1: Policy Development and Implementation Costs (1000 Employees)

**Base=No Restrictions**

| | | Units | Cost/Unit [1] | Number of Units Low | Number of Units High | Cost Low ($) | Cost High ($) |
|---|---|---|---|---|---|---|---|
| **Initial Cost** | | | | | | | |
| | **Policy Development** | | | | | | |
| | Managerial Personnel | hours | 20.00 | 5 | 10 | 100 | 200 |
| | Legal Personnel | hours | 21.00 | 2 | 8 | 42 | 168 |
| | Administrative Personnel | hours | 12.00 | 15 | 25 | 180 | 300 |
| | Total [2] | | | | | 322 | 668 |
| | **Policy Distribution** | | | | | | |
| | Printing | pages | 0.05 | 1,000 | 2,000 | 50 | 100 |
| | Administrative Personnel | hours | 12.00 | 4 | 8 | 48 | 96 |
| | Total | | | | | 98 | 196 |
| | **Policy Implementation** | | | | | | |
| | No Smoking Signs [3] | signs | 25.00 | 20 | 30 | 500 | 750 |
| | Maintenance Personnel | hours | 16.00 | 4 | 6 | 64 | 96 |
| | Total | | | | | 564 | 846 |
| | Outdoor Receptacles [4] | receptacle | 130.00 | 5 | 10 | 650 | 1,300 |
| | Maintenance Personnel | hours | 16.00 | 3 | 6 | 40 | 96 |
| | Total | | | | | 690 | 1,396 |
| | Smoking Cessation [5] | participants | 75.00 | 38 | 50 | 2,813 | 3,750 |
| | **Total Initial Cost** | | | | | 4,487 | 6,856 |
| **Annual Cost** | | | | | | | |
| | **Policy Maintenance** | | | | | | |
| | Compliance | | | | | | |
| | Managerial | hours | 20 | 10 | 30 | 200 | 600 |
| | Administrative | hours | 12 | 15 | 100 | 180 | 1,200 |
| | Other | | | | | | |
| | Managerial | | 20 | 3 | 6 | 60 | 120 |
| | Other | hours | 12 | 5 | 10 | 60 | 120 |
| | Maintenance Personnel | hours | 16 | 3 | 6 | 52 | 96 |
| | **Total Annual Cost** | | | | | 552 | 2,136 |

1. Unit labor costs are approximated using BLS Median Weekly Earnings inflated by 24% to account for *fringe benefits*. Maintenance labor hours are estimated *using Means Building Cost Data and the Engineered Performance Standards, Janitorial Handbook.*
2. Five responses to limited survey suggest a cost range of $50 to $200, median = $100. Size of firms in whole survey ranged from 30 *to 1800 employees:* median =240 and mean = 512 *(Lewit, 1994).*
3. No smoking signs in Grainger,1992 are $10.00. The $25 figure is from Lewit, 1994, who also suggests a median cost of about $300 based on company responses.
4. The cost of outdoor recepticals is from Grainger 1992. However, Lewit (1994) suggests that outdoor recepticals at entrances cost $25 each, with total costs for firms ranging from $25 to $1200.
5. Assumes 25% of employees are smokers, and that 10% (low) and 20% (high) will participate in such programs directly as a result of instituting smoking restrictions, but that this will be a one time increase in participation.

## Exhibit 1-2: Cost of Implementing Smoking Bans

Base=No Restrictions

| | | Cost per 1000 Emp. | Employees (millions) | Total Cost (million) | Recurrent Portion | Amortized Portion [1] | Total Annual |
|---|---|---|---|---|---|---|---|
| **Low Estimate** | | | | | | | |
| | Initial Cost | $4,487 | 110 | 494 | 74 | 25 | 99 |
| | Annual Policy Maintenance | $552 | 110 | 61 | | | 61 |
| | Total | | | | | | 159 |
| **High Estimate** | | | | | | | |
| | Initial Cost | $6,856 | 110 | 754 | 113 | 38 | 151 |
| | Policy Maintenance | $2,136 | 110 | 235 | | | 235 |
| | 10% with Outdoor Shelter | | | | | | 69 |
| | Total | | | | | | 455 |

1. Annualized capital cost without time limit is equivalent to borrowing funds and paying the interest every year, but not the principal. For convenience, a single discount (interest) rate of 5% is used for these calculations.
2. Figure is for 5% discount (interest) rate (see Exhibit 1-4)

## Exhibit 1-2a: National Cost of Indoor Lounges

Base=No Restrictions

| | Total Annual Cost | | | | | |
|---|---|---|---|---|---|---|
| | 3% | | 5% | | 7% | |
| | Low Estimate ($ million) | High Estimate ($ million) | Low Estimate ($ million) | High Estimate ($ million) | Low Estimate ($ million) | High Estimate ($ million) |
| All with Lounges | 3,509 | 4,562 | 3575 | 4,648 | 3641 | 4733 |
| 10% w Lounges | 351 | | 358 | | 364 | |
| 20% w Lounges | | 912 | | 930 | | 947 |

## Exhibit 1-3: Smoking Lounge Design (100 smokers)

| | Average | Peak | Square Feet Per Lounge Occup. |
|---|---|---|---|
| Lounge Density (ASHRAE, 1989) | | | 200 |
| Smokers Served by Lounge | 100 Smokers | | |
| Time Frame | 2 hours | | |
| Smokers per Hour | 50 smokers | | |
| Break time per smoker | 12 minutes | | |
| Expected Lounge Occupancy | 10 smokers | 15 smokers | |
| Construction Requirements per Smoking Occupant Served | | | 2 |

## Exhibit 1-4: Cost of Building Smoking Lounges

**Base=No Restrictions**

| | Persons (million) | Square Feet per Occupant | Initial Cost per Square Foot | Total Cost ($ million) | Recurrent Portion (20%) | Amortized Portion | Annualized Initial cost ($ million) | Annual Costs: Cost per Sq. Ft. | Annual Costs: Annual Cost ($ million) | Total Annual Cost: Low Estimate ($ million) | Total Annual Cost: High Est. [1] ($ million) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Smokers | 46 | | | | | | | | | | |
| Smoking Occupants | 55 | | | | | | | | | | |
| Occupants serviced | 55 | | | | | | | | | | |
| Indoor Lounges | | | | | | | | | | | |
| 3% Discount | 55 | 2 | 30 | 3300 | 660 | 99 | 759 | 25 | 2750 | 3509 | 4562 |
| 5% Discount | | | | | | 165 | 825 | | | 3575 | 4648 |
| 7% Discount | | | | | | 231 | 891 | | | 3641 | 4733 |
| Outdoor Lounges | | | | | | | | | | | |
| 3% Discount | 5.50 | 2 | 25 | 275 | 55 | 8 | 63 | | | 63 | 127 |
| 5% Discount | | | | | | 14 | 69 | | | 69 | 138 |
| 7% Discount | | | | | | 19 | 74 | | | 74 | 149 |

1. High estimate is 30% higher than low estimate (see text) for indoor lounges, and 100% higher for outdoor lounges based on Lewit (1994).

## Exhibit 1-5: Total National Implementation (with Smoking Lounge) and Enforcement Costs

**Base=No Restrictions**

| | 3% | | | 5% | | | 7% | |
|---|---|---|---|---|---|---|---|---|
| | Low Estimate | High Estimate | | Low Estimate | High Estimate | | Low Estimate | High Estimate |
| Implementation (with Smoking Lounge) | 510 | 1,367 | | 517 | 1,384 | | 524 | 1,401 |
| Enforcement | 100 | 500 | | 100 | 500 | | 100 | 500 |
| Total | 610 | 1,867 | | 617 | 1,884 | | 624 | 1,901 |

**Exhibit 2-1a: Estimates of U.S. Nonsmoker Annual Mortality Associated With Exposure to Other People's Smoke**

| MORTALITY | U.S. EPA[1,a] | CENTERS FOR DISEASE CONTROL[2] | OTHERS | COMMENTS |
|---|---|---|---|---|
| Lung Cancer (ICD 162-163) | 3,000 Total | 3,800[3] | 12[4], 240 to 2000[5] | ETS a Group A carcinogen. ETS concentrations similar in smoking homes and offices. Generally higher in restaurants. |
| Home ETS sources | 800 | -- | 300[6], 3000[7], 5000[8] | |
| Other ETS sources | 2,200 | -- | 4000[9] | |
| Other Cancers | b | | 11,000-12,000[7,10] | Limited evidence for cancers other than lung |
| Heart Disease (410-414) | | | 32,000-40,000[7,10,11] | Evidence continues to mount on ETS and heart disease |
| Burn Deaths | | 1,300[12] | 1200[13], 150[13b] | Due to fires initiated by smoking materials |
| Spontaneous Abortions | | | 145,000[14] | |
| Sudden Infant Death Syndrome | c | 700 | 1,900[14] | |
| Respiratory Conditions, newborn (769-760) | | 2,000 | 4,400[14,d] | Estimates are based on maternal smoking |
| Short Gestation, Low Birthweight (765) | | 900 | 4,400[14,d] | |

[a]EPA[1] evaluated only the respiratory hazards of ETS; also, was the only source to breakdown home vs. nonhome risks.
[b]Deaths to children under age 18.
[c]EPA[1] concluded that maternal smoking is a strong risk factor for SIDS. ETS exposure to the newborn is also considered to be a risk factor for SIDS.
[d]Defined by DiFranza as perinatal deaths, which includes stillborns.

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**Exhibit 2-1b: Estimates of ETS-Attributable Morbidity in Children Due to Home and Nonhome Sources**

| MORBIDITY[a] | HOME | | NONHOME |
|---|---|---|---|
| | U.S. EPA[1] | DiFranza[14] | |
| Low Birth Weight (≤2500g) | | 59,000[b] | |
| Admission to Neonatal Intensive Care Units | | 25,000[b,c] | |
| Operations on Tonsils or Adenoids | | 27,000[d] | 30,000[e] |
| Tympanotomy Operations | | 139,000 | 160,000[e] |
| Episodes of Otitis Media | | 2,366,000 | 2,900,000[e] |
| Asthma Exacerbation | 300,000 - 700,000 | 536,000[f] | 100,000 - 300,000[g] |
| Asthma Induction | 12,000 - 40,000[h] | | 1,000 - 5,000[g,h] |
| Physician Visits for Cough | | 2,176,000[d] | 3,400,000[e] |
| Lower Respiratory Tract Infections (Pneumonia, Bronchitis, Bronchiolitis) | 135,000 - 270,000[i] | 885,000 - 1,138,000[i] | 15,000 - 30,000[g,i] |
| Fire-Related Injuries | | 359[k] | |

[a]Age < 18 years, unless noted otherwise
[b]From maternal smoking during pregnancy
[c]DiFranza provides cost estimates of 302 m - 773 m $
[d]Age < 15 years
[e]As estimated by U.S. EPA based on results from DiFranza[14]
[f]Physician visits
[g]As estimated by U.S. EPA based on results from U.S. EPA[1]
[h]Nonthreshold model, Z=10
[i]Under 18 months of age only
[j]Bronchitis in children under 16 years plus pneumonia in children under 5 years
[k]From all sources of smoking materials

Exhibit 2-1c: *Recent studies of heart disease among ETS exposed persons who never smoked

| Study | Design | Exposure definition | Relative risk | Comment |
|---|---|---|---|---|
| [illegible]te of Gillis et al. [1984] by Hole et al. [1989]† | 12-yr followup, 3,960 men and 4,037 women aged 45-64 in 1972-76 | Living with smoker or ex-smoker in early 1970s | 2.01 (CI, 1.21-3.35; 485 observed) | Adjusted for cardiovascular risk factors,§ positive dose response |
| Humble et al. [1990] | 20-yr followup, 513 women aged 40+ | Living with smoker in 1960 | 1.59 (CI, 0.99-2.57) | Adjusted for cardiovascular risk factors, dose response in some strata |
| Helsing et al. [1988] | 12-yr followup, 4,162 men and 14,873 women, aged 25+ in 1963 | Living with smoker or ex-smoker in 1963 | Men: 1.31 (CI, 1. 1-1.6; 492 observed) Women: 1.24 (CI, 1.1-1.4; 1,539 observed) | Adjusted for education, positive dose response among women only |
| Svendsen et al. [1985, 1987] ** | 7-yr average followup, 1245 men aged 35-57 in 1973-82 | Married to smoker or ex-smoker | 1.61 (CI, 0.96-2.71; 90 observed) | Adjusted for cardiovascular risk factors, positive dose response |
| Garland et al. [1985] | 10-yr followup, 695 women aged 50-79 in 1972-74 | Married to smoker or ex-smoker | 2.9 (estimate; 19 observed) | Adjusted for age |
| Hirayama [1984] | 16-yr followup, 91,540 women aged 40+ | Married to smoker or ex-smoker 0.91- 1.33) High exposure: 1.31 (90% CI, 1.06-1.93; 494 observed) | Low exposure: 1.10 (90% CI, | Significant dose response |
| Lee et al. [1986] | 48 cases, 182 controls | Married to smoker or ex-smoker | Men: 1.24 Women: 0:93 | No apparent dose response |

* Confidence interval is 95% unless otherwise indicated.
† Hole et al. [1989] provide updated results of the same population studied by Gillis et al. [1984].
§ Serum cholesterol, blood pressure, and body mass index.
** Svendsen et al. [1987] is the full report of the abstract published by Svendsen et al. [1985].

As referenced in: NIOSH: Current Intelligence Bulletin 54. June 1991.

## Exhibit 2-2: Proportional Reduction in Mortality Ratio (PRMR) By Years Since ETS Exposure

| | MR | PRMR | | | |
|---|---|---|---|---|---|
| Years Quit: | Cancer | Cancer | Heart Disease | Overall | |
| <1 | 22.40 | | | | |
| 1 to 4 | 18.80 | 16% | 66% | 59% | |
| 5 to 9 | 7.70 | 66% | 79% | 77% | |
| 1 to 10 | | | | | 68% |
| 10 to 14 | 4.70 | 79% | 91% | 89% | |
| 15 to 19 | 4.80 | 79% | 91% | 89% | |
| 10 to 20 | | | | | 89% |
| 21+ | 2.10 | 91% | 100% | 99% | 100% |

1. Cancer mortality ratio for male smokers (DHHS 1989).
2. Heart disease mortality ratio assumed to decline twice as fast as the cancer mortality ratio.
3. Average of cancer and heart disease weighted by the average proportion of cancer and heart disease deaths between high and low estimates.

## Exhibit 2-3: Percent Reduction Smoking Population and in Total Consumption due to Smoking Restrictions
## Reductions From Quitting, Reduced Initiation, and a Reduced Consumption Rate of Smokers

***Base=No Restrictions***

| | Quitting & Reduced Initiation [1] | Reduced Cons. Rate [2] | Total Reduced Consumption (50 yr av) |
|---|---|---|---|
| Annual Average Reduction: | | | |
| Low Estimate | 4.24% | 9.58% | 13.81% |
| High Estimate | 8.48% | 13.73% | 22.20% |

1. Proportional reductions in consumption due to quitting and reduced initition is assumed to be equivalent to the reductions in smokers due to quitting and reduced initiation.. Since the population changes are relatively constant over time from these combined effects, the results would not be affected greatly by alternative discount rates. Therefore, for convenience, an arithmetic annual average over all time periods is used for the annual equivalent reduction over all discount rates.
2. This is the proportional reduction in cigarette consumption due to the reduced consumption rate of the smoking population remaining after quitting and reduced initiation is taken into account.

## Exhibit 2-4: Premature Deaths Avoided from Reduced Exposure to Environmental Tobacco Smoke

**Base=No Restrictions**

| | Annual ETS Related Deaths | | | | 50 Year Total Premature Deaths Avoided Estimates | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low Estimate | | High Estimate | | Low Estimate | | | High Estimate | | |
| | Home | NonHome | Home | NonHome | Home | NonHome | Total | Home | NonHome | Total |
| Major Illnesses | | | | | | | | | | |
| Heart Disease Deaths [1] | 3,240 | 8,760 | 6,480 | 17,520 | | | | | | |
| Cancer Deaths [2] | 800 | 2,200 | 800 | 2,200 | | | | | | |
| Total | 4,040 | 10,960 | 7,280 | 19,720 | 7,818 | 450,430 | 458,248 | 26,176 | 810,445 | 836,622 |
| Yearly Average for 50 Year Period | | | | | 156 | 9,009 | 9,165 | 564 | 16,209 | 16,772 |

1. Heart disease death rates for ETS are conservatively adjusted from the literature text. The estimates are allocated between home and nonhome in the same proportion as lung lung cancer.
2. Lung cancer for home and nonhome exposures is from EPA (1993).
3. Home exposure effects result from decreases in tobacco use from quitting and reduced initiation. Reductions in smoking due to decreased cigarette consumption by smokers is assumed to take place outside the home and are therefore not included. The time delay in premature deaths avoided results by assuming that the reduction in the mortality ratio for cancer over time follows the same time pattern as the mortality ratio for a smoker who quits. The reduction over time for heart disease is assumed to occur twice as fast as for cancer (see calculations in Exhibit 2-2).
4. Impacts of smoking restrictions are calculated to be 90% of nonhome exposures (see text).

## Exhibit 2-5: Morbidity Effects from Reductions in ETS Exposure

**Base=No Restrictions**

| | Base Level (1990) Annual Incidence Rates | | | | Estimated Annual Reductions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low Estimate | | High Estimate | | Low Estimate | | | High Estimate | | |
| | Home | NonHome | Home | NonHome | Home [1] | NonHome [2] | Total | Home [1] | NonHome [2] | Total |
| Morbidity Effects | | | | | | | | | | |
| Tonsils and Adenoids Operations | | 30,000 | | 30,000 | | 27,000 | 27,000 | | 27,000 | 27,000 |
| Tympanostomy Operations | | 160,000 | | 160,000 | | 144,000 | 144,000 | | 144,000 | 144,000 |
| Ear Infection Episodes | | 2,800,000 | | 2,800,000 | | 2,520,000 | 2,520,000 | | 2,520,000 | 2,520,000 |
| Asthma Exacerbation | 300,000 | 100,000 | 700,000 | 300,000 | 12,714 | 90,000 | 102,714 | 59,331 | 270,000 | 329,331 |
| Asthma Induction | 12,000 | 1,000 | 40,000 | 5,000 | 509 | 900 | 1,409 | 3,390 | 4,500 | 7,890 |
| Physicians Visits for Cough | 2,176,000 | 3,400,000 | 2,176,000 | 3,400,000 | 92,217 | 3,060,000 | 3,152,217 | 184,434 | 3,060,000 | 3,244,434 |
| Lower Respiratory Tract Infections | 135,000 | 15,000 | 270,000 | 30,000 | 5,721 | 13,500 | 19,221 | 22,885 | 27,000 | 49,885 |

1. Estimates based on reduction in cigarette consumption due to smokers quitting, and reduced initiation of new smokers. See Exhibit 2-
3. Reductions due to reduced consumption of smokers are not included because these are assumed to take place out of the home. Reductions are assumed to be immediate, without time delay.
2. 90% reduction (see text).

## Exhibit 2-6: Annual Benefits from ETS Related Premature Deaths Avoided.

**Base=No Restrictions**

**Total Value [1]**

| Discount Rate | Low Estimate Home | Low Estimate Non-Home | Low Estimate Total | High Estimate Home | High Estimate Non-Home | High Estimate Total |
|---|---|---|---|---|---|---|
| 3% | 726 | 41,856 | 42,582 | 2,618 | 75,310 | 77,928 |
| 5% | 689 | 39,681 | 40,370 | 2,482 | 71,398 | 73,880 |
| 7% | 662 | 38,118 | 38,780 | 2,384 | 68,585 | 70,970 |

1. A willingness to pay estimate of $4.8 million per premature death avoided is used. See text for meaning of willingness to pay. See Appendix for discussion of how we arrived at a value of $4.8 million per premature death avoided.

## Exhibit 2-7: Annual Benefits from Reduced Morbidity Effects of ETS

**Base=No Restrictions**

| Morbidity Estimate | Medical Cost Per Episode [1] | Total Cost Per Case [2] | Low Estimate Annual Reduction | Low Estimate Ann. Medical Savings [5] (million) | Low Estimate Total Annual Savings [5] (million) | High Estimate Annual Reduction | High Estimate Annual Medical Savings [5] (million) | High Estimate Total Annual Savings [5] (million) |
|---|---|---|---|---|---|---|---|---|
| Tonsils and Adenoids Operations | 1,500 | 1,500 | 27,000 | 41 | 41 | 27,000 | 41 | 41 |
| Tympanostomy Operations | 1,500 | 1,500 | 144,000 | 216 | 216 | 144,000 | 216 | 216 |
| Ear Infection Episodes | 75 | 75 | 2,520,000 | 189 | 189 | 2,520,000 | 189 | 189 |
| Asthma Exacerbation | 10 | 32 [3] | 102,714 | 1 | 3 | 329,331 | 3 | 11 |
| Asthma Induction | 100 | 1,500,000 [4] | 1,409 | 0 | 2,113 | 3,945 | 0 | 5,918 |
| Physicians Visits for Cough | 50 | 50 | 3,152,217 | 158 | 158 | 3,244,434 | 162 | 162 |
| Lower Respiratory Tract Infections | 100 | 100 | 19,221 | 2 | 2 | 49,885 | 5 | 5 |
| *Total Annual Savings* | | | | 608 | 2,721 | | 616 | 8,541 |

1. Guestimates based on professional judgement.
2. Likely to be higher than medical cost, but data to support a higher estimate was available only where indicated.
3. Midrange estimates of willingness to pay to avoid a day of episodic asthma symptoms (Unsworth, 1993a.)
4. Midrange estimate of willingness to pay to avoid having a case of chronic bronchitis (Unsworth, 1994). Since asthma is more life threatening than chronic bronchitis, it is assumed that this is a useful lower bound estimate for asthma.
5. *These savings are assumed to occur immediately. There is therefore no discounting.*
6. The high range estimate in Exhibit 2-1b is reduced by 50% to account for the uncertainty in the estimate.

## Exhibit 3-1: Unit Costs for Housekeeping and Maintenance

| Task by building | Duration (minutes) | Cost Per Hour | Cost Per Task | Annual Frequency | | Annual Cost Per 1,000 Square Feet | |
|---|---|---|---|---|---|---|---|
| | | | | Smoking | No Smoking | Smoking | No Smoking |
| | [1] | [2] | [3] [1] X [2] | [4] | [5] | [6] [3] X [4] | [7] [3] X [5] |
| **Housekeeping:** | | | | | | | |
| Empty and damp wipe ashtrays | 2.5 | $8.39 | $0.35 | 250 | 0 | $87.50 | $0.00 |
| Dusting Desktops | 2.2 | $8.39 | $0.31 | 250 | 52 | $77.50 | $16.12 |
| High Dusting | 4.5 | $8.39 | $0.63 | 52 | 12 | $32.76 | $7.56 |
| Venetian/Horizontal Blinds | 2 | $8.39 | $0.28 | 6 | 1 | $1.68 | $0.28 |
| Clean HVAC Vents | 10 | $8.39 | $1.40 | 4 | 1 | $5.60 | $1.40 |
| Empty and damp wipe ashtrays (per seat for smokers) | 0.25 | $8.39 | $0.03 | 2190 | 0 | $65.70 | $0.00 |
| Sweeping/Vacuuming | 10.0 | $8.39 | $1.40 | 78 | 52 | $109.20 | $72.80 |
| General Cleaning for a Smoking Room (Lodging) | 30 | $8.39 | $4.20 | 292 | | $1,226.40 | |
| General Cleaning for a Non Smoking Room (Lodging) | 24 | $8.39 | $3.36 | | 292 | | $981.12 |
| Empty and damp wipe ashtray stands | 4 | $8.39 | $0.56 | 292 | 0 | $163.52 | $0.00 |
| Empty and damp wipe ashtrays (per hospital bed for smok | 0.25 | $8.39 | $0.03 | 730 | 0 | $21.90 | $0.00 |
| Sweeping (per hospital bed for smokers) | 5.0 | $8.39 | $0.70 | 547.5 | 365 | $383.25 | $255.50 |
| **Maintenance/Repair/Replacement:** | | | | | | | |
| Replace Office Furniture | | | $4,530 | 0.2 | 0.14 | $906.00 | $634.20 |
| Carpet Repairs | | | $100 | 1 | 0 | $100.00 | $0.00 |
| Computer Maintenance (per computer for smokers) | 120 | $85.00 | $170 | 0.5 | | $85.00 | |
| Computer Maintenance (per computer for nonsmokers) | 90 | $85.00 | $128 | | 0.5 | | $63.75 |
| Computer Keyboard Replacement (per computer for smokers) | | | $50.00 | 0.67 | 0.5 | $33.50 | $25.00 |
| Painting | 6800 | $15.35 | $1,739.79 | 0.2 | 0.2 | $347.96 | $347.96 |
| Replace Table and/or chair (Food Service, per seat) | | | $448 | 0.2 | 0.14 | $89.50 | $62.65 |
| Replace Furniture (Lodging, per room) | | | $2,125.00 | 0.2 | 0.14 | $425.00 | $297.50 |

[1] Source: Means Facility Maintenance Standards, BOMA Office Building Cleaning Operations in North America, DOA 1981.

[2] Source: Average Hourly Wage Rate Plus Fringe, *Bureau of Labor Statistics, Means Square Foot Costs, 1991*

[4] and [5]: Source: Various sources, see Appendix for full listing. For housekeeping, Dineger 1994, Weiss 1985, Best Western 1994, Kelliher 1987. For maintenance, Weiss 1985, Ledger 1994 (computer maintenance and replacement).

## Exhibit 3-2: National Savings in Housekeeping and Maintenance Costs

| | | Total Square Feet (million sq. ft.) [1] | Potential Savings Per 1,000 Sq. Ft. Or Per Unit [2] | Applicable Sq. Ft. [3] | Annual Savings Low (millions of dollars) [4] | Annual Savings High (millions of dollars) [4] |
|---|---|---|---|---|---|---|
| **Office** | | | | | | |
| Housekeeping | | 11,802 | $181.24 | 7,081 | $1,283 | $1,283 |
| Maintenance | | 11,802 | $547.03 | 7,081 | $863 | $3,793 |
| Total Savings | | | | | $2,146 | $5,077 |
| Total Savings per Sq. Ft. | | | | | $0.18 | $0.43 |
| **Mercantile & Service** | | | | | | |
| Housekeeping | | 13,157 | $236.32 | 3,158 | $746 | $746 |
| Maintenance | | 13,157 | $204.39 | 3,158 | $165 | $481 |
| Total Savings | | | | | $911 | $1,227 |
| Total Savings per Sq. Ft. | | | | | $0.07 | $0.09 |
| **Food Service** | | | | | | |
| Housekeeping | | 1,167 | $85.70 | 700 | $438 | $438 |
| Maintenance | | 1,167 | $123.84 | 700 | $128 | $306 |
| Total Savings | | | | | $565 | $744 |
| Total Savings per Seating Capacity (smoking) | [5] | | | | $84.84 | $111.69 |
| **Health Care** | | | | | | |
| Housekeeping | | 2,054 | $333.34 | 507 | $228 | $228 |
| Maintenance | | 2,054 | $502.28 | 507 | $33 | $222 |
| Total Savings | | | | | $261 | $449 |
| Total Savings per Sq. Ft. | | | | | $0.13 | $0.22 |
| **Assembly** | | | | | | |
| Housekeeping | | 6,838 | $236.32 | 821 | $194 | $194 |
| Maintenance | | 6,838 | $204.39 | 821 | $43 | $125 |
| Total Savings | | | | | $237 | $319 |
| Total Savings per Sq. Ft. | | | | | $0.03 | $0.05 |
| **Education** | | | | | | |
| Housekeeping | | 8,148 | $394.04 | 600 | $160 | $160 |
| Maintenance | | 8,148 | $502.28 | 600 | $0 | $301 |
| Total Savings | | | | | $160 | $461 |
| Total Savings per Sq. Ft. | | | | | $0.02 | $0.06 |

## Exhibit 3-2: National Savings in Housekeeping and Maintenance Costs continued

| | Total Square Feet | Potential Savings Per 1,000 Sq. Ft. Or Per Unit | Applicable Sq. Ft. | Annual Savings Low | Annual Savings High |
|---|---|---|---|---|---|
| | (million sq. ft.) | | | (millions of dollars) | |
| | [1] | [2] | [3] | [4] | |
| **Lodging** | | | | | |
| Housekeeping | 3,476 | $373.03 | 342.6 | $44 | $354 |
| Maintenance | 3,476 | $457.98 | 342.6 | $49 | $391 |
| Total Savings | | | | $93 | $745 |
| Total Savings per Guest Room (smoking) [6] | | | | $73.56 | $589.84 |
| **Warehouse/Industrial** | | | | | |
| Housekeeping | 12,253 | $305.14 | 7,351 | $781 | $995 |
| Maintenance | 12,253 | $0.00 | 7,351 | $0 | $0 |
| Total Savings | | | | $781 | $995 |
| Total Savings per Sq. Ft. | | | | $0.06 | $0.08 |
| **Total Savings** | | | | | |
| Housekeeping | 58,895 | | 20,561 | $3,874 | $4,398 |
| Maintenance | | | | $1,280 | $5,620 |
| Total Savings | | | | $5,154 | $10,017 |
| Total Savings per Sq. Ft. | | | | $0.09 | $0.17 |

[1] Total Squre Feet per building use is from Department of Energy, Energy Information Administration, Commercial Building Characteristics, 1989, page 17.

[2] See Appendix for detailed calculations.

[3] Proportion of Square Footage to report savings. May vary by activity. See Kaiser 1984 for square feet in secondary education, Statistical Abstract for number of personal computers, Swart 1990 for reported savings.

[4] See Appendix for detailed calculations.

[5] Units for Food Service establishments are seating capacity for smokers.

[6] Units for Lodging are square feet for common areas and per guest room for smokers.

## Exhibit 4-1: Excess Absenteeism of Smokers and Former Smokers

| | Annual Days | Excess Days | Days Saved |
|---|---|---|---|
| Smokers | 4.50 | 1.50 | |
| Former Smokers | 3.90 | 0.90 | |
| Never Smokers | 3.00 | | |
| Quitting | | | 0.60 |
| Failure to Initiate | | | 1.50 |

1. Quitters go from smoking to former smoking status
2. Those that fail to initiate smoking go from a potential smoker to a never smoker

## Exhibit 4-2: Value of Reduced Absenteeism

**Base=No Restrictions**

| | Days Saved Per Person Per Year | Unemplymnt Factor | Net Days Saved Per Person | Average Daily Earnings | Annual Value Per Person |
|---|---|---|---|---|---|
| Quitting | 0.60 | 0.04 | 0.576 | 104.00 | 59.90 |
| Fail to Initiate | 1.50 | 0.04 | 1.44 | 104.00 | 149.76 |

## Exhibit 4-3: National Annual Savings from Reduced Absenteeism [1]

**Base=No Restrictions**

| | 3% | | 5% | | 7% | |
|---|---|---|---|---|---|---|
| | Low Estimate millions | High Estimate millions | Low Estimate millions | High Estimate millions | Low Estimate millions | High Estimate millions |
| Quitting | 53 | 107 | 67 | 133 | 73 | 147 |
| Fail to Initiate | 170 | 340 | 121 | 241 | 93 | 186 |
| Total | 223 | 447 | 187 | 375 | 166 | 333 |

1. Detailed discounting is necessary to separate out the differential effect of quitting and reduced initiation. See Appendix B for discount calculations.

## Exhibit 5-1: Average Annual Fire Related Injuries and Property Damage (1988-1990)

**Base=No Restrictions**

| | Residential [1] | Non-Resid. [1] | Unit Cost [3] (million) | Total Unit Cost (million) | Total Cost Residential (million) | Non-Resid. (million) | Total (million) |
|---|---|---|---|---|---|---|---|
| Injuries | | | | | | | |
| Fatal | 1,328 | 38 | | 4.8 | 6,373 | 184 | 6,557 |
| Non-Fatal | 3,325 | 318 | 0.17 | 0.17 | 551 | 53 | 603 |
| Total | 4,652 | 357 | | | 6,924 | 237 | 7,160 |
| Prop. Loss [1] | 111,500 | 36,800 | | | 316 | 115 | 430 |
| Total Cost | | | | | 7,239 | 351 | 7,591 |

1. From Miller (1993). Figures are an average of 1988-1990. Figures for 1991 are excluded because of distortion due to the Oakland fire storm.
2. Number of fires.
3. Average cost per injury from Ray (1993). Estimates include medical costs, transport costs, lost earnings, legal and health insurance administrative costs, and pain and suffering
4. The unit cost for hospitalized injuries only is $.78 million (Ray, 1993)
5. Total Value of each reduced fire-related fatality is assumed to be $4.8 million. See text.

## Exhibit 5-2: Fire Related Premature Deaths, Injuries, and Property Losses Avoided

**Base=No Restrictions**

| | Current Annual Average Injuries | | Low Estimate Annual Reductions in Injuries | | | High Estimate Annual Reductions in Injuries | | | Est. Reductions Over 50 Yrs Total Residen. and Non-Residen. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Residential | Non-Resid. | Residential [1] | Non-Resid. [2] | Total | Residential [1] | Non-Resid. [2] | Total | Low | High |
| Injuries | | | | | | | | | | |
| Fatal | 1,328 | 38 | 56 | 33 | 89 | 113 | 31 | 144 | 4,462 | 7,198 |
| Non-Fatal | 3,325 | 318 | 141 | 274 | 415 | 282 | 261 | 543 | 20,733 | 27,141 |
| Total | 4,652 | 357 | 197 | 307 | 504 | 394 | 292 | 687 | 25,195 | 34,339 |

1. Reductions are assumed to be proportional to reductions in the total consumption of cigarettes due to quitting and reduced initiation. Since the reduction in consumption of smokers likely takes place solely outside the home, these reductions are not included in the calculations.
2. Uses a 90% reduction for the estimated portion of the nonresidential environments that ban smoking, and 50% reduction for the estimated portion that provide smoking lounges. For costing purposes, the proportion of establishments with indoor lounges in the low estimate is less than in the high estimate. Therefore, the low estimates for fire related deaths and injuries avoided is higher than the high estimate because of this oddity.

## Exhibit 5-3: Annual Benefits in Fire Related Injuries and Property Damage

**Base=No Restrictions**

| | Low Estimate Residential million | NonResidential million | Total million | High Estimate Residential million | NonResidential million | Total million |
|---|---|---|---|---|---|---|
| Injuries | | | | | | |
| Fatal | 270 | 158 | 428 | 540 | 151 | 691 |
| Non-Fatal | 23 | 45 | 69 | 47 | 43 | 90 |
| Total | 293 | 204 | 497 | 587 | 194 | 781 |
| Property Loss | 13 | 99 | 112 | 27 | 94 | 121 |
| Total Savings | 307 | 302 | 609 | 614 | 288 | 902 |

## Exhibit 6-1: Estimating the Effect of Smoking Restrictions on Quit Rates, Consumption Rates, and Rates of Initiation

**Base=No Restrictions**

**Quit**

| Site Conditions | Reference | Quit Rate Reported (Annual) | Assumed Relapse Rate | Net Quit Rate | Net Quit Rate w/o Smoke Restr. | Net Quit Rate due to Smoking Restr. |
|---|---|---|---|---|---|---|
| N-B. | Baile, et al.(1991) | 15% | 30% | 10.50% | 2.50% | 8.00% |
| | Hudzinski, et al.(1990) | 9% | 30% | 6.30% | 2.50% | 3.80% |
| | Stave, et al.(1991) | 17% | 30% | 11.90% | 7.50% | 4.40% |
| | Stillman, et al.(1990) | 15% | 30% | 10.50% | 2.50% | 8.00% |
| N-R or R-B | Andrews (1983) | 16% | 30% | 11.20% | 2.50% | 8.70% |
| | Borland et al. (1990) | 9% | 30% | 6.30% | 2.50% | 3.80% |
| | Gottlieb et. al. (1990) | 13% | 30% | 9.10% | 2.50% | 6.60% |
| | Sorensen et al. (1993) | 12% | 30% | 8.40% | 2.50% | 5.90% |

| | Low | High |
|---|---|---|
| Estimated Net Quit Rate due to workplace smoking policies | 4% | 8% |
| Estimated Net Quit Rate due to Comprehensive Legislation [2] | 3% | 6% |

**Consumption**

| | | Consumption Reduction |
|---|---|---|
| N-B | Stave et tal. (1991) | 34% |
| | Stillman, et al.(1990) | 20% |
| R-B | Borland et al. (1990) | 18% |
| | Hocking et al. (1991 | 20% |

| | Low | High |
|---|---|---|
| Estimated Reduction in Consumption Rate due to Workplace Restrictions | 15% | 20% |
| Estimated Reduction in Consumption Rate due to Comprehensive Legislation [2] | 10% | 15% |

**Initiation**

| | | Reduced Initiation |
|---|---|---|
| N-B | Woodruff et al. (1993) | 36% [3] |
| R-B | Wasserman et al.(1991 | 41% [4] |

| | Low [5] | High [5] |
|---|---|---|
| Estimated Reduction in Initiation Rate due to Comprehensive Legislation | 5% | 10% |

1. N-B refers to sites that go from no restrictions (N) to a ban (B). R-B refers to sites that go from partial restrictions (R) to a ban (B).
2. Because only about 60% of the population is employed, comprehensive legislation would have less average effect on the whole population than the effect of workplace policies on employees.
3. Cross sectional analysis of California worksites.
4. Not a workplace study. The 41% reduction refers to the difference between teenagers who live in communities with legislation mandating few restrictions in public places, compared with teenagers living in communities with comprehensive legislation, including legislation restricting smoking in workplaces. Most of the reduced consumption is attributed to reduced initiation.
5. Estimate is both conservative and exceptionally uncertain because of the paucity of information.

## Exhibit 6-2: Proportional Reduction in Mortality Ratio (PRMR) By Years Since Quitting

| | | Ratio to Base Mortality Rate | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Smoker Mortality | Years Quit: | | | | | | | | | | |
| | Ratio [1] | 1 to 2 | 3 to 5 | 6 to 10 | 1 to 10 [2] | 11 to 15 | 16 + | 11 to 20 [3] | 21 to 30 [4] | 31 to 40 [4] | 41 to 50 [4] | 50 + [4] |
| Age | Base = 1.00 | | | | | | | | | | | |
| 0-34 | | | | | 51% | 64% | 64% | 64% | 90% | 95% | 95% | 100% |
| 35-44 | | | | | 51% | 64% | 64% | 64% | 90% | 95% | 95% | 100% |
| 45-54 | 3.02 | 42% | 43% | 59% | 51% | 64% | 64% | 64% | 90% | 95% | 95% | 100% |
| 55-64 | 2.92 | 26% | 30% | 45% | 36% | 55% | 61% | 58% | 90% | 95% | 95% | 100% |
| 65-74 | 2.67 | 11% | 26% | 27% | 23% | 39% | 59% | 49% | 80% | 90% | 90% | 100% |
| 75+ | 1.85 | 19% | 19% | 17% | 18% | 2% | 32% | 17% | 70% | 85% | 85% | 100% |

1. Males only. Average of mortality rates for above and below 20 cigarettes per day.
2. Weighted average of 1-2, 3-5, and 6-10 years. Ages 30-44 assumed to be the same as 45-54.
3. Average of 11-15, and 16 + years.
4. *Assumed to reach 90% average reduction after 20 years based on cancer rate mortality ratios (DHHS 1989), and full reduction (100%) in 50 years with a slight lag for ages older than 65.*

Source: DHHS (1990), Table 7, page 95.

**Exhibit 6-3: Premature Deaths Avoided (PDA) From Quitting by Years of Abstinence**

**Base=No Restrictions**

| Years | 1990 | | 1991 to 2000 | | 2001 to 2010 | | 2011 to 2020 | | 2021 to 2030 | | 2031 to 2040 | | 50 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Deaths | % Quit | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PDA Low Estimate Quit Rate = 3% | Percent | PDA High Estimate Quit Rate = 6% |
| 0-34 | 2,215 | 3% | 51% | | | | | | | | | | 3,073 | 1.86% | 18,148 |
| 35-44 | 33,291 | 3% | 51% | 507 | 84% | | 90% | | | | | | 9,938 | 5.85% | 19,876 |
| 45-54 | 28,901 | 3% | 51% | 440 | 84% | 553 | 90% | 1560 | 95% | | | | 33,398 | 11.89% | 64,780 |
| 55-64 | 58,510 | 3% | 36% | 937 | 58% | 1022 | 80% | 3859 | 90% | 4341 | 90% | | 116,888 | 43.89% | 233,760 |
| 65-74 | 160,780 | 3% | 23% | 1128 | 49% | 2357 | 80% | 3859 | 90% | 4341 | 90% | | 196,188 | 39.71% | 216,370 |
| 75+ | 131,051 | 3% | 19% | 700 | 17% | 883 | 70% | 2752 | 85% | 3342 | 85% | 3342 | 272,439 | 100.00% | 544,878 |
| Total | 414,748 | | | 3413 | | 4816 | | 8191 | | 7683 | | 3342 | | | |
| Yearly Average for the 50 Year Period | | | | | | | | | | | | | 5,449 | | 10,898 |

1. Proportional reduction in mortality.
2. Premature Deaths Avoided

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology.

**Exhibit 6-4: Premature Deaths Avoided (PDA) From Reduced Initiation**

**Base=No Restrictions**

| | Year | | | | | | | | 50 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991-2000 | 2001-2010 | 2011-2020 | 2021-2030 | 2031-2040 | 2041-2050 | 2051 + | PDA | | PDA |
| Age | Deaths | in Deaths [1] | | | | | | | Low Est. | Percent | High Est. |
| 0-34 | 2,215 | 3% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | | 10% |
| 35-44 | 33,291 | | 3% | 5% | 5% | 5% | 5% | 5% | 5,039 | 3% | 10,078 |
| 45-54 | 28,901 | | | 3% | 5% | 5% | 5% | 5% | 59,091 | 31% | 118,182 |
| 55-64 | 58,510 | | | | 3% | 5% | 5% | 5% | 36,849 | 19% | 73,698 |
| 65-74 | 160,780 | | | | | 3% | 5% | 5% | 45,345 | 24% | 90,691 |
| 75+ | 131,051 | | | | | | 3% | 5% | 44,214 | 23% | 88,428 |
| Total | 414,748 | | | | | | | | | | |
| PDA/Year | | 81 | 1,026 | 2,570 | 4,629 | 10,587 | 17,789 | 20,737 | | | |
| Cumulative Total | | 809 | 10,672 | 38,572 | 84,389 | 190,539 | 368,428 | | 190,539 | 100% | 381,078 |
| Yearly Average for the 50 Year Period | | | | | | | | | 3,811 | | 7,622 |

We assumeall new smokers come from the youngest age group, that a constant number is added every year, and that it takes 60 years for the smoking population to completely change. Therefore, it takes 60 years for the smoking population to be reduced by the estimated reduction in the initiation rate, with 1/60th of that reduction taking place each year.
2. Average rate over the first 10 year increment in which new smokers are added each year.

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology.

**Exhibit 6-5: Premature Deaths Avoided From Reduced Consumption**

**Baseline Restrictions**

| Years | | | 1991 to 2000 | | | 2001 to 2010 | | 2011 to 2020 | | 2021 to 2030 | | 2031 to 2040 | | 2041 & beyond | | 50 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ages | 1990 Deaths Per Year | Adjusted for Quitting & Reduced Initiation [1] (Low Estimate) | % Reduction (Low Estimate) | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | Lives Saved Low Est 10% | Percent | Lives Saved High Est 20% |
| 0-34 | 2,215 | 2,121 | 10% | 51% | 108 | 84% | 135 | 80% | 181 | 85% | 202 | 95% | 202 | 100% | 212 | 8,370 | 0.64% | 16,388 |
| 35-44 | 33,291 | 33,880 | 10% | 51% | 1,810 | 84% | 2,035 | 80% | 2,869 | 85% | 3,029 | 95% | 3,029 | 100% | 3,188 | 126,883 | 9.60% | 245,899 |
| 45-54 | 28,901 | 28,577 | 10% | 51% | 1,406 | 84% | 1,706 | 80% | 2,491 | 85% | 2,629 | 95% | 2,629 | 100% | 2,768 | 109,216 | 8.34% | 213,445 |
| 55-64 | 58,510 | 58,030 | 10% | 36% | 2,034 | 56% | 3,263 | 80% | 5,043 | 85% | 5,323 | 95% | 5,323 | 100% | 5,603 | 200,850 | 15.02% | 410,115 |
| 65-74 | 168,780 | 153,866 | 10% | 23% | 3,900 | 48% | 7,525 | 80% | 12,317 | 80% | 13,857 | 90% | 13,857 | 100% | 15,397 | 611,663 | 30.06% | 999,762 |
| 75+ | 131,051 | 125,497 | 10% | 18% | 2,235 | 17% | 2,180 | 70% | 8,785 | 85% | 10,887 | 85% | 10,887 | 100% | 12,550 | 345,344 | 26.36% | 674,916 |
| Total | 414,748 | 397,171 | | | 11,892 | | 16,994 | | 31,686 | | 35,706 | | 35,706 | | 39,717 | 1,310,148 | 100.00% | 2,560,458 |
| Yearly Average for the 50 Year Period | | | | | | | | | | | | | | | | 26,203 | | 51,209 |

1. The reduced consumption rate applies only to smokers after reducing the current smoking population to account for those that quit or fail to initiate smoking.
2. The maximum proportional reduction in mortality is equal to the percent reduction in consumption, and is assumed to be reached in 50 years (PRM factor = 100%). The time path of PRM factor is assumed to be the same as for quitting.

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology

## Exhibit 6-6: Life Expectancies of Ever Smokers and Never Smokers by Age

| Age | Ever Smokers: Probability of Survival [1] | Ever Smokers: Probability of Deaths | Ever Smokers: Expected Life Years Remaining To Life Expect. | Ever Smokers: To Age 65 | Never Smokers: Probability of Survival [1] | Never Smokers: Probability of Deaths | Never Smokers: Expected Life Years Remaining to Life Expect. | Never Smokers: To Age 65 | Difference: Exp.Life Years Ever Minus Never |
|---|---|---|---|---|---|---|---|---|---|
| 35 | 1.000 | | 34.06 | 26.73 | 1.000 | | 39.48 | 28.28 | 5 |
| 45 | 0.975 | 0.025 | 24.31 | 16.98 | 0.987 | 0.013 | 29.61 | 18.41 | 5 |
| 55 | 0.916 | 0.084 | 15.15 | 7.82 | 0.957 | 0.043 | 20.04 | 8.84 | 5 |
| 65 | 0.782 | 0.218 | 7.33 | | 0.884 | 0.116 | 11.20 | | 4 |
| 75 | 0.548 | 0.452 | 1.85 | | 0.725 | 0.275 | 3.95 | | 2 |
| 85 | 0.185 | 0.815 | | | 0.395 | 0.605 | | | |

1. Survival probabilities from Hodgson (1992)

## Exhibit 6-7: Years of Life Lost per Smoking Related Death by Age

| Age | Excess Probability of Death (End of Interval) | Excess Probabil. Of Death (Within Interval)[1] | Ever Smokers in 1990 | Expected Smoking Related Deaths/year [2] (thousands) | Percent | Life Years Lost Per Death: To Life Expect. (Within Interval)[1] | Life Years Lost Per Death: To Age 65 (Within Interval)[1] | Life Years Lost Per Death: To Life Expect. (Within Interval)[1] | Life Years Lost Per Death: To Age 65 (Within Interval)[1] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Discounted Years at 3% [4] [5] | | | Undiscounted Years | |
| 35-44 | 0.012 | 0.009 | 17.29 | 15.56 | 3.75% | 20.50 | 17.10 | 31.62 | 24.29 |
| 45-54 | 0.041 | 0.034 | 13.80 | 46.58 | 11.21% | 16.05 | 11.75 | 22.02 | 14.69 |
| 55-64 | 0.102 | 0.087 | 13.80 | 119.72 | 28.81% | 10.75 | 5.30 | 13.20 | 5.87 |
| 65-74 | 0.177 | 0.158 | 14.00 | 221.55 | 53.32% | 4.58 | | 5.96 | |
| 74-85 | 0.210 | 0.202 | 0.60 | 12.10 | 2.91% | 1.34 | | 1.39 | |
| Total | | | 59.49 | 415.51 | 100.00% | | | | |
| Average Life Years Lost per Death [3] | | | | | | 6.15 | 3.48 | 10.67 | 4.25 |

1. Estimated as 75% of the difference between beginning and ending values.
2. Excess probability of death times the number of ever smokers within the age interval.
3. Average of all smoking related deaths of all ages weighted by the percent of deaths in each age group.
4. The discounted value of future expected life years lost at time of death. Only a 3% discount rate is used throughout the analysis.
5. EPA does not believe that discounting physical effects such as premature deaths or live years extended has no meaning. Only monetary values should be discounted. Discounting physical effects is done here only for analytic convenience and to display discounting methodology.

## Exhibit 6-8: Life Years Extended Per Premature Death Avoided by Type of Smoking Activity

| Age | Expected Life Years Remaining: To Life Expect[1] | Expected Life Years Remaining: To Age 65[1] | Percent Premature Deaths Avoided, 50 Year Period: Quitting | Reduced Cons. | Reduced Initiat. |
|---|---|---|---|---|---|
| 00-35 | 74.68 | 74.68 | | 1% | 3% |
| 35-44 | 20.50 | 17.10 | 2% | 10% | 31% |
| 45-54 | 16.05 | 11.75 | 4% | 8% | 19% |
| 55-64 | 10.75 | 5.30 | 12% | 16% | 24% |
| 65-74 | 4.58 | | 43% | 39% | 23% |
| 74-85 | 1.34 | | 40% | 26% | |
| Total | | | 100% | 100% | 100% |
| Av. Life Years Extended per Premature Death Avoided | | | | | |
| | | | Average Life Years Extended Over 50 Year Period [2] | | |
| | | To Life Expectancy | 4.74 | 7.65 | 15.06 |
| | | To Age 65 | 1.38 | 3.95 | 10.81 |

1. Perinatal deaths. Expected life years remaining is from OTA (1993).
2. Average of all age groups weighted by the percent of deaths in each age group.

## Exhibit 6-9: Excess Medical Costs per Smoking Related Premature Death

| | Excess Med. Cost 5 Year Total *(million )* | Adjustment *Factor* | Annual Excess Medical Cost *(million)* | Annual Excess Med. Cost Per Prem. Death *(dollars)* |
|---|---|---|---|---|
| **Male** | 113,500 | 0.95 | 21,526 | |
| **Female** | 73,100 | 0.95 | 13,864 | |
| **Both Sexes** | 186,600 | 0.95 | 35,391 | 85,174 |

1. Excess medical costs for the 1985 population of ever smokers versus never smokers in 1990 dollars. This figure accounts for the extended life expectancy of never smokers and the medical expenses incurred during those years.
2. Excess medical costs provided by Hodges are discounted by 3%. To obtain the undiscounted value, we multiply by 1.09. To obtain the excess cost of a "nonsmoking smoker", we multiply by 0.87 (see Hodges,1992).

Source: Hodges (1992)

## Exhibit 6-10: Costs Per Smoking Related Premature Death and Life Years Lost

| | Direct Medical (dollars) | Lost Earnings Morbidity [1] (dollars) | Lost Earnings Mortality [2] (dollars) |
|---|---|---|---|
| Excess Cost per Premature Death | 85,174 | 16,630 | |
| Cost per Life Year Lost to Age 65 | | | 31,150 |

1. Calculated from OTA, 1993
2. Estimated daily earnings of smokers (see Exhibit 5-2) times 260 days times 1.2 to account for earnings after 65

## Exhibit 6-11: Annual Savings Due To Changes in Smoking Behavior

Base=No Restrictions

| Savings from Smoking Restrictions | Low Estimate | | | High Estimate | | |
|---|---|---|---|---|---|---|
| | Direct Medical [1] (million) | Lost Earnings Morbidity [1] (million) | Lost Earnings Mortality [1] (million) | Direct Medical [1] (million) | Lost Earnings Morbidity [1] (million) | Lost Earnings Mortality [1] (million) |
| 3% Discount | | | | | | |
| Quitting | 343 | 67 | 248 | 686 | 134 | 495 |
| Reduced Consumption | 2,221 | 434 | 826 | 4,443 | 867 | 1,652 |
| Reduced Initiation | 513 | 100 | 983 | 1,026 | 200 | 1,965 |
| **Total** | **3,077** | **601** | **2,056** | **6,155** | **1,202** | **4,112** |
| 5% discount | | | | | | |
| Quitting | 387 | 75 | 203 | 773 | 151 | 406 |
| Reduced Consumption | 1,838 | 359 | 1,127 | 3,676 | 718 | 2,253 |
| Reduced Initiation | 161 | 31 | 448 | 322 | 63 | 896 |
| **Total** | **2,386** | **466** | **1,778** | **4,771** | **932** | **3,555** |
| 7% Discount | | | | | | |
| Quitting | 387 | 76 | 170 | 774 | 151 | 339 |
| Reduced Consumption | 1,589 | 310 | 1,319 | 3,179 | 621 | 2,638 |
| Reduced Initiation | 67 | 13 | 230 | 135 | 26 | 459 |
| **Total** | **2,044** | **399** | **1,718** | **4,088** | **798** | **3,436** |

1. Estimates provided here only for those interested. These are not included in evaluation of benefits. See text.

## Exhibit S-1: Summary of Costs and Benefits*

**Base = No Restrictions**

| | ****3% Discount Rate**** | | ****5% Discount Rate*** | | **7% Discount Rate** | |
|---|---|---|---|---|---|---|
| | Low Estimate | High Estimate | Low Estimate | High Estimate | Low Estimate | High Estimate |
| | (Millions of Dollars) | | (Millions of Dollars) | | (Millions of Dollars) | |
| **Cost of Implementing the Legislation** | 616 | 1,867 | 617 | 1,884 | 624 | 1,901 |
| Smoking Bans | 159 | 455 | 159 | 455 | 159 | 455 |
| Smoking Lounge | 351 | 912 | 358 | 930 | 364 | 947 |
| National Enforcement | 100 | 500 | 100 | 500 | 100 | 500 |
| **Benefits from Reduced Exposure the ETS** | 45,363 | 84,469 | 43,881 | 80,421 | 41,501 | 77,511 |
| Value of Premature Deaths Avoided | | | | | | |
| Home Exposure | 726 | 2,618 | 689 | 2,482 | 662 | 2,387 |
| Non-Home Exposure | 41,856 | 75,310 | 39,681 | 71,398 | 38,118 | 68,585 |
| Improved Health [1] | 2,721 | 6,541 | 2,721 | 6,541 | 2,721 | 6,541 |
| Increased Occupant Comfort | # | # | # | # | # | # |
| **Savings in Operating and Maintenance Expenses** | 5,154 | 10,018 | 5,154 | 10,018 | 5,154 | 10,018 |
| Housekeeping | 3,874 | 4,398 | 3,874 | 4,398 | 3,874 | 4,398 |
| Maintenance | 1,280 | 5,620 | 1,280 | 5,620 | 1,280 | 5,620 |
| **Net Change in Productivity** | # | # | # | # | # | # |
| **Savings in Reduced Smoker Absenteeism** | 223 | 447 | 187 | 375 | 166 | 333 |
| **Savings in Smoking Related Fires** | 689 | 982 | 689 | 982 | 689 | 982 |
| Value of Injuries and Deaths Avoided | | | | | | |
| Residential | 293 | 587 | 293 | 587 | 293 | 587 |
| Non-Residential | 204 | 194 | 204 | 194 | 204 | 194 |
| Property Damage Avoided | 112 | 121 | 112 | 121 | 112 | 121 |
| **Benefits Without Regard to Smokers [2]** | 50,679 | 93,968 | 49,426 | 89,831 | 48,997 | 86,862 |

### Benefits or Losses Regarding Smokers

| | Annual Average over 60 Year Period | | Annual Rate After 60 Years | |
|---|---|---|---|---|
| **Premature Deaths Avoided (Smokers)** | Low Estimate | High Estimate | Low Estimate | High Estimate |
| Quit Smoking | 5,449 | 10,898 | 0 | 0 |
| Reduced Consumption | 26,203 | 51,209 | 39,717 | 77,620 [1] |
| Reduced Initiation | 3,811 | 7,622 [3] | 20,737 | 41,475 [3] |
| Total | 35,462 | 69,728 | 60,455 | 119,095 |
| **Benefit Losses to Smokers** | # | # | # | # |

*Totals may appear to be greater than the sum of individual items due to rounding.
# Not quantified. See text for discussion.
1. Most of this estimate is due to the estimated value of reduced asthma induction in children.
2. Considers just the above costs and benfits.
3. Annual premature deaths avoided after 60 years. Annual reduction in premature deaths gradually increases over the first 60 years before it reaches a constant value.

## Exhibit 7-1: Percent of Worksites with 50 or More Employees that Prohibit Smoking or Restrict Smoking to Separately Ventilated Areas

| Size of Worksite | Percent |
|---|---|
| 50 - 99 | 55% |
| 100 - 249 | 61% |
| 250 - 749 | 66% |
| 750 + | 74% |
| All Sites | 59% |

## Exhibit 7-2: Number of States and Territories with Legislated Smoking Restrictions - 1993

| | None | Designated Areas Only | Designated w/Separate Ventilation | 100% Smoke Free |
|---|---|---|---|---|
| Public Places | 13 | 40 | 0 | 0 |
| Government Workplace | 18 | 34 | 1 | 0 |
| Private Workplace | 35 | 18 | 0 | 0 |
| Restaurants | 22 | 31 | 0 | 0 |
| Bars | 53 | 0 | 0 | 0 |

## Exhibit 7-3a: Proportion of All Employees Under Restrictive Smoking Policies

| | Assumed % of Firms with Restrictive Policies | | | | |
|---|---|---|---|---|---|
| | Firms w/more than 50 Emp. | Firms Under 50 Employees: | | | |
| | 59% | 5% | 10% | 15% | 25% |
| Percent all Employees | 45% | 55% | 55% | 55% | 55% |
| % Employees Covered by Ban or Lounge | 59% | 29% | 32% | 35% | 40% |
| % Employees Covered by Smoking Ban | 34% | 18% | 21% | 24% | 29% |
| % Employees Covered by Lou | 25% | 11% | 11% | 11% | 11% |
| Assume 20% meet HR3434 Standards | 5% | 2% | 2% | 2% | 2% |

## Exhibit 7-3b: Proportion of Employees with Smoking Bans and Lounges

| | Before HR 3434 | After HR 3434 | Low | High |
|---|---|---|---|---|
| Smoking Bans | 21% | 90% | 90% | 80% |
| Complying Smoking Lounge | 2% | 10% | 10% | 20% |
| Total Compliance | 23% | 100% | 100% | 100% |

## Exhibit S-2: Summary of Costs and Benefits*

**Base=23% Restrictions**

| | ***3% Discount Rate**** Low Estimate | High Estimate | ***5% Discount Rate*** Low Estimate | High Estimate | **7% Discount Rate** Low Estimate | High Estimate |
|---|---|---|---|---|---|---|
| | (Millions of Dollars) | | (Millions of Dollars) | | (Millions of Dollars) | |
| **Cost of Implementing the Legislation** | 476 | 1,437 | 476 | 1,461 | 480 | 1,484 |
| Smoking Bans | 123 | 350 | 123 | 350 | 123 | 350 |
| Smoking Lounge | 270 | 703 | 276 | 716 | 280 | 729 |
| National Enforcement | 77 | 385 | 77 | 385 | 77 | 385 |
| **Benefits from Reduced Exposure the ETS** | 34,884 | 85,041 | 33,180 | 81,924 | 31,956 | 80,693 |
| *Value of Premature Deaths Avoided* | | | | | | |
| Home Exposure | 559 | 2,016 | 530 | 1,911 | 509 | 1,836 |
| Non-Home Exposure | 32,229 | 57,988 | 30,555 | 54,976 | 29,351 | 52,810 |
| Improved Health[1] | 2,095 | 5,037 | 2,095 | 5,037 | 2,095 | 5,037 |
| Increased Occupant Comfort | # | # | # | # | # | # |
| **Savings in Operating and Maintenance Expenses** | 3,969 | 7,714 | 3,969 | 7,714 | 3,969 | 7,714 |
| Housekeeping | 2,983 | 3,386 | 2,983 | 3,386 | 2,983 | 3,386 |
| Maintenance | 986 | 4,327 | 986 | 4,327 | 986 | 4,327 |
| **Net Change in Productivity** | # | # | # | # | # | # |
| **Savings in Reduced Smoker Absenteeism** | 172 | 344 | 144 | 289 | 128 | 256 |
| **Savings in Smoking Related Fires** | 469 | 894 | 469 | 894 | 469 | 894 |
| *Value of Injuries and Deaths Avoided* | | | | | | |
| Residential | 226 | 452 | 226 | 452 | 226 | 452 |
| Non-Residential | 157 | 149 | 157 | 149 | 157 | 149 |
| Property Damage Avoided | 86 | 93 | 86 | 93 | 86 | 93 |
| **Benefits Without Regard to Smokers [2]** | 39,023 | 72,356 | 37,287 | 69,170 | 36,041 | 66,894 |

### Benefits or Losses Regarding Smokers

| | *Annual Average over 50 Year Period* Low Estimate | High Estimate | Annual Rate After 50 Years Low Estimate | High Estimate |
|---|---|---|---|---|
| **Premature Deaths Avoided (Smokers)** | | | | |
| Quit Smoking | 4,196 | 8,391 | 0 | 0 |
| Reduced Consumption | 20,178 | 39,431 | 30,592 | 59,766 [1] |
| Reduced Initiation | 2,934 | 5,869 [3] | 15,968 | 31,936 [3] |
| Total | 27,309 | 53,691 | 46,550 | 91,703 |
| **Benefit or Losses to Smokers** | # | # | # | # |

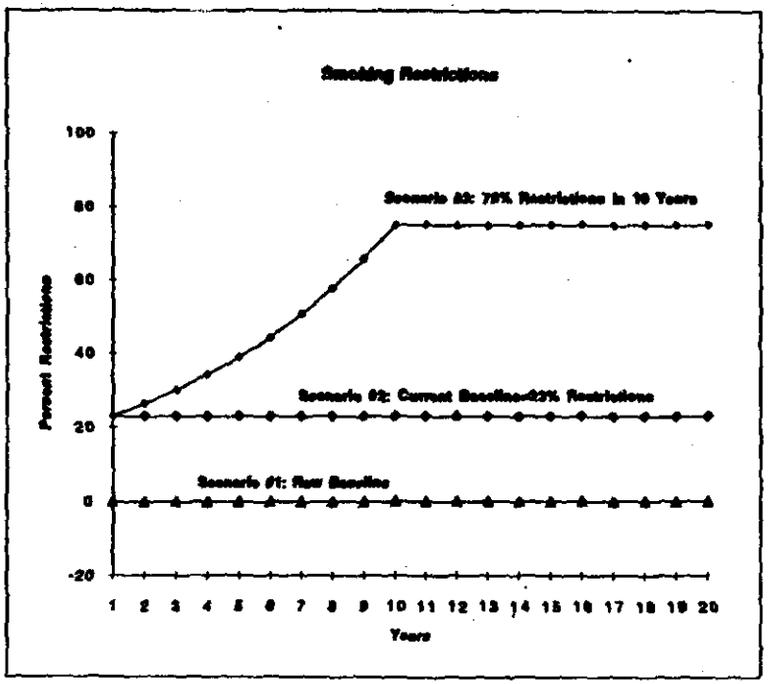
*Totals may appear to be greater than the sum of individual items due to rounding.
# Not quantified. See text for discussion.
1. Most of this estimate is due to the estimated value of reduced asthma induction in children. The high estimate in Exhibit ES-1 is reduced by 50% because of uncertainty of its magnitude.
before it reaches a constant value.
2. Considers just the above costs and benfits.
3. Annual premature deaths avoided after 60 years. Annual reduction in premature deaths gradually increases over the first 60 years

## Exhibit S-3: Analysis of Alternative Baselines*

| | Low Estimates [1] | | | | |
|---|---|---|---|---|---|
| | Scenario #1 Raw Baseline No Restrictions (1988 Cig. Cons) [2] | Scenario #2 Current Baseline 23% Restrictions (1988 Cig. Cons.) [3] | Scenario #3 75% Restrictions in 10 Years (1988 Cig. Cons.) [4] | Scenario #4 Current Baseline 23% Restrictions Contin Cons Decl 10 Years [5] | Scenario #5 Current Baseline 23% Restrictions Contin. Cons. Decl. 20 Years [6] |
| | (Millions of Dollars) | | | | |
| Cost of Implementing the Legislation | 610 | 470 | 209 | 456 | 382 |
| Benefits from Reduced Exposure the ETS | 45,303 | 34,884 | 15,521 | 33,864 | 28,364 |
| Savings in Operating and Maintenance Expenses | 5,154 | 3,969 | 1,766 | 3,853 | 3,227 |
| Net Change in Productivity | $ | $ | $ | $ | $ |
| Savings in Reduced Smoker Absenteeism | 223 | 172 | 77 | 167 | 140 |
| Savings in Smoking Related Fires | 609 | 469 | 209 | 455 | 381 |
| Net Benefits | 59,679 | 39,023 | 17,363 | 37,893 | 31,730 |

*Totals may appear to be greater than the sum of individual items due to rounding.

1. All estimates use 3% discount rate, and assume the same enforcement cost of $160 million.
2. This is the scenario used in the main text.
3. The principal estimates in the text for assessing the effects of H.R. 3434 are based on this scenario.
4. Assumes no additional compliance after 10 years.
5. Per capita consumption has declined by about 3% per year from 1980 to 1990 (DHHS, 1994). Assumes the rate of decline will continue for 10 years, and then level off.
6. Assumes the rate of decline in per capita consumption over the past 10 years will continue for the next 20 years and then level off.



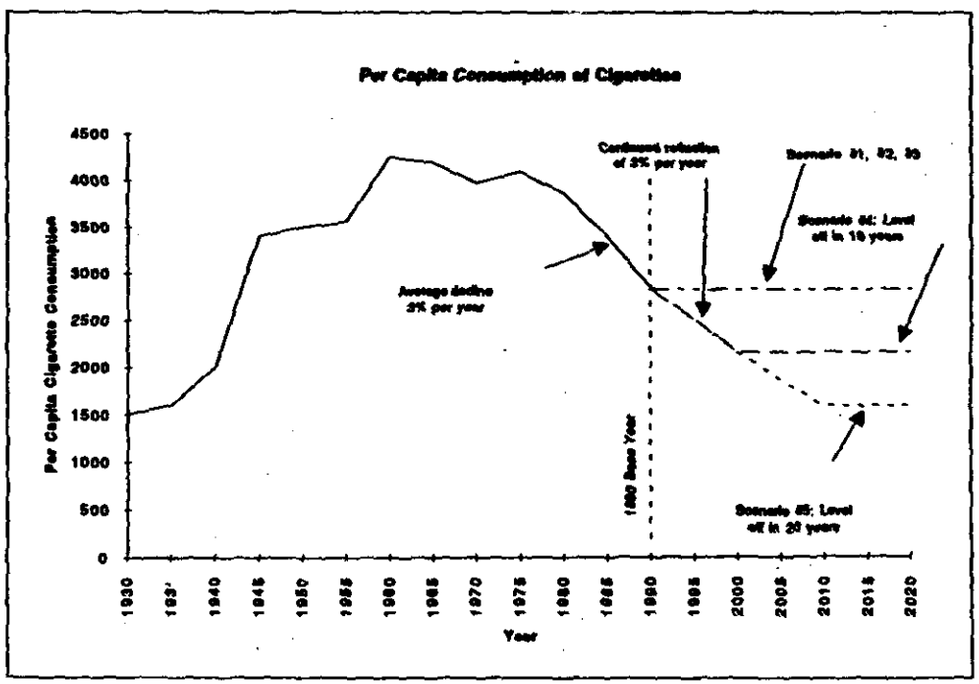



**Exhibit S-4: Benefits Minus Costs**

**Base=23% Restrictions**

| | $ million | | |
|---|---|---|---|
| | 3% Disc. Rate | 5% Disc. rate | 7% Disc. Rate |
| Low Estimate | 39,023 | 37,287 | 36,041 |
| High Estimate | 72,358 | 69,170 | 66,884 |
| Low Benefits Minus High Costs | 38,056 | 36,311 | 35,057 |

# APPENDIX A

## Review of Selected Literature

# Appendix A-1

## Value of Avoiding the Risk of Premature Death

The Environmental Protection Agency recently undertook a review of various approaches to evaluating the the value that persons place on an incremental risk of death (Unsworth, 1992), sometimes referred to as the value of a statistical life. In general, the studies attempt to determane people's willingness to pay to avoid an increase in the risk of premture death. The following summarizes portions of that review.

### Methodological Issues

There are three types of estimates that are commonly used. They are wage-risk studies, contingent evaluation studies, and consumer behavior studies. Wage-risk studies estimate the additional compensation individuals demand in the labor market for taking riskier jobs. Contingent valuation studies ask individuals to state how much they would pay to avoid additional increments of statistical mortality risk. Finally, consumer behavior studies examine market situations (e.g. smoke detectors) other than the labor market that involve a risk-dollar tradeoff.

Most studies reported in the literature apply a wage-risk framework. These studies compare wage rates among different jobs involving different risks and estimate the amount of additional compensation that is associated with the additional risk. Difficulties in these studies include isolating job related risks from risks associated with lifestyle, and isolating compensation due to job related risk from other job related factors that may account for wage differentials. Wage-risk studies assume a perfect labor market in which workers are free to move between jobs and where wages respond readily to forces of supply and demand for labor. The prevalence of unions and other institutional forces which move the labor market away from a perfectly competitive state compromise the validity of these studies. Most wage-risk studies rely on wage data for manual labor and therefore may not be fully representative of the population at large.

The subject population may not be representative for other important reasons. Individuals value risk differently. Some individuals are inherently more apt to accept risk than others. The base level of risk in one's life may be a factor. It has been suggested, for example, that individuals with higher baseline risks tend to place a higher value to risk reduction (Blomquist 1981).

Age is another important factor. It is generally assumed that if one were to differentially value saving the life of a young person compared with saving the life of an elderly person, that the young person's life would be valued more highly. However, the propensity to avoid mortality risk tends to increase with age. That is, the elderly tend to value opportunities to avoid risk more highly, and they therefore reveal a greater implicit value of life. To avoid distortion, the age distribution of subjects in the study should represent the population to which the value of life estimates are being used.

All value of life studies involving the market value of risk suffer from difficulties encountered when participants in the study, or in the market being studied, perceive the risks to be different than the true risks. If, as is sometimes the case, those accepting the risk

as part of the market transaction (or as part of a contingent evaluation study) underestimate the true risks, then the market (or the contingent evaluation study) will undervalue the risks. In addition, since many individuals have difficulty accurately distinguishing, for example, between the risk of death at 1 in 100,000 versus 1 in 1,000,000, value of life estimates can easily be distorted, perhaps by an order of magnitude.

Finally, the way in which individuals value risk depends on the type of risk. Voluntary risks are generally more acceptable than involuntary risks. Other factors of potential importance include whether the risk is controllable or uncontrollable, ordinary or catastrophic, old or new, necessary or unnecessary, and occasional or continuous (Litai 1980).

**Review of the Literature**

Unsworth (1992) reviewed three major surveys of the literature of the value of a statistical life in which each of these methods was evaluated: Viscusi (1992), Miller (1990), and Fisher et al. (1989). The summary of results provided by Unsworth is presented in the exhibit below

Viscusi (1992) examined 39 wage-risk, consumer market and contingent valuation estimates of the value of life. He concludes that labor market studies with carefully constructed risk variables, and contingent value studies with relatively large sample sizes are the most suitable for policy applications. Applying his expert judgement, he finds that the most reasonable estimates of the value of life are clustered in the $3-$7 million range (1990 dollars).

Fisher et al. (1989) examined 21 studies of willingness to pay for reductions in risk. They conclude the most defensible estimates lie in a range from $1.9-$10 million (1990 dollars). The authors go on to express a greater confidence in the lower end of this range. However, they also suggest that this range is an underestimate.

Miller (1990) examined 67 estimates of the value of life in which he considered 47 to be reasonably sound. Making adjustments to the 47 studies on the basis of age, income, accuracy of risk perception, and baseline level of risk, Miller calculates a mean value of the adjusted 47 studies of $ 2.4 million (1990 dollars), and considers a relevant range to be plus or minus 30% of the mean, or $1.7-$3.1 million.

**Choice of an Appropriate Range of Estimates**

Of the three surveys reviewed, Unsworth (1992) concludes that Viscusi and Fisher et al. are a more appropriate starting point for estimating the value of life, because Miller incorporates estimates from consumer behavior studies which are deemed less appropriate for environmental policy purposes, and because the adjustments made by Miller are subject to considerable debate and are less defensible. Unsworth (1992) further suggests that Viscusi estimates are more appropriate because they include more recent studies, and also include more recent versions of some of the studies also considered by Fisher et al. to be sound.

Unsworth (1992) then adds two studies included in Fisher et al. (1989), and which Viscusi will include in a more recent survey soon to be published in the Journal of

Economic Literature. Applying criteria suggested by Viscusi(1992) for studies applicable to policy analysis, Unsworth (1992) narrows the review to 26 studies. Simulating a lognormal distribution and two triangular distributions, and comparing the shape of the simulated distributions to the observed distribution of the 26 studies, Unsworth (1992) concludes that the lognormal distribution is the most appropriate. That distribution has a mean value of $4.8 million per life saved, and a standard deviation of $ 3.2 million.

## SUMMARY OF RECENT VALUE OF LIFE SURVEYS

| Survey Author and Publication Date | Number and Type of Studies Surveyed | Range of Reported Best Estimates of Value of Life (1990 dollars) | Recommendations (1990 dollars) | Comments |
|---|---|---|---|---|
| Viscusi (1992) | 9 studies published from 1974 to 1991 (26 wage risk studies, 7 consumer market studies, 6 contingent value studies) | $70,000 to $16.2 million (originally reported in 1990 dollars) | Most reasonable estimates of the value of life are clustered in the $3 to $7 million range | • Concludes that market studies other than wage risk studies are not appropriate for policy application.<br>• Concludes that structural models do not yield robust estimates<br>• Places less emphasis on "exploratory" pilot scale contingent valuation studies |
| Fisher, Chestnut, and Violette (1989) | 21 studies published from 1974 to 1988 (15 wage risk studies, 4 consumer market studies, 2 contingent valuation studies) | $530,000 to $10.1 million (or $450,000 to $8.5 million as originally reported 1986 dollars) | The most defensible empirical results indicate a range of estimates from $1.9 to $10.1 million | • Concludes that wage risk estimates below $1.9 million result from biases in the measured risk variable and thus should not be used for policy purposes<br>• Concludes that results from consumer market studies reflect potentially significant downward biases<br>• States that most estimates reported in the literature understate the value per statistical life appropriate for environmental policy analysis |
| Miller (1990) | 67 studies published from 1973 to 1990 (37 wage risk studies, 15 consumer market studies, and 15 contingent valuation studies) | $40,000 to $16.7 million (or $36,000 to $15.1 million as originally reported 1988 dollars) | The suggested value of a statistical life for use in cost benefit analysis and legal damage cases is in the range from $1.7 million to $11 million, with a central tendency of $2.4 million | • Adjusts studies for: use of before tax earnings, error in risk perception; error in specification of risk variables, exclusion of non fatal injury risks, age of sample population; and applies a standardized 2.5 percent discount rate<br>• Excludes 20 studies from consideration based on concerns over study quality |

Note: All values converted to 1990 dollars using the CPI deflator

# APPENDIX A-2

## Review of Recent Literature on the Effect of Smoking Policies on Smoking Behavior

***Studies Suggesting Limited Effect***

Baile, Walter F. et al., 1991. *Impact of a Hospital Smoking Ban: Changes in Tobacco Use and Employee Attitudes.* Addictive Behaviors. Vol. 16. pp. 419-426.

A survey was taken approximately 4 months after a hospital wide smoking ban at the Lee Moffit Cancer Center and Research Institute where a hospital wide ban on smoking was instituted. Separate questionnaires were developed for smokers, non smokers and those who had quit smoking since the ban. Only five out of 88 smokers quit since the policy. The authors conclude that the ban had little effect on employee quit rates.

Beiner, Lois et al., 1989. A Comparative Evaluation of a Restrictive Smoking Policy in a General Hospital. American Journal of Public Health. Vol. 79. No. 2. February.

A comparative study was made of two similar hospitals One hospital instituted a restrictive smoking policy while the other did not. Surveys were conducted one month prior to the policy, and 6 months and 12 months after the policy. No significant difference was found in the quit rates at the two hospitals. However, cigarette consumption while at work was reduced at the policy hospital, without a commensurate increase in smoking while at home.

The smoking policy in the policy hospital was only partially restrictive. Smoking was permitted in sections of the cafeteria and coffee shop, and patients were also allowed to smoke in their rooms if their roommate did not object. It is not clear what impact the policy may have had if the policy were more restrictive.

Gottlieb, Nell H. et al., 1990. Impact of a Restrictive Work Site Smoking Policy on Smoking Behavior, Attitudes, and Norms. Journal of Occupational Medicine. Vol. 32. No. 1. January.

Questionnaires were mailed to employees of the Texas Department of Human Resources. Subjects were surveyed 3 months prior to implementation of a smoking policy ( but 2 months after it was announced), and 1 month and 6 months after the policy became effective The results showed no significant change in smoking prevalence, quit attempts, or daily cigarette consumption. However, cigarette consumption while at work was significantly reduced.

Daughton D.M. et al. 1992. Total Indoor Smoking Ban and Smoker Behavior.

Preventive Medicine. Vol 21. No. 5. pp 670-76. September.

Hospital employees were surveyed 1 year after announcing, and 5 months after implementing a total ban on smoking. A second follow up survey was conducted 2 years after the announcement. The results showed little effect on overall institutional quit rates. However, there was a decrease in consumption during working hours, particularly by moderate to heavy smokers.

Petersen, Lyle R. et al. 1988. *Employee Smoking Behavior Changes and Attitudes Following a Restrictive Policy on Worksite Smoking in a Large Company.* Public Health Reports. Vol. 103. No. 2. March-April.

Study of an Connecticut insurance company which adopted a smoking ban in all areas except in designated rest rooms and lounges. The authors collected data 1 year prior and 1 month and 3 months after the policy. The results suggested no increase in quit rates but a substantial reduction in cigarette consumption.

- ***Studies Showing a Moderate to Substantial Effect***

Brenner, Hermann and Mielck, Andreas. 1992. Smoking Prohibition in the Workplace and Smoking Cessation in the Federal Republic of Germany. Preventive Medicine. Vol 21. pp 252-261.

- A national survey was conducted in the Federal Republic of Germany, with an overall response rate of 66%. Respondents were asked if smoking was allowed in their workplace. Quit ratios for women and men were examined and compared with workplace smoking policy. Smoking restrictions at the workplace showed no affect on the quit ratio for men (0. 32 smoking allowed, vs. 0.33 smoking not allowed) but showed a substantial affect for women (0.18 smoking allowed vs 0.45 smoking not allowed). Both men and women showed a considerably higher attempt to quit rate in places were smoking was not allowed. The mean number of cigarettes smoked per day for men was 20.2 (smoking allowed) and (18.4 smoking not allowed), and for women was 17.1(smoking allowed) and 15.7 (smoking not allowed). This represents a 9% and an 8% reduction for men and women respectively.

Borland et al. 1990. Effect of Workplace Smoking Bans on Cigarette Consumption. American Journal of Public Health. Vol. 80. No 2. February.

A total of 2,113 employees at the Australia Public Service were surveyed to determine the effect of a smoking ban on smoking behavior. Surveys were completed two and four weeks before and five to six months after the ban was instituted. The pre-ban results showed that individuals restricted from smoking at their work stations consumed an average of 16.01 cigarettes per day compared with 20.54 cigarettes per day (22% less) at stations where smoking was allowed. After the ban, the consumption rates were 14.16 and 15.36 (8% less) respectively. This shows that the effect of the workplace ban was to reduce consumption by 12% (16.01 versus 14.16) where there were prior work station restrictions, and by 25% where

there were no prior work station restrictions on smoking.

Borland, Ron, et al. 1991. Predicting Attempts and Sustained Cessation of Smoking After the Introduction of Workplace Smoking Bans. Health Psychology. Vol 10. No. 5. pp 336-342.

Using the data from the survey of Australia Public Service employees, the authors examined factors that predict the initiation of cessation attempts, and the maintenance of cessation. The strength of the desire to quit was the best predictor of making an attempt to quit. Having quit before the ban, as well as support from family and friends were also good predictors of attempting to quit. As expected, heavy smokers have the most trouble maintaining abstinence, and persons who have quit before are less likely to maintain abstinence. Social support for quitting was a modest predictor of maintenance. The authors postulate that the imposition of smoking bans should provide a context where smoking cessation is more likely.

Hocking Bruce, et al. 1991. A Total Ban on Workplace Smoking Is Acceptable and Effective. Journal of Occupational Medicine. Vol 33. No. 2. February.

Telecom Australia is a telecommunications organization with 85,000 staff. After several years of introducing progressively more restrictive policies, Telecom Australia introduced a total ban on smoking in 1988. Prior to and 6 and 18 months after the ban, a survey of employees was conducted in representative areas. The number of smokers decreased by about 5% over the two year period, compared with 2% for the Australian community as a whole. In addition, smokers were smoking 3-4 fewer cigarettes/day after the ban.

Hudzinski, Leonard D. 1990. One-Year Longitudinal Study of a No-Smoking Policy Medical institution. CHEST. Vol. 97. No. 5. May.

The Ochner Medical Institutions in New Orleans instituted a campus wide smoke free policy. A survey (1986-87) was conducted 6 months prior, 6 months after, and 1 year after the policy was instituted. Results suggested a 30% reduction (from 20 to 14%) in population of smokers after 1 yr. Half of those who quit said the policy had helped them a great deal. 80% of smokers after 1 year smoked less than 8 cigarettes per day.

Sorensen e. al. 1993. Promoting Smoking Cessation at the Workplace: Results of a Randomized Controlled Intervention Study.

In a controlled intervention study at 8 sites in Bloomington Minnesota, smokers were surveyed 1 month and 6 months after a three month intervention program was completed. The intervention consisted of consultation with employees about the adoption of a nonsmoking policy, training to nonsmokers in providing assistance to smokers attempting to quit, and cessation classes for smokers. After 1 month, the quit rate for the intervention group was 11.5% compared to 5.2% for the

control group. At the 6 month interval, the quit rate for the intervention group was 12 % compared to 8.8% of the control group. These rates are adjusted for the effects of age, sex, and education. Quit rates were based on answers to the simple question, "Do you now smoke cigarettes?"and also, not assessing the length of abstinence. The long term quit rates therefore are likely to be substantially lower than those reported. Those supported by an intervention program had a slightly higher quit success rate than those without such a policy.

Sorensen G. et. al. 1991. Effects of a Worksite Nonsmoking Policy: Evidence of Increased Cessation. American Journal of Public Health. Vol. 81, No. 2, February.

In 1986, the New England Telephone Company instituted a no smoking policy. A random sample of employees was taken 20 months after the policy was implemented. The results revealed a 21% reduction in smokers after 20 months (reduced to 18 % for those who had quit for more than 3 months). 42% of those who quit (9% of smokers) attributed their quitting to the no smoking policy.

Sorensen, Glorian and Pechacek, Terry F. 1989. Implementing nonsmoking policies in the private sector and assessing their effects. New York State Journal of Medicine. Vol. 89. January.

Data was collected in a telephone interview from 711 smokers and recent ex-smokers at seven worksites in Bloomington, Minnesota. In a survey conducted in 1986, 12-18 months after intervention, 58% felt that quitting would be easier if they could not smoke at work. Of the 42% who tried to quit in the last 2 years, 20% succeeded.

Stave, G.M. and Jackson, G.W. 1991. Effect of a Total Work-site Smoking Ban on Employee Smoking Attitudes. Journal of Occupational Medicine. Vol 33. No.8. pp 884-90.

In this study, the authors compared data on smoking attitudes and behaviors at Duke University Medical Center which adopted a smoking ban, and on an adjacent campus where no such ban was adopted. Surveys were conducted three months and 9 months after the smoking ban was in affect (9 months and 15 months after announcement). Three months after policy implementation, mean cigarette consumption during working hours had dropped from 8.1 to 4.3 cigarettes

(47% decline) at the medical center and from 9.3 to 8.78 (6% decline) at the University Campus. In the fifteen months after the announcement 12.6% of smokers at the Medical Center and 6.9% at the University Campus had quit.

Stillman, Frances A. et al. Ending Smoking at The Johns Hopkins Medical Institutions: An Evaluation of Smoking Prevalence and Indoor Air Pollution. JAMA, Vol 264. No. 12. September 26, 1990.

In 1988, The Johns Hopkins University Hospital Complex decided to eliminate

smoking in all areas of the building complex. Previous policy allowed smoking in designated areas of cafeterias, waiting areas, lounges, patient areas and offices. Surveys were conducted 6 months before and 6 month after the policy was instituted. Smoking prevalence declined from 21.7% to 16.2% (25% decline). The number of cigarettes smoked per day went from 16.4 to 13.1 (20% decline), and the cigarettes smoked while at work went from 7.8 to 3.8 (51% decline). The quit rate was 20.4% between surveys, but would be reduced to 10% assuming all nonrespondents (50%) did not quit. For those that had quit for more than 3 months at the time of the survey, the quit rates are adjusted to 18.2% and 9% respectively.

Wasserman, Jeffrey, et al. 1991. The Effects of Excise Taxes and Regulations on Cigarette Smoking. Journal of Health Economics. Vol 10. pp 43-64.

The authors used data on smoking status and behavior from 1970 to 1985 for adults from the National Health Interview Survey, conducted annually by the National Center for Health Statistics. Data for teenagers was taken from the National Health and Nutrition Examination Survey II. A generalized linear model was used to estimate the effects of excise taxes and regulations on adult and teenage smoking behavior.

The authors used a regulation index in which a value of one was assigned to communities with comprehensive smoking laws in most public places, including that including restrictions in workplaces, zero for no restrictions in any places, and values of .75, .50, .25 for combinations in between. They used a two stage model in which the decision to smoke and the level of demand were analyzed sequentially.

The authors predict that if the regulation index was raised from 0.25 (smoking restrictions in areas where people spend little time) to 1.00 (restrictions in almost all places, including workplaces), then per capita cigarette consumption for adults would decrease by 5.9%. For adults, the regulation index had a statistically significant result only on the number of cigarettes smoked, not on the decision to smoke. The same change in the regulation index would have a different effect on teenage behavior. Teenage consumption would decrease by 41%. However, this effect results mostly from preventing teens from starting to smoke rather than reducing the consumption of teenage smokers.

Woodruff, T. J. et al. 1993. Lower Levels of Cigarette Consumption Found in Smoke-free Workplaces in California. Archives of Internal Medicine. Vol. 153. No. 12. pp 1485-93. June 28.

Woodruff, et al. (1993) applied a logistics regression on data from the 1990 California Tobacco Survey in which subjects were queried by telephone. Prevalence was 13.7% in smoke-free workplaces compared with 20.6% in places with no restrictions (33% difference). When the influence of demographic variables were accounted for, it was estimated that persons with little restrictions on smoking were approximately 30% more likely to be smokers than were those working in smoke-free workplaces.

The workplace smoking policies showed little effect on changing the smoking status

of persons who were regular smokers 1 year prior to the survey. Approximately 85% remained regular smokers regardless of workplace smoking policy. The authors note that most of California's smoking policies had been implemented before the survey date of July 1990, and that smokers who were likely to change their behavior had already done so by the time the survey was taken.

However, there was a substantial effect of smoking policies on the proportion of occasional smokers who became regular smokers. Of those that had been occasional smokers one year prior to the survey, 21% had become regular smokers in smoke free workplaces compared to 33% in workplaces with no restrictions. No data were shown for individuals who were previously non smokers.

Cigarette consumption per smoker was 13 % less among those with no workplace restrictions compared with those working in a smoke-free environment (296 versus 341 packs per year). Accounting for reduced smoking prevalence and reduced consumption by smokers, including occasional smokers, the authors estimate that if all workplaces were smoke free, consumption would be 41% lower than if there were no workplace smoking restrictions.

# APPENDIX B

## Technical Appendix

# Explanation of Housekeeping

# and

# Maintenance Methodology

**Technical Appendix**
**Housekeeping and Maintenance Impacts of H.R. 3434**

**Offices**

Offices reported reduced cleaning costs due to reduced emptying and cleaning of ashtrays, easier dusting of desktops and high areas, reduced washing of walls, reduced cleaning of carpets, reduced cleaning of venetian and horizontal blinds, reduced cleaning of HVAC vents, and reduced cleaning of indirect lighting. For the purposes of this analysis, savings associated with ash trays, dusting desktops and high areas, cleaning venetian/horizontal blinds, and cleaning HVAC vents are quantified. Cleaning costs are estimated using a prototype annual cleaning budget for items that would change in a smoke-free environment. Generally, the estimates are calculated by multiplying the time required for each task by the labor rate and the frequency that each task would be performed on an annual basis to develop annual costs per 1,000 square feet. Detailed calculations are discussed below:

- Ash trays: The analysis assumed that under a smoking environment, ash trays would be emptied and cleaned each business day for a total of 250 times per year (52 weeks multiplied by 5 days per week, minus 10 holidays). One source actually reported that ash trays in their facility were emptied 3 times per day, however, once per day is more common. In a smoke-free environment, emptying ash trays would be completely eliminated. The estimate of the time required to empty and clean ash trays for 1,000 square feet of office space (2.5 minutes) is from a BOMA report on cleaning costs in office buildings.

- Dusting: According to one documented study by BOMA, the dusting of desks was reduced from daily to once per week in an office with a non-smoking policy. The analysis assumes that the frequency for dusting desktops will be reduced from 250 times per year to 52 times per year. The estimate of the time required to dust desk tops for 1,000 square feet of office space (2.2 minutes) is from a BOMA report on cleaning costs in office buildings.

- Dusting High Areas: According to the BOMA study, the dusting of high areas (top of partitions) was reduced from once per week to once per month. The analysis assumes that the frequency for dusting high areas will be reduced from 52 times per year to 12 times per year. The estimate of the time required to dust high areas for 1,000 square feet of office space (4.5 minutes) is from a BOMA report on cleaning costs in office buildings.

- Cleaning Venetian/Horizontal Blinds: According to the BOMA study, the cleaning of blinds was reduced from 6 times per year to once per year. The analysis assumes that the frequency for dusting high areas will be reduced from 6 times per year to 1 time per year. The estimate of the time required to clean blinds for 1,000 square feet of office space (2.0 minutes) is from a BOMA report on cleaning costs in office buildings.

- Dusting HVAC Vents: According to the BOMA study, the dusting of HVAC vents was reduced from 4 times per year to once per year. The analysis assumes that the frequency for dusting vents will be reduced from 4 times per year to 1 time per year. The estimate of the time required to dust HVAC vents for 1,000 square feet of office space (10.0 minutes) is from a BOMA report on cleaning costs in office buildings.

Cost savings in offices were also reported due to reduced damage to carpets, furniture, and computer equipment. Cigarette burns to carpets would be eliminated in a smoke free

environment. Managers have the choice of either repairing burns or replacing the entire carpet when the problem becomes too noticeable. This analysis assumes that carpets will be repaired at an estimated cost of $100 per burn. One carpet repair is estimated to be necessary per year per 1,000 square feet of office.

Office furniture will also be protected from burn damage in a smoke-free environment. One article estimated that furniture would last three times as long with a smoking ban. Tax policy estimates that the average depreciation life of business furniture is 7 years. The analysis assumes that offices will normally replace furniture once every 7 years (when it can no longer be depreciated) if there is no excess damage to the furniture (from burns, for example). Following the estimate that furniture would need to be replace three times as often would lead to replacing furniture once every 2 to 3 years in a smoking environment. Although this may be accurate in extreme cases, the norm is probably less. The analysis assumes that office furniture would be replaced once every 5 years in a smoking environment in comparison with once every 7 years in a smoke-free building. The value of office furniture was estimated by determining the average price of a desk and upholstered desk chair from a large office furniture supplier ($525 for a desk and $230 for a chair). Six desk and chair sets were assumed to be contained in 1,000 square feet of office space (based on occupancy standards).

Computer equipment, especially personal computers, represent another category of potential savings in a smoke-free environment. Computers will remain cleaner, requiring less time to repair and, in extreme cases, not need to be replaced as frequently. Based on interviews, the analysis assumes that computer keyboards used by smokers will require replacement once every 1.5 years in comparison with once every 5 years for keyboards used by non-smokers. Also, maintenance and repairs to computers of smokers would take 30 minutes longer due to increased cleaning required.

The need for painting would also be reduced. The analysis assumes that painting would be required once every 5 years in a smoking environment and once every eight years in a non-smoking area. The estimate of time required to paint 1,000 sq. ft of office space is from Means Facilities Maintenance Standards.

Will every building or business experience the potential savings estimated? A survey of businesses found that 43 to 60 percent of businesses instituting a smoking ban experienced maintenance cost savings. There are many plausible explanations as to why a firm may not experience cost savings. For example, a business may have a fixed maintenance and janitorial staff that will not be reduced but work on other activities if the smoking-related activities are reduced. Also, some businesses may not be able to renegotiate existing cleaning contracts. Finally, some businesses may simply have a higher tolerance for a dirty, dingy environment with damaged carpets and furniture.

To take into account these possibilities a high and low estimate of savings is calculated. Also, it is assumed that only a portion of potential office space will fully realize the benefits. For Offices, the low estimate included cleaning cost savings and reduced painting. In the case of cleaning, 60 percent of the total square feet (7,081 million sq. ft out of 11,802 million sq. ft) of office space is estimated to report the savings. For painting, some tenant occupied office space will in fact be painted more often than once every 5 years due to turnover of occupants. To take this into account, the savings is only claimed for offices expected to have longer occupancy including government owned space and single-owner occupied space (6,610 million sq. ft).

In the high estimate, carpet repairs, replacing of office furniture, replacing computer keyboards,

and computer maintenance are added to the low estimate. Carpet repairs and furniture replacement are calculated for 60 percent of the total square feet (7,081 million sq. ft out of 11,802 million sq. ft) of office space. Computer-related costs are calculated based on the estimate of personal computers used by smokers in the workforce (estimated at 25 percent of 20,330,000 total PC's in the workplace or 6,657,500 personal computers). This figure does not take into account damage to equipment other than PC's such as printers or PC's used by non-smokers, but in an office that permits smoking.

**Mercantile and Service**

Retail stores and service outlets usually restrict smoking to certain common areas in the building. In these areas, as smoking ban will eliminate the need to empty and damp wipe ashtray stands, reduce sweeping and vacuuming, eliminate carpet burns, reduce the need to clean windows and display cases, and reduce painting. For the purposes of this analysis, cleaning costs are calculated for elimination of cleaning ashtray stands and reduced need to sweep or vacuum. With smoking allowed, ashtray stands were assumed to require cleaning and emptying once every day for approximately 290 days per year. In actuality, ash tray stands may require more frequent cleaning such as two or three times per day, 365 days per year. The cleaning time per 1,000 sq. ft (4.0 minutes) is derived by assuming 10 stands in 1,000 sq. ft requiring 0.4 minutes per stand (from Means Facility Maintenance Standards) to empty and clean. Sweeping and vacuuming is assumed to be required twice per week with smoking allowed and once per week in a smoke-free environment. The time required to sweep/vacuum 1,000 sq. ft is the minimum estimate from Means Facility Maintenance Standards.

Reduced maintenance costs were calculated for reduced carpet repairs and reduced painting. Carpet repairs were estimated using the same assumptions described for Office space. Painting was assumed to be reduced from once every 5 years to once every 7 years. This estimate may be low since retail and service space must retain appearance to attract customers and may therefore have lower tolerance for dingy walls.

Of the total 13,157 million square feet of building space classified as Mercantile and Services in the Department of Energy estimates, it was assumed that for cleaning and carpet repairs, only 60 percent of this space would report savings. For painting, it was assumed that 30 percent would report savings. Of this space, 40 percent was assumed to be in common areas subject to smoking resulting in an applicable area of 3,158 square feet for housekeeping and by 1,579 million square feet for painting.

**Food Service**

Restaurants and lounges face much the same situation as hotels and motels. One restaurant owner stated that they would need 20 additional employees to empty ashtrays, sweep butts, wash windows, and fill in absences without a no-smoking policy in the establishment. The owner also reported less clean up time and fewer burns on tables. One restaurateur was considering installing expensive air cleaning and filtration equipment that were not necessary when a no smoking policy was instituted.

For the purposes of this analysis, cleaning cost savings were calculated for the elimination of emptying ash trays every day, 6 times per day, under the assumption that ash trays will be

cleaned each time a new group arrives at a smoking table (2,190 times per year). This assumption may be low since staff at nicer restaurants will often clean ashtrays several times during a meal, particularly for heavy smokers. The cost time estimate to clean one ashtray is from Department of the Army Janitorial Formulas. Reduced time due to sweeping butts and washing windows was not estimated.

Painting is assumed to be necessary once every 4 years with smoking instead of once every 5 years. The painting frequency may in fact be much higher in nicer establishments subject to heavy smoking. Damages due to cigarette burns are estimated assuming once carpet repair per year per 1,000 square feet. The need to repair and replace table linens, chairs, and tables is estimated at once every 5 years with smoking and once every 7 years (as employed in tax depreciation calculations) without smoking. The value of a table and chair set is from Means Square Foot Costs.

Expected savings are calculated on the basis of food service seating capacity for smokers. According to the Department of Energy, the food service seating capacity is 27,753,000. It was assumed that 80 percent of this capacity are expected to report savings due to a smoke-free environment. This is a bit higher than the 60 percent expected in office spaces because food service establishments will place a greater emphasis on appearance and cleanliness, and have a lower tolerance for damages. Painting benefits were expected to accrue to 60 percent of the smoking capacity. Assuming that 30 percent of the capacity is used by smokers, the smoking seating capacity is 8,325,900.

**Health Care**

Health Care facilities contain a number of different types of space that is used for a variety of purposes. Some space is used for administrative purposes such as billing and personnel. The savings to this space would be the similar to that for offices. Space devoted to patient care would have different types of savings. For the purposes of this analysis, administrative space was assumed to have savings identical to those described for offices. It was assumed that 20 percent of space in Health Care facilities will be devoted to administrative functions.

Building space devoted to patient care will contain bed-ridden patients. It was assumed that each smoking patient will require cleaning and emptying of an ashtray twice per day, 365 days per year (730 days per year total). Also, space containing smoking patients will require sweeping 1.5 times more often than rooms with non-smokers (548 vs. 365 times per year).

The total amount of space for Health Care facilities is 4,225 million square feet. Savings identical to those calculated for offices are expected to accrue to 60 percent of this space. Painting savings are expected to accrue to only 30 percent of the potential space. Administrative functions is assumed to account for 20 percent or 845 million square feet.

Savings associated with patient care is calculated on the basis of the number of hospital beds used by smokers. It was assumed that 25 percent of the total beds (25 percent of 3,602,000, or 900,500) would be occupied by smokers. Given that smokers have a higher rate of hospitalization than non-smokers, this figure may be low.

### Assembly

Buildings that are used for assembly will accrue benefits to that portion of their space used as a common areas with smoking permitted. The reductions in cleaning and maintenance were calculated using the same categories and assumptions as the common areas for the Mercantile and Services category. Savings are expected to accrue to 60 percent of this space for cleaning and carpet repairs, and to 30 percent for painting. It was assumed that 20 percent of the area expected to report savings would be in common areas, resulting in an applicable area of 821 million square feet for housekeeping and carpet repairs, and 410 million square feet for painting.

### Education

As with Health Care facilities, Education facilities can be used in a variety of different ways, particularly at the higher education (college and university) level. Since it is more likely that smoking will be limited in elementary and secondary level schools, this estimate will focus only on institutions of higher learning (colleges, universities, junior colleges). A fair portion of space in colleges and universities is devoted to administrative and office functions. These spaces would accrue the same types of savings as general office space. Colleges and universities would also have common areas similar to Assembly and Mercantile and Services space.

It is expected that benefits will be reported by 60 percent of the total space in colleges and universities (approximately 1,200 million square feet of 2,000 million square feet). For the purposes of this analysis, it was assumed that half of the space in colleges and universities (600 million square feet) will be devoted to administrative and office uses. Benefits for this space were calculated in the same manner as benefits for the office use. Another 20 percent will be in common areas (240 million sq. ft). Benefits for these areas are calculated the same as common areas in other types of buildings (Assembly, for example).

### Lodging

Hotels and motels face the unique challenge of maintaining a pleasant, clean, and attractive building in the presence of smoking. Very often business and profits depend on how good a room looks, its overall cleanliness, and its odor. Thus, cleaning, painting, and replacing carpets and furnishings are done at a greater frequency than in an office environment. For the purposes of this analysis, the only cleaning cost savings claimed is from the elimination of emptying and cleaning ashtrays. The same basic methodology as described under offices was used. Carpet repairs were also estimated to occur at the same frequency and cost the same amount. This will probably underestimate actual savings since hotels and motels will have less tolerance to unsightly carpets, thereby leading to increased replacement of carpets rather than repair.

Lodging space can also be divided into different uses. The bulk of the space is used for guest rooms, but some of the space is in common areas. Cost savings for common areas are estimated using the same assumptions as other types of common areas. It is assumed that 20 percent of the Lodging space is devoted to common areas.

Cost savings to guest rooms used by smokers could be quite large including reduced cleaning time for each room, reduced carpet repairs, reduced painting, and reduced replacement of furniture and linens. The need to repair and replace furniture and linens is estimated at once

every 5 years with smoking and once every 7 years (as employed in tax depreciation calculations) without smoking. The value of a standard set of furniture is from Means Square Foot Costs. It is unclear whether H.R. 3434 will prohibit smoking in guest rooms designated for smoking use, thus, savings associated with guest rooms are included only in the high estimate of benefits.

Benefits are expected to accrue to 60 percent of lodging establishments for cleaning, repair and replacing, but to 30 percent for painting savings.

### Industrial/Warehouse

Warehouse and industrial environments will have lower aesthetic standards than other types of establishments for their production areas. Reported activities for production areas that would decrease under a no smoking policy for a warehouse include emptying ash trays and sweeping floors. The savings associated with eliminating the need to empty ash trays is calculated in the same manner as for other categories. Savings from reduced sweeping are calculated based on the assumption that the frequency of sweeping would go from 2 times per week to once per week in a smoke free environment, as reported in the literature.

The portion of industrial/warehouse space expected to report savings was assumed at 60 percent. A portion of this space would be devoted to administrative and office functions that would be expected to have the same types of savings as offices. For the purposes of this analysis, 20 percent of the space in this category will be used for administrative purposes and the remaining 80 percent will be used in production areas.

### Total Savings

Exhibit B3-1 summarizes the low and high estimates of cleaning and maintenance savings for each building category under H.R. 3434. Total square feet for each building category and applicable square feet are also displayed. The savings per square feet are also calculated.

**Exhibit B3-1: Detailed Housekeeping and Maintenance Cost Savings by Type of Establishment**

| | Potential Savings (per 1000 sq ft) | Total Area (Million Square Feet) | Portion Expected to Report Savings | Applicable Area | Total Expected Savings (millions of dollars) | Total Expected Savings (millions of dollars) |
|---|---|---|---|---|---|---|
| **ASSEMBLY** | | | | | | |
| **Cleaning:** | | | | | | |
| *Empty and damp wipe ashtray stands* | $163.52 | 6,838 | 4,103 | 821 | $134 | $134 |
| Sweeping/vacuuming | $72.80 | 6,838 | 4,103 | 821 | $60 | $60 |
| **Maintenance/Repair/Replacement:** | | | | | | |
| Carpet Repairs | $100.00 | 6,838 | 4,103 | 821 | | $82 |
| Painting | $104.39 | 6,838 | 4,103 | 410 | $43 | $43 |
| TOTAL | | | | | $237 | $319 |
| **HEALTH CARE** | | | | | | |
| **Cleaning:** | | | | | | |
| Empty and damp wipe ashtrays | $87.50 | 4,225 | 2,535 | 507 | $44 | $44 |
| Dusting Desktops | $62.94 | 4,225 | 2,535 | 507 | $32 | $32 |
| High Dusting | $25.20 | 4,225 | 2,535 | 507 | $13 | $13 |
| Venetian/Horizontal Blinds | $7.00 | 4,225 | 2,535 | 507 | $4 | $4 |
| Clean HVAC Vents | $1.05 | 4,225 | 2,535 | 507 | $1 | $1 |
| Per Hospital Beds used by smokers: | | | | | | |
| Empty and damp wipe ashtrays | $21.90 | 3,602,000 | 2,161,200 | 900,500 | $20 | $20 |
| Sweeping | $127.75 | 3,602,000 | 2,161,200 | 900,500 | $115 | $115 |
| **Maintenance/Repair/Replacement:** | | | | | | |
| Replace Office Furniture | $271.80 | 4,225 | 2,535 | 507 | | $138 |
| Carpet Repairs | $100.00 | 4,225 | 2,535 | 507 | | $51 |
| Painting | $130.48 | 4,225 | 2,535 | 254 | $33 | $33 |
| TOTAL | | | | | $261 | $449 |
| **EDUCATION** | | | | | | |
| **Cleaning:** | | | | | | |
| Administrative/Office Space: | | | | | | |
| Empty and damp wipe ashtrays | $87.50 | 8,148 | 1,200 | 600 | $53 | $53 |
| Dusting Desktops | $62.94 | 8,148 | 1,200 | 600 | $38 | $38 |
| High Dusting | $25.20 | 8,148 | 1,200 | 600 | $15 | $15 |
| Venetian/Horizontal Blinds | $1.40 | 8,148 | 1,200 | 600 | $1 | $1 |
| Clean HVAC Vents | $4.20 | 8,148 | 1,200 | 600 | $3 | $3 |
| Common areas: | | | | | | |
| Empty and damp wipe ashtray stands | $140.00 | 8,148 | 1,200 | 240 | $34 | $34 |
| Sweeping/vacuuming | $72.80 | 8,148 | 1,200 | 240 | $17 | $17 |

**Exhibit B3-1: Detailed Housekeeping and Maintenance Cost Savings by Type of Establishment Continued**

| | Potential Savings (per 1000 sq ft) | Total Area (Million Square Feet) | Portion Expected to Report Savings | Applicable Area | Total Expected Savings (millions of dollars) | Total Expected Savings (millions of dollars) |
|---|---|---|---|---|---|---|
| **EDUCATION, continued** | | | | | | |
| **Maintenance/Repair/Replacement:** | | | | | | |
| Administrative/Office Space: | | | | | | |
| Replace Office Furniture | $271.80 | 8,148 | 1,200 | 600 | | $163 |
| Carpet Repairs | $100.00 | 8,148 | 1,200 | 600 | | $60 |
| Painting | $130.48 | 8,148 | 1,200 | 600 | | $78 |
| TOTAL | | | | | $160 | $461 |
| **MERCANTILE AND SERVICES** | | | | | | |
| **Cleaning:** | | | | | | |
| Empty and damp wipe ashtray stands | $163.52 | 13,157 | 7,894 | 3,158 | $516 | $516 |
| Sweeping/vacuuming | $72.80 | 13,157 | 7,894 | 3,158 | $230 | $230 |
| **Maintenance/Repair/Replacement:** | | | | | | |
| Carpet Repairs | $100.00 | 13,157 | 7,894 | 3,158 | | $316 |
| Painting | $104.39 | 13,157 | 7,894 | 1,579 | $165 | $165 |
| TOTAL | | | | | $911 | $1,227 |
| **LODGING** | | | | | | |
| **Cleaning:** | | | | | | |
| Common Area: Empty and damp wipe ashtrays | $127.75 | 2,855 | 1,713 | 343 | $0 | $0 |
| Guest Room (smoking): General Cleaning (per room) | $245.28 | 5,053,000 | 3,031,800 | 1,263,250 | | $310 |
| **Maintenance/Repair/Replacement:** | | | | | | |
| Common Area: Carpet Repairs | $100.00 | 2,855 | 1,713 | 343 | $0 | $0 |
| Common Area: Painting (per 1000 sq ft) | $86.98 | 5,053,000 | 3,031,800 | 171,300 | $15 | $15 |
| Guest Room (smoking): Replace Furniture (per room) | $127.50 | 5,053,000 | 3,031,800 | 1,263,250 | | $161 |
| Guest Rooms (smoking): Carpet Repairs (per room) | $100.00 | 5,053,000 | 3,031,800 | 1,263,250 | | $126 |
| Guest Rooms (smoking): Painting (per room) | $43.49 | 5,053,000 | 3,031,800 | 1,263,250 | | $55 |
| TOTAL | | | | | $15 | $667 |
| **WAREHOUSE/INDUSTRIAL** | | | | | | |
| **Cleaning:** | | | | | | |
| Administrative Space: | | | | | | |
| Empty and damp wipe ashtrays | $87.50 | 12,253 | 7,352 | 1,470 | $129 | $129 |
| Dusting Desktops | $62.94 | 12,253 | 7,352 | 1,470 | $93 | $93 |
| High Dusting | $25.20 | 12,253 | 7,352 | 1,470 | $37 | $37 |
| Venetian/Horizontal Blinds | $1.40 | 12,253 | 7,352 | 1,470 | $2 | $2 |
| Clean HVAC Vents | $4.20 | 12,253 | 7,352 | 1,470 | $6 | $6 |
| | $0.00 | 12,253 | 7,352 | 1,470 | $0 | $0 |

**Exhibit B3-1: Detailed Housekeeping and Maintenance Cost Savings by Type of Establishment**
**Continued**

| | Potential Savings (per 1000 sq ft) | Total Area (Million Square Feet) | Portion Expected to Report Savings | Applicable Area | Total Expected Savings (millions of dollars) | Total Expected Savings (millions of dollars) |
|---|---|---|---|---|---|---|
| **WAREHOUSE/INDUSTRIAL, continued** | | | | | | |
| Production Areas: | | | | | | |
| Empty and damp wipe ashtrays | $87.50 | 12,253 | 7,352 | 5,881 | $515 | $515 |
| Sweeping | $36.40 | 12,253 | 7,352 | 5,881 | | $214 |
| TOTAL | | | | | $781 | $995 |
| **FOOD SERVICE** | | | | | | |
| Cleaning: | | | | | | |
| Empty and damp wipe ashtrays | $65.70 | 27,753,000 | 22,202,400 | 6,660,720 | $438 | $438 |
| Maintenance/Repair/Replacement: | | | | | | |
| Replace Table and chair set | $26.85 | 27,753,000 | 22,202,400 | 6,660,720 | | $179 |
| Carpet Repairs | $10.00 | 27,753,000 | 22,202,400 | 6,660,720 | $67 | $67 |
| Painting (per 1000 sq feet) | $86.99 | 1,167 | 700 | 700 | $0 | $0 |
| TOTAL | | | | | $504 | $683 |
| **OFFICES** | | | | | | |
| Cleaning: | | | | | | |
| Empty and damp wipe ashtrays | $87.50 | 11,802 | 7,081 | 7,081 | $620 | $620 |
| Dusting Desktops | $62.94 | 11,802 | 7,081 | 7,081 | $446 | $446 |
| High Dusting | $25.20 | 11,802 | 7,081 | 7,081 | $178 | $178 |
| Venetian/Horizontal Blinds | $1.40 | 11,802 | 7,081 | 7,081 | $10 | $10 |
| Clean HVAC Vents | $4.20 | 11,802 | 7,081 | 7,081 | $30 | $30 |
| Maintenance/Repair/Replacement: | | | | | | |
| Replace Office Furniture | $271.80 | 11,802 | 7,081 | 7,081 | | $1,925 |
| Carpet Repairs | $100.00 | 11,802 | 7,081 | 7,081 | | $708 |
| Painting | $130.48 | 11,802 | 6,610 | 6,610 | $863 | $863 |
| | | Computers | Computers | Computers | | |
| Computer Maintenance (smokers) | $21.25 | 26,630,000 | 6,657,500 | 6,657,500 | | $141 |
| Computer Keyboard Replacement (smokers) | $23.50 | 26,630,000 | 6,657,500 | 6,657,500 | | $156 |
| TOTAL | | | | | $2,146 | $5,077 |

# Examples of

# Discounting Methodology

## Exhibit B4-1: Value of Reduced Absenteeism

| Years | 1991-2000 | 2001-2010 | 2011-2020 | 2021-2030 | 2031-2040 | 2041-2050 | 2051 + | |
|---|---|---|---|---|---|---|---|---|
| **3% Calculations** | | | | | | | | |
| **Quitting (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 1.35 | 1.29 | 1.09 | 0.73 | 0.38 | 0.10 | 0.00 | |
| Reduced Absentee Days | 0.78 | 0.77 | 0.66 | 0.44 | 0.23 | 0.06 | | |
| Value | 80.77 | 80.58 | 68.18 | 45.51 | 23.52 | 6.28 | | |
| Discount Factor | 0.862068784 | 0.841861947 | 0.477605569 | 0.355383398 | 0.264438624 | 0.196787171 | 0.194789408 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 33.33 | |
| Present Value | 696.74 | 517.21 | 325.62 | 161.75 | 62.19 | 12.36 | | 1,776 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 63 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 107 |
| **Reduced Initiation (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 0.21 | 0.58 | 0.97 | 1.35 | 1.74 | 2.12 | 2.28 | |
| Reduced Absentee Days | 0.30 | 0.89 | 1.48 | 2.03 | 2.60 | 3.18 | 3.44 | |
| Value | 31.44 | 92.29 | 151.83 | 211.37 | 270.91 | 330.45 | 357.24 | |
| Discount Factor | 0.862068784 | 0.841861947 | 0.477605569 | 0.355383398 | 0.264438624 | 0.196787171 | 0.194789408 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 33.33 | |
| Present Value | 271.18 | 592.36 | 725.13 | 751.16 | 716.38 | 650.21 | 1,982.31 | 5,689 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 179 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 349 |
| **5% Calculations** | | | | | | | | |
| **Quitting (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 1.35 | 1.29 | 1.09 | 0.73 | 0.38 | 0.10 | | |
| Reduced Absentee Days | 0.78 | 0.77 | 0.66 | 0.44 | 0.23 | 0.06 | | |
| Value | 80.77 | 80.58 | 68.18 | 45.51 | 23.52 | 6.28 | | |
| Discount Factor | 0.783526166 | 0.481017098 | 0.295302772 | 0.181290285 | 0.111296508 | 0.068326402 | 0.050986213 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 20.00 | |
| Present Value | 632.87 | 387.60 | 201.33 | 82.51 | 26.17 | 4.29 | | 1,335 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 67 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 133 |
| **Reduced Initiation (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 0.21 | 0.59 | 0.97 | 1.35 | 1.74 | 2.12 | 2.28 | |
| Reduced Absentee Days | 0.30 | 0.89 | 1.48 | 2.03 | 2.60 | 3.18 | 3.44 | |
| Value | 31.44 | 92.29 | 151.83 | 211.37 | 270.91 | 330.45 | 357.24 | |
| Discount Factor | 0.783526166 | 0.481017098 | 0.295302772 | 0.181290285 | 0.111296508 | 0.068326402 | 0.050986213 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 20.00 | |
| Present Value | 246.32 | 443.92 | 448.35 | 383.19 | 301.51 | 225.76 | 364.29 | 2,413 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 121 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 241 |
| **7% Calculations** | | | | | | | | |
| **Quitting (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 1.35 | 1.29 | 1.09 | 0.73 | 0.38 | 0.10 | | |
| Reduced Absentee Days | 0.78 | 0.77 | 0.66 | 0.44 | 0.23 | 0.06 | | |
| Value | 80.77 | 80.58 | 68.18 | 45.51 | 23.52 | 6.28 | | |
| Discount Factor | 0.712986179 | 0.36244602 | 0.184249178 | 0.093662939 | 0.047613489 | 0.024204263 | 0.016128338 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 14.29 | |
| Present Value | 575.69 | 292.06 | 125.62 | 42.63 | 11.20 | 1.52 | | 1,049 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 73 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 147 |
| **Reduced Initiation (Low Estimate)** | | | | | | | | |
| Number Persons (million) | 0.21 | 0.59 | 0.97 | 1.35 | 1.74 | 2.12 | 2.28 | |
| Reduced Absentee Days | 0.30 | 0.89 | 1.48 | 2.03 | 2.60 | 3.18 | 3.44 | |
| Value | 31.44 | 92.29 | 151.83 | 211.37 | 270.91 | 330.45 | 357.24 | |
| Discount Factor | 0.712986179 | 0.36244602 | 0.184249178 | 0.093662939 | 0.047613489 | 0.024204263 | 0.016128338 | |
| Number Years Factor | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 14.29 | |
| Present Value | 224.14 | 334.48 | 279.74 | 197.97 | 129.66 | 79.96 | 82.31 | 1,328 |
| Ann. Equivalent Value (Lo Est.) | | | | | | | | 93 |
| Ann. Equivalent Value (Hi Est.) | | | | | | | | 186 |

Note: EPA does not believe that discounting physical effects such as premature deaths or life years extended has any meaning. *Only monetary values should be discounted. Discounting physical effects is done above only for* analytic convenience and to display discounting methodology.

## Exhibit B6-3: Premature Deaths Avoided (PDA) From Quitting by Years of Abstinence

**Baseline Restrictions**

| Years | 1990 | | 1991 to 2000 | | 2001 to 2010 | | 2011 to 2020 | | 2021 to 2030 | | 2031 to 2040 | | 50 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | Deaths | % Quit | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PRMR[1] | PDA[2] Per Year | PDA Low Estimate | Percent | PDA High Estimate |
| | | | | | | | | | | | | | Quit Rate = 3% | | Quit Rate = 6% |
| 0-34 | 2,215 | 3% | 51% | | | | | | | | | | 5,073 | 1.06% | 10,146 |
| 35-44 | 33,291 | 3% | 51% | 507 | 84% | | | | | | | | 9,038 | 3.06% | 18,076 |
| 45-54 | 28,001 | 3% | 51% | 440 | 84% | 553 | 90% | | | | | | 32,398 | 11.89% | 64,796 |
| 55-64 | 56,510 | 3% | 36% | 637 | 58% | 1022 | 90% | 1580 | 95% | | | | 116,988 | 42.89% | 233,780 |
| 65-74 | 100,780 | 3% | 23% | 1128 | 40% | 2357 | 80% | 3850 | 90% | 4341 | 90% | | 108,188 | 39.71% | 216,376 |
| 75+ | 131,051 | 3% | 16% | 700 | 17% | 883 | 70% | 2752 | 85% | 3342 | 85% | 3342 | 272,639 | 100.00% | 545,278 |
| Total | 414,748 | | | 3413 | | 4816 | | 8181 | | 7683 | | 3342 | | | |
| Yearly Average for the 50 Year Period | | | | | | | | | | | | | 5,449 | | 10,898 |

1. Proportional reduction in mortality.
2. Premature Deaths Avoided

| | | | | | | Discounted Values Low Estimate Tot. Pres. Val. | Low Estimate Ann. Equiv. | High Estimate Tot. Pres. Val. | High Estimate Ann. Equiv. |
|---|---|---|---|---|---|---|---|---|---|
| **3% calculations** | | | | | | | | | |
| 3% Disc. Fctr. | 0.862608764 | 0.641861947 | 0.477605568 | 0.355383396 | 0.264438824 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | | | | |
| Premature Deaths Avoided | 34,129 | 48,157 | 81,908 | 78,829 | 33,418 | | | | |
| Discounted to 1990 | 29,440 | 29,826 | 39,119 | 27,304 | 8,837 | 134,526 | 4,030 | 298,662 | 8,888 |
| Disc. LYE to Life Exp | 304,215 | 315,794 | 383,327 | 243,474 | 44,667 | | | | |
| Discounted to 1990 | 262,419 | 202,696 | 183,079 | 86,527 | 11,812 | 746,532 | 22,366 | 1,493,065 | 44,732 |
| Disc. LYE to Age 65 | 172,261 | 119,192 | 83,728 | | | | | | |
| Discounted to 1990 | 148,594 | 76,505 | 39,989 | | | 266,088 | 7,963 | 530,178 | 15,868 |
| **5% calculations** | | | | | | | | | |
| 3% Disc. Fctr. | 0.783526166 | 0.461017008 | 0.295302772 | 0.181290285 | 0.111296509 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | | | | |
| Premature Deaths Avoided | 34,129 | 48,157 | 81,908 | 78,829 | 33,418 | | | | |
| Discounted to 1990 | 26,741 | 22,202 | 24,187 | 13,928 | 3,719 | 90,776 | 4,539 | 181,566 | 9,078 |
| Disc. LYE to Life Exp | 304,215 | 315,794 | 383,327 | 243,474 | 44,667 | | | | |
| Discounted to 1990 | 238,381 | 151,902 | 113,198 | 44,139 | 4,971 | 552,571 | 18,577 | 1,105,142 | 35,154 |
| Disc. LYE to Age 65 | 172,261 | 119,192 | 83,728 | | | | | | |
| Discounted to 1990 | 134,971 | 57,334 | 24,725 | | | 217,030 | 6,511 | 434,059 | 13,022 |
| **7% Calculations** | | | | | | | | | |
| 3% Disc. Fctr. | 0.712986179 | 0.38244602 | 0.184249178 | 0.093662939 | 0.047613489 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | | | | |
| Premature Deaths Avoided | 34,129 | 48,157 | 81,908 | 78,829 | 33,416 | | | | |
| Discounted to 1990 | 24,334 | 18,729 | 15,091 | 7,196 | 1,591 | 64,941 | 4,546 | 129,883 | 9,092 |
| Disc. LYE to Life Exp | 304,215 | 315,794 | 383,327 | 243,474 | 44,667 | | | | |
| Discounted to 1990 | 216,901 | 114,456 | 70,628 | 22,804 | 2,127 | 426,916 | 12,806 | 853,837 | 25,615 |
| Disc. LYE to Age 65 | 172,261 | 119,192 | 83,728 | | | | | | |
| Discounted to 1990 | 122,820 | 43,201 | 15,427 | | | 181,447 | 5,443 | 362,895 | 10,887 |

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology.

## Exhibit B6-4: Premature Deaths Avoided (PDA) From Reduced Initiation

**Base=No Restrictions**

| | Year | | | | | | | | 60 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 1991-2000 | 2001-2010 | 2011-2020 | 2021-2030 | 2031-2040 | 2041-2050 | 2051 + | PDA | | PDA |
| Age | Deaths | Proportional Reduction in Deaths [1] | | | | | | | Low Est. | Percent | High Est. |
| 0-34 | 2,215 | 3% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | | 10% |
| 35-44 | 33,291 | | 3% | 5% | 5% | 5% | 5% | 5% | 5,939 | 3% | 10,678 |
| 45-54 | 28,901 | | | 3% | 5% | 5% | 5% | 5% | 59,891 | 31% | 119,182 |
| 55-64 | 58,510 | | | | 3% | 5% | 5% | 5% | 36,848 | 19% | 73,696 |
| 65-74 | 160,780 | | | | | 3% | 5% | 5% | 45,346 | 24% | 90,691 |
| 75+ | 131,051 | | | | | | 3% | 5% | 44,214 | 23% | 88,428 |
| Total | 414,748 | | | | | | | | | | |
| PDA/Year | | 91 | 1,026 | 2,570 | 4,829 | 10,587 | 17,789 | 20,737 | | | |
| Cumulative Total | | 909 | 10,872 | 36,572 | 84,866 | 190,539 | 368,426 | | 196,539 | 100% | 381,078 |
| | Yearly Average for the 60 Year Period | | | | | | | | 3,811 | | 7,622 |

We assumeall new smokers come from the youngest age group, that a constant number is added every year, and that it takes 60 years for the smoking population to completely change. Therefore, it takes 60 years for the smoking population to be reduced by the estimated reduction in the initiation rate, with 1/60th of that reduction taking place each year.

2. Average rate over the first 10 year increment in which new smokers are added each year.

| | | | | | | | | Low Estimate | | High Estimate | Low E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **3% Discount Calculations** | | | | | | | | Tot. Pres. Val. | Ann. Equiv. | Tot. Pres. Val. | Ann. Equiv. |
| 3% Disc. Fctr. | 0.862608784 | 0.641861947 | 0.477605568 | 0.355383398 | 0.264438624 | 0.196787171 | 0.146413254 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | 10 | 33.33333333 | | | | |
| Premature Deaths Avoided | 909 | 10,262 | 25,701 | 48,294 | 105,873 | 177,887 | 891,247 | | | | |
| Discounted to 1990 | 525 | 6,587 | 12,275 | 17,163 | 27,944 | 35,002 | 101,208 | 200,704 | 6,021 | 401,408 | 12,042 |
| Disc. LYE to Life Exp | | 187,715 | 466,884 | 746,241 | 1,090,251 | 1,304,094 | 4,478,351 | | | | |
| Discounted to 1990 | | 120,487 | 223,942 | 265,202 | 288,304 | 258,603 | 855,690 | 1,810,228 | 54,307 | 3,620,456 | 108,614 |
| Disc. LYE to Age 65 | | 156,549 | 378,022 | 539,708 | 609,482 | 609,482 | 2,031,606 | | | | |
| Discounted to 1990 | | 100,483 | 180,545 | 191,803 | 161,170 | 119,926 | 297,454 | 1,051,382 | 31,541 | 2,102,764 | 63,083 |
| **5% Discount Calculations** | | | | | | | | | | | |
| 5% disc factor | 0.783526166 | 0.481017096 | 0.295302772 | 0.181290285 | 0.111296509 | 0.068326402 | 0.041946484 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | 10 | 20 | | | | |
| Premature Deaths Avoided | 909 | 10262 | 25701 | 48294 | 105873 | 177887 | 414748 | | | | |
| Discounted to 1990 | 477 | 4936 | 7589 | 8755 | 11781 | 12154 | 17397 | 63,071 | 1,892 | 126,142 | 3,784 |
| Disc. LYE to Life Exp | | 187,715 | 466,884 | 746,241 | 1,090,251 | 1,304,094 | 4,478,351 | | | | |
| Discounted to 1990 | | 90294.29415 | 138462.7601 | 135286.1995 | 121341.1245 | 89104.02987 | 187851.0931 | 762,339 | 22,870 | 1,524,679 | 45,740 |
| Disc. LYE to Age 65 | | 156,549 | 378,022 | 539,708 | 609,482 | 609,482 | 2,031,606 | | | | |
| Discounted to 1990 | | 75302.69277 | 111630.9456 | 97843.90026 | 67833.18196 | 41643.66843 | 85218.70957 | 479,473 | 14,384 | 958,946 | 28,768 |
| **7% Discount Calculations** | | | | | | | | | | | |
| 7% disc factor | 0.712986179 | 0.36244602 | 0.184249176 | 0.093662939 | 0.047613489 | 0.024204263 | 0.01230423 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | 10 | 14.28571429 | | | | |
| Premature Deaths Avoided | 909 | 10262 | 25701 | 48294 | 105873 | 177887 | 296249 | | | | |
| Discounted to 1990 | 434 | 3720 | 4735 | 4523 | 5031 | 4306 | 3645 | 26,395 | 792 | 52,789 | 1,584 |
| Disc. LYE to Life Exp | | 187,715 | 466,884 | 746,241 | 1,090,251 | 1,304,094 | 4,478,351 | | | | |
| Discounted to 1990 | | 68,037 | 86,392 | 69,895 | 51,911 | 31,565 | 55,103 | 362,901 | 10,887 | 725,803 | 21,774 |
| Disc. LYE to Age 65 | | 156,549 | 378,022 | 539,708 | 609,482 | 609,482 | 2,031,606 | | | | |
| Discounted to 1990 | | 58,741 | 69,850 | 50,551 | 29,020 | 14,752 | 24,997 | 246,710 | 7,371 | 491,421 | 14,743 |

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology.

## Exhibit B6-5: Premature Deaths Avoided From Reduced Consumption

**Baseline Restrictions**

| Years | | | 1991 to 2000 | | | 2001 to 2010 | | 2011 to 2020 | | 2021 to 2030 | | 2031 to 2040 | | 2041 & beyond | | 90 Year Totals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1990 Deaths Per Year | Adjusted for Quitting & Reduced Initiation [1] (Low Estimate) | % Reduction Low Estimate | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | PRMR | PDA Per Year | Lives Saved Low Est 10% | Percent | Lives Saved High Est 20% |
| 0-34 | 2,215 | 2,121 | 10% | 51% | 108 | 64% | 135 | 80% | 191 | 95% | 202 | 95% | 202 | 100% | 212 | 8,370 | 0.64% | 16,380 |
| 35-44 | 33,201 | 31,680 | 10% | 51% | 1,618 | 64% | 2,035 | 90% | 2,889 | 95% | 3,029 | 95% | 3,029 | 100% | 3,188 | 126,603 | 9.60% | 248,669 |
| 45-64 | 29,001 | 27,677 | 10% | 51% | 1,406 | 64% | 1,769 | 90% | 2,491 | 95% | 2,629 | 95% | 2,629 | 100% | 2,768 | 109,216 | 8.34% | 213,446 |
| 65-74 | 58,510 | 56,030 | 10% | 36% | 2,034 | 58% | 3,263 | 90% | 5,043 | 95% | 5,323 | 95% | 5,323 | 100% | 5,603 | 200,880 | 16.02% | 410,118 |
| 75+ | 160,780 | 153,666 | 10% | 23% | 3,600 | 40% | 7,525 | 80% | 12,317 | 90% | 13,857 | 90% | 13,857 | 100% | 15,397 | 511,663 | 39.06% | 999,782 |
| 75+ | 131,051 | 125,497 | 10% | 18% | 2,295 | 17% | 2,199 | 70% | 8,785 | 85% | 10,867 | 85% | 10,867 | 100% | 12,550 | 348,344 | 26.36% | 674,919 |
| Total | 414,748 | 397,171 | | | 11,062 | | 16,884 | | 31,696 | | 36,706 | | 35,706 | | 39,717 | 1,310,146 | 100.00% | 2,560,456 |
| Yearly Averages for the 90 Year Period | | | | | | | | | | | | | | | | 20,263 | | 51,209 |

1. The reduced consumption rate applies only to smokers after reducing the current smoking population to account for those that quit or fail to initiate smoking.
2. The maximum proportional reduction in mortality is equal to the percent reduction in consumption, and is assumed to be reached in 90 years (PRM factor = 100%). The time path of PRM factor is assumed to be the same as for quitting.

| | | | | | | | Discounted Values: Low Estimate Tot. Pres. Val. | Low Estimate Ann. Equiv. | High Estimate Tot. Pres. Val. | High Estimate Ann. Equiv. |
|---|---|---|---|---|---|---|---|---|---|---|
| 5% calculations | | | | | | | | | | |
| 5% Disc. Fctr. | 0.8626088 | 0.6418619 | 0.4776056 | 0.3553834 | 0.2644386 | 0.221463184 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | 33.33333333 | | | | |
| Premature Deaths Avoided | 110,021 | 199,037 | 316,958 | 357,085 | 357,085 | 1,323,905 | | | | |
| Discounted to 1990 | 94,905 | 108,498 | 151,381 | 126,895 | 94,422 | 293,196 | 869,297 | 26,979 | 1,738,894 | 53,958 |
| Disc. LYE to Life Exp | 1,014,051 | 1,052,847 | 1,277,758 | 511,580 | 148,889 | | | | | |
| Discounted to 1990 | 874,729 | 675,654 | 610,264 | 288,422 | 39,372 | | 2,488,441 | 74,683 | 4,976,882 | 149,366 |
| Disc. LYE to Age 65 | 574,203 | 397,308 | 279,093 | | | | | | | |
| Discounted to 1990 | 495,313 | 255,017 | 133,299 | | | | 883,629 | 28,589 | 1,767,261 | 53,018 |
| 5% calculations | | | | | | | | | | |
| 5% Disc. Fctr. | 0.7835262 | 0.4810171 | 0.2953028 | 0.1812995 | 0.1112996 | 0.083061169 | | | | |
| # years factor | 10 | 10 | 10.00 | 10 | 10 | 20 | | | | |
| Premature Deaths Avoided | 110,021 | 199,037 | 316,958 | 357,085 | 357,085 | 784,343 | | | | |
| Discounted to 1990 | 86,204 | 81,310 | 93,598 | 64,732 | 39,740 | 65,071 | 431,656 | 21,579 | 863,112 | 43,156 |
| Disc. LYE to Life Exp | 1,014,051 | 1,052,847 | 1,277,758 | 511,580 | 148,889 | | | | | |
| Discounted to 1990 | 794,536 | 506,341 | 377,325 | 147,132 | 16,571 | | 1,841,904 | 92,095 | 3,683,808 | 184,190 |
| Disc. LYE to Age 65 | 574,203 | 397,308 | 279,093 | | | | | | | |
| Discounted to 1990 | 449,903 | 191,112 | 82,417 | | | | 723,432 | 36,172 | 1,446,864 | 72,343 |
| 7% calculations | | | | | | | | | | |
| 7% Disc. Fctr. | 0.7129882 | 0.362449 | 0.1842492 | 0.0936828 | 0.0476135 | 0.031728878 | | | | |
| # years factor | 10 | 10 | 10 | 10 | 10 | 14 | | | | |
| Premature Deaths Avoided | 110,021 | 199,037 | 316,958 | 357,085 | 357,085 | 567,388 | | | | |
| Discounted to 1990 | 78,449 | 61,267 | 58,399 | 33,444 | 17,001 | 18,001 | 266,560 | 13,328 | 533,112 | 26,656 |
| Disc. LYE to Life Exp | 1,014,061 | 1,052,847 | 1,277,758 | 511,580 | 148,889 | | | | | |
| Discounted to 1990 | 723,004 | 381,528 | 235,426 | 76,015 | 7,089 | | 1,423,062 | 71,153 | 2,846,123 | 142,306 |
| Disc. LYE to Age 65 | 574,203 | 397,308 | 279,093 | | | | | | | |
| Discounted to 1990 | 409,399 | 144,003 | 51,423 | | | | 604,824 | 30,241 | 1,209,648 | 60,482 |

Note: EPA does not believe that discounting physical effects such as premature deaths or live years extended has any meaning. Only monetary values should be discounted. Discounting physical effects is done above only for analytic convenience and to display discounting methodology.