# MINUTES OF THE MEETING NATURAL RESOURCES COMMITTEE HOUSE OF REPRESENTATIVE 50TH LEGISLATIVE SESSION

February 4, 1987

The meeting of the Natural Resources Committee was called to order by Chairman Tom Jones on February 4, 1987, at 1:00 p.m. in the SRS Auditorium.

ROLL CALL: All committee members were present with the exception of Reps. Grady, Kadas and Harp who were excused.

HOUSE BILL NO. 534: Rep. Tom Hannah, District #86, sponsor, stated HB 534 pertains to ambient air standards as it relates to sulfur dioxide, and primarily, as it related to the Yellowstone River Valley and the industries that are This is important, stating the substance of the bill there. is found on Page 1, liens 23-24, and Page 2, line 1. effect of these changes are simply to take the current air quality standards for sulfur dioxide, at the state level, and raise them to the existing federal level in two areas; the annual and the 24-hour. It effects sulfur dioxide only, not particulate or any other chemicals that might be in the It effects simply, sulfur dioxide, and because of that, it primarily effects Billings. In fact, this bill regards only one community in this state that has an industry base, as Billings does. Billings is the only community in this state that has any pressure on whether or not it ought to be within the state or federal standards for sulfur dioxide emissions. This bill effects one community, namely, There are new plant standards, and if another Billings. community tried to develop an industrial base the size of Billings, the new plants would be manufactured and put together is such a way that sulfur dioxide and other emissions would be much less than they are now. The net effect of this bill is to simply maintain the status quo. Currently, Billings is operating at the federal level through on ongoing allowance from the State Board of Health which is allowing industry to work and emit under the federal stan-We are not asking to allow industry to put more sulfur dioxide in the air, but simply to maintain the status This bill will do that; however, one of the most important points of the bill has been industries' agreement to reduce emissions during air inversion standards. majority, if not all, of the 24-hour violations for sulfur dioxide occur during the time when we get an inversion. inversion traps smoke, particulate and dust from automobiles and, of course, sulfur dioxide. Usually, this occurs half a dozen times a year, which many people say is

the main problem for respiratory disease aggravated by sulfur dioxide. We are working toward an agreement. fact, Exxon has already reduced, through some technological means, their sulfur output by 15%, with Conoco moving in the same direction. The oil refineries have agreed to try and monitor this; to reduce during air inversion periods by going to a natural gas burn, which results in a reduction anywhere from 10% to 40%, depending on the crude being burned. Montana Power has agreed to cut down on the amount of electricity produced out of the Corette Plant. It is significant that we are heading in the direction for cleaner air for Billings. This bill points out two important aspects: taking the pressure off those industries which allows them to operate, and sets the stage for some cooperation and agreement with the Board of Health in resolving the 24-hour standard violations.

PROPONENTS: Rep. Bruce Simon stated, for the record, he does support this measure.

Rep. Jack Ramirez stated these industries have been corporate citizens in the City of Billings and Yellowstone County. The reason his family is in Montana, is because of the refinery. His father became an accountant for, what was then, Carter Oil Company, and did the auditing for oil distribution made to the bulk plants from the refinery. For those years, that refinery had been an integral part of our community and continues to be a good corporate citizen by its voluntary efforts in trying to reduce the SO2 emissions. It must be taken into account the social good that has come from educating families and children, providing homes and many jobs for our community. We want to preserve it, because, it is not only our past, but our future. The Corette Plant, which is extremely important to our future and the MHD project, depends on the existence of that plant and is important to our community and the State of Montana. He urged the committee to be flexible in seeing these industries through this time of their needs.

Henry Hubble, Refinery Manager, Exxon, distributed testimony (Exhibit 1). He stated the EPA standards proposed in this bill are health based standards, designed to protect the health of the most sensitive members of society with an adequate margin of safety, protecting agriculture, visibility and anesthetics. The Billings area does not exceed any federal air quality standards, and there are no other areas in Montana which come close to violation of the State S02 standards. Most importantly, S02 air quality measurements in Billings continue to show a steady downward trend due to voluntary industry efforts. This table, which was compiled from EPA data, shows that average S02 measurements in Billings have decreased from .026 to .022. Exxon, in the

last decade, has spent millions of dollars in energy conservation and emissions reduction equipment to improve air quality. In conclusion, we have tried to work through the administrative process in good faith. We have been willing to make reductions, but at the same time, have asked the Board of Health to consider the negative economic costs associated with achieving the existing state standards. The Board has not indicated a willingness to re-evaluate and/or change the state standard. We feel continuing through the administrative process is costly to industry and the state; however, the legislature is in the best position to assess state economic impacts. Passage of this legislation will allow for the protection of human health and air quality, which will help Montana industries remain competitive.

Jim Scott, Billings Chamber of Commerce, distributed testimony (Exhibit 2). It is appropriate the Chamber can testify on HB 534, which effects both profitability of existing industry and quality environment. There are two very important issues in the question of SO2 levels in the Yellowstone Valley. The first is standards of acceptable levels of S02. The Chamber believes the federal standards appropriate, given current health information and current economic conditions in our community. Having more stringent state standards seems counterproductive. Compliance will become more expensive for the industries involved and will put numerous jobs at risk. Secondly, while air quality is made up of numerous components, we are concerned with S02 levels. The fact that S02 levels are high relative to other cities, which studies have shown, is a negative for Billings in attracting new industry and a weakness we must address. Progress is being made to address the problem that exists and needs to continue through a cooperative and good faith effort of the industries, the Department of Health and the community.

Bob Holtsmith, Manager, Conoco, distributed testimony (Exhibit 3). He stated Conoco applauds the action of the Legislature to consider eliminating more stringent state sulfur dioxide emission standards and implement the federal Nation Ambient Air Quality for several reasons. We feel the national standards have been established after rigorous review to protect even the most sensitive members of the community. Their federal standards are subjected to scientific and public review. Also, special scrutiny by an independent national board of leading health scientists, known as the Clean Air Scientific Advisory Committee. The federal standards are under periodic, legally required review. The current review has produced little data to indicate the 24-hour, or the annual average, should be stringent. State industries could better utilize their resources to remain competitive. The refining industries in

the Yellowstone Valley not only compete with each other, but with other refineries as well. These refineries have only to achieve the federal ambient air quality standards. Emission controls for improving air quality are expensive; however, Conoco is willing to spend its fair share to prevent any endangerment to human health or the environment. In this case, however, we do not believe any such endangerment exists. Despite our beliefs, the present air quality standards are not reasonable. Conoco has consistently offered to reduce its sulfur dioxide emissions by some 15%. Conoco will continue to cooperate with the state to decrease emissions, even if the state standards are changed to the federal level.

Louis Day, Refinery Manager, CENEX, distributed testimony (Exhibit 4). In accordance with a 1977 stipulation between the Air Quality Bureau and the Billings area industry, CENEX invested millions in a sulfur dioxide emission reduction program to achieve a 15% reduction in plant sulfur dioxide emissions. This investment program, completed in 1979, showed an 80% drop in the ambient sulfur dioxide concentration in Laurel. There are, presently, rules before the Board of Health, which will require additional emission reductions of up to 45%. These rules, if implemented, will require the immediate commitment to an investment exceeding \$70,000,000. Any additional regulation will affect the economic viability of our operation. CENEX will reduce the sulfur dioxide emissions from the refinery for short time periods, by 10% to 20%, if necessary, to comply with the federal 24-hour standard. Such a program can be implemented without the major economic impact of the proposed rules but would require the revision of the present Montana ambient standards.

Carlton Grimm, Director, Generation System Development for Montana Power, distributed testimony (Exhibit 5). support adoption of the federal annual 24-hour ambient standards. Our position is we would offer voluntary intermittent emission reductions at the J.E. Corette Plant. Along with this, would be the sue of a continuous monitor which acquires the emissions from our plant. Also, the participation in ambient monitoring with other industries, the Department of Health and the Board of Health. At this time, Mr. Grimm summarized background information contained in his testimony. He stated, they felt the federal standards should be adopted and are prepared to comply with intermittent emission reductions at the Corette Plant. We believe this approach protects the health of the people in Billings and will allow existing industry to continue operations which provide margins below the federal standards and the opportunity for some economic growth in the area.

Ken Williams, representing Western Energy, distributed testimony (Exhibit 6). Western Energy is concerned that failure to adopt the changes contemplated by HB 534 may cause the loss of coal sales. A fuel switch to Wyoming Coal would have serious economic consequences on Montana by the total loss of coal severance tax revenues, coal gross proceed taxes, as well as other taxes. However, the human tragedy is greater with loss of direct and indirect mining jobs that would weaken the economic vitality of Montana. Mr. Williams then summarized testimony regarding employment figures. From those figures, one sees the economic impacts of the coal switch significant to the State of Montana, which goes beyond the totals of coal taxes, jobs, and direct expenditures. The impacts would reach into and effect all sections of Montana's economy.

John Gibson, Division Manager, Montana Dakota Utilities, commended Rep. Hannah for initiating a bill, in attempt to come up with legislation that is not so stringent that it runs industry out of the state, yet affords clean air to those living in the industry area. Those industries are providing good paying jobs and tax base that Montana needs so badly. The current Montana standards threaten the future of these industries. He believed that emissions occur only a few days each year, when atmospheric conditions are heavy. It seems we would hear very little concern about air quality in Billings if those few days were eliminated. From previous testimony, one of the solutions to help reduce air emissions on those days is by the use of clean burning natural gas. MDU is a natural gas distributor in the Billings area and several other towns in Eastern Montana. MDU has an abundance of natural gas available, and pledge their cooperation to serve those customers on days when they might be having air quality problems. He believed there are alternatives to imposing standards so strict that it forces industry to close its doors.

Mike Micone, Executive Director, Western Environmental Trade Association, stated WETA believes industry has been making great strides in Billings and are committed to further reductions of S02 emissions. The record indicates industry has worked with the department for a number of years in an effort to reduce the emissions in Billings. In looking at the department's testimony presented in June, they stated it would only be fair to allow the administrative process to come to a decision regarding emission reduction, before taking any legislative action. They have stated there is no action pending before the board, which in any quantitive way, dictates action by the Legislature. They believe administrative processes could continue and it is time for this Legislature to take some action to allow their standards to comply with national standards. Montana, legally,

must discontinue the sending of signals to our neighbors out-of-state, that Montana is an anti-business state.

Dan Farmer, Billings Chamber of Commerce, distributed testimony (Exhibit 7). Mr. Farmer, a chemical engineer, stated from an engineering stand-point, the information given of the present Montana standard, is inadequate to support, with any degree of accuracy, in two ways. First, no model has been developed to accurately determine the source and amount of SO2 emissions and the probable effect of a reduction at any of the six emitting companies. Reliable data is essential to an accurate decision. Secondly, no health data has been presented to justify Montana's lower SO2 level. Federal studies are, by all accounts, considered to be accurate and have an adequate margin of safety. There is no known health reason to justify Montana's lower SO2 Ambient Air Standard. If no benefit is shown, how can we justifiably force businesses to spend millions to reduce.

At this time, Rep. Hannah asked those in support to simply state their names.

Terry Carmody, representing Montana Farmer's Union; Jo Brunner representing Montana Cattle Feeders Association; Stuart Daggett representing Montana Chamber of Commerce; Carol Mosier representing Montana Stockgrower's and Montana Cattlemen.

OPPONENTS: Rep. Joan Miles stated she is testifying because she has an alternative proposal in the works and wanted to stress a few points because reference will be heard to at least some of the ideas that will be talked about. She had hoped this would be in bill form by now; however, it was clear, she would not be able to delay this hearing. She emphasized, if she lived in Billings and was facing this situation, particularly if her livelihood depended on this, she would be in the audience also. She felt it is a big problem that must be addressed. However, HB 534 as written now, is not the way to do it. This is not the same bill that was before them in June when they heard the only standard the people wanted changed was the annual standard. They heard in committee and on the House floor, the sponsor was concerned about the short term standards, but had no intention of changing short term standards. Rep. Miles did not understand why, suddenly, they need to change both long and short term standards. She stated it was not appropriate to disregard the standards that were defended as being necessary for public health six months ago. Those were defended as being important for the protection of the health of the people in Billings and now, in essence, they must disregard and change the standard. She understood, after

listening to the proposals, industries' concern about going through an administrative process without knowing what the outcome was going to be. The proposal she was putting together, hopefully, addresses all the things being looked at. They have heard a lot about the willingness of industry to look at intermittent controls and to cut back on production during inversion periods. Her proposal addressed continuing administrative process with very clear directives from the Legislature, not considering scrubbers and continuous monitoring devices acceptable in this situation. agreement drawn up, should be the short-term intermittent voluntary type cutbacks, and will be put in writing, to make sure that they do in fact, get it. It also states nothing will be done regarding enforcement of industries' to change the process, until at least June of 1988. This gave a year and a half to arrange some kind of administrative agreement by October, 1987, which would be implemented in June, 1988. This gave them needed time, before they had to start doing anything regarding intermittent cutbacks or slowing emissions down during inversions. The industries are frustrated because there has been a real reluctance to look at standards again, and it would direct the department and Board of Health to go through this processing and start looking at those standards in light of all the new data and changes the EPA is expected to make. Personally, she felt at that point, enough new information was coming about and enough concern had been expressed, that they should direct the Board of Health to do this. They must consider what was going on in Billings, regarding jobs, social good, the past and the future. They need to consider alternative proposals before they jump in and change standards they knew nothing about.

Ed Zaidlicz, member of Montana Health Board, Billings, distributed testimony (Exhibit 8). He stated for six years, the Board has patiently waited for the professional staff of the Department of Health and Environmental Science plus the six contributing companies to reach some reasonable and equitable solution to this growing problem. He must rise to the defense of the Air Quality Bureau's interminable effort to bring about some progress. Based on the record, they are professionally competent and fully committed to serving the public under the state and federal law. Now, at the peak of deliberations, to reduce this complex issue to a simple face off of job versus "bureaucratic standards" may prove to be a serious mistake. To simply "legalize" the status quo by discarding the state standard and relying on the lenient federal, ignores a host of surfacing concern. By EPA evaluations, covering 70 major cities over four years, Billings has received national recognition of having the dirtiest (S02) pollution of any city but Pittsburgh. We are now the "Pittsburgh of the West". The trend for Pittsburgh

is improving, and unless we take concise action, we shortly will be the "Pittsburgh of America". Rep. Hannah's efforts to relax the SO2 standard, by relying on the federal, is to safequard jobs and tax base while ensuring adequate health safequards. Considerable concern exists that those objectives can be reached. Our recent economic downturn has stimulated creditable and creative efforts, at local and state levels, to improve our economic opportunities for new business, existing operations, and to fully capitalize on the generally recognized potential of fully exploiting tourism. To lock the current air quality into a "status quo" posture would prove hard to rationalize in light of those efforts. Mr. Zaidlicz encouraged the concerned public and legislators to allow the administrative process to continue to completion and not be stampeded into an ill-advised irreversible action. Threats of plant closures should not interfere with the public's right to be fully informed and involved.

Hal Robbins, representing the Department of Health Air Quality Bureau, distributed testimony (Exhibit 9). He stated the department had several concerns about the bill. The first being, status quo, which they feel are not good enough. We are in the middle of administrative process and would like that to continue to work the problem out. light of those kinds of things, they asked that HB 534 do not pass. Specifically, in regard to the status quo questions and the standards. There have been many health studies done and information compiled on sulfur dioxide emissions and their effects. Epidemiological studies show health risks occurred in the range of .03 to .06 on an annual average. At those levels, existed increased mortality rates for people having respiratory diseases, and increased disease symptoms themselves. As far as short term standards are concerned, clinical evidence showed effects in the .08 to .11 ppm range with the standard set a .10. Evidence showed decreases in various lung functions, especially in children, worsening health threats among the sensitive population, which included asthmatics or asthmatic problems, people with chronic destructive pulmonary diseases, and people with allergy type reactions. That group accounted for approximately 10% to 20% of the population. A study was done in the Billings area, which looked at air pollution effects on the population of the state, which was called the Montana Air Pollution Study and was funded by the 1977 and 1079 Legislatures. His testimony did present some results of that study.

Scott Frasier, Chairman of the Yellowstone Valley Citizens Council, distributed testimony (Exhibit 10). He stated much has been said about the economics of this issue. Unfortunately, the focus had been misdirected. The economic scope

was greater than the limited business interests of six Billings industries. Considerations must take into account the total business climate of Billings, as well as the entire state of Montana. It is important to note that only Yellowstone County is, and has been, unable or unwilling to meet the state standards for sulfur dioxide. This bill would ease the air quality standards for all of Montana allowing previously compliant industries to emit 50% more S02. Are we to place the entire state's air quality in jeopardy to accommodate the motives of a few industries in Billings. Because the Billings area is basically meeting the federal standards of SO2, this bill would essentially legalize the status quo for Billings' air quality. Included in the status quo is an air quality ranking for Billings second only to Pittsburgh in sulfur dioxide. There would be a cap on industrial expansion since the ambient S02 concentration is very near the federal limit. Without emission improvements, the refineries would be restricted to operating at their present output of about 75% capacity. If the state standard is kept, and if the administrative process is allowed to work through the Board of Health, we are optimistic that an equitable solution is possible.

Carolyn Hamlim, President, Montana Public Health Association, distributed testimony (Exhibit 11). She stated MPHA supported the right to breath clean air. Although effects of S02 are controversial, a two-year study by Pemberton and Goldberg in 1954 showed high sulfur dioxide standards were consistently correlated with higher bronchitis death rates in 35 county boroughs analyzed. We have the technology to remove sulfur compounds from industrial flue gases. The U.S., in 1986, spent \$32.4 million on research and cleanup of environmental and chronic disease through the CDC budget alone. Could the state of Montana afford to be so hind-sighted. Further, did the state of Montana wish to gamble with the health of its citizens.

Paul Berg, Chairman of the Yellowstone Basin Sierra Club, submitted testimony (Exhibit 12). He stated proponents for HB 534 have frequently asked those who favor a more stringent state ambient air quality standard to prove the federal standard is unhealthy. There have been studies indicating sulfur dioxide is harmful in concentrations below .03 ppm. Unfortunately, such studies are often inconclusive. Lack of undisputed evidence does not lead to the conclusion that .03 ppm S02 is safe; rather it indicates, in many long-term cause and effect toxicity studies, it is very difficult to establish conclusions satisfactory to everyone.

Steve Dogherty, a Great Falls resident, stated in 1981, enforceable standards were adopted. However, a republican legislature very wisely rejected a notion that a scientific

and health decision should be made in a pressure cooker atmosphere. There was ample evidence of that pressure cooker atmosphere being placed upon them that day. Often times, in leaving a message, today we honor, applaud and award commitment, achievement and excellence. Think about the message that accompanies HB 534. Did it promote and reward aggressive enforcement of the law, or did it promote innovative technology. Would it reward creative individuals in businesses. Long term, would the message be, "it's okay to wait for the political winds to change and hope you can change the rules of the game, not in the middle of the game but at the end of the game, so you can benefit and others may pay". Think about the message that will accompany the passage of the bill, and what it means to the future economic development of Montana to defeat it.

Earl Thomas, Executive Director, American Lung Association, submitted testimony (Exhibit 13). He stated HB 534 weakened our clean air standards. The Constitution says the state and each person shall maintain and improve a clean and healthful environment for Montana for present and future generations. HB 534 would not maintain or improve clean air, but in fact weaken it. We estimate that 75% of all lung disease can be prevented.

Torian Donohoe, law student, emphasized this bill represents the most elementary tenant of history, that history repeats itself. In the early days of Montana statehood, the Legislature was held hostage by the copper industry, which threatened to shut down, if demands were not met. Today, after almost 100 years of statehood, the Legislature is again being threatened with reduced coal sales, plant closures and lost jobs. Don't allow that standard, which was adopted after two years of effort by men and women on the Board of Health, with volumes of testimony both by industry, health professions, and the citizens of Montana, fall victim to economic scare tactics. If you honestly believe the changes in the SO2 standard are warranted, please provide for a study, with the same level of technical expertise and careful consideration exercised when the standards were initially adopted. The people of Montana deserve nothing less. While no one wants to see jobs lost in Billings, the answer is interim solutions which address those specific problems, not wholesale replacement of the state standards, with a lesser federal standard and the absence of adequate technical information and careful consideration.

Due to a time shortage, Chairman Jones asked people to state their name and position.

Rick Meis, representing the Environmental Information Center presented testimony in opposition to HB 534. (Exhibit 14).

Tom Tully, a Billings resident, presented testimony in opposition to the bill (Exhibit 15).

Russ Brown, representing the Northern Plains Resource Council, presented summations of both the final ambient air quality environmental impact statement, and the second addendum on air quality. NPRC opposes HB 534 (Exhibit 16).

Wendy Alderson, presented testimony on behalf of Grace Edwards, Chair/Yellowstone County Commissioners, in opposition to HB 534. (Exhibit 17).

Mignon Waterman, on behalf of Montana Association of Churches, submitted testimony in opposition to HB 534. (Exhibit 18).

Joan Tool, representing the League of Women Voters of Montana, submitted testimony in opposition to HB 534. (Exhibit 19).

Roger Young, President, Great Falls Chamber of Commerce, submitted testimony in opposition to HB 534. (Exhibit 20).

Rep. Addy stated the .02 standard has been in place for six years, causing no one to shut down and no lost jobs. The air quality, while it may not be .02, is better, and wanted to know if it will get any better by going to .03.

Rep. Hannah stated this was the whole intent of the bill, which did two things, providing a solution for the board and industry. The board kept putting out proposals on non-definable standards so no one has been able to put together any kind of model establishing where things come from and how it should be used. It seems they had reached a stale-mate with the department and this bill would generate the kind of discussion and agreements that were necessary, which are represented in the voluntary reductions that are already in place by Exxon, with Conoco promising a 15% reduction. Thus, the result will end the non-winable debate between industry and the department for cleaner air.

Rep. Addy stated the reason they had received cooperation was due to the .02 standard, and asked Rep. Hannah if he felt the same amount of cooperation would exist if the standard were raised.

Rep. Hannah stated he thought they would.

Rep. Addy stated if the bill passed, the air would not get any dirtier; however, if it did not, the air would not get any cleaner and he just is not sure what the bill did.

Rep. Hannah replied they had the commitment from industry to clean up the air. In a way, they had not been able to reach an agreement with the department, which was during the times they had air inversion periods. They had agreed to reduce sulfur dioxide emissions, which would go a long way toward reducing during those times when the 24-hour violations had occurred.

Rep. Addy asked Rep. Hannah how he felt about a provision in the bill that sunsets the legislation at the end of the biennium, so the Legislature in 1989 would also have to review the problem.

Rep. Hannah stated they had been reviewing the problem since 1980, and they could not seem to get any kind of an agreement finally in place by the board and the Department of Health and Industry. Rep. Hannah stated he felt they should finally end this, and they would get cleaner air and have the standards as a result.

Rep. Addy stated as long as industry knew this legislation would come up for review in two years, it should be a factor that may persuade them to vigorously pursue reduction efforts. If they thought they had won the ballgame, if already complying, and need not do anything else to comply with the law in the State of Montana, they might just take their ball and go home. Why not put a sunset in.

Rep. Hannah stated the assumption there was that industry, will in fact, continue to deal in a dishonest fashion with the state of Montana and if we don't leave this hook in industry, they will go ahead and increase emissions.

Rep. Simon stated regarding Rep. Miles' testimony, that he had shifted horses, by going from an annual standard to include the 14-hour, and he seemed to indicate there was a breach of faith on his part, and asked him to elaborate on why he did go to that measure.

Rep. Hannah stated he agreed with Rep. Miles regarding the real health effects of the 24-hour standard; however, he had the legislative staff from EQC write the Board of Health in a letter asking if the Legislature, in its upcoming session, were to change the annual standard on sulfur dioxide emission, what would be the board's response and what would the department do to that. He did have the response and would distribute (Exhibit 21). They, in effect, stated they felt the same standards of enforcement were necessary to bring

about compliance in the annual as well as the 24-hour standard. To change the annual standard would have been an absolute useless task, because the board would have continued in the same way. He had no choice, but to either abandon the bill or address the 24-hour standard. The result of that was industries' agreement to voluntarily reduce during environmentally difficult times in the valley.

Rep. Simon asked Mr. Grimm in the levels of S02 they are talking about, what color and what odor does sulfur dioxide have.

Mr. Grimm stated it is a colorless, odorless gas at these levels.

Rep. Simon asked Mr. Grimm in regard to his testimony, he had stated it would cost MPC \$40 million to put scrubbers on the Corette Plant in Billings, and wondered how much it would cost annually to operate those scrubbers, and also, who was going to pay for them.

Mr. Grimm stated, in their best estimation of the annual operating costs of these scrubbers, it would run between \$2.5 and \$3.5 million dollars. As far as who would pay, that seemed to be the question. The Department of Health assumed that it would be passed on the the rate payers, and he stated that is quite presumptious of the Department to come forward and state.

Rep. Raney stated in the June session, Rep. Hannah discussed .10 as being the level most important to human health, and now it was .14. Somewhere along the line, you had said you had done this because industries have agreed to voluntarily shut down during emission times like this. Rep. Raney wondered if any plan were made to get that into statute or writing so we knew they are, in fact, going to do it or should they feel they could trust them.

Rep. Hannah stated he intended to trust them, and felt this issue would not go away. If industry were to throw up; their hands and say they had what they wanted, another bill would probably be in this legislature very quickly, to address that particular issue. Rep. Hannah felt industry would go ahead and implement what they said they were going to do.

Rep. Meyers stated Missoula had often times been referred to as having problems with their air, and wondered if that would have the same force and effect on Missoula as it did in Billings.

Rep. Hannah stated the law would be statewide the way it was drafted. The key ingredient, regarding the situation in the state of sulfur dioxide, was Billings was the only area that had anywhere close to the sulfur dioxide emissions as opposed to other kinds of emissions.

Rep. Addy commended Mr. Hubble and Exxon for making the effort and going to the trouble and expense to reduce emissions 15%. The thing that made it such a frustrating issue, is they don't really have any hard data, and it seemed they don't have the capability to enforce the standard that they had on the books presently. In your opinion, is it realistic to expect us to be able to develop a workable, viable model for that portion of the Yellowstone Valley that Billings is in.

Mr. Hubble stated he was not an expert in model development; however, he felt they could make a lot of improvements in the model that had been developed.

Rep. Addy then asked how long would it take and how much would it cost.

Mr. Hubble stated he really didn't know, but in hearing some figures, it was about \$300,000, which he felt was very well spent, when talking about the kinds of investments they were going to be required to make.

Rep. Addy asked Mr. Hubble what was needed to be done to clean up Billings' image as the "Pittsburgh of the West".

Mr. Hubble stated one of the things they must do, was to get the facts. They were making comparisons with compliance monitors which were set up to measure the absolute highest concentrations in Billings and using that to compare against a more "urban comparison", that being the only data they had available for the Billings area at that time.

Rep. Addy asked once they got the accurate data, where would they go from there.

Mr. Hubble stated he thought they would find they were again in compliance with federal standards, and will still show themselves to be out of compliance in specific areas, with the state standards.

Rep. Roth asked Mr. Grimm if the MHD project is implemented at the Corette plant, would that reduce the S02 emissions by that plant, and if so, by how much.

Mr. Grimm stated the MHD proposal, of course was in conceptual form presently. It was some time off, but the

expectation was that it would reduce the emissions somewhat, but how much, they did not know.

Rep. Roth asked if they had an estimate.

Mr. Grimm stated just in estimating, someplace between 10 and 20%.

In closing, Rep. Hannah stated one of the reasons that Pittsburgh's air was cleaning up, was they no longer had the steel mills. The point simply being, we have a battle we are fighting in the Yellowstone Valley and is, a subjective battle in many ways. Many of us are worried about preserving and maintaining industrial base in the only industrial city in our state. We are also worried about the impacts of the national economy, oil and gas economy, and of our own Many of us are looking at the fact that state economy. there are jobs, and there is a tax base. We are talking about people who actually make a living off of the jobs they have, important jobs that are important to the community. The question is, is Billings going to be any better off if they continue to put the pressure on industries to the point where one or two of them would leave. If we do, and that were to happen, would we be better off, or would we be better off as a state and a community to say, we recognize we have a problem, and we have a solution that will work for our community, to keep our community running, keep industry there, which will result in cleaner air.

The solution for industry is to voluntarily comply. That is a creative alternative that has come out of the legislature, not the experts, that would reduce emissions during the times that there are air inversion problems. We will go to a natural gas burn in our refineries, which would reduce anywhere from 10-20%. We will also reduce the kilowatt reduction from the Montana Power Plant that will result in less coal being burned and less sulfur coming out. We will do our part to try and reduce the impacts of sulfur dioxide in our valley during these air inversions, because we believe these are important businesses for our community. The end result is a better cooperation between the department and the Board of Health. Secondly, we will have a stronger industry in our valley, and moving in the direction of having cleaner air. The result of HB 534 will be cleaner sulfur dioxide emissions in the Yellowstone Valley, which will offer some growth. Finally, hopefully, to send a message that we are trying in Montana and in Billings, to clean up our air and say to big business, we'd like to keep you here.

Rep. Hannah urged the committee to pass HB 534.

ADJOURNMENT: There being no further business, the meeting was adjourned at 2:56 p.m.

rom Jónes, Chairman

#### DAILY ROLL CALL

ATURAL.	RESOURCES	COMMITTEE
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### 50th LEGISLATIVE SESSION -- 1987

Date Feb. 4, 1987

NAME	PRESENT	ABSENT	EXCUSED
TOM JONES, CHAIRMAN	X		
CLYDE SMITH, VICE CHAIRMAN	X		
KELLY ADDY	X		
TOM ASAY	X		
JOHN COBB	X		
BEN COHEN	X	······································	
ED GRADY			X
JOHN HARP			×
HAL HARPER	X		
MIKE KADAS			x
AL MEYERS	x		
JOAN MILES	×		
MARY LOU PETERSON	X		
BOB RANEY	×		
RANDE ROTH	_ K		
ANGELA RUSSELL	X		
BRUCE SIMON	×		
BILL STRIZICH	×		
STAFF: EQC HUGH ZACKHEIM			

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EXHIBIT—

PROPOSED TESTIMONY - HB - 534
HOUSE NATURAL RESOURCES COMMITTEE
BY HENRY HUBBLE, REFINERY MANAGER
EXXON COMPANY, U.S.A.

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

WE ARE SUPPORTING THIS BILL IN ORDER TO REACH A REASONABLE AND EQUITABLE SOLUTION TO THE NOT MY NAME IS HENRY HUBBLE. I AM THE MANAGER OF THE EXXON REFINERY IN BILLINGS, BILLINGS AIR QUALITY CONCERNS, AND BECAUSE A COMPROMISE ON THE STANDARDS DOES MONTANA. I APPRECIATE THIS OPPORTUNITY TO TESTIFY IN SUPPORT OF HB 534. APPEAR POSSIBLE WITH THE BOARD OF HEALTH. WE BELIEVE THIS BILL SHOULD RECEIVE A DO PASS RECOMMENDATION FOR THE FOLLOWING REASONS:

 $(\widehat{X})$ 

DESIGNED TO PROTECT THE HEALTH OF THE MOST SENSITIVE MEMBERS OF SOCIETY WITH AN FIRST, THE FEDERAL STANDARDS PROPOSED IN THIS BILL ARE HEALTH-BASED STANDARDS, ADEQUATE MARGIN OF SAFETY AND TO PROTECT AGRICULTURE VISIBILITY AND AESTHETICS.

The second secon

TO PUT THIS IN PERSPECTIVE IN SETTING AND TESTING THE 24-HOUR EPA STANDARDS, THE EPA STUDIED THE EFFECTS ON CHILDREN, THE ELDERLY, AND ASTHMATICS. THEY FOUND STRINGENT TO PREVENT ANY RESPONSE IN 99.5% OF EXERCISING ASTHMATICS WHO WERE DENIED MEDICATION, AND THE RESPONSES THEY DID FIND WERE MILD AND TEMPORARY. THESE ASTHMATICS TO BE MOST SENSITIVE. THEY ALSO FOUND THE EPA STANDARD IS SUFFICIENTLY WERE FAR MORE LIKELY TO REACT TO POLLEN, DUST, ANIMAL DANDRUFF, ETC. PEOPLE

OUR KNOWLEDGE OF PRELIMINARY DATA INDICATES THAT EXISTING FURTHERMORE, THE EPA IS IN THE PROCESS OF REEVALUATING THE NATIONAL STANDARDS FOR THEY WILL BE LOWERED FOR ALL STATES AND ALL REFINERIES WE COMPETE WITH WILL HAVE NATIONAL STANDARDS WILL NOT BE MADE MORE STRINGENT. HOWEVER, IF THEY ARE LOWERED, SULFUR DIOXIDE. TO COMPLY.

THE THERE ARE NO OTHER AREAS IN MONTANA WHICH COME CLOSE TO VIOLATION OF THE STATE SO2 STANDARDS. SECOND, IT IS HELPFUL TO HAVE SOME PERSPECTIVE ON THE OVERALL MONTANA SITUATION WHEN EVALUATING THE CONSEQUENCES OF RAISING THE STATE STANDARDS. BILLINGS AREA DOES NOT EXCEED ANY FEDERAL AIR QUALITY STANDARDS.

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ALTHOUGH WE KNOW OF NO PLANS FOR THE SITING OR CONSTRUCTION OF INDUSTRIES WHICH EMIT 502 IN OTHER AREAS OF THE STATE, IN THE EVENT THIS DOES OCCUR, THE NEW INDUSTRY WOULD HAVE TO MEET STRICT EPA NEW SOURCE PERFORMANCE STANDARDS. SUBMIT THAT CHANGING THE STANDARDS WILL NOT DEGRADE STATE AIR QUALITY.

THIRD, AND IMPORTANTLY, SO2 AIR QUALITY MEASUREMENTS IN BILLINGS CONTINUE TO SHOW A STEADY DOWNWARD TREND DUE TO VOLUNTARY INDUSTRY EFFORTS. THIS TABLE WHICH WAS COMPILED FROM EPA DATA SHOWS THAT AVERAGE SO2 MEASUREMENTS IN BILLINGS HAVE DECREASED FROM . 026 TO . 022.

WERE WILLING TO MAKE THIS REDUCTION VOLUNTARILY IN A GOOD FAITH EFFORT TO REDUCES EXXON, IN THE LAST DECADE, HAS SPENT OVER \$15M IN ENERGY CONSERVATION AND EMISSIONS REDUCTIONS EQUIPMENT TO IMPROVE AIR QUALITY, AND I AM PLEASED TO REPORT THAT WE RECENTLY IMPLEMENTED AN ENGINEERING DESIGN CHANGE WHICH HAS ENABLED US TO ACHIEVE AN ADDITIONAL 15 PERCENT REDUCTION IN SO2 EMISSIONS. WHILE THIS OPERATING CHANGE RESULTS IN A SUBSTANTIAL \$100K ADDITION TO OUR YEARLY BUSINESS COSTS, WE EMISSIONS AS MUCH AS POSSIBLE.

AREA INDUSTRIES TO MAKE SHORT TERM OPERATING CHANGES TO ENHANCE AIR QUALITY DURING WE HAVE ALSO STATED OUR WILLINGNESS TO WORK WITH THE AIR QUALITY BUREAU AND OTHER

PERIODS OF INVERSION. WE BELIEVE THAT IN COOPERATION WITH OTHER AREA INDUSTRIES, WE CAN AND WILL CONTINUE TO MAKE IMPROVEMENTS IN BILLINGS AIR QUALITY. I DO NOT BELIEVE THE EXISTING STATE SIGNIFICANTLY UNDERESTIMATED THE COSTS AND ECONOMIC IMPACT OF ENFORCING THE STATE REDUCTION WOULD BE IN THE \$8-20M RANGE. I WOULD EXPECT COSTS OF THIS MAGNITUDE TO STANDARDS ARE JUSTIFIABLE. THE EIS USED TO JUSTIFY THE STATE 502 STANDARD 502 STANDARD. ASSUMING THE AIR QUALITY BUREAU'S REDUCTION ESTIMATES ARE ACCURATE, OUR CAPITAL COSTS ALONE TO ACHIEVE THE REQUIRED ADDITIONAL 15 TO 30 HOWEVER, THIS LEADS ME TO MY FOURTH POINT. HAVE A VERY NEGATIVE IMPACT ON OUR BUSINESS.

PLAN TO STAY IN BUSINESS HERE. BUT LIKE OTHER BUSINESSES WE NEED THE COOPERATION LOSS CENTER. THAT MEANS, WE OPERATE LIKE A SMALL BUSINESS AND ARE ACCOUNTABLE FOR I WOULD LIKE TO STRESS THAT OUR REFINERY OPERATES AS A TOTALLY SEPARATE PROFIT AND OUR REFINERY HAS BEEN IN BUSINESS IN MONTANA FOR A LONG TIME, AND WE OF GOVERNMENT TO HELP MAINTAIN A HEALTHY BUSINESS CLIMATE THROUGH REASONABLE IF A UNIT IS UNABLE TO MAKE A PROFIT, IT WILL EVENTUALLY GO OUT REGULATORY REQUIREMENTS. BUSINESS.

ARE AT THE PRESENT TIME, THERE IS SURPLUS REFINING CAPACITY IN THE ROCKY MOUNTAIN IS HIGHLY COMPETITIVE. FOR THIS REASON, THE REFINING BUSINESS EXHIBIT 1 P. DATE 2 4 6.7

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COMPETING WITH REFINERIES IN SURROUNDING STATES AND CANADA WHICH WILL NOT BE REQUIRED TO MAKE SIMILAR INVESTMENTS TO STAY IN BUSINESS. FOR EXAMPLE, THE UTAH ENVIRONMENTAL STANDARDS TO THE FEDERAL LEVEL TO IMPROVE THEIR BUSINESS CLIMATE. IN THIS BILL, LEGISLATURE IS NOW CONSIDERING LEGISLATION TO RAISE ALL THEIR WE ARE TALKING ABOUT ONE STANDARD ONLY--THAT FOR 502.

SUPPORT IN RESOLVING THIS ISSUE THROUGH THE PASSAGE OF THIS THE BOARD OF HEALTH TO CONSIDER THE NEGATIVE ECONOMIC COSTS ASSOCIATED WITH IN CONCLUSION, WE HAVE TRIED TO WORK THROUGH THE ADMINISTRATIVE PROCESS IN GOOD FAITH. WE HAVE BEEN WILLING TO MAKE REDUCTIONS BUT AT THE SAME TIME HAVE ASKED ACHIEVING THE EXISTING STATE STANDARDS. THE BOARD HAS NOT INDICATED A WILLINGNESS CONTINUING THROUGH THE ADMINISTRATIVE PROCESS IS COSTLY TO INDUSTRY AND THE STATE RE-EVALUATE AND/OR CHANGE THE STATE STANDARD. WE HAVE COME TO FEEL THAT WE BELIEVE THAT PASSAGE OF THIS LEGISLATION WILL ALLOW FOR THE PROTECTION OF HUMAN AND THAT THE LEGISLATURE IS IN THE BEST POSITION TO ASSESS STATE ECONOMIC IMPACTS. HEALTH AND AIR QUALITY AND WILL HELP MONTANA INDUSTRIES REMAIN COMPETITIVE. WE ASK FOR YOUR LEGISLATION. 10

THANK YOU. I WILL BE GLAD TO ANSWER ANY QUESTIONS YOU MAY HAVE.

## TESTIMONY OF JIM SCOTT President-elect Billings Chamber of Commerce

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February 4, 1987

The Billings Chamber of Commerce is in business to foster a high quality overall business climate for the Billings area. We believe that the definition of a business climate is multifaceted and complex. It certainly includes insuring that local industries can operate profitably so that they can grow, add jobs and increase their contribution to our economy. It also clearly includes however insuring that Billings has a healthy environment consistent with our Big Sky image and perceived high quality of life. That also will attract new business investment as well as visitors through tourism and convention activity.

We feel it is appropriate then that the Chamber is here to testify on this issue which affects both profitability of existing industry and quality environment.

We believe that there are at least two very important issues in this question of  $SO_2$  levels in the Yellowstone Valley.

The first is standards of acceptable levels of SO<sub>2</sub>. This is a very complex area that is not as objective as any of us would like. There are numerous ways to measure SO<sub>2</sub> levels. Annual averages, 24-hour levels, 3-hour levels, etc. There are numerous ways to interpret the health effect of those measurements.

The Chamber believes that the federal standards are appropriate given current health information and the current economic conditions in our community.

Having more stringent state standards seems counter-productive.

Compliance will become more expensive for the industries involved and puts at risk numerous jobs in our community.

We understand that the federal standards are being reviewed for their appropriateness, and we look forward to analyzing the results of that review.

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There is a second important issue, however. While air quality is made up of numerous components -- and we believe that Billings has good quality air overall -- we are concerned with our levels of  $SO_2$ . The fact that studies have shown that the  $SO_2$  levels are high relative to other cities in the country is a negative for Billings in attracting new industry and is a weakness that we need to address.

I was very encouraged in attending the Department of Health hearings January 16th to hear that there is progress being made. Responsible voluntary reductions have been made by the refineries in the Valley. I learned that when climatic conditions are poor and when SO<sub>2</sub> levels are at their highest levels, a cooperative effort by the industries can further drastically reduce SO<sub>2</sub> emmission and the inherent health risk. I learned that the industries are willing to fund the acquisition and operation of additional ambient air monitors to get a better and more accurate measurement of the condition that exists. I learned that through a cooperative and relatively inexpensive effort between the industries and the Department, a more accurate model can be developed to better determine an accurate picture of how much SO<sub>2</sub> is emmitted and from where. This information has not been agreed upon to date.

Progress is being made to address the problem that exists. That progress needs to continue through a cooperative and good faith effort of the industries, the Department of Helath and the community. That effort is of high priority. It will influence our ability to develop a M.H.D. project, other projects which desire to add value to our energy resources locally or to any other meaningful growth. After we adopt the federal standards, that effort must go on.

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### TESTIMONY OF ROBERT HOLTSMITH MANAGER, BILLINGS REFINERY, CONOCO INC.

Sulfur Dioxide Air Quality Standards
House Bill 534
State of Montana
February 4, 1987

My name is Robert Holtsmith. I reside at 2750 Gregory Drive North in Billings, Montana. I am Manager of the Conoco Billings Refinery. The Conoco Refinery has an annual pay roll of \$11,500,000 and pays in excess of \$1,600,000 property tax. We are a major industry in the Yellowstone Valley and have a particular interest in the sulfur dioxide issue.

Conoco favors the action of the legislature to eliminate the more stringent state sulfur dioxide emission standards and implement the federal National Ambient Air Quality Standards for the following reasons.

- 1. The National Ambient Air Quality Standards have been established after rigorous review to protect even the most sensitive members of the community.
- 2. The federal standards are subjected to exhaustive scientific and public review and to the special scrutiny of an independent national board of leading health scientists known as the Clean Air Scientific Advisory Committee.
- 3. The federal standards are under periodic, legally required, review.
  The current review has produced little data to indicate that the
  24-hour or the annual-average should be more stringent.

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4. The state industries could better utilize their resources to remain competitive and viable. The refining industries in the Yellowstone Valley not only compete with each other but they have to compete with refineries such as Amoco, Chevron, and Phillips in Utah, and Sinclair and Frontier in Wyoming. These refineries only have to achieve the federal ambient air quality standards.

Emission controls for improving air quality are expensive.

Nevertheless, as a responsible corporate citizen. Conoco is willing to spend its fair share to prevent any endangerment to human health or the environment. In this case, however, we do not believe that any such endangerment exists. We also spend whatever is necessary to comply with environmental laws and regulations. However, we try to ensure that such laws and regulations are reasonable. That's what we are doing here today.

Despite our belief that the state air quality standards are not reasonable, Conoco has consistently offered to reduce its sulfur dioxide emissions by some 15% from the 1981-82 baseline study period. We made that offer to the Air Quality Bureau in September 1985 and to the Board of Health in January 1987 to help resolve the issue. We will make that offer to the legislature as well. Conoco will continue to cooperate with the state and decrease emissions 15% from the 1981-82 baseline study period if the state standards are changed to the federal standards. We would do this to help provide further assurance that the federal standards would continue to be met and to provide a margin for some

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degree of industrial growth. In addition, we would help sponsor air design of the sponsor air quality monitoring in the Billings area to ensure continued attainment of the federal standard.

In conclusion, Conoco urges this body to enact legislation mandating Montana's air quality standards for sulfur dioxide be made identical to the federal National Ambient Air Quality Standard.

THANK YOU



CENEX • Post Office Box 909 • Laurel, Montana • 59044-0909 • Phone (406) 252-9326

Louis J. Day Refinery Manager Petroleum Division

I am Louis J. Day, Refinery Manager at the CENEX Refinery in Laurel, Montana.

I wish to thank you for the opportunity to speak to you today and for your concern that has resulted in this hearing.

In accordance with a 1977 stipulation between the Air Quality Bureau and the Billings area industry CENEX invested \$5,700,000 in a sulfur dioxide emission reduction program to achieve a 15% reduction in plant sulfur dioxide emissions. This investment program was completed in 1979 and the Air Quality Bureau ambient data showed an 80% drop in the ambient sulfur dioxide concentration in Laurel. The data showed Laurel to be approximately 50% of the present state standards and to have sulfur dioxide levels lower than those measured in 1985 in Alaska and the Virgin Islands.

There are presently rules before the Board of Health which will require additional emission reductions, up to 45%, at our refinery. These rules, if implemented, will require the immediate commitment to an investment which may exceed \$70,000,000. The decision to make this investment must be made by CENEX in the face of a company wide loss in 1986 of

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\$12,000,000 and fiscal uncertainty in 1987. Any additional regulation will affect the economic viability of our operation.

CENEX will reduce the sulfur dioxide emissions from the refinery for short time periods, one or two days, by 10 to 20% if necessary to comply with the federal 24 hour standard. Such a program can be implemented without the major economic impact of the proposed rules but would require the revision of the present Montana ambient standards. We support House Bill 534 as a means of providing both a sound environment and a sound economy in Montana.

Thank you for your consideration of this matter.

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#### HOUSE BILL 534 - BILLINGS SO<sub>2</sub> STANDARDS

The Montana Power Company (MPC) supports adoption of the Federal annual and 24-hour ambient sulfur dioxide standards as proposed in House Bill 534. These Federal standards are based on extensive studies and hearings and are sufficient to protect public health and welfare. We have held this conviction since the State standard was established in 1980 after a hearing by the Board of Health and Environmental Sciences (BHES). opinion, the stringent State ambient SO, standards are not necessary and are based upon an inadequate record. The cost to comply with them is exorbitant. Further, there is no health and welfare necessity for more stringent standards Billings-Laurel area. In a September 1986 EPA staff report, after reviewing current Federal ambient air SO2 standards, the EPA concluded "the current [Federal] standards provide substantial protection against the effects identified as being associated with 24-hour and annual exposures."

MPC proposes and endorses the adoption of the Federal sulfur dioxide ambient annual and 24-hour standards. In conjunction with adoption of the Federal standard, MPC supports voluntary reduction of the emissions from the J.E. Corette plant for certain identifiable weather episodes that cause 24-hour SO<sub>2</sub> readings above the present State ambient standard. These reductions would be obtained through intermittent control of the plant.

Further, MPC supports the continued use and reporting of data from the J.E. Corette plant (in-stack) continuous emission monitor, and participation in an ambient monitoring program with other industries and with the Department and BHES.

The perceived ambient SO<sub>2</sub> problem is not as significant as various groups have alleged. In a three-year period, 32 episodes

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were recorded exceeding the 24-hour state standard at the four Billings ambient monitoring stations. At the monitoring station closest to the J.E. Corette plant, only four episodes exceeded the State standard when the Corette plant was a 25% or greater contributor.

The perception that a problem exists, however, has led to three proposed rules requiring continuous SO<sub>2</sub> emission reductions for the Billings area industries. These proposed rules show that the BHES intends to enforce strictly the more stringent State standards, regardless of the necessity and economic consequences of enforcement. One of the facilities most affected by the proposed rules is the J.E. Corette coal-fired thermal electric generating plant, which uses low sulfur Rosebud seam coal. Any of these emission reduction proposals would, if adopted, require the installation of a \$40 million scrubber or a change to Wyoming coal. Either alternative would lead to increased costs to the people of Montana and the consumers of electric power.

In closing, MPC's approach of intermittent control, along with adoption of the Federal standards:

- 1. protects the health of the people of Billings;
- 2. allows existing industry to continue operations; and
- 3. provides both a margin below the Federal standard and the opportunity for some economic growth in the area.

The Montana Power Company Carlton D. Grimm

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## BEFORE THE BOARD OF HEALTH AND ENVIRONMENTAL SCIENCES OF THE STATE OF MONTANA

In The Matter of Adoption of	)	Statement
Proposed Sulfur Dioxide Emission	)	of
Standards	)	The Montana Power Company

## Presented by Carlton D. Grimm

I am Carlton D. Grimm; my employer is The Montana Power Company and my position is that of the Director of Generation System Development in the Thermal Engineering Department. My education is in chemical engineering and I have both a Bachelor of Science degree and a Ph D. I have worked the past fourteen years in the area of pollution control for thermal power plants, specifically the Colstrip 1 through 4 units and the J. E. Corette Plant.

The Montana Power Company (MPC) has reviewed the three proposed sets of emission regulations pertaining to sulfur dioxide emissions that are before the Board of Health today and objects to the adoption of any of the rules. Montana Power wishes to comment on how these rules would affect our coal-fired steam electric generating facility at Billings, Montana, if any one of them were enacted.

First, we wish to give some background information on that facility. The location of the plant is at the south end of Billings, next to the Yellowstone River just downstream from the municipal water treatment plant. To the north is the Conoco oil refinery and to the northwest is the sugar refinery. The J. E. Corette coal-fired plant and the F. W. Bird plant, an oil/gas fired unit which is operated infrequently, are adjacent to each other.

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The J. E. Corette plant, which is nominally a 180 MW unit, first entered service in the fall of 1968, eighteen years ago. It presently has 18-20 years of economic life remaining. The cost to construct this unit, at that time, was \$21 million. Since the plant entered operation on our system, it has burned low sulfur coal (less than I percent sulfur) from the Rosebud seam of Western Energy's Colstrip mine in southeastern Montana. The plant emissions have been regulated under the Montana State Standard (ARM 16.8.1411) for sulfur in fuel, which limits the sulfur to one pound of sulfur per million BTU fired. A continuous sulfur dioxide emission monitor was placed in operation in 1978 to maintain a close watch on the coal sulfur quality. This monitor provides SO2 emission data which is routinely reported to the State Air Quality Bureau. The installation of this monitor was part of a costly retrofit project to provide emission monitoring and testing facilities on the generation unit's 350 foot stack. The plant has in operation an electrostatic precipitator to control particulate emissions to the required State emission limit. When the unit first entered operation in 1968, the State had just enacted ambient air quality guidelines. These guidelines were changed to "enforceable" standards by Board of Health action in 1980.

Keeping that information in mind, we now wish to discuss each of the emission reduction proposals:

A. Alternative 1 is stated to be "Sulfur Dioxide Emission Standards through a roll-back method" and calls for MPC to reduce  ${\rm SO}_2$  emissions from the 1981-82 levels thirty to thirty-five

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percent. However, close inspection of this proposed rule leads the reader to believe that the actual emission limit would be much more stringent requiring a larger  $SO_2$  reduction. The emission limit is required to be met on a daily basis and is set at 1/365th of the annual emission rate of the test year (1981-1982). If the plant operated at less than full capacity during that test year, which it did, then a substantially greater emission reduction is asked for in this proposed rule. When this rule was presented to us in draft form and we commented on it, the daily emission rate of 1/365th of the annual total was not mentioned.

MPC sees three possible options for our Corette plant, which might meet this emission reduction contained in Alternative 1.

They are:

- 1. Installation of a scrubber. This is a very costly option -- both from the capital cost and annual operating cost standpoint. Costs and limitations of this option are discussed under Alternative 3, the 70 percent reduction case. For both this nominal 30 percent alternative and the 70 percent reduction alternative, the scrubber option is considered unacceptable. Limited space around the existing unit and the need for off-site waste disposal add substantially to the design problems and cost of the flue gas desulfurization retrofit.
- 2. Permanent reduction of load by approximately 1/3 of the rated capacity of the unit would reduce the  $SO_2$  emissions by the same fraction. The loss in generating capacity would be 60 MW. Loss of this much generation would cost approximately \$46 million

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in annual levelized dollars over an 18-year period to purchase from off-system sources and would not be an acceptable long-term solution.

- Switch fuels from Colstrip Rosebud seam to a lower sulfur coal. It its analysis of the draft proposed rules, MPC searched for lower sulfur coal and did not locate any viable supply source in the State of Montana that could meet existing boiler requirements and the coal sulfur level necessary to meet the proposed sulfur dioxide emission limitation. However, lower sulfur fuels are currently being mined in Wyoming. The Rosebud seam coal, when burned, generally produces sulfur dioxide emission in the 1.4 to  $2.0~{\rm lb}~{\rm SO}_{2}/{\rm MMBTU}$  range. One specific Wyoming coal we looked at would produce between 0.6 and 1.1 lb SO<sub>2</sub>/MMBTU. Depending on how the daily emission rate is computed, even this low sulfur coal might not be an option. Should the coal change become necessary, test burns to prove the alternate fuel's acceptability in the present station would be required. The economic costs to entities other than MPC for switching fuel from a Montana source to Wyoming are as follows and represent those costs accumulated over a 20-year period, which is approximately the remaining economic life of the J. E. Corette plant:
  - 1) The State of Montana would lose approximately \$25 million in Coal Severance Taxes;
  - 2) Loss of Gross Proceeds Taxes would be \$3.8 million;
  - 3) Loss to the State of Montana of 1/2 of associated Federal Coal Royalties -- \$3.8 million;

- 4) Loss of Resource Indemnity Trust Tax -- \$330,000;
- 5) Loss to a Montana supplier, Western Energy Company, of coal sales in excess of \$120 million;
- 6) Loss to the private sector for support goods and services -- \$25 million;
- 7) Direct employment -- \$9.4 million;
- 8) Indirect employment -- \$6.4 million; and
- 9) Loss of corporate and Individual Income Taxes on direct and indirect employment.

From these figures, one sees the economic impacts of the coal switch are significant to the State of Montana and go beyond the totals of coal taxes, jobs, and direct expenditures. The impacts would reach into and affect all sections of Montana's economy.

B. Alternative 2 sets the emission performance standard of 1.2 lb SO<sub>2</sub>/NMBTU for the J. E. Corette plant. This alternative requires an emission reduction at the Corette plant of approximately 1/3. This emission standard is the same as the 1971 New Source Performance Standards (NSPS) for new plant construction and is the standard under which Colstrip Units 1 and 2 operate utilizing scrubbers. MPC is not aware of any older unit, that is a pre-1971 NSPS facility, that has been required to retrofit emission controls to meet this emission limit.

The control options for this alternative are similar to those stated for Alternative 1:

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- 1) Load reduction of up to 60 MW at a cost of approximately \$46 million in annual levelized dollars over 18 years for power that must be purchased elsewhere.
- 2) Fuel switch with the resulting costs already outlined.
- C. Alternative 3 calls for the selective source emission reduction and singles out MPC's J. E. Corette unit for the largest emission reduction (70 percent) even though this source has significantly less emissions than other contributors in the Billings area. The annual emission inventory for the 1981-82 time period reported by the Air Quality Bureau in their draft Billings Sulfur Dioxide Study Draft lists Exxon at 8269 tons of SO<sub>2</sub> per year, Cenex at 8794, MPC at 5460, Conoco at 3603, Montana Sulfur at 2527 and Great Western at 503.

Two options to comply with this emission reduction standard are the installation of a scrubber or the shut down of the generating facility.

1) Scrubber Installation. The plant's emissions should not exceed approximately 0.6 lb  $\rm SO_2/MMBTU$  to meet the 70 percent reduction required under this alternative. Again in the proposed rule, the statement requiring a daily limit not to exceed 1/365th of the test year's emissions is found. This would mandate greater than 70 percent control and can be translated to an emission limit of about 0.2 lb  $\rm SO_2/MMBTU$ . This very onerous limitation is similar to that imposed on Colstrip 3 and 4. Late in 1985, MPC began a study to evaluate possible  $\rm SO_2$  control options taking into consideration the

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various limitations of the J.E. Corette plant site. The result of this study was that a dry flue gas desulfurization (FGD) system with a supplemental precipitator is necessary to meet the 0.6 target originally stated in the September draft proposed rules. The capital cost of this installation is in the range of \$40 to \$50 million in 1986 dollars and the additional annual operating cost is \$2.5 to \$3.5 million. These costs take into consideration that this is a difficult retrofit situation; i.e., that when the plant was originally designed and built in 1968, no provision was made for future SO2 control (the first NSPS became law in late 1971). Also, MPC is not aware of any utility plant that has had to retrofit scrubbers for any State Ambient air quality standard more stringent than the Federal ambient air quality standards. The retrofit costs for providing the J. E. Corette plant with a scrubber are clearly unacceptable.

2) Close the plant. Rather than install the scrubber and considering the economic life of the unit, which was 18 years in 1986, MPC would almost undoubtedly decommission the J. E. Corette unit. This plant is currently the highest incremental power cost coal-fired station in our system. Scrubbing costs would significantly add to the overall plant dispatched power cost. Decommissioning would result in the loss of 45 jobs at the plant site, which represents in excess of \$1.5 million in annual payroll, and the loss of 500,000 tons of coal mined each year in Montana, with that specific cost impact already

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detailed. Energy would have to be replaced at a much higher cost to the ratepayer. In addition, the amortization of the remaining investment in the facility must be considered, as the plant would be decommissioned halfway through its economic life.

Each of the alternatives discussed contains a heavy cost, which is ultimately borne by the citizens of the State of Montana, whether from increased cost of electricity or from loss of coal mined within the State.

We, therefore, submit that any of these proposed rules for emission reductions are unacceptable and the Board should reject the proposed rules.

Now, we wish to address some of the ambient  $SO_2$  data gathered in the Billings area and comment on the analysis we performed on that ambient data.

Last December, after our comments on the draft rules had been submitted to the Department, we found that the Air Quality Bureau had examined a number of 24-hour  $\rm SO_2$  episodes in the Billings area.

We asked the DHES-AQB for its draft report compiled by Bob Raisch in July, 1986, entitled "Draft Analysis of Sulfur Dioxide Episodes at the Billings and Lockwood Monitoring Sites." This report looks specifically at the 24-hour state standard  ${\rm SO}_2$  episodes during the years 1983, 1984 and 1985. We have prepared several histograms of the information contained within this report that relate directly to the significance of the perceived  ${\rm SO}_2$  problem in Billings.

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Perceptions and emotions have created a mind-set that the  $\rm SO_2$  ambient levels in the Billings area are serious. We do not believe that the facts support such a position. The number of times that the ambient  $\rm SO_2$  levels exceeded the state standard is low.

The histograms we prepared from that report are included with this statement (Exhibit A). In our analysis, we used the state's assignment of source apportionment. We also understand that data captured at the monitoring sites over the three-year period is between 75 and 90 percent.

The first histogram shows 32 episodes where the state standard was exceeded over the three-year period. This is the total for the four monitoring sites operated. It also includes those episodes arising from malfunctions at one or another of the process industries emitting  $\rm SO_2$ . Three of the four episodes over the Federal standard level occurred during those periods of upsets. It is important to know there were no violations of the Federal standard recorded, as the episodes did not give rise to more than one exceedance of the Federal standard at any one site more than once in any calendar year.

Now, examining the rest of the histogram's plots that show frequency distribution, one finds:

If using the state's method of apportionment where MPC is a contributor of 15% or greater, then there were 14 episodes in 3 years at all sites.

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- where MPC is a contributor of 25% or greater; the frequency falls to 7 episodes in 3 years -- (all this factors out the known upsets).
- Looking at one site only, at Coburn Road, without upsets: there were 8 exceedances of the State standards in 3 years. -- This represents contribution from all sources. The number of instances where MPC was listed as a 25% contributor or greater at this site (excluding upset conditions) was 4 in this 3-year period.

Now, we ask you, is the problem significant enough to require continuous emission controls on our electric generating facility to the tune of \$40 or more million; or to go to an out-of-state source of coal with the loss to the State of the associated revenues from that coal? We do not believe it is.

To solve the problem, we suggest:

- 1) Use intermittent control at the MPC J. E. Corette facility along with various degrees of control as proposed by the other industries: and
- 2) Adopt the Federal 24-hour and annual ambient standards.

The operational control we suggest would require feedback from ambient monitoring and meteorological systems. Such feedback would be analyzed and responded to by the plant operating personnel, according to criteria set up by the meteorologists. This criteria should predict the onset of unfavorable meteorological conditions that lead to the episodes described above in the histogram analysis.

EXHIBIT (52)

DATE 2:4:87

HB 534

When the unfavorable conditions occur and persist, the generating plant's load would be backed down to an agreed upon level.

We feel that such an approach would minimize the short-term exceedances of the present Montana 24-hour standard.

In addition, we strongly recommend that the Federal 24-hour and the Federal annual  $\mathrm{SO}_2$  standards be adopted or enacted. MPC has supported and continues to support proposed legislation which would adopt these standards. We have recommended and continue to recommend the Federal standards to this Board. Attached to this statement is the EPA staff conclusion and summary document on the review of the National ambient air quality standard for sulfur oxides, dated September 12, 1986 (Exhibit B). Pertinent passages from this document state that EPA sees no reason to revise the 24-hour and annual  $\mathrm{SO}_2$  standards to a more stringent level in order to protect human health.

We feel adopting this approach of intermittent control, along with the Federal standards (a) protects the health of the people of Billings, (b) allows existing industry to operate and (c) provides both a margin below the Federal Standard and the opportunity for further economic growth in the area as, for example, the MHD retrofit of the Corette plant.

We have received and reviewed the recent draft "Interim Compliance Stipulation" sent by the Air Quality Bureau to the Billings' industries on December 31, 1986. We agree in concept with this method of administrative settlement and we met on January 14th with the Bureau to express our position.

EXHIBIT (5a)
DATE 2.4.87
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We do not agree with all aspects of the Bureau's stipulation. The essence of disagreement is that the stipulation, as now written, proposes a continuous, daily, emission reduction.

Although the proposal calls for, in the case of MPC, a 15% reduction, we believe, subject to further analysis, that this continuous reduction is too extreme and not supported by the facts.

However, as we have earlier stated, MPC is prepared to reduce emissions intermittently in response to identification of adverse meteorological conditions. This will alleviate and attempt to minimize the number of 24-hour  $\rm SO_2$  episodes which exceed the present state standards and may reduce the annual ambient levels presently recorded.

During these episodes, which generally last less than 24-hours, MPC would be willing to reduce its emissions through operational methods which could include load reductions. In addition, MPC would propose to fund one ambient air monitoring station and continue its emission monitoring activity.

We propose that this voluntary reduction be accomplished through agreement of all parties, including the Department and Board of Health.

In summary, MPC reiterates its position that adoption of the three proposed rules before the Board of Health is not necessary, is not supported by the data and would cause extremely expensive

EXHIBIT (5a)

DATE 2.4.87

HB 534

controls or solutions to be adopted. We feel our suggested alternate of going to the Federal ambient  $\rm SO_2$  standards and the use of intermittent operational controls of our plant is the best solution.

DATED this <u>(Gineral</u> day of January, 1987.
RESPECTFULLY SUBMITTED,

THE MONTANA POWER COMPANY

By

Carlton D. Grimm 40 East Broadway Butte, MT 59701 (406) 723-5421

EXHIBIT (5a)

DATE 2.4.87

HP 534

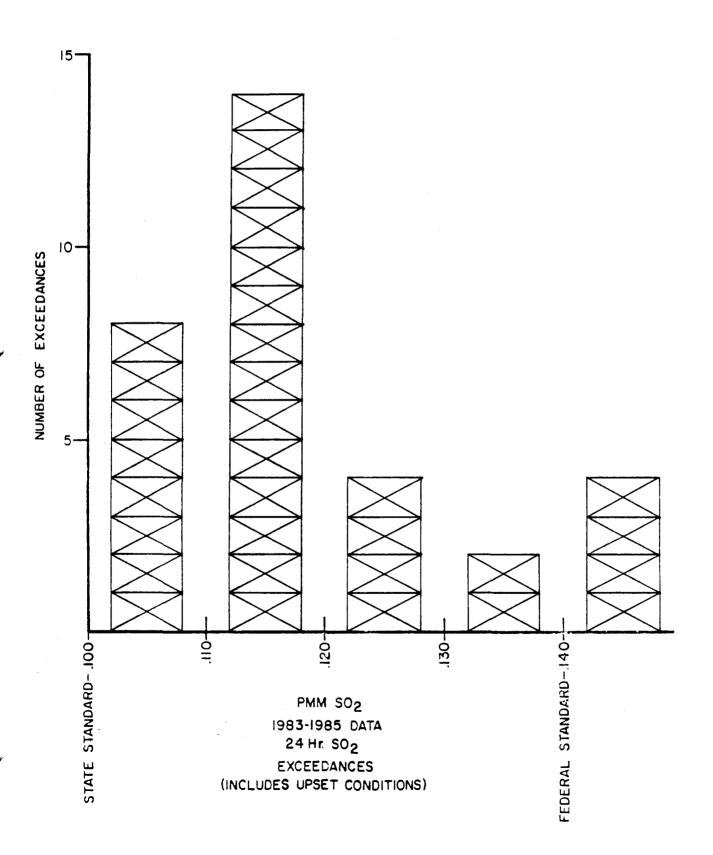


EXHIBIT (5a)

DATE 2.4.87

HB 5.34

# ALL SITES INCLUDES UPSET CONDITIONS

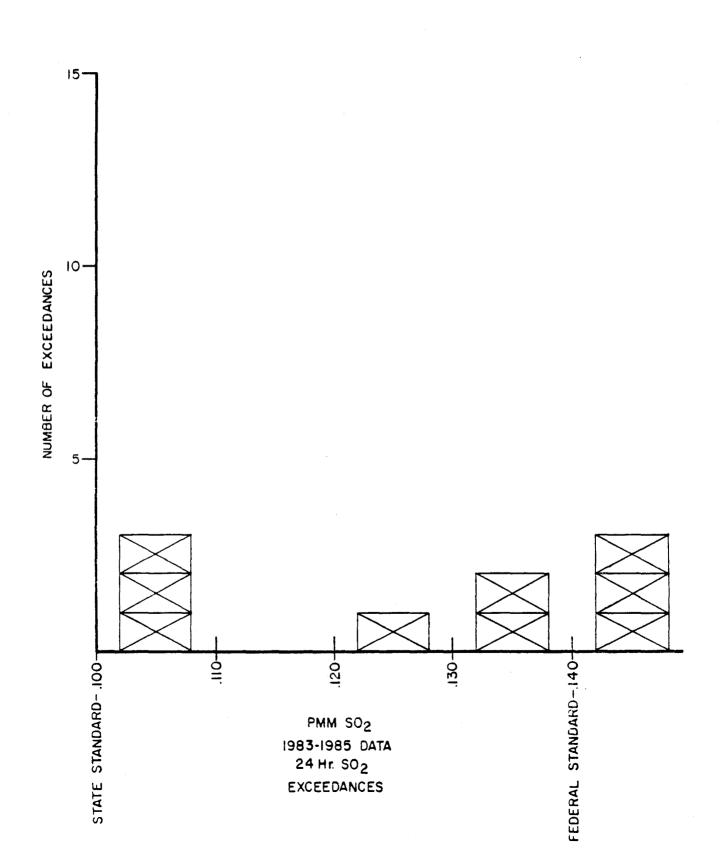


EXHIBIT	(5a)
DATE	2.4.87
HB _5	34

ALL SITES
MPCo CONTRIBUTOR
15% AND GREATER
NO UPSETS

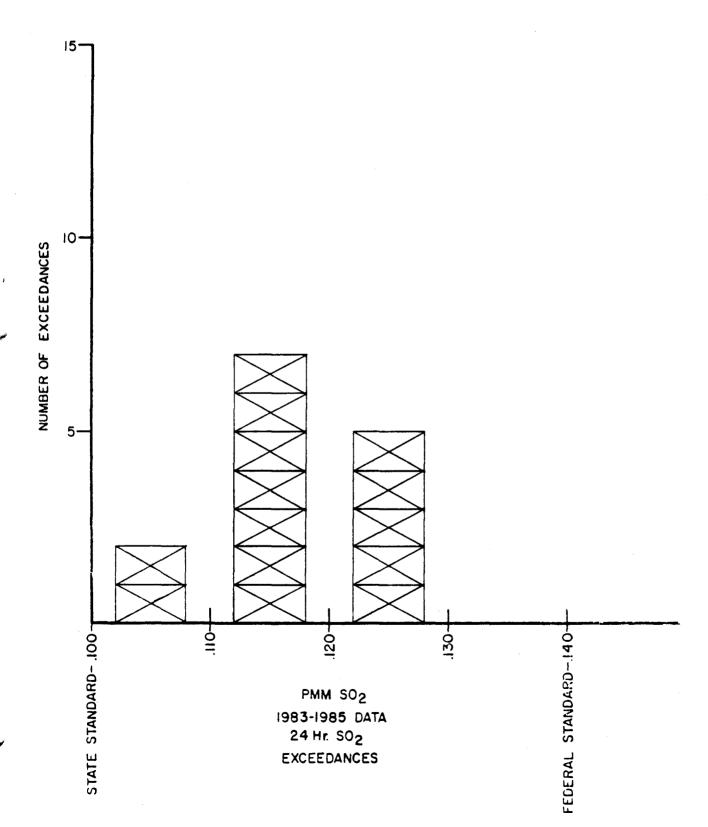


EXHIBIT (5a)

DATE 2.4.87

HB 534

ALL SITES
MPCo CONTRIBUTOR
25% AND GREATER
NO UPSETS

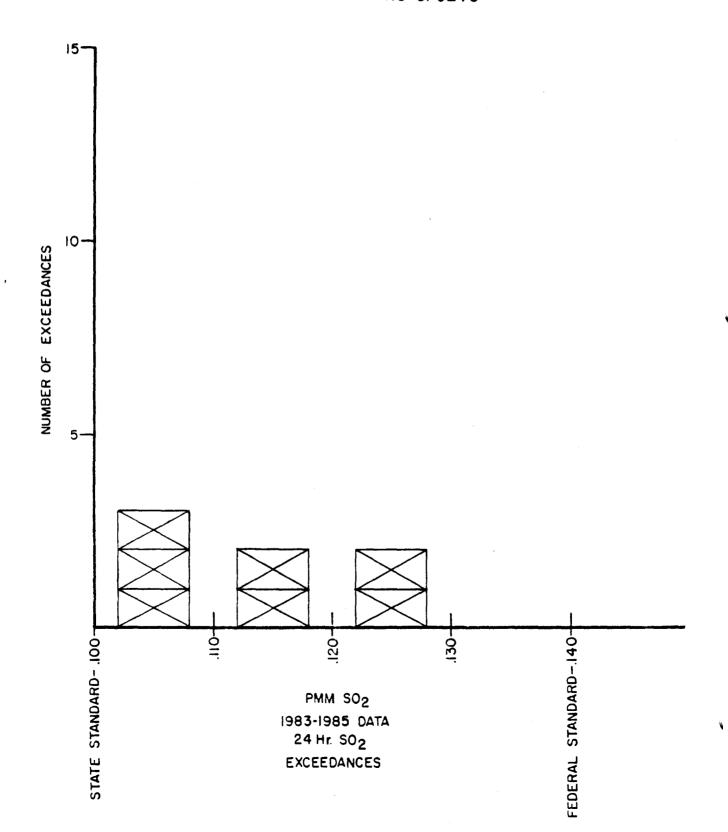


EXHIBIT (5a)
DATE 2:4.87
HB 534

## COBURN ROAD NON-UPSET CONDITIONS

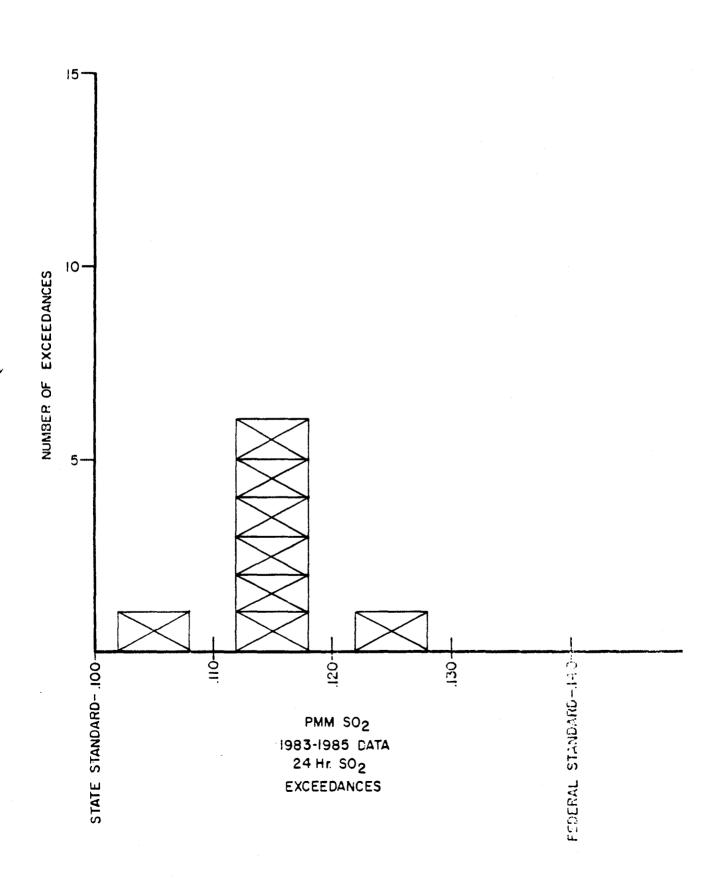


EXHIBIT B
EXHIBIT (52)
DATE 2.4.87
up 534

REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR SULFUR OXIDES

UPDATED ASSESSMENT OF SCIENTIFIC AND TECHNICAL INFORMATION

DRAFT ADDENDUM TO THE 1982 OAQPS STAFF PAPER

September 12, 1986

- C. Summary of Staff Conclusions and Recommendations
  The major updated staff conclusions and recommendations made in Section
  IV. A-B are briefly summarized below:
- The more recent data provide additional support for the earlier staff 1) recommendations regarding consideration of a new 1-hour SO<sub>2</sub> standard. Based on an updated staff assessment of controlled human exposures to peak (minutes to hours) SO2 concentrations, the staff has revised the range of potential 1-hour levels of interest to 0.2 to 0.5 ppm (525 to 1300  $\mu g/m^3$ ). The lower bound represents a 1-hour level for which the maximum 5 to 10 minute peak exposures are unlikely to exceed 0.4 ppm, which is the lowest level where potentially significant responses in free (oronasal) breathing asthmatics have been reported in the criteria document addendum. The upper bound of the range represents a 1-hour level for which 5 to 10 minute peak concentrations are unlikely to exceed 1 ppm, a concentration at which the risk of significant functional and symptomatic responses in exposed sensitive asthmatics and atopics appears high. In evaluating these laboratory data in the context of decision making on possible 1-hour standards. the following considerations are important: (a) the significance of the observed or anticipated responses to health, (b) the relative effect of SO<sub>2</sub> compared to normal day to day variations in asthmatics from exercise and other stimuli, (c) the low probability of exposures

of exercising asthmatics to peak levels, and (d) five to ten minute peak exposures may be a factor of two greater than hourly averages.

Independent of frequency of exposure consideration, the upper bound of the range contains little or no margin of safety for exposed sensitive individuals. The limited geographical areas likely to be affected and low frequency of peak exposure to active asthmatics if the standard is met add to the margin of safety. The data do not suggest other groups that are more sensitive than asthmatics to single peak exposures, but qualitative data suggest repeated peaks might produce effects of concern in other sensitive individuals. Potential interactions of SU2 and U3 have not been investigated in asthmatics. The qualitative data, potential pollution interactions, and other considerations listed above should be considered in determining the need for and evaluating the margin of safety provided by alternative 1-hour standards.

- Based on a staff assessment of the recent short-term epidemiological data, the original range of 24-hour  $SO_2$  levels of interest 0.14 to 0.19 ppm (365 to 500  $\mu g/m^3$ ) still appears appropriate, although some consideration could be given to the findings of physiological changes of uncertain significance at levels as low as 0.1 ppm. Earlier staff conclusions and recommendations concerning a 24-hour standard (SP, pp. 85-86) remain appropriate.
- 3) The previous staff assessment concluded that although the possibility of effects from continuous lower level exposures to  $SO_2$  cannot be ruled out, no quantitative rationale could be offered to support a specific range of interest for an annual standard. The more

recent epidemiological data provide additional support for the original recommendation for retaining an annual standard at or near the current level 0.03 ppm (80  $\mu g/m^3$ ). This recommendation was based in part on a finding that alternative short-term standards would not prevent annual levels in excess of the current standard in a limited number of heavily populated urban areas. Given the additional information and the possibility of effects from a large increase in population exposure, the staff recommends maintaining the primary annual standard at its current level.

- 4) Analyses of alternative averaging times and population exposures suggest that:
  - a) The current standards provide substantial protection against the effects identified as being associated with 24 hour and annual exposures.
  - b) The current standards as reflected by current emissions or emissions when the standards are just met with somewhat less restrictive implementation assumptions also provide some limit on peak SO<sub>2</sub> exposures of concern for asthmatics. In some cases, however, up to 10 to 15% of the sensitive population in the vicinity of major sources could be exposed once a year to levels at or above 0.5 ppm for 5 minutes, while at elevated ventilation.
  - c) The range of 1-hour standards analyzed (0.25 to 0.5 ppm) provides increased protection against such exposures, limiting the fraction of asthmatics exposed to less than 4%.

The relative protection afforded by current vs. alternative standards as indicated by current and ongoing exposure analyses is an important consideration in determining what, if any, standard revisions may be necessary.

2 A E T ...

# Testimony by Kenneth L. Williams Entech/Western Energy Co. Butte, Mt. at House Natural Resources Committee Hearing February 4, 1987

Mr. Chairman, members of the Committee, my name is Kenneth Williams. I appear here today on behalf of Western Energy Company in support of House Bill 534.

Western Energy Company supplies coal from our Rosebud Mine at Colstrip to the J.E. Corette Generating Station in Billings. In 1986 we supplied 392,840 tons for the Corette Plant. Those 392,840 tons translate into approximately 19 to 20 direct mining jobs at Colstrip.

Western Energy is concerned that the failure to adopt the changes contemplated by House Bill 534 may cause the loss of those coal sales from our Rosebud Mine. A fuel switch to Wyoming Coal would have serious economic consequences on Montana by the total loss of coal severance tax revenues, coal gross proceeds taxes as well as other taxes. However, the human tragedy is greater with the loss of direct and indirect mining jobs that weakens the economic vitality of Montana.

If Montana loses the coal supply for the remaining life of the Corette plant impacts of the following magnitude are predictable:

- 1) The State of Montana would lose approximately \$25 million in Coal Severance Taxes;
- 2) Loss of Gross Proceeds Taxes would be \$3.8 million;
- 3) Loss to the State of Montana of 1/2 of associated Federal Coal Royalties -- \$3.8 million;
- 4) Loss of Resource Indemnity Trust Tax -- \$330,000;
- 5) Loss to a Montana supplier, Western Energy Company, of coal sales in excess of \$120 million;
- 6) Loss to the private sector for support goods and services-- \$25 million;
- 7) Direct employment -- \$9.4 million;

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- 8) Indirect employment -- \$6.4 million; and
- 9) Loss of corporate and Individual Income Taxes on direct and indirect employment.

From these figures, one sees the economic impacts of the coal switch are significant to the State of Montana and go beyond the totals of coal taxes, jobs, and direct expenditures. The impacts would reach into and affect all sections of Montana's economy. We urge a do pass recommendation for HB 534.

EXHIBIT	(7)
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Good Afternoon. I would like to speak in support of House Bill 534.

My name is Dan Farmer. I am a chemical engineer by profession and registered in Montana and Wyoming. My experience is in the design and construction of oil and gas production, transmission, and distribution facilities.

Over the last year, many knowledgeable people in the Billings area have watched this  $SO_2$  Ambient Air Quality issue with great concern. The economic impacts of enforcing the present standard on the Billings economy could be extremely harmful and long-lasting. I would like to address the issue from an engineering standpoint.

The information presented in support of the present Montana Standard is inadequate to support, with any degree of accuracy, the .02 parts per million standard in two ways.

- 1) No model has been developed to accurately determine the source and amount of SO<sub>2</sub> emissions and the probable effect of a reduction at any of the six emitting companies. Reliable data is essential to an accurate decision.
- No health data has been presented to justify Montana's lower SO<sub>2</sub> level. Federal studies are, by all accounts I can find, considered to be accurate and to have an adequate margin of safety.

In summary, there is not any known health reason to justify Montana's lower  $SO_2$  Ambient Air Standard. If no benefit is shown, how can we justify forcing business to spend millions for  $SO_2$  Scrubbers?

FX: yr. (7) 2 4.87 HD 534

It is my opinion that high business taxes and excessive regulation, such as the present Montana  $\mathrm{SO}_2$  Standard, are the major controllable reasons that Montana faces the economic crisis that now exists.

I ask your support of House Bill 534 both because it is an adequate standard and because it will send a positive message to business.

Respectfully.

Dan Farmer

The Billings Gazette is dedicated to the continued growth of Billings and Montana while recognizing that our unique quality of life must be maintained and preserved.

シートニショニー!

Wayne E. Schile: Publisher Richard J. Wesnick: Editor Carl E. Rexroad: Managing Editor Gary Svee: Opinion Editor

NGS GAZETTE

# Haste makes waste

Don't rush to adopt federal levels

As a member of the Montana Health Board, I am appalled at the unseemly haste shown by Mr. Hannah and the Billings Chamber of Commerce to thwart the administrative process under way to improve the most precious resource we need for life — breathable air. I speak to our on-going problem of SO2 pollution in Billings-Yellowstone Coun-

For six years, the board has patiently waited for the professional staff of the Department of Health and Environmental Science and the six contributing companies to reach some reasonable and equitable solution to the growing problem.

In March 1986 we recognized that the expectation of self-policing on the part of all SO2 generating industry was futile.

I must rise to the defense of the Air Quality Bureau's interminable effort to bring about some progress. Based on the record and my exposure to them, they are professionally competent and fully committed to serving the public under state and federal law. If they can be criticized for anything, it's for chasing rabbits that were bred faster than they could be captured.

Now at the peak of our public deliberations-to reduce this complex issue to a simple face-off of jobs versus "capricious bureaucratic standards," may prove a serious mistake. To simply "legalize" the status quo by discarding the state standard and relying on the lemient federal ignores a host of sur-

# Guest columnist



SO2 pollution is not understood or measurable state-wide.

What we are sure of are several troublesome facts. By EPA evaluations covering 70 major cities over four years, Billings has received national recognition of having the dirtiest (SO2) pollution of any city but Pittsburg. We are now the Pittsburgh of the West. The trend for Pittsburg is improving. Unless we take concise action, we shortly will be the Pittsburgh of America.

Further study of controlled and monitored industrial areas like the Bay Area of California and Puget Sound in Washington proves that they are operating about and well below our state standards for SO2. How and why is this?

Ostensibly Hannah's efforts to relax our SO2 standard by relying on the federal is to safeguard jobs and the tax while ensuring adequate ealth ards.

Considerable concern exists that those objectives can be reached. Personally I am troubled by the apparent short-sightedness of this approach.

EXHLULL (25)

Our recent economic downturn has stimulated many creditable and creative efforts at the local and state levels to improve our economic opportunities for new business, for existing operations and to fully capitalize on the generally recognized potential of fully exploiting tourism. To lock in the current air quality into a "status quo" posture would prove hard to rationalize in light of those efforts.

To admit to having air dirtier than Denver's, Chicago's and Detroit's hardly encourages foreign visitor interest. Additionally, our air shed for SO2 is now saturated even by the lenient federal standard. What price do we pay there for limiting new business, for expansion or modification of the more efficient plants now in operation? Are we penalizing the more efficient operations and freezing possible improvement of our tax base?

Many, I am one of them, have strong reservations as to whether we in fact are not violating the
federal standard. A verifiable, unquestionable process of documenting violations of either the state
or federal standards on the annual and 24-hour
basis doesn't exist! Only MPC has an emission
monitor in operation.

While I applaud the recent efforts to reduce SO2 emission at the six plants, I frankly am cynical about this "breakthrough" and the fortuitous timing.

Our board has been keenly sensitive to the impacts our decisions have on Montana citizens, both healthwise and economically. If our exhaustive deliberations and decisions are not to be trusted and the results prejudged before finalization, I respectfully suggest the Legislature discard the citizen board concept. It becomes a futile waste of time.

Personally, I encourage our concerned public and our legislators to allow the aadministrative process to continue to completion and not be stampeded into an ill-advised, irreversible action. Veiled threats of plant closures should not interfere with the muhlic's right to be fully informed and involved.



# Department of Health and Environmental Sciences

AIR QUALITY BUREAU Cogswell Building (406) 449-3454

A C Knight, M D .F C C P Director

EXHIBIT (4)

DATE 2-187

HB. 6-1

February 14, 1980

TO: INTERESTED PERSONS

SUMM a TIONS FROM

This is the final Environmental Impact Statement on the Montana Ambient Air Quality Standards Study. Copies of this impact statement are being sent to persons who filed comments on the draft environmental impact statement as well as to all the major libraries in the state.

Issuance of this final Environmental Impact Statement commences the process of rulemaking by the Board of Health and Environmental Sciences under the Montana Administrative Prodecure Act. A description of the upcoming rulemaking process is provided in the Preface of this document.

Persons desiring information about the library availability of the impact statement or wishing to obtain a copy of the impact statement may contact the Department of Health and Environmental Sciences, Air Quality Bureau, in Helena, at 406-449-3454.

The Department wishes to thank all those persons who contributed their interest and information to the EIS process.

Sincerely,

Michael D. Roach, Chief

Air Quality Bureau

### SUMMARY

In the fall of 1977 the Montana Department of Health and Environmental Sciences (DHES) was considering enforcement action against some Montana industries for violations of the administrative regulation on Ambient Air Quality Standards (ARM 16-2.14(1)-S14140). This rule had been on the books more than ten years and had been regarded during that time as an enforceable regulation. During the research in preparation for the enforcement action, however, it was discovered that there was some doubt whether the Board of Health and Environmental Sciences had adopted the standards with the intent that they be enforceable.

When advised of the uncertain status of the Montana Ambient Air Quality Standards, the Board indicated it wanted the state to have enforceable standards. It was decided that before such standards were adopted anew, there should be a thorough review to determine whether the old standards were still appropriate or whether scientific research completed since their adoption indicated different standards were needed.

The process followed by the Department in determining the proposed standards may be summarized as follows:

1. Compilation and Assessment of Scientific and Factual Information

The Department first reviewed the scientific literature on the health effects of pollutants found in Montana. Information was also assembled regarding the various pollution sources within the state.

2. <u>Determination of Which Pollutants to Regulate</u>
The Department selected for regulation those pollutants currently

occurring in significant levels in the state and for which there was scientific evidence to derive a meaningful standard. These include sulfur dioxide, total suspended particulate, settleable particulate, lead, carbon monoxide, fluorides, nitrogen dioxide, photochemical oxidants, hydrogen sulfide and visibility. Several portions of the current ambient rule were recommended for deletion. These included the ambient standards for beryllium, acii mist, and suspended sulfate, and the calcium borate and sulfate plate methods of sampling.

The data were judged insufficient to support standards for arsenic, cadmium, polycyclic organic matter, beryllium, respirable particles, suspended sulfate, and sulfuric acid mist. Therefore, no standards were proposed for these. The Department decided to continue reviewing new research results as they become available, with the commitment to recommend additional standards when appropriate.

### 3. Determining the Level of Apparent Health Response

The Department relied on scientific information to establish for each pollutant a level which apparently was sufficient to produce a detectable health response in the most sensitive persons.

- 4. Once the level of apparent health response was established, the Department assessed the risk associated with effects of the pollutant. Several considerations were weighed to determine what level of risk was acceptable without jeopardizing public health. This determination indicated the stringency necessary to compensate for uncertainties as to what exposures were safe.
- 5. Considerations Above and Beyond Health to Determine Final Standard to be Proposed

Once the health standard was determined, the Department reviewed

the scientific evidence to determine whether the pollutant would have effects upon the state's economic and social welfare at concentrations more dilute than the level required to protect health. Where such effects were likely to occur, they were weighed against the other specific welfare interests specified in the Montana Clean Air Act to determine whether a standard to protect more than human health was "practicable." If the anticipated impacts were not offset or outweighed by the other concerns, then the standard was modified to prevent anticipated welfare effects.

Following completion of this process, a draft EIS was compiled and issued on January 3, 1979. The standards recommended in the draft EIS and the final EIS are shown in Table 1. Table 1 also shows the relationship of these proposed standards to existing state and federal standards.

The draft noted that there are in Montana approximately 50 "major sources" of air pollution, with a "major source" defined as a source emitting at least 100 tons of pollution per year. The draft was concerned primarily with the 13 sources that could potentially be affected by an ambient standard. These are: The Anaconda Aluminum plant at Columbia Falls, the Hoerner Waldorf pulp and paper mill in Missoula, the Anaconda Copper Smelter at Anaconda, the Stauffer Chemical Company phosphate plant at Ramsay, the Berkeley Pit copper mine in Butte, the ASARCO lead smelter in East Helena, the Cenex, Conoco and Exxon refineries in the Billings-Laurel area, the Montana Sulfur and Chemical Company plant in Billings, the Corette coal-fired generator in Billings, and the coal fired generators in Colstrip and Sidney. Figure 1 shows the sites of major pollution sources in Montana, and their relationship to existing and proposed Prevention of Significant Deterioration (PSD) Class I areas.

The most recent emission estimates from major sources are shown in Table 2.

Ambient air pollution levels in the vicinity of these sources are shown in Table 3.

TABLE I . PROPOSED AND EXISTING AMBIENT AIR REGULATIONS

		Existing Montana	Montana Amhient	Montana Ambient
Pollutant	Federal Standard	Ambient Air Rule	Standard Pronosed in Draft FIS	Standard Pronosed in Final EIS
Sulfur Dioxide	0.03 ppm annual average	0.02 ppm maximum annual average	0.02 nom annual average	0.02 pom annual averane
	0.14 ppm 24-hour average not to be exceeded more than once a year	0.10 ppm 24-hr average not to be exceeded over 1% of the days in any 3-month period	not to be exceeded more than once a year	1.10 ppm 2f-hour average not to be exceeded more than once a year
	0.5 ppm 3-hour average not to be exceeded more than once a year		0.40 nnm hourly average not to be exceeded more than once a year	
		0.25 npm 1-hr average not to be exceeded for more than one hour in any 4 consecutive days	•	0.5 pnm 1-hr average not to be exceeded more than once a year
Total Suspended Particulate	75 micrograms per cubic meter, geometric annual average	75 ug/m <sup>3</sup> annual deometric mean	75 ug/m³ annual everage	75 ug/m <sup>3</sup> annual average
	260 ug/m <sup>3</sup> , 24-hr average not to be exceeded more than once a year	200 uq/m <sup>3</sup> not to be exceeded more than 1% of the days a year	200 ug/m <sup>3</sup> 24-hr average not to be exceeded more than once a year	200 ug/m <sup>3</sup> 24-hr average not to be exceeded more than once a year
Carbon Monoxide	35 ppm, 1-hr average not to be exceeded more than once a year	••	q nnm A-hr average not to be exceeded more than once a year	9 ppm 8-hr average not to be exceeded more than once a year
	9 ppm, 8-hr average not to be exceeded more than once a year		one a year once a year	
Photochemical Oxidants (Ozone)	0.12 ppm hourly average not to be exceeded on more than one day a year	••	0.10 pmm hourly average, not to be exceeded more than once a year	0.10 hourly average, not to be exceeded nore than once a year
Nitrogen Dioxide	0.05 ppm annual average	<del></del>	0.05 ppm annual average 0.17 ppm hourly average, not to be exceeded more than once a year	0.05 annual average 0.30 opm, hourly average, not to be exceeded more than once a year
Hydrogen Sulfide		0.03 prm 's-hour average, not to be exceeded more than twice in any consecutive days 0.05 prm 'z-hour average, not to be exceeded over twice a year	0.10 npm hourly average, not to be exceeded more than once a year	0.05 pom hourly average, not to be exceeded
Lead	1.5 ug/m <sup>3</sup> , calendar nuarter average	5.0 ug/m $^3$ , 30-day average	1.5 un/m <sup>3</sup> calendar quarter average	1.5 up/m <sup>3</sup> , 3-month average
Fluoride		1.0 ppb. 24-hr average, total fluoride (as HF) 0.3 micrograms per shuare centimeter per 20 days	1.0 nob 24-hr average 0.30 nob 30-day average	1.0 nnh 24-hr average. gaseous fluoride 0.3 nnh 30-day average
		(qasenus)	0.11 onb arrowing season average	
Folfar Fluoride	••	35 ppm, dry weight hasis	30 un/n, drv weight hasis	35 un/q in forage, annual average, no monthly average to exceed 50 uq/q
Settled Particulate (Dustfall)	<b></b>	15 tons/so mile/month, 3 month averane in residential areas 30 tons/so mile/month 3 month average in heavy industrial areas	]∩ om/m² 3∩ day average	10 $\mathrm{gm/m^2}$ , 30-day average
Visibility	••	• ••	Particle scattering co- efficient of 2 X 10-5 per meter annual average	Particle scattering cq- efficient of 3 X 10 <sup>-5</sup> per meter annual average
Reactive Sulfur (sulfation)		0.25 milligrams sulfur trioxide/ind so. centi- meter/day, maximum annual average 0.50 milligrams sulfur trioxide/ind so. centi- meters/day, max. for any 1-month period	<del></del>	
Suspended Sulfate	•• •	4 ug/m <sup>3</sup> of air, max. allowable annual avo. 12 ug/m <sup>2</sup> of air, not to be exceeded more than 1% of the time		•-
Sulfuric Acid Hist		4 ug/m <sup>3</sup> of air, max. allowable annual average 12 ug/m <sup>2</sup> of air, not to be exceeded more than 1% of time 30 ug/m <sup>3</sup> of air, hourly average, not to be ex-	<u>-</u>	
		everage, not to be ex- ceeded over 1% of the time		
Beryllium		0.01 un/m <sup>3</sup> , 30-day average	••	••
Arsenic	••	••		Deferred for further study
Cadinifum		••	••	Deferred for further study

ESTIMATED EMISSIONS FROM POINT SOURCES OF AIR POLLUTION AND PRESENT DEGREE OF CONTROL

TABLE 2

	SULFUR DIOXIDE	αш	PARTI	PART I CULATE	LEAD	0	FLUORIDE	<u>u</u>	NITROGEN OXIDES	OGEN DES	HYDROCARBONS	RBONS
SOURCE	t/yr	36	t/yr	3-6	t/yr	36	t/yr	<b>\$-2</b>	t/yr	<b>3-6</b>	t/yr	<del>} 0</del>
Anaconda Aluminum	2,200	0	1440	11	•		455	90				
Anaconda Copper	281,750	34	4780	95	179	95						
Berkeley Pit	207	unk	4023	33								
ASARCO Lead	14,000	9/	418	96	48	98						
CENEX Refinery	10,380	unk	398	unk					540	unk	1317	unk
Conoco Refinery	3,198	unk	263	unk					1,194	unk	1991	unk
Exxon Refinery	9,800	unk	735	unk					1,401	unk	4177	unk
Hoerner Waldorf Paper	365	unk	160	86					1,008	unk	115	unk
Montana-Dakota Utilities, Sidney	2,372	15	430	86								
Mont. Power Co. (Colstrip 1 & 2)	5,326	75	618	66					7,000	unk		
Mont. Power Co. (Corette)	986,6	10	1124	97					6,757	unk	94	unk
Montana Sulphur	1,530	6							4	unk		
Stauffer Chemical	208	unk	66	96			35*	90				

unk=unknown or unmeasurable

Source: Gelhaus, et al., 1978; Constant et al., 1977

\*Anticipated emissions based on emission control projection.

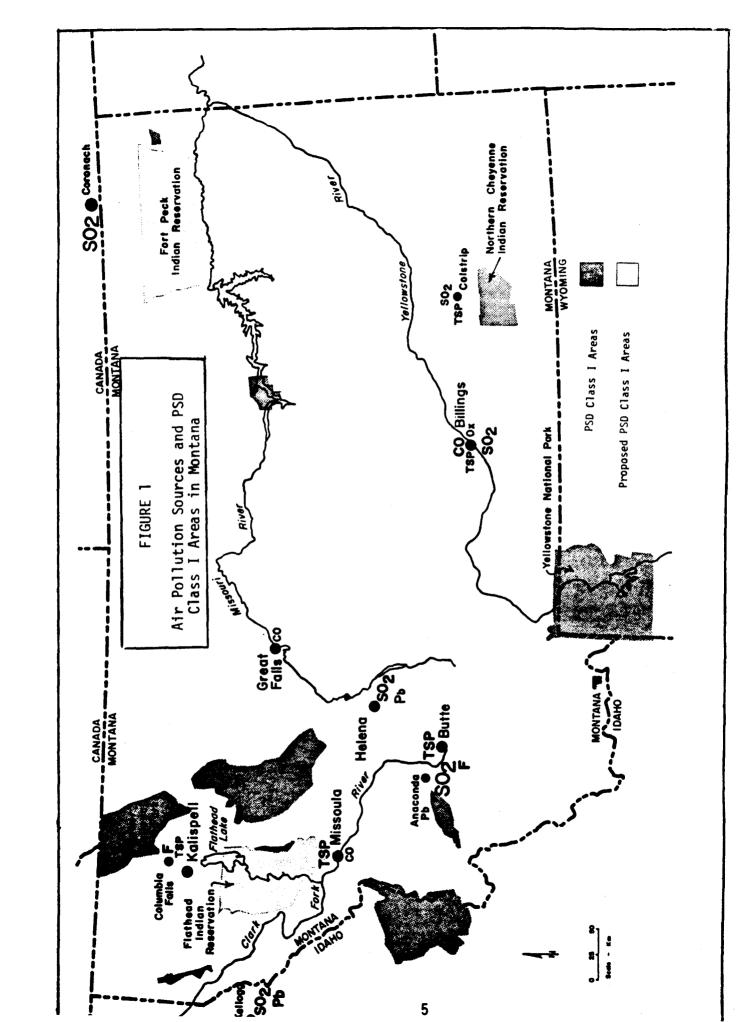


TABLE 3
SUMMARY OF SELECTED AMBIENT AIR QUALITY DATA (1978)

Pollutant and Averaging Time	Missoula	Anaconda	East Helena	Great Falls	Billings	Colstrip
Sulfur Dioxide Max. 1-hr. (ppm) Max. 24-hr. (ppm) Annual Average (ppm)	Lions Park 0.05 0.02 0.00 (10 months)	Lincoln School 1.21 0.37 0.02 (7 months)	East Stack 0.48 0.10 0.004 (11 months)		Central Park 0.195 0.091 0.010 (7 months)	
Particulates Max. 24-hr. (ug/m <sup>3</sup> ) Annual Geom. Mean	Courthouse Roof 389.7 64.0 (12 months)	Highway Junction 155.0 26.9 (12 months)	Microwave 101.0 23.4 (12 months)	Fire Station 125.0 55.4 (12 months)	City Hall 175.0 64.8 (11 months)	BN 138.0 13.0 (4 months)
Settled Particulate (gm/m²) monthly mean				Fire Station 4.52 (9 months)		
Visibility Annual Avg. (miles)	Lions Park 17 (12 months)					
Carbon Monoxide Max. 1-hr. (ppm) Max. 8-hr. (ppm)	Mal. Junction 28.0 15.0 (5 months)	<del></del>		10th Ave. S. 15.1 11.5 (10 months)	27th & Mont. 15.9 8.4 (6 months)	
Ozone Max. 1-hr. (ppm)	Lions Park 0.078 (12 months)	*	n = #		27th & Mont. 0.120 (7 months)	*
Nitrogen Dioxide Max. 1-hr. (ppm) Annual Arith. Mean	Lions Park 0.098 0.016 (10 months)	Lincoln School 0.050 0.006 (3 months)			Central Park 0.075 0.012 (4 months)	
Total Hydrocarbons Max. 1-hr. (ppm)	Lions Park 8.13 (11 months)				'27th & Mont. 11.40 (5 months)	

\*=no data
---=less than 3 months data

### AIR OUALITY TRENDS IN MONTANA

### Billings

The sulfur dioxide levels in Billings have remained generally the same over the past three years with an annual average of about .003 ppm in residential and traffic areas. The sulfur dioxide levels near the Cenex refinery in Laurel seem to have decreased from 1976 to 1978. The 1979 data, although incomplete, appear to be about the same as the 1978 data. No clear trends emerge from the total suspended particulate data. The data from 1975 through 1978 appear relatively constant at most sites. The 1979 data analyzed so far may be a little higher.

The ozone and carbon monoxide data from Billings follow the same general trend as total suspended particulate. These pollutants were monitored at different locations throughout the past four years, making an analysis of the trend difficult.

It would appear that the readings from the Billings stations have not changed significantly, with a few exceptions, over the past four years. The emissions from industrial sources of pollution have generally remained constant, while the population base has been increasing. A slight increase in the total suspended particulate number for 1979 may be due to a combination of meteorological conditions and population expansion.

### Anaconda

The air monitoring work done in the Anaconda area has generally been limited to sulfur dioxide and total suspended particulate. In general, the sulfur dioxide readings have been increasing since 1975 from about .014 (annual average) to .056 in 1978. The data are not complete enough for 1979 to yield a valid annual average. The change shown is unusual since the



The cause of the lower 1977 reading is unknown. Lead also has been measured at this site for the last two years. The data show exceedance of the proposed state and existing federal lead standard.

### AIR POLLUTION IN MONTANA

The draft EIS pointed out that there is reason for concern about the extent and seriousness of air pollution in Montana. Although there are relatively few sources of industrial pollution, the areas affected generally are the population centers of the state. Furthermore, the measured levels of several pollutants are higher than those which have been scientifically established to cause health effects in humans. The pollutants reaching these excessive levels in Montana are sulfur dioxide, particulates, lead, carbon monoxide, nitrogen dioxide and ozone. There are no completed studies to show whether these effects are occurring in Montana, but there is no reason to believe that people in Montana would be more or less endangered by a given pollutant level than residents of other areas. It was said in the draft EIS that hydrogen sulfide was a threat to health at levels found in Montana, but further review of the data led to the recommendation of a standard based on welfare effects.

Besides human health effects, many of the pollutants found in Montana can affect plants and animals, m terials, and other elements important to human "welfare." Two pollutants, hydrogen fluoride and hydrogen sulfide, affect plants and animals at levels more dilute than those necessary to threaten human health, so the standards recommended to the Board in the final EIS are based exclusively on these "welfare effects." The recommended standards for each pollutant are expected to protect both human health and the environment. Mobile and area sources, such as automobiles, strip mines, and

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dusty roads, also can be significant emission sources, but emissions from these are not generally as significant as those from industrial point sources.

The issuance of the draft EIS was followed by a massive outpouring of comments from industry and other concerned groups and individuals. In response to these comments, there was much reanalysis of data, review of a few research results not previously reviewed, and other efforts to clarify and update the findings and conclusions of the draft. As a result, there were some changes made in the recommended standards. These changes are apparent in Table I.

The proposal in the draft EIS to make the standards directly enforceable generated a considerable volume of comments, all of which were reviewed and evaluated in determining the Departments final recommendation on an enforcement stance.

The following are the principal enforcement recommendations of the Department's final proposal:

- Change the ambient air quality standards from their current form to expressly enforceable standards (no change from draft EIS);
- Adopt the standards without limitation of enforcement measures (no change from draft EIS);
- Limit the definition of "ambient air" to include only areas where the general public has access (change from the draft EIS).

A major need pointed out in the comments on the draft EIS regarded the need for an analysis of the alternatives available to the Department. The Final EIS states the Department's position that there are no legal alternatives to the standards recommended to protect health, in view of the Clean Air Act's requirement that health be protected, and the scientific evidence and analysis

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indicating that the standards recommended are necessary to fulfill that requirement.

There also were many comments to the effect that alternative modes of enforcement should have been analyzed in the draft EIS. The final EIS discusses the limitations of these suggested alternatives, and points out why they are not available for adoption.

Many comments asserted that draft EIS did not contain adequate information regarding the impacts of the Department's proposal. The discussion of impacts in the draft was concerned primarily with the effects of various levels of pollution on human health and welfare. These findings are organized and supplemented in the final EIS with an analysis of the probable impacts of the Department's proposal.

### ANTICIPATED IMPACTS OF THE DEPARTMENT'S PROPOSAL

The impacts of the proposed ambient air quality standards would occur in two broad areas: (1) a reduction in the effects of air pollution upon humans and the natural environment, and (2) economic and environmental costs necessary to achieve the air quality standards.

There are two fundamental constraints upon the Department's ability to predict the exact impacts of its proposed ambient rule. The first is the important role played by the existing regulatory background. Particularly with respect to new sources, current regulatory programs would largely determine the abatement requirements which would be applied to pollution sources.

Secondly, as noted previously, it is difficult to quantify the impacts of the proposed standards either as cost (additional control of emissions) or benefits (reduced effects on humans, plants, animals and the environment.)

For this reason, the discussion on anticipated impacts is largely cast in qualitative terms rather than quantitative.

It can be said, for example, that standards based upon health considerations would reduce the potential for human health effects. Lower potential for disease, fewer sick days, and the reduced potential for interference with normal human activities may be expected to increase the productivity of the state's people.

Farming and ranching, wood products and recreation, which account for more than one-half of the state's economic activity, all depend upon clean air.

The proposed standard could contribute to preserving the productivity of these sectors.

Furthermore, much of the state's residential growth can be attributed to the natural amenities available in Montana, including its unpolluted air. The proposed standards, particularly those for the urban pollutants, visibility, and settled particulate should preserve these amenities and Montana's attractiveness as a place to live.

In an attempt to quantify the economic aspects of air pollution in Montana, the Department contracted the production of a study (Otis et al., 1979) to define the situation. This study estimates the change in death rates that could be anticipated in Helena, Anaconda, and Billings if sulfur dioxide emissions were reduced to meet the existing federal and state ambient air quality standards. Using two procedures for calculating the health effects and two values for the reduction in risk to life and health, estimates of social economic benefit were obtained for moving from present ambient levels to the federal standard (\$1 million to \$4 million per year) and moving from present ambient levels to the proposed state standard (\$1 million to \$7 million per year). Estimates for the loss of agricultural crops and ornamental plants in four

Montana counties were calculated. The crops included alfalfa, wheat, and timber. The estimated economic benefits were approximately \$800 thousand per year for meeting the federal standard and approximately \$1 million per year if the state standard were met. The reduction in damage to materials, primarily galvanized zinc surfaces and paints, was estimated to be approximately \$100 thousand per year for meeting either state or federal standards. Finally, estimates were made for the loss of visibility from particulate matter derived from sulfur dioxide in the Billings area. Depending on the choice of assumptions regarding who "owns" clean air, the annual value of improved visibility is calculated to be between \$100 thousand and \$1 million for achieving the federal standard and \$200 thousand to \$2 million for achieving the state standard.

The costs of reducing emissions to meet the federal and state standards were estimated for the seven largest sources of sulfur dioxide in Montana. At Anaconda Copper a \$21 million acid plant already scheduled for installation to meet federal standards is expected to reduce emissions sufficiently to achieve both the federal and state standards. The CENEX petroleum refinery in Billings already is planning to spend about \$5 million to meet the federal standards. An additional \$1 million might have to be spent to meet the state standard. The controls needed by Montana Power's Corette plant to meet the state standard could cost between \$7 million and \$11 million, depending on the engineering difficulty. The Exxon refinery might have to spend about \$9 million on controls to meet the state standard. No additional control is likely to be required at either the Corette power plant or the Exxon refinery to meet the federal standards. The Conoco refinery does not appear to require any additional controls to meet either standard. Montana Sulfur already had agreed to install a new stack for less than \$1 million that may permit the plant to meet both standards. The ASARCO lead smelter in East Helena recently

installed control equipment that may enable it to meet both standards. Approximately \$40 million was spent on the control program.

When control costs are compared to the estimated benefits of control, it is found that for both the high and low estimates, the additional costs of moving from the federal to the more stringent state standard is roughly equal to the additional benefits. This is the best measure of economic efficiency and it suggests that the proposed state standard is economically optimal for Montana.

The final EIS also discusses the economic aspects of the proposed fluoride standards in relation to the state's two major sources of fluoride emissions, the Anaconda Aluminum plant and the Stauffer Chemical phosphorus plant. Estimates are reported for damage from fluorides in the Columbia Falls and Ramsay areas. Both facilities are completing installation of new control equipment. The control programs at both plants are expected to achieve the proposed fluoride standards. In both instances the analysis indicates that the present control programs are economically justified but further indicate that new control programs would not be economically justified on the basis of currently available economic and engineering information.

## III. POLICY CONSIDERATIONS IN DEVELOPMENT OF AMBIENT AIR QUALITY STANDARDS

#### INTRODUCTION

The purpose of this chapter is to outline and clarify the policy considerations underlying the development of the Department's proposals.

The chapter is divided into three sections. The first section summarizes the statutory directives contained in the Montana Clean Air Act. The second outlines and discusses the Department's methodology for determining the standards. The third section clarifies how the Department chose among alternative ambient air quality standards.

#### Montana Clean Air Act

Section 75-202 of the Montana Clean Air Act (MCAA) provides:

Board to set ambient air quality standards. The board shall establish ambient air quality standards for the state.

Section 75-2-102 of the MCAA provides:

Policy and Purpose. (1) It is hereby declared to be the public policy of this state and the purpose of this chapter to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state.

- (2) It is also declared that local and regional air pollution control programs are to be supported to the extent practicable as essential instruments for the securing and maintenance of appropriate levels of air quality.
- (3) To these ends it is the purpose of this chapter to: (a) provide for a coordinated statewide program of air pollution prevention, abatement, and control;
- (b) provide for an appropriate distribution of responsibilities among the state and local units of government;

- (c) facilitate cooperation across jurisdictional lines in dealing with problems of air pollution not confined within single jurisdictions; and
- (d) provide a framework within which all values may be balanced in the public interest.

In preparing its recommendations the Department has necessarily referred to Section 75-2102 which sets out the policy and purpose of the Montana Clean Air Act. That section requires the Board to engage in a two-step process in the establishment of air quality standards in Montana.

The Board must first determine what levels of air quality are necessary to protect human health. The Board must establish air quality standards to achieve at least that level of air quality.

Once the level needed to protect human health is determined, the Board must decide whether other social, environmental, or economic needs of Montana call for air quality beyond that necessary to protect human health. The Board accomplishes this second step by weighing the four specific "welfare" factors set out in section 75-2-102. If the Board's weighing of these factors indicates a need for air quality beyond that required to protect human health, then more stringent ambient air standards may be established to achieve such air quality levels. If the Board concludes that the advantages to be gained by better air quality are outweighed by considerations pertaining to the other objectives, then it may leave the standard at the level required to protect human health. Direct economic comparisons among these factors is not possible. Section 75-2-102 contemplates that, once human health is protected, the Board has broad discretion to balance these objectives and establish standards which will serve the state as a whole.

A standard established to protect human health includes a margin of safety to account for uncertainties and hazards which research may not yet have identified or resolved. The margin of safety for any given pollutant is determined by the acceptability of the risk associated with the pollutant. A

standard established to protect a welfare interest such as wildlife or vegetation is not specifically designed to include such a margin of safety. The level of air quality needed to protect welfare interests is based upon effects which are either known or may reasonably be anticipated.

## Policy Considerations

The Montana Clean Air Act requires establishment of ambient air quality standards sufficient to protect human health and welfare. The standards cannot be derived solely by reference to available scientific information. The process of setting such standards demands that some judgments be made and applied to the available information. For example, if health is to be protected, is it only healthy persons who should be protected? Conversely, must every aspect of health be protected from every possible effect of air pollution?

As a foundation for the standards, the Department gathered and analyzed information concerning the sources, concentrations and effects of pollutants. The information was assessed in accordance with the policies which the Department is carrying out. Therefore, the final form of the rule derives from the application of a policy framework to scientific findings.

Several policy choices were made by the Department and incorporated into the proposed rule. They may be stated generally as follows:

<u>Protected population</u>: Health standards are established to protect not only healthy persons but also the most sensitive or vulnerable segments of the population.

Health Related Response - The Department concluded that a response is of regulatory concern if it results in or contributes to a reduction in one's present or future capacity to engage in normal activities. The Department's determinations of whether a response is health-related were made on a case-by-case basis.

Level of Apparent Health Response - For some pollutants there is no apparent health effects threshold below which exposure may automatically be deemed safe. Therefore rather than use the term threshold, the Department has used the term "level of apparent health response" to indicate the pollutant level at which health related responses begin to be observed. This level of apparent health response dictated the minimum standards for each pollutant.

Margin of Safety - There are uncertainties concerning the full range of health effects caused by air pollutants. To account for these uncertainties the Department generally has proposed a standard more stringent than the level of apparent health response. The margin of safety is based upon a case-by-case evalution of the uncertainties and risks associated with a given pollutant.

Enforceability: - The ambient air quality standards are recommended to be legally enforceable limitations which may be enforced by the measures provided in the Montana Clean Air Act.

Ambient Air - The Department has determined that the ambient air standards are to be enforceable in areas to which the general public has access. The standards are not enforceable inside the property lines of pollution sources.

Discussion of these policy considerations is incorporated into the discussion on Determination of Ambient Air Quality Standards.

### Determination of Ambient Air Quality Standards: Summary

The process followed by the Department in determining the proposed standards may be summarized as follows:

- 1. <u>Compilation and Assessment of Scientific and Factual Information</u>.

  The Department first reviewed the available health effects literature on pollutants of concern in Montana. It focused upon studies indicating effects of concentrations at or near the federal standards. Information was also assembled regarding the various pollution sources within the state.
- 2. <u>Determination of Which Pollutants to Regulate</u>. The Department selected for regulation those pollutants currently occurring in significant levels in the state and for which there was scientific evidence to derive a meaningful standard.
- 3. <u>Determining the Level of Apparent Health Response</u>. The Department relied on scientific information to establish for each pollutant a level which apparently was sufficient to produce a detectable health response to whichever segment of the public was most vulnerable.
- 4. Margin of Safety. Once the level of apparent health response was established, the Department assessed the risk associated with unknown effects of the pollutant. Several factors were weighed to determine what level of risk was acceptable to assure protection of public health. In accordance with that estimate, the standard was made more stringent than the level of apparent health response.
- 5. Considerations Above and Beyond Health to Determine Final Standard to be Proposed. Once the health standard was determined, the Department reviewed the scientific evidence to determine whether the pollutant would have effects upon the state's economic and social welfare at concentrations lower than the level required to protect health. Where such effects were likely to occur,

they were weighed against the other specific welfare interests specified in section 75-2-102 of the Montana Clean Air Act to determine whether a standard to protect more than human health was "practicable." If the anticipated impacts were not offset or outweighed by the other concerns, then the standard was modified to prevent anticipated welfare effects.

DETERMINATION OF AMBIENT AIR QUALITY STANDARDS: DISCUSSION

Compilation and Assessment of Data

1. <u>Use of Data</u> - The initial task of the Department was to gather scientific information concerning air pollutants of concern in Montana. In order to gain an overview, the Department conducted a computerized scan of literature on the effects of air pollutants on the public health and welfare. Much of this literature was cited and discussed in the EIS.

While it did consult the general body of scientific data; the Department chose to focus its attention upon studies indicating effects at or near the federal standards. The proposing of state standards less stringent than the federal standards would have been a largely academic exercise.

Throughout the process of reviewing scientific data, the Department preferred to consult original scientific papers and generally avoided reliance upon reviews which summarize and critique several different studies in a particular area of research. Reference to original articles allowed the Department to examine the actual experiments conducted and thereby to assess the degree of reliability of the scientific conclusions. There also was a preference for studies appearing in scientific journals since they are more widely available and generally will be better known by other researchers in the field. Some reports by government agencies also receive wide distribution and were utilized where appropriate.

In certain cases, reports published by panels of scientists have drawn conclusions based upon a review of existing literature. Some researchers suggest that these reports embody the scientific consensus regarding any given pollutant. The Department seriously considered the findings of such panels but did not automatically defer to their conclusions.

A scientific consensus depends in part upon common assumptions governing the interpretation of data. Not all researchers approach scientific data with the same assumptions. For example, some researchers may contend that there is a safe effects threshold for every pollutant or that reversible effects have no biological significance. Other reseachers may proceed under different assumptions. Therefore some scientific disagreement and uncertainty is inevitable concerning important factors in the setting of standards.

2. Types of Studies - Three types of experiments are used to define the impacts of air pollutants on human health: animal studies, clinical studies, and epidemiological studies.

Animal studies are valuable for determining the effects of pollutants on laboratory animals under controlled conditions in experiments that would be too hazardous with human subjects. Animal experiments allow the use of high pollutant concentrations and examination of affected tissues. They make possible the repetition of experiments and the determination of relationships between given pollution levels and the effects observed. Although the findings of these studies are not directly applicable to humans, there is a general understanding that responses found in experimental animals may be paralleled in humans.

Clinical health studies are used for more direct determination of air pollution responses in humans. The advantage of this method is that precise levels of pollutant can be administered under consistent study conditions. Because the experiments usually use volunteers, often college students, it is

difficult to experiment with long-term or repeated exposures. There is little doubt these studies understate the effects on the general population, given the better than average health of college students.

The epidemiological studies evaluate health responses under ambient conditions common to the human environment. Testing for low level effects in humans often is possible only through statistical survey in cities alike except for their pollution levels. These studies relate pollution levels to illness and death rates. Epidemiological studies are especially useful in identifying a sensitive group or detecting an unusual type of illness or cause of death that might be associated with pollution.

Each of the three types of studies has its own benefits and disadvantages. A good epidemiological study is probably the most desirable, since it most closely reflects the everyday world. However, it is extremely difficult to produce clear results, because of the large number of uncontrolled variables inherent in any such study. One approach is to rely on epidemiological results only if they report effects consistent with clinical and animal studies.

Some researchers use only clinical studies. Such studies are the most easily controlled, but are, necessarily, the most artificial, and application of the results to the everyday world often involves data interpretations and inferences that may be subject to dispute.

Animal studies often explore the physiological mechanisms by which pollutant exposures produce effects, but may reveal little about the exposure levels at which human health is affected.

Rather than weighing any one type of study, the Department chose to look for composite sets of results: epidemiologic studies backed up by clinical and animal studies. The greater the degree of consistency and convergence among these three approaches, the more reliable the conclusions.

## Protected Population

The objective in establishing health-based ambient air quality standards is to estimate the concentrations of various pollutants in the air to which all groups within the general population can be exposed without an unacceptable risk to health. Susceptibility to ambient air pollution often varies significantly from one person to another. Similarly, different segments of the population with preexisting limitations or health conditions may exhibit more dramatic responses to air pollution than other healthy groups. The question arises as to which of such groups should be afforded protection from health effects.

Congress has specified that the responsibility of the federal government under the Federal Clean Air Act is to protect the most sensitive segment of the population which is regularly exposed to ambient air. The only limitation is that such segments be large enough to be statistically definable.

The Department has determined that it has an equal responsibility to protect the health of Montana's citizens. Therefore standards are designed to protect those persons who are most sensitive or vulnerable to air pollutants. For example, persons with asthma or other respiratory disorders, children, pregnant women and other statistically significant groups, will be afforded protection under the proposed standards. The exact identity of the sensitive populations will vary by pollutant.

## Determination of Which Pollutants to Regulate

Once the scientific literature was compiled and reviewed, the initial decision which had to be made was whether a standard should be proposed for a particular pollutant.

There are numerous air pollutants presently found within the state. The Department's review gave particular consideration to the pollutants regulated

in the existing ambient standards rule. Standards for four pollutants (beryllium, suspended sulfate, sulfuric acid mist, and total reactive sulfur) were removed and do not appear in the rule proposed by the Department. While standards for these pollutants may again be considered in the future, they are not included in the present proposal for the reasons stated in Appendix F of the draft EIS and on p. 102, Chapter III of this final EIS.

The process of selecting pollutants for regulation is not accomplished by applying a general rule to all pollutants. Certain criteria must be applied on a case-by-case basis. The first consideration is whether the pollutant occurs in sufficient concentrations to warrant the adoption of an ambient air quality standard. In the case of beryllium, for example, there currently are no significant sources in the state nor are any proposed.

Another consideration is the extent of knowledge regarding the effects of a pollutant. The Department proposed a standard only for those pollutants for which there was sufficiency of reliable scientific information. There must be enough reliable scientific information to suggest what concentrations may cause identified effects and what levels are safe. For example, current scientific information on suspended sulfate, sulfuric acid mist, cadmium, polyclic organic matter and arsenic does not provide an adequate basis for specific standards. Intensifying research may allow the adoption of standards for these pollutants in the near future.

Furthermore, the scientific information must be sufficiently precise to allow accurate measurement of pollutant concentrations and enforcement of standards. It is only with such information that a standard may be confidently derived.

A standard for sulfuric acid mist would be impractical because of the difficulty of operating ambient measuring devices accurately under field condition. A standard for total reactive sulfur was not proposed because of

ambiguities associated with the sulfation plate measurement method. Scientific research has associated suspended sulfate with health effects but does not yet allow the formulation of an accurate and workable regulation. The Department also reviewed the current evidence on respirable particulates but deferred proposing a standard until more information is available.

## Health Related Response

Although the Montana Clean Air Act requires that ambient air quality standards be established to protect human health from the effects of air pollution, not all effects of air pollution necessarily endanger human health. Therefore, in preparing to propose air quality standards, the Department examined the range of pollutant effects and emphasized those believed to be significant to human health.

There is no universal agreement about what constitutes a health related response. Exposure of the human organism to varying concentrations of air pollutants results in a spectrum of responses which may be summarized as follows:

- <u>Substantial and significant effects</u>, such as death or incapacitating disease;
- Clinically observable illness or disability, such as an elevated temperature, a persistent cough, or nausea;
- <u>Subclinical effects or predisposition</u> such as a change in the mucal clearance rate, change in lung function (e.g. mid maximal expiration flow rate), or a change in blood protein composition;
- Body burden and subjective responses, such as an accumulation of heavy metals in the body or psychological responses.

A reasoned judgement was necessary in determining the initial point where health related effects begin to occur on the continuum of physiological response Also required was a decision concerning the kinds of responses to pollution which could be discounted in establishing the level of apparent health response.

Some physiological responses to air pollution are undramatic but may be biologically significant. For example, chronic exposure to low levels of pollution may go undetected but may have significant effects on health over the long term. On the other hand, effects such as eye irritation may at times be dramatic but are temporary and reversible and therefore may have only minimal biological significance if they occur infrequently.

There are differences of opinion concerning which effects should be discounted in establishing air quality standards to protect human health. It may be stated generally that the higher the levels of pollution, the more medical researchers will agree that a response may be expected and the more medical researchers will agree that the response has biological significance.

One school of thought as to which effects are "adverse" is reflected in the standard used by the World Health Organization. That organization's concept of a health effect includes the "well-being" of the exposed human population. This is a broad perspective which includes subjective considerations such as whether a person feels better or worse on a given day.

Other researchers follow a narrower course. For example, some argue that any effects which were reversible should be discounted in establishing a health standard. According to this view, for example, a chest cold is a temporary and fully reversible respiratory infection and therefore should not be of regulatory concern.

Between these two positions is an approach which adequately protects public health and also allows the Department to discount effects too subtle

to be considered "adverse." The principal factor in determining if an effect is health related is whether it contributes to a reduction in the ability to engage in normal activities. Use of this approach is intended to prevent all but minimal interference with bodily functions upon which physical activity and mental ability depend. For example, a chest cold constitutes a significant interference with the normal condition of the body. A reduction in mucal clearance rate is likely to increase the susceptability of a person to chest colds. Therefore, a measured reduction in mucal clearance rate should be considered an adverse health effect.

Similarly, a subtle change in the formation of blood proteins may not have any immediately observable effect on behavior. However, if prolonged, such interference could leave the body in an anemic state which could significantly reduce the ability to engage in normal activities. Conversely, an effect of minimal biological significance such as eye irritation occurring at sufficient intensity over a short period may create such discomfort that it interferes with normal activities.

The Department has determined that reactions to odor and other subjective responses should be considered nuisance effects rather than health effects.

## Level of Apparent Health Response

In the past, health based standards rested primarily on the belief that there were safe pollutant thresholds below which no adverse health effects would be expected even after a lifetime of exposure. Control of emissions to achieve this safe threshold was considered adequate to protect public health.

More recently, increasingly sophisticated scientific research has found definite health responses for many pollutants at concentrations which previously were thought to be below the threshold. This recognition of effects at lower levels suggests that even the lowest levels of these pollutants may affect the human body.

In light of this, the Department has not attempted to establish definite thresholds as the basis for its health-related standards. Rather, the Departmen reviewed the scientific evidence to establish the range of concentrations at which definite health responses have been observed. The Department has used the term "level of apparent health response" to indicate this range.

#### Margin of Safety



## The Need for a Margin of Safety

The level of apparent health response indicates the pollution concentration at which health related responses have been reliably detected. Setting an ambient air quality standard at that level would limit the public exposure to those effects. However, it does not follow that the public health would be adequately protected at that level.

There are a number of uncertainties associated with the protection afforded at the level of apparent health response. It is because of these uncertainties that the level of apparent health response may not be relied on to determine the standard ultimately needed to protect health. A margin of safety is required to take into account these uncertainties which may be summarized as follows:

Inherent Uncertainty in Scientific Data - Some degree of uncertainty is inevitable in probing new areas of scientific research. The true significance of scientific results may not be known until further research dispels, affirms, or clarifies initial findings.

<u>Undetected Effects</u> - Failure to detect effects at low concentrations is not proof that such effects do not exist. Expanded health effects research along with new investigative methods have and may further disclose adverse health effects at levels lower than those currently believed to produce such effects.

Variable Susceptibility - Susceptibility to air pollution varies from one person to another. Certain segments of the population are sensitive to one or more particular air pollutants. There is no certainty that experiments to date have accounted for the full range of susceptibility to each pollutant. Since much of the experimentation is performed on healthy, young males, the vulnerability of less healthy segments of the population is often unknown. Further research may reveal sensitivities which are as yet unsuspected. Synergistic Effects - Some pollutants appear to exhibit enhanced effects in the presence of other pollutants. In such cases, the total effect may be greater than the sum of the effects of the individual pollutants. Substantial uncertainty still exists regarding this phenomenon, even for pollutants currently believed to be associated with it. Nor has synergism been demonstrated for every pollutant.

Scientific research regarding pollutant interactions is intensifying. Until such effects are well understood, allowances must be made for the uncertain role they play in environmental health.

Uncertainty in Predicting Actual Exposure - The extent to which the human population will actually be exposed to air pollutants may only be estimated. An individual's exposure to air pollution will depend partly on where he lives and on the amount of time he spends indoors where pollutant levels are typically somewhat lower. For example, some people tend to remain indoors during winter when outdoor air pollution levels generally

increase. Indoor pollutant levels themselves may vary substantially depending, for example, on exposure to gas heating or cooking stoves. Other persons may frequently exercise outdoors in urban areas, thus increasing their exposure.

Meteorological variations occurring on an hourly or daily basis may allow periodic excursions beyond pollutant levels known to produce adverse health effects. These excursions may occur even though longer averaging time ambient standards set at known health effect levels are not exceeded.

Similarly, air pollution monitors cannot be said to measure precisely the actual human exposure to air pollutants. Although monitor locations are selected to reflect typical ambient concentrations, actual pollutant levels at a given place may vary significantly due to variances in air movement, source emissions, and other influences. Therefore, it is inevitable that a monitor at times will either overstate or understate actual human exposure in the vicinity.

The essential objective of ambient air quality standards is to minimize the exposure of the public to harmful air quality conditions. Since many factors combine to determine the level of actual exposure, it may be either more or less intense than anticipated. By making some allowance for the uncertainty in predicting actual exposure, the potential for abnormally high exposures is taken into account.

In light of these qualifications, the level of apparent health response should not serve as the sole determinant of an ambient air quality standard.

The uncertainties associated with both the health effects of a pollutant and the

exposures to it must be assessed, and allowances made for them in the final standard. In this way the final standard includes a margin of safety to insure protection of human health.

## The Derivation of a Margin of Safety

The specific margin of safety recommended for each pollutant is based upon a reasoned judgement regarding the acceptable level of risk for that pollutant. It is not derived by applying any general rule to all pllutants. Rather, certain common considerations are weighed to assess the degree of protection needed.

The following are indicators of the margin of safety required for each pollutant:

Seriousness of Potential Harm - If existing scientific evidence has associated the pollutant with severe effects such as incapacity or irreversible reduction in lung function, then a wide margin of safety may be necessary. If, on the other hand, only less serious effects have been observed, then less protection is needed and a narrow margin of safety may be acceptable.

Degree of Uncertainty in the Data - In general, the greater the uncertainty the wider a margin of safety is needed. If there is a substantial body of relable scientific information which has largely foreclosed the possibility of effects at lower levels than the level of apparent health response, then a narrow margin of safety may be acceptable. If evidence is inconclusive or if studies suggest effects at lower levels, then a wide margin of safety may be indicated.

<u>Degree of Exposure Across the Population</u> - When experiments indicate the adverse effects of a given pollutant exposure

are seen only in vulnerable segments of the population, such as persons with emphysema, it is likely that healthier people are not subject to the same immediate risks. Although such experiments say little about the long-term ability of healthy persons to tolerate given pollutant concentrations, such results may alleviate the need for a substantial margin of safety. On the other hand, if the harmful effects of the pollutant are observed in healthy young persons, then a substantial margin of safety may be necessary to protect less healthy people.

Likelihood of Occurrence - If there are significant emissions of a pollutant within the state, there is a likelihood that frequent low level concentrations will occur. Frequent exposures of the population to low level concentrations increases the risk that potentially harmful effects will be experienced. In such cases, a wide margin of safety may be indicated. If a pollutant is not present in significant amounts within the state, then public exposure will be less frequent and a smaller margin of safety may be acceptable.

Similar considerations apply to conditions caused by pollutant combinations or synergisms. Occasionally, harmful effects may be anticipated when mixtures of two or more pollutants are present in sufficient concentrations. If the conditions giving rise to the risk are not likely to occur, then a narrow margin of safety may be acceptable. If these conditions are likely to be frequent, then a wide margin of safety may be required.

All the indicators mentioned above must be considered together in the assessment of the risk associated with a pollutant. In the case of a given pollutant, for example, one or two factors may suggest the need for a wide margin of safety while in other cases all factors may indicate a wide margin. These factors are the primary indicators of the appropriate margin of safety. They form the basis for the Department's judgment regarding the levels of acceptable risk for each pollutant.

# Considerations of Welfare and Practicability upon the Department's Proposal

Once the level of apparent health response has been determined and the appropriate margin of safety applied to it, there remains the final step in selecting the standard to be recommended. A determination must be made as to whether the social and economic needs of the state require air quality better than that needed to protect human health.

As noted previously, the Montana Clean Air Act requires the Board to establish standards which will not only protect human health but also will, to the greatest degree practicable, foster four goals which embody the social and economic welfare of the state. These welfare goals were previously set out in the discussion on the Montana Clean Air Act (p. 145). They refer generally to the quality of life available to the citizens of the state, including the beneficial use of the state's resources and the availability of employment. They also include the preservation of the state's natural attractions and productivity.

A balance must be struck among the four objectives. Such a balance may be determined only after careful consideration of the needs of the state. For example, use of an area by a polluting activity may foster economic growth and employment but may render the area undesirable for other uses such as agriculture,

residential growth, or recreation. Although section 75-2-102 does not specifically require that each factor must be given equal weight, it clearly obliges the Board to consider the advancement of each objective before adopting a standard.

The Department's recommendations are intended to advance all of these objectives. No single consideration has been accorded paramount importance. It was necessary for the Department to first determine the level of air quality necessary to protect human health. Then the Department examined the scientific research to see whether welfare interests such as vegetation, property, social growth or natural attractions would be affected at lower pollutant concentrations. If such effects were noted, then an attempt was made to determine the advantages to the state of achieving air quality sufficient to eliminate them. These advantages were then weighed against the disadvantages which achievement of such air quality would impose upon attainment of the other objectives set out in Section 75-2-102. If the estimated advantages of better air quality were outweighed by the likely interference with other objectives, then the standard was not made more stringent than necessary to protect human health.

The determination of practicability under Section 75-2-102, is of necessity, largely a qualitative balancing of welfare objectives. It is difficult at best to quantify such things as social comfort and convenience, enjoyment of natural attractions, and socioeconomic development. Certain components of these broad categories, such as crop and timber losses or industrial control costs do, however, lend themselves to varying degrees of estimation. Where available, such information was used by the Department to assess the advisability of proposing standards more stringent than those necessary to protect health.

The Department used all reasonably available and reliable information in striking a balance among welfare objectives. In some cases, scientific evidence suggests that air quality better than that needed to protect human health would protect the state's various ecosystems from the potential effects of air pollution. While this is undoubtedly true in a general sense, there is not sufficient reliable scientific evidence to allow assessment of these advantages with any degree of accuracy.

For similar reasons, long-term projections concerning matters such as the rate of energy development in the state or the future economic consequences of air quality regulation upon industry and employment were avoided since such projections involve substantial speculation.

For six pollutants (sulfur dioxide, particulate matter, carbon monoxide, nitrogen dioxide, photochemical oxidants, and lead) the standards now proposed by the Department were indicated by human health considerations. Given the limitations of current scientific knowledge on the environmental effects of air pollution, there is very little basis for determining the respective advantages and disadvantages of standards below those necessary to protect human health. However a review of scientific evidence indicates that in every case the standards proposed to protect human health with a margin of safety will also to a great extent prevent known or anticipated effects upon the state's welfare interests. Therefore, none of the standards for these six pollutants was made more stringent on the basis of welfare considerations.

As to the four remaining pollutants (hydrogen sulfide, settled particulate, fluorides and visibility impairment) the standards now proposed by the Department were indicated by welfare considerations rather than health considerations. In the case of hydrogen sulfide, fluorides and settled particulate, effects on human health are observed only at concentrations above those levels asso-

ciated with welfare effects. Visibility impairment is not directly related to human health. Therefore, standards for these four pollutants were determined by the balancing of welfare objectives.

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While the Department used economic information, it did not engage in discrete cost-benefit analyses for standards based upon considerations of practicability. Precise cost and benefit information is difficult to obtain. Moreover, the Montana Clean Air Act does not require that a welfare-based ambient air quality standard be justified by a dollar for dollar cost-benefit analysis. In its recommendations the Department sought to advance the best interests of the state as a whole, as expressed in the four objectives established by the Legislature.

#### ALTERNATIVE AMBIENT AIR QUALITY STANDARDS

As noted earlier, the ambient standards rule proposed by the Department is based upon the application of a policy framework to scientific and technical information. This policy framework is derived from the Montana Clean Air Act. Pertinent aspects of this process have been reviewed and discussed in the draft EIS and elsewhere in this final EIS.

The scientific and technical information gathered and assessed by the Department serves as the foundation for the proposed ambient standards rule. In general, such information is made up of scientific findings, which by themselves do not constitute an ambient standards rule. Policy considerations must be applied to these findings in forging a rule which will carry out the mandates of the Montana Clean Air Act. Policy decisions generally do have alternatives.

The fact that the proposed rule has resulted from the application of policy to a process of information review makes it difficult to discuss alternatives which would apply to a site-specific project such as a bridge or highway

Alternatives in ambient air standards rulemaking fall among a wide range of policy choices.

The Department has previously identified and discussed a number of individual policy areas inherent in establishing the proposed rule. Each of these policy areas itself has alternatives. For example, the Montana Clean Air Act requires that standards be established which will protect human health. A decision must be made regarding which responses of the human body to air pollution signify some threat to health. Judgements as to what constitutes a health response could range from "only severe and irreversible effects" to "any detectable biological effect." The determination of what is a tolerable pollutant concentration thus has a major role in the setting of an air quality standard. Similarly, a decision as to whether reactions to odor or other subjective responses should be considered a health response could importantly affect what levels of pollutants would be acceptable.

An analysis of the proposed rule reveals that these selections, among alternatives within each of these policy areas, led to the final determination of standards. Different standards flow from different choices among policy components. Elsewhere in the final EIS the Department has clarified the reasoning behind its choices in these basic policy areas. A consideration of the alternatives to the Department's choices is implicit in such discussions.

In a theoretical sense, there are no alternatives to the Department's proposed standards. The Montana Clean Air Act requires the establishment of standards which will protect health and welfare. The Act calls upon the Board to decide what concentrations of pollutants are acceptable within the state. Once the policy decisions are made, the process of reviewing information leads to a decision as to what standard is appropriate. This principle is perhaps best illustrated in the assessment of risks which leads to a margin of safety included in a standard. After all considerations are weighed, the

Department can make only one judgement as to what level of risk is tolerable and only one judgement as to what margin of safety is appropriate. Such judgements implicitly consider and reject all other alternatives.

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In this sense, the Department could recommend the no-action alternative (i.e., recommend the standards in the existing ambient rule) only if the application of its policy decisions to scientific and technical information indicated that the standards in the current ambient rule would carry out the mandate of the Montana Clean Air Act better than any other standards. For example, the current rule includes a standard for suspended sulfates. Even though sulfates have been suspected of causing health and welfare effects, the Department decided to establish standards only where there is sufficient reliable scientific information to allow formulation of a standard. Such information regarding sulfates is not yet available. Therefore no standards for sulfates have been proposed at this time and, at least for this pollutant, the no-action alternative has implicitly been rejected.

Similar reasoning applies to the alternative of recommending adoption of the national ambient air quality standards. In some cases, the Department recommended adoption of standards identical to existing national standards. In other cases, the Department's evaluation indicated the advisability of standards somewhat more stringent than national standards. In a few instances, the Department proposed standards for pollutants which have no national standards.

Recommending adoption of the national ambient standards in their entirety without an independent evaluation by the Department would not fulfill the responsibility imposed upon the Department by the Montana Clean Air Act. This is especially true since there is an important element of judgement inherent in establishing standards which will protect human health.

In actuality, the individual national ambient standards were considered as alternatives in the Department's evaluation of possible standards. As noted above, specific national standards were in some cases selected as the proper alternative. In such cases, however, the recommended state standard coincided with the federal standard purely because the state policy as applied to the relevant scientific information independently indicated the same number set forth in the federal standard. There was no effort to justify the federal standard as such.

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## V. ANTICIPATED IMPACTS OF THE DEPARTMENT'S PROPOSAL

#### INTRODUCTION

The impacts of the proposed ambient air quality standards would occur in two broad categories: (1) a reduction in the effects of air pollution upon humans and the natural environment, and (2) economic and environmental costs resulting from efforts to achieve the air quality standards.

There are two fundamental constraints upon the Department's ability to predict the exact impacts of its proposed ambient rule. The first is the important role played by the existing regulatory background. Particularly with respect to new sources, current pollution control programs may largely determine the abatement requirements to be applied to pollution sources.

Secondly, it is difficult to quantify the impacts of the proposed standards either as costs (additional control of emissions) or benefits (reduced effects on humans, plants, animals and the environment). For this reason, the discussion on anticipated impacts is largely cast in qualitative rather than quantitative terms.

#### IMPACTS WITHIN EXISTING REGULATORY BACKGROUND

Any discussion of the impacts of the proposed standards must take into account the existing regulatory background within which the proposed ambient rules must operate. The impacts of the proposed rules can be estimated only after reference to the principal elements of existing regulations:

- Existing Ambient Air Quality Standards
- Montana air quality regulations

- New Source Performance Standard (NSPS)
- Nonattainment provisions applying to areas in violation of federal air quality standards
- Prevention of Significant Deterioration (PSD)

Each of these elements merits some discussion.

## Existing Ambient Air Quality Standards

There are two sets of ambient air quality regulations which already apply to pollution sources in Montana. These are the National Ambient Air Quality Standards (NAAQS) and the Montana rule on ambient air quality standard found in the Administrative Rules of Montana.

National Ambient Air Quality Standards (NAAQS). The
National Ambient Air Quality standards were established by Congress in 1970.
These standards apply across the nation. Currently there are standards for six pollutants with others to be set for different pollutants in the near future. There are "primary" standards designed to protect public health and "secondary" standards designed to protect public welfare.

Each of the states has been required to submit to the EPA a State Implementation Plan (SIP) to achieve and maintain the national ambient standards and to implement other federal air quality requirements. The Montana air quality regulations governing allowable emissions constitute the major component of the SIP. Since 1970, EPA has obliged the states to revise their state plans to reflect changing federal requirements, particularly those contained in the 1977 Federal Clean Air Act Amendments. The 1977 Amendments required in part that the state plans be revised to assure that the national primary ambient air quality standards (NAAQS) are achieved in every state by the new deadline of December 31, 1982. The Montana Board of Health submittits latest revised plan to the EPA in April of 1979 and should soon have final approval for the plan.

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Currently over one-half of the states have either formally adopted or use the national standards as their own state ambient air standards. Therefore, if adopted, the standards proposed by the Department would be among the more stringent state standards in effect.

The federal standards must be achieved nationally and therefore in Montana within a short time. Consequently, where the proposed state standards and the national standards are the same or nearly the same, there should be little or no impact on sources.\* In such cases, achieving the national standard sources would also achieve the state standard. Table 1 indicates which proposed state standards are essentially the same as existing federal standards.

As Table ? also reveals, some of the proposed Montana standards are somewhat more stringent than existing national standards. While these differences are numerically small, it does not necessarily follow that the impact of the proposed rule will also be small. Sometimes a slightly stricter standard can mean the difference between the onset of a health or welfare effect and the avoidance of those effects. In cases where the proposed standards are more stringent than the federal standards, some effects which may occur at concentrations allowed by the federal standard would be prevented by the proposed state standard. Some effects are possible at pollutant levels more dilute than the proposed standards.

By the same token, costs of controlling emissions are not always constant.

At times the costs of controlling the last 20 percent of emissions can equal the costs of controlling the first 80 percent.

Therefore, only a slight tightening of an ambient standard can have a substantial cost impact, particularly for a facility that has reached the limit

<sup>\*</sup>The Montana Clean Air Act contemplates a more comprehensive enforcement approach than that followed by the federal EPA.

of its installed control capacities in attempting to attain the national standards. Certain sources may incur expense in moving from federal compliance to compliance with the proposed standards. However, most sources in the state are expected to comply with the proposed standards with their current pollution control programs.

Montana Ambient Air Quality Standards.

Air Act specifically requires the Board to establish ambient air quality standards for the state. The Montana rule currently governing ambient air quality is one of the Department's regulations found in the Administrative Rules of Montana.

Pollution sources in the state have been subject to this rule since its adoption in 1967. Some of the air quality requirements in the rule have not been achieved although many sources in the state have initiated emission control programs to meet them. As noted earlier, it currently is unclear whether these ambient standards were intended to be enforceable standards or merely guidelines.

It is difficult to estimate the impacts of the proposed standards in light of the existing ambient rule. As Table 1 indicates, some of the proposed standards are different than those in the existing ambient rule. In cases when the proposed standards are the same or similar to the standards in the current rule, the proposals may be expected to have less of an impact than if they were being newly introduced into the state. Since adoption of the rule in 1967, sources in the state have been on notice that the Board has specified maximum permissible concentrations for the state. It is only recently that questions concerning their precise enforcement status have arisen.

On the other hand, the adoption of a rule establishing the proposed ambie standards and eliminating any reference to goals and guidelines would remove



ambiguity surrounding the enforcement status of the existing rule. In that sense, the proposed rule would constitute a tightening of air quality regulations in the state, even though many of the proposed ambient requirements were adopted in 1967. For some existing facilities there may be increased compliance costs when the ambient limitations in the current rule are adopted as standards.

On the other hand, adoption of the proposed rule should result in a greater reduction in health and welfare effects than provided by either the national standard or the current state rule. It is obvious that proposed state standards more stringent than existing standards would provide more reduction in pollutant impacts than less stringent standards. However, increased protection would be provided even in the proposed standards that are the same as the federal standards or the current state rule, because of the more effective administrative and judicial enforcement features.

## Montana Air Quality Regulations

The Montana air quality regulations forbid the operation of most significant air pollution sources in the state without an air quality permit. Permits for new or newly altered sources are granted only in cases where the source will install best available control technology (BACT). Therefore, for every new or altered source requiring a permit, the Department determines the maximum degree of pollution control which is achievable, taking into account energy demands, environmental and economic costs.

The regulations also include several emission standards for specific pollutants such as sulfur oxides, particulates, and fluorides. These regulations apply to both new and existing sources. In some cases, a particular emission standard may already require controls sufficient to allow compliance with the proposed ambient standards. In such cases, the proposed standards would not be likely to have a significant impact.

In other cases, emission standards may not be stringent enough to provide compliance with the proposed standards. In these cases, the proposed standards could have an impact on an existing source by expanding the source's responsibility to include achieving and maintaining necessary ambient air quality in the area.

Emission standards should correspond at least generally to ambient air quality standards. The Department will ensure this relationship through a gradual review of the state's emission standards for comparison with the ambient standards.

## New Source Performance Standards (NSPS)

One aspect of regulation affecting industrial development is the new source performance standards program now incorporated into the Montana Air Quality Regulations as Section 16-2.14(1)-S14082 (Standards of Performance for New Stationary Sources). The regulation imposes minimum emission controls upon 28 categories of new or modified industrial sources.

The performance standards require new plants to use the best system of emission reduction which the federal Environmental Protection Agency has determined has been adequately demonstrated. Performance standards are scheduled to be issued in the next few years for most significant industrial categories.

Since the new source performance standards are applied nationwide, a given type of source would be required to attain the specified level of control no matter where it was built. Such a program would largely offset the economadvantages of being located in a state with ambient air quality standards less stringent than in other states.

In some cases it is likely that the proposed ambient standards could require more stringent controls than necessitated by new source performance standards.

However, in many cases current Montana law other than air quality requirements could require new sources to install controls beyond those required by new source performance standards. For example, the existing emission standards and the permit requirement for best available control technology may in some cases already require a level of emission control beyond the minimum design control set out in the new source performance standards. In such cases, the proposed ambient standards are not likely to impose further controls. Actual control requirements and the application of specific regulations which require them will be determined on a case-by-case basis.

#### Nonattainment

Another provision of the federal Clean Air Act Amendments of 1977 dealt with areas not in compliance with the national ambient air quality standards.

By the original deadline for achievement of the national ambient air standards (July 1, 1975) more than one-half of the nation's air control regions were still experiencing monitored violations. EPA then required the states to identify all areas which had not yet attained either the federal primary or secondary standards. The areas currently designated nonattainment in Montana are:

Table 5 Nonattainment Areas in Montana

	Carbon Monoxide (CO)	Total Suspended Particulate (TSP)	Sulfur Dioxide (SO <sub>2</sub> )	
Anaconda area			X	
Billings Area	χ	X		
Sutte Ărea		X		
Columbia Falls		X		
Colstrip Area		Χ		
E. Helena Area		Χ	X	
Great Falls Area	1	X		
Laurel Area			Х	
Missoula	X	χ		

Subsequently, the EPA required the states to revise their state implementation plans to achieve reasonable further progress each year in such areas and to allow new growth in such areas only if stringent conditions were met.

Therefore, existing sources in nonattainment areas must reduce their emissions to achieve reasonable further progress and, by the end of 1982, actual compliance with national standards. In addition, new sources proposed for location in nonattainment areas must attain a very high degree of control, known as "the lowest achievable emission rate" and must offset their projected emissions by obtaining emission reductions from sources already in the area (the so-called emissions offset). Those reductions must exceed the amount of emissions to be produced by the new source. Montana regulations currently impose such conditions.

The impact of the proposed ambient standards in nonattainment areas is subject to a number of variables. Generally speaking, emissions in such arear already are subject to further reduction. Therefore, to the extent that these reductions are prompted by nonattainment requirements, the proposed ambient standards will have little or no effect. In a few cases, controls beyond those being undertaken for compliance with a national standard may be necessary for compliance with a proposed Montana ambient standard. The proposed ambient standard thus may cause some impacts that otherwise would not occur.

## Prevention of Significant Deterioration (PSD)

While the objective of the nonattainment provisions is to attain the national ambient standards, the fundamental purpose of the PSD requirements is to prevent the degradation of air already cleaner than required by the national standards.

The PSD regulations have been incorporated as part of the recently revision Montana implementation plan. They establish a system whereby areas of the



state with air quality better than national ambient standards remain at such relatively clean levels, unless state or local decisions change their status.

Three land classifications are defined: In Class I areas, only minimal pollution increments will be allowed over baseline levels; in Class II areas somewhat higher increments, consistent with moderate growth and development will be permitted; in Class III areas pollution levels may increase up to current national ambient standards. Initially, the entire state was designated Class II except for special areas such as wilderness and national parks, which Congress designated mandatory Class I. Also, the Northern Cheyenne Indian Reservation in eastern Montana has been redesignated as a Class I PSD area. Except for mandatory Class I areas, there are established procedures for redesignation of an area from one class to another.

The current regulations apply to twenty-eight (28) categories of "major" new or modified sources. A source is "major" if it has the potential to emit (after the application of control equipment) 100 tons per year of any pollutant regulated under the federal Clean Air Act.\* New or modified sources not within the twenty-eight (28) categories are covered if they have the potential to emit (after the application of control equipment) two hundred-fifty (250) tons per year of any such pollutant.\*

The PSD regulations currently apply to only two pollutants, sulfur dioxide and particulate matter. At present, the Environmental Protection Agency is developing PSD regulations for all pollutants for which there are national ambient air quality standards.

The basic principle of the PSD regulations is simple. A major new source or major modification may not be constructed unless the owner first obtains a

<sup>\*</sup>Proposed modification to Federal PSD regulations in response to recent U.S. Court of Appeals decision in Alabama Power Co. vs. Costle.

permit requiring the source to apply best available control technology (BACT) and to meet other requirements. One of these requirements is that the new source will not exceed the increments allowed over the pollution baseline level. The allowable increases over the baseline are as follows:

MONTANA RULE ON PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

Allowed Increase Above Baseline Levels

Particulate	Fed. Std.	Proposed Mont. Standard	Class I Allowable Increment	Class II Allowable Increment	Class II Allowable Incremen
2 <b>4-hour (u</b> g/m <sup>3</sup> ) Annual	260 75	200 75	10 5	37 19	<b>75</b> 37
Sulfur Dioxide 1-hr (ppm) 3-hr (ppm) 24-hr (ppm) Annual (ppm)	0.50 0.14 0.03	0.50  0.10 0.02	0.01 0.002 0.0008	0.20 0.035 0.0008	0.27 0.07 0.016

The allowable increments are defined in terms of increases in pollution levels over the "baseline concentration." The baseline concentration reflects pollution levels existing in an area at the time the first application for a PSD permit is filed in that area by a major source.\*

For large areas of the state, the PSD ule in effect establishes ambient sulfur dioxide and particulate standards more stringent than those proposed by the Department. For example, in a Class II area with sulfur dioxide concentrations near zero, the ambient standard under the PSD rule would be near 0.035 ppm 24-hour average, rather than the Department's proposed 0.10 24-hour average. Therefore, with the PSD rule in its current form, the Department's proposed standards for sulfur dioxide and particulate matter would have a negligible impact in large areas of the state. For example, the PSD rule rather than

<sup>\*</sup>Proposed modification to Federal PSD regulations in response to recent U. S. Court of Appeals decision in Alabama Power Co. vs. Costle.

the proposed standards would largely determine the levels of sulfur dioxide and particulate that would be allowed in the ambient air surrounding future coal development facilities.

Nevertheless, the PSD rule could be weakened in the future to the extent that the Montana ambient standards might be required to ensure the maintenance of acceptable air quality in the area now controlled by the PSD rule. For the moment, the proposed standards ensure acceptable air quality for the entire state.

#### OTHER IMPACTS

## Economic and Environmental Costs and Benefits of the Proposed Standards

Introduction The Department took two measures in order to assess as completely as possible the economic and environmental impacts of its proposals. First, it gathered and reviewed all the information pertinent to possible costs and benefits of its proposed ambient rule. This information included emission data, ambient air quality data, reports on current control programs, and the like. Secondly, the Department awarded a research grant to faculty at the University of Montana (Otis, et al.) to perform an economic analysis based largely upon the information provided by the Department.

The study by Otis et al., "Some Economic Aspects of Air Pollution in Montana," is the principal reference used by the Department in making its assessments. The Department combined its own findings with the conclusions reached in Otis, et al. to identify the major areas of concern and to estimate the major costs and benefits of its proposal.

Summary The benefits of the proposed standards are the reductions of air pollution effects upon human health and welfare, while their costs are the

expenditures necessary to control emissions to comply with them.

The number of unknowns and variables relating to costs and benefits limit the depth of the Department's analysis. Sufficient information to even make estimates was available for only two pollutants, sulfur dioxide and fluoride.

Overall, the Department estimates that the benefits of achieving the proposect sulfur dioxide standards are roughly equal to the benefits to be gained. The Department also concludes that the state's two major fluoride sources would not need further controls to meet the proposed fluoride standards.

Sulfur Dioxide The Otis, et al. study estimated the costs and benefits likely to result from one of the proposed sulfur dioxide standards. The study concluded that the control benefits of moving from the federal 0.03 annual standard to the state's proposed 0.02 parts per million standard were of approximately the same magnitude as the expected costs.

Benefits. The estimated benefits were based upon anticipated reductions in sulfur dioxide effects on human health (sickness and death), vegatation, materials, and visibility.

The study calculated the economic value of reducing the risk of sickness and death for three Montana cities. If sulfur dioxide emissions were reduced to achieve the federal standard (0.03 ppm), the estimated economic value of reduced risk of health effects on residents of Billings, Anaconda and Helena would range from \$1 million to \$4 million per year. If sulfur dioxide emissions were reduced from their present levels to achieve the proposed Montana standard (0.02 ppm), the reduction in risk of sickness and death would have an estimated economic value ranging from \$1 million to \$7 million.

Sulfur dioxide can damage crops (such as alfalfa and wheat), timber, and ornamental plants (such as private and public gardens, and roadside trees).

Otis et al. estimated economic losses to these types of vegetation for four Montana counties, Silver Bow, Deer Lodge, Yellowstone and Lewis and Clark. Estimated reductions in the economic damage to crops, timber, and ornamentals were \$1 million per year for meeting the federal standard and approximately \$1.2 million per year for achieving the state standard.

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Damage to materials, such as paint and metals, was estimated to be reduced by approximately \$100,000 per year if either state or federal standards were met. Annual average benefits of improving visibility (from reductions in particulate derived from sulfur dioxide) ranged from \$100,000 to \$1 million for achieving the federal standard and from \$200,000 to \$2 million for achieving the state standard. The estimated benefits of meeting the state standard include the estimated benefits of meeting the federal standard. Therefore, the total benefits of achieving the federal standard range from \$2 million to \$6 million per year. The benefits of moving current ambient levels into compliance with the proposed state annual standard range from \$3 million to \$10 million per year.

Costs The Otis et al. study also estimated the costs associated with meeting the federal and state annual standards. Costs were approximated for the seven largest sources of sulfur dioxide in the state. The analyses relied heavily on control cost estimates provided by the industrial sources.

The Anaconda Copper smelter is the state's largest source of sulfur dioxide emissions. The Environmental Protection Agency has determined that 86 percent control of process input sulfur is necessary for the smelter to meet the federal 24-hour primary standard. The construction of a second large sulfuric acid plant at the smelter at a capital cost of \$21 million should result in compliance with both the annual and 24-hour average federal standards and also the proposed Montana annual standard. Assuming relative stability in the price of sulfuric

acid, the Company's cost for marketing sulfuric acid should not exceed \$1 million per year.

In East Helena, the ASARCO lead smelter recently has undergone the installation of a new sulfuric acid plant at a cost of \$40 million, and the company plans to raise the height of its blast furnace stack. These modification are predicted to reduce sulfur dioxide emissions sufficiently to allow the plant to meet both the federal and state annual standards. If additional control were necessary to comply with these standards, the additional modifications required for air pollution control could cost approximately \$2 million.

In the Billings area, the CENEX petroleum refinery is the major source of sulfur dioxide emissions. The company already has agreed to construct two new stacks and initiate several modifications in its process equipment to achieve the federal annual standard for sulfur dioxide. These modifications will cost approximately \$5 million. Meeting the proposed Montana annual standard could require an additional \$1 million expenditure.

The Exxon petroleum refinery in Billings could require additional controls to meet the Montana standard. Costs for these added controls could reach approximately \$9 million although substantially less expensive control measures may be available. The controls needed by Montana Power Company's J. E. Corette 180 MW power plant to meet the Montana standard could costs between \$7 million and \$11 million, depending on the engineering difficulty. It appears that both the Corette power plant and the Exxon refinery could comply with the federal standard with their present controls.

Other sources of sulfur dioxide in Billings are the Conoco petroleum refinery and the Montana Sulfur and Chemical Company. It appears likely that the Conoco refinery would not require any further controls to meet either the federal or the state standards. Montana Sulfur already has agreed to specific

approximately \$700,000 to raise its exhaust stack, which should allow the plant to meet both the federal and the state standard.

In overall terms, the costs to all sources of achieving the federal standard range from \$4.2 million to \$8.5 million per year. The costs of achieving the Montana standard range from \$5.6 million to \$14.4 million per year.

Conclusion According to Otis, et al., the best measure of the net economic efficiency of achieving the state standard is the difference in benefits and costs of moving from the federal to the state standard. The study estimates that the annual benefits of moving from the federal to the state standard would be between \$900,000 and \$3.8 million. The annual costs of meeting the state standard would be between \$1.4 million and \$5.9 million. Since the increases in benefits and costs are of comparable magnitude, the Department's recommendation of 0.02 ppm is the standard most likely to provide the best balance between social costs and social benefits.

It is unclear whether the Otis, et al. estimate of the relationship between costs and benefits of the annual standard also would hold true for the proposed 24-hour and 1-hour standards. It appears that any increases in costs necessary for sources to comply with either the 24-hour or 1-hour standard would be offset by health and welfare benefits of comparable value. However, substantially more information would be needed before such estimates could be stated conclusively.

#### Fluoride

The Anaconda Aluminum Reduction Plant. Located at Columbia Falls, the Anaconda Aluminum Company's aluminum reduction plant is the largest source of fluoride emissions in the state. The Otis et al. study

reports that from 1968 to 1977 the plant's fluoride emissions caused an estimated loss of 27 million board feet of timber with an approximate economic los of \$1,640,000. Furthermore, the study reports that approximately 77,000 acres of Glacier National Park have been subjected to elevated levels of fluoride.

Since 1974 the Company has operated under a variance from the state's emission standards for fluorides. During this time it implemented controls for its fluoride emissions. The Company presently is completing a major change over of its production process at a cost of approximately \$30 million. The new control process is designed to recover approximately 8,000 tons of aluminum fluoride annually producing an annual savings of \$4.2 million to the Company.

The current control program is expected to reduce fluoride emissions from the plant from 2500 pounds per day to approximately 850 pounds per day. A further reduction to 400 pounds per day could be achieved but the additional capital cost of such a system might exceed \$25 million with no significant resource recovery expected. It is unlikely that the environmental benefits that would result from these additional controls could justify their costs.

Otis et al. projects that the current control program would end violations of the existing 24-hour ambient rule for fluoride. A Department review of emissions data and related ambient air quality readings in the vicinity of the plant indicates that the current control program at the facility would allocompliance with the proposed 24-hour ambient standard for fluorides. Also, and the basis of its emissions review, the Department expects that the control program would achieve compliance with the proposed 30-day standard and the proposed forage standard. Therefore the fluoride standards proposed by the Department are not expected to impose costs beyond those already committed for the current control program.

# VI. CONCLUSIONS

This chapter contains a distillation of the Department's review of the scientific data, along with the rationale that went into determining the appropriate standards for each pollutant.

#### SULFUR DIOXIDE

The Department reviewed the literature on the effects of sulfur dioxide on the public health and welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 49-112.

#### General Findings

#### Human Health

1

Sulfur dioxide and its oxidation products have been associated with adverse human health effects and adverse effects on vegetation. Sulfur oxides may irritate the throat and lungs and exacerbate existing respiratory disease. The growth and yield of timber, wheat, oats and other agricultural crops important to Montana is reduced by exposure to sulfur oxides.

Studies of the effects of sulfur dioxide on people have been of two distinctly different types. One group of studies exposed subjects to sulfur dioxide in the laboratory for relatively short periods of time usually a few minutes to a few hours. Another group of studies attempted to analyse the results of exposure under natural conditions by comparing the effects on individuals from several communities with differing pollution levels or by following the reactions of individuals within one community over a period of time. These community studies most often are based on measurements of the twenty-four-hour average or annual average concentrations of sulfur dioxide. A definite response to sulfur dioxide exposures has been observed in healthy young subjects after short-term exposures to concentrations of 0.75 to 3.0 ppm. Sensitive measures detected changes of lung function following exposure to 3 ppm of sulfur dioxide for less than 5 minutes (Kreisman et al. 1976), to 1 ppm for 15 minutes (Snell and Luchsinger 1969), and to 0.75 ppm for 90 minutes when subjects were exercising (Bates and Hauzucha 1973). A few

subjects among a group of fifteen reported discomfort and demonstrated a reduced mucous flow rate during an exposure to 1 ppm of sulfur dioxide over 1 to 6 hours (Andersen et al. 1974). Mucous flow is believed to be an important part of the body's defense against infection.

Exposures to mixtures of sulfur dioxide, particulates, and other pollutants found in the ambient air have been associated with aggravation of illness and an increase in death rates. In a review of several studies, Lawther (1963) concluded that an increase in the number of illness-related deaths had been observed when the daily average sulfur dioxide concentration was above 0.25 ppm and suspended particulate was in excess of 750 ug/m³. In a separate series of studies, Lawther et al. (1970) analysed health records of elderly bronchitis patients. From these data he concluded that the minimum daily pollution level that would result in aggravation of the patients' condition was 0.19 ppm of sulfur dioxide and about 250 ug/m³ BS\* of particulate. However, in a follow up study a few years later he again observed health effects associated with sulfur oxides and particulates, even though the pollution levels were much lower. Similarly, a study of asthma patients observed a relationship between the frequency of asthma attacks and concentrations of sulfur oxides and particulates, without any distinct threshold (Cohen et al., 1972).

Studies of the long-term health effects of air pollution observed an increased death rate and increased respiratory diseases in more polluted areas. Douglas and Waller (1966) noted an increased incidence of bronchitis and colds in the chest among school children in areas with sulfur dioxide concentrations greater than 0.05 ppm annual average and suspended particulate levels greater than 132  $\text{ug/m}^3$  BS. An increase in the death rate was reported by Wicken and

<sup>\*</sup> BS refers to particulate measurement by the British Smoke method; see pp. 53-54 of the draft EIS.

Buck (1964) when annual average sulfur dioxide levels were at 0.04 ppm and suspended particulate at 160  $\mu$ m BS.

Kerre bijn et al. (1975) found an increased incidence of cough and chronic lung disease among children in an area with an annual average concentration of 0.06 ppm of sulfur dioxide and an annual average particulate matter concentration of less than 40 ug/m<sup>3</sup> BS.

### Vegetation

**\**\footnote{17}

Vegetation damage from sulfur dioxide has been recorded in Montana in the past (Scheffer and Hedgecock, 1955). The levels causing this damage are not accurately known. It may be assumed, however, that the concentrations of sulfur dioxide which caused past vegetation damage were higher than are present occurring in the state.

Scientific studies have determined a range of adverse effects that occur in vegetation from sulfur dioxide either alone or in combination with other pollutants. Table III.A-III on pp. 79-83 of the draft EIS gives results from a number of these studies. The information depicted in Table III.A-III indicat several important facts: 1) that sulfur dioxide in combination with other pollutants can cause synergistic type vegetation damage 2) that environmental conditions of moisture and nutrition can alter plant response to sulfur dioxide 3) that sulfur dioxide levels of 0.02 to 0.5 ppm for one hour can cause measureable alterations in normal plant functions (it is not clear if such alterations are irreversibly detrimental) 4) that sulfur dioxide average concentrations between 0.5 and 0.1 ppm for four to 24 hours when combined with other pollutants cause an increase in leaf destruction 5) that annual sulfur dioxide levels below 0.03 ppm are associated with the elimination of certain lower plant forms and possible growth loss in non native forest species.

Sulfur dioxide enters into a number of chemical reactions in the atmosphere. The result of several of these reactions is the production of acids which may fall to earth as acidic rain, snow, or other forms of precipitation. Acid precipitation has been noted by scientists throughout the world to be increasing with increased utilization of fossil fuels for electrical power generation and industrial development (Shriner et al. 1977).

Acid precipitation has been shown to cause increased acidity in many lakes and in forest soils with concomittant losses in fish populations and forest yields (Dochinger and Selinga, 1976). The extent of potential and actual acid precipitation in Montana is not known.

## Other Welfare Effects

Sulfur dioxide can cause significant damage to materials especally when sufficent humidity is present. Materials particularly suseptible to sulfur dioxide and its derivatives are paint, building stone, and both galvanized and untreated iron and steel. (Salmon, 1970).

#### Measurement of Sulfur Dioxide

Sulfur dioxide is routinely measured by the pararnosaniline method described in the draft EIS. This measuring technique has been prescribed by the EPA for the measurement of sulfur dioxide to determine compliance with the federal standards. It is accurate and reliable within the expected range of ambient concentrations.

Automated methods for the measurement of sulfur dioxide have been developed. The Air Quality Bureau is presently using certain of these techniques approved by the EPA as equivalent to the pararosaniline method, such as the Philips coulometric and the Thermal Electron pulsed fluoresence instruments. These methods are accurate and reliable within the expected range of ambinet concentrations.

## Susceptible Populations

Several studies observed that about 10 percent of their subjects were especially sensitive to sulfur dioxide. In a study of the occurrance and development of chronic bronchitis, Fletcher et al. (1976) found that 13 percent of their sample was especially susceptible to the development of chronic obstructive lung disease.

It is not known if the persons who were particularly susceptible to lung disease represented the same portion of the population as the 10 percent who have been found to be sensitive to sulfur dioxide. Quite apart from these individuals, children and persons with existing respiratory conditions also are considered to be particularly vulnerable to sulfur dioxide. The National Center for Health Statistics (1973) reports that in the western U.S. approximately three percent of the population experience continuing asthma, one percent add emphysema, and three percent were chronic bronchitis patients. Among those over 65 years, approximately four percent had asthma, three percent emphysema, and four percent chronic bronchitis. Persons with chronic bronchitis who are over 55 years have been found to be more vulnerable to sulfur oxides pollution than younger chronic bronchitis patients (Carnow et al. 1969).

# Level of Apparent Health Response

Based on the studies cited above, the Department identified 0.75 to 1.0 ppm of sulfur dioxide for one hour as likely to be associated with the response of decreased lung function measurements in sensitive but otherwise healthy populations 0.19 to 0.25 ppm of sulfur dioxide for twenty-four hours as likely to be associated with decreased physical capacity for exercise, and with death among persons with advanced heart and lung disease; and 0.04 ppm to 0.05 ppm of sulfur dioxide annual average with an increased incidence of respiratory disease among general populations, especially children.

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The primary effects on human health associated with exposure to sulfur dioxide (a decrease in lung function, an increased incidence of respiratory disease among children, a decline in the health of individuals with chronic obstructive lung conditions to and including death, and an increase in the number of asthma attacks among persons with asthma) present a risk to the health of a vulnerable population group in the community and may result in permanent damage.

The changes in lung function observed in brief, sporadic exposures to sulfur dioxide concentrations of 0.75 to 3.0 ppm appear to be entirely reversible in otherwise healthy individuals with exposure to clean air. In laboratory experiments repeated or continued exposure to such concentrations often results in an acclimatization such that the effects tend to diminish (Frank et al. 1962). This is thought to be due to an adaptation of the nervous reflex responsible for the effect.

Lung function gradually declines with age in all people. An individual who smokes or who has an obstructive lung condition will lose lung function at a faster than normal rate. Some diseases can result in a substantial decline in lung function, even among young people. There is no specific loss that marks the onset of chronic obstructive lung disease for each individual, but rather a gradual increase in poor health and limitation of activities due to shortness of breath is observed. Thus an additional loss in lung function from air pollution will simply increase the degree of disability at any age and lung capacity. Persons with already impaired lung function, such as an individual with chronic obstructive lung disease, could find their meager reserves of lung capacity severely eroded by even a small additional loss of lung function Under such circumstances a person might complain that they are not able to get enough breath for almost any exertion, even such a simple act

as feeding themselves. In many instances this also will place a strain on the heart.

An increased incidence of respiratory disease among children can have long-term as well as immediate adverse effects. Burrows et al. (1977) and others have observed that children with a history of respiratory disease are much more likely to develop chronic obstructive lung conditions when they are grown. As adults, these individuals also were reported as having a lower average lung function than individuals without a history of childhood respiratodisease.

An increased incidence of asthma symptons and asthma attacks increases the financial and health cost imposed by each such incident and increases the risk that an especially severe attack may be experienced. Such a severe attack can result in hospitalization and long-term or permanent health damage.

Substantial uncertaintly exists in the identification of a minimum concertration below which such human health effects do not occur. Laboratory studies of short-term exposures to moderate concentrations have relied almost entirely on healthy subjects, although some of these otherwise healthy subjects have proven to be sensitive to sulfur dioxide. Many of the studies of community health response have focused directly on the more sensitive segments of the population. This reduces the uncertainty in developing standards from these studies. However, several epidemiological studies of general populations have observed a relationship between reported health effects and sulfur dioxide and particulate pollution that increases from the lowest to the highest pollution levels without any apparent threshold. Some studies report a lower limit of exposure simply because their control group also is experiencing an exposure to sulfur dioxide. Other studies report an apparent threshold which may be due more to the size and composition of their sample than to any property of the pollutant.

Long-term studies of air pollution effects are difficult to interpret. Although a pollution level can be measured and associated with a group of individuals who are being observed, the effects may be partly due to exposures in past years that may have been higher either because the pollution has been reduced in the interim or the family has moved to a less polluted area. On the other hand, pollution levels may have been increasing as the economy and production have increased or the family may have moved to a more polluted area. Synergistic Effects

Many epidemiological studies have been made in cities where both sulfur dioxide and particulate concentrations are high. It is not possible to say if the effects observed are greater from the sum of the effects from each pollutant separately. Although the effects are observed in situations with and without particulate matter present, it is not known if the effects are significantly increased by the presence of particulate matter.

Attempts to demonstrate the synergistic effect with laboratory animals have involved tests at high concentrations of sulfur dioxide and particulates (Asmundson et al., 1973). Amdur (1978) reported a synergistic response between sulfur dioxide and copper sulfate particles at moderate concentrations but has not observed synergism for other sulfate particulates. The mechanism of the synergistic effect in studies such as this is not known nor is it clear that a synergistic effect exists at low concentrations. In developing the standards, the Department's utilization of studies measuring both sulfur dioxide and particulate matter will assure that synergistic effects, if any, will be taken into account.

A few laboratory studies have observed synergistic effects between oxidants and sulfur dioxide, especially in the presence of low concentrations of particulate matter (Hazucha and Bates, 1975 and Bell et al., 1977). Other studies (Bedi et al., 1979) have not observed the synergism at the same concentrations.

Since ozone levels of the magnitude utilized in these experiments have never been observed in Montana and even moderate concentrations occur only infrequenthese synergistic effects were not taken into account developing the Department recommendations. If they had been an element of consideration, the recommendations might have been revised toward a more stringent standard.

#### Recommended Standard - One Hour

The response observed from brief exposures to 0.75 to 1.0 ppm of sulfur dioxide is of minimal health significance in healthy populations. However, substantial uncertainty remains in identifying the concentration that will not adversely affect the health of individuals with currently impaired heart and lung function since experimental subjects typically have been healthy, young individuals. Therefore, to protect the health of vulnerable individuals and to protect the general public from five- to fifteen-minute exposures in the range of 0.75 to 1.0 ppm, the Department recommends an ambient air quality standard for sulfur dioxide of 0.5 ppm, averaged over one hour, not to be exceeded more than once a year.

The current Montana one-hour standard is 0.25 ppm, not to be exceeded more than once in any four consecutive days. The federal secondary standard is 0.5 ppm, averaged over three hours, not to be exceeded more than once a year. Although an exact equivalence cannot be stated, the present state standard might permit a one-hour exposure between 1 and 2 ppm, not to be exceeded more than once a year, at many locations in the state. Similarly, achievement of the federal standard can be estimated to permit a one-hour average exposure of between 0.6 and 0.8 ppm, not to be exceeded more than once a year, at most monitoring locations in the state. Although the one hour standard of 0.5 ppm could be expected to permit only one twenty-minute per interest to exceed 0.8 ppm during the year, a three-hour standard could be expected to

permit between two and five twenty-minute periods to exceed 0.8 ppm during a one year period at most monitoring locations in the state.

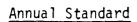
### Twenty-four Hour Standard

The health responses observed in community studies from twenty-four-hour exposures to 0.19 to 0.25 ppm of sulfur dioxide often were most apparent when contemporaneous particulate matter concentrations were greater than 250 ug/m³ BS.\* However, in several studies described here and in the draft EIS, health responses were observed at significantly lower sulfur dioxide and particulate matter concentrations with no apparent threshold. At the lower concentrations the responses become less dramatic and more difficult to identify with statistical precision but are nevertheless observed. There is not convincing evidence that the presence of particulate is necessary to observe the effect at low concentrations. Therefore the Department concedes a substantial degree of uncertainty in the identification of a concentration that will clearly protect the public health and safety, and recommends an ambient air quality standard of 0.10 ppm averaged over twenty-four hours, not to be exceeded more than once a year.

The current Montana twenty-four hour rule is 0.10 ppm, not to be exceeded more than one day in any three month period. This is expected to be functionally equivalent to the proposed standard, since violations of air quality standards often occur only during a single season at most monitoring locations. The current Federal regulations require the State to achieve a standard of not more than 0.14 ppm, not to be exceeded more than once a year.

An averaging time of twenty-four hours is consistent with the time periods reported in the community epidemiological studies cited above and is consistent with the averaging time of the federal standards. An exceedance level of once per year, which is essentially a prohibition on concentrations above that amount, has been selected to be consistent with the other air quality standards being recommended by the Department.

<sup>\*</sup>BS refers to particulate measurement by the British Smoke method; see pp. 53-54 of the draft EIS.



Studies of the long term effects of sulfur dioxide exposure have associated the observed health response with annual average concentrations of 0.04 to 0.05 ppm. In many of these studies, particulate matter concentrations are high where sulfur dioxide levels are high, and low where sulfur dioxide levels are low.

Thus in these studies, the relative importance of the two pollutants cannot be clearly separated. Nor is it known if there is a synergistic relationship between sulfur dioxide and particulate matter at low concentrations. A few studies have observed similar health responses at similar or slightly higher concentrations of sulfur dioxide where annual average concentrations of particulate matter were very low. Because of the uncertainty involved in identifying the long term concentrations of sulfur dioxide that will not adversely affect health, the Department recommends an annual average standard of 0.02 ppm.

The current Montana annual average rule is 0.02 ppm. The current federal primary standard is 0.03 ppm annual average.

## Consideration of Welfare Effects

The Department's review and analysis of current scientific evidence indicates that the standards proposed to protect human health should largely protect the state's commercially important plants from the known or anticipated effects of sulfur dioxide. Some potential exists for some sensitive species to be affected at concentrations allowed by the proposed standards. It is anticipated the effects of sulfur dioxide on materials, property, and other welfare interest would be prevented by the proposed standards.

The current evidence pertaining to the welfare benefits from more stringent sulfur dioxide standards than that needed to protect human health is inconclusive and leaves the Department without a sufficient basis to ascertain the extent significance of harm at concentrations below those proposed. Until further

research clarifies these uncertainties, the Department has determined the proposed standards to adequatly protect welfare interests and therefore does not recommend standards beyond that needed to protect human health.

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Research and Development

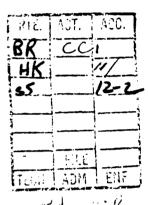
**SEPA** 

# Second Addendum to Air Quality Criteria for Particulate Matter and Sulfur Oxides (1982):

Assessment of Newly Available Health Effects Information

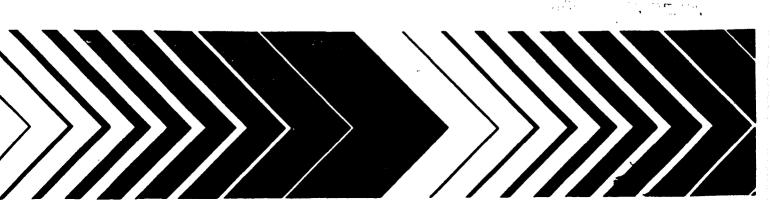
# Review Draft

(Do Not Cite or Quote)



#### **NOTICE**

This document is a preliminary draft. It has not been formally released by EPA and should not at this stage be construed to represent Agency policy. It is being circulated for comment on its technical accuracy and policy implications.



#### CHAPTER 1. INTRODUCTION

The United States Clean Air Act and its 1977 Amendments mandate that the U.S. Environmental Protection Agency (U.S. EPA) periodically review criteria for National Ambient Air Quality Standards (NAAQS) and revise such standards as appropriate. The most recent periodic review of the scientific bases underlying the NAAQS for particulate matter (PM) and sulfur oxides (SO\_) culminated in the 1982 publication of the EPA document Air Quality Criteria for Particulate Matter and Sulfur Oxides (U.S. EPA, 1982a), an associated PM staff paper (U.S. EPA, 1982b) which examined the implications of the revised criteria for the review of the PM NAAQS, an addendum to the criteria document addressing further information on health effects (U.S. EPA, 1982c), and another staff paper relating the revised scientific criteria to the review of the SO, NAAQS (U.S. EPA Based on the criteria document, addendum and staff papers, revised 24-hr and annual-average standards for PM have been proposed (Federal Register, 1984a) and public comments on the proposed revisions have been received both in written form and orally at public hearings (Federa! Register, 1984b). eration of possible revision of the sulfur oxides NAAQS is still under way.

Since preparation of the above criteria document, addendum, and staff papers (U.S. EPA, 1982a, b, c, d), numerous new scientific studies or analyses have become available that may have bearing on the development of criteria for PM or  $\mathrm{SO}_{\mathrm{X}}$  and thus may notably impact proposed revisions of those standards now under consideration by EPA. In December 1985 the Clean Air Scientific Advisory Committee (CASAC) of EPA's Science Advisory Board met to discuss the PM proposals and possible implications of the newly available information. CASAC recommended that a second addendum to the 1982 Criteria Document (U.S. EPA, 1982a) be prepared to evaluate new studies and their implications for derivation of health-related criteria for the PM NAAQS. In the process of responding to CASAC's recommendations, the Agency also determined that it would be useful to examine studies that have emerged since 1982 on the health effects of sulfur oxides.

Accordingly, the present addendum (1) summarizes key findings from the 1982 EPA criteria document and first addendum (U.S. EPA, 1982a,c) as they pertain to derivation of health-related criteria, and (2) provides an updated assessment of newly available information of potential importance for derivation of health criteria for both the PM and  $\rm SO_{X}$  standards, with major emphasis on evaluation of human health studies published since 1981. Certain background information of crucial importance for understanding the assessed health effects findings is also summarized. This includes information on physical and chemical properties of PM, sulfur oxides, and associated aerosols (including acid aerosols) and ambient monitoring techniques. However, new studies on associations between acid aerosols and health effects are being evaluated in a separate issue paper.

# 1.1 PHYSICAL AND CHEMICAL PROPERTIES OF AIRBORNE PARTICULATE MATTER AND AMBIENT AIR MEASUREMENT METHODS

As noted in the 1982 EPA criteria document (U.S. EPA, 1982a), airborne particles exist in many sizes and compositions that vary widely with changing source contributions and meteorological conditions. However, airborne particle mass tends to cluster in two principal size groups: coarse particles, generally larger than 2 to 3 micrometers (µm) in diameter; and fine particles, generally smaller than 2 to 3 µm in diameter. The dividing line between the coarse and the fine sizes is frequently given as 2.5 µm, but the distinction according to chemical composition is neither sharp nor fixed; it can depend on the contributing sources, on meteorology, and on the age of the aerosol.

Fine particle volume (or mass) distributions often exhibit two modes. Particles in the nuclei mode (which includes particles from 0.005 to 0.05 µm in diameter) form near sources by condensation of vapors produced by high temperature processes such as fossil-fuel combustion. Accumulation-mode particles (i.e., those 0.05-2.0 µm in diameter) form principally by coagulation or growth through vapor condensation of short-lived particles in the nuclei mode. Typically, 80 percent or more of the atmospheric sulfate mass occurs in the accumulation-mode. Particles in the accumulation mode normally do not grow into the coarse mode. Coarse particles include re-entrained surface dust, salt spray, and particles formed by mechanical processes such as crushing and grinding.

Primary particles are directly discharged from manmade or natural sources. Secondary particles form by atmospheric chemical and physical reactions, and most of the reactants involved are emitted as gaseous pollutants. In the air, particle growth and chemical transformation occur through gas-particle and particle-particle interactions. Gas-particle interactions include condensation of low-vapor-pressure molecules, such as sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) and organic compounds, principally on fine particles. The only particle-particle interaction important in atmospheric processes is coagulation among fine particles.

As shown in Figure 1, fine atmospheric particles mainly include sulfates, carbonaceous material, ammonium, lead, and nitrate. Coarse particles consist mainly of oxides of silicon, aluminum, calcium, and iron, as well as calcium carbonate, sea salt, and material such as tire particles and vegetation-related particles (e.g., pollen, spores). The distributions of fine and coarse particles overlap; some chemical species found mainly in one mode may also be found in the other.

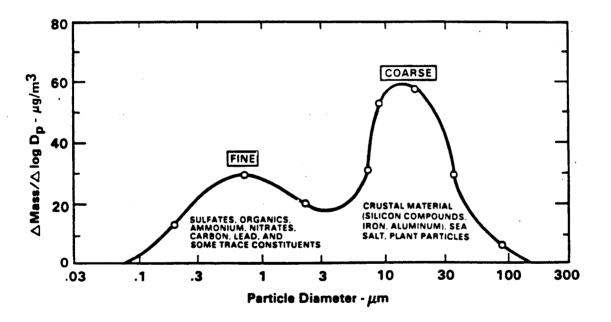


Figure 1. Representative example of typical bimodal mass distribution (measured by impactors) and chemical composition in an urban aerosol. Although some overlap exists, note substantial differences in chemical composition of fine versus coarse modes. Chemical species of each mode are listed in approximate order of relative mass contribution. Note that the ordinate is linear and not logarithmic.

Source: Modified from Whitby (1975) and NAS (1977).

The carbonaceous component of fine particles contains both elemental carbon (graphite and soot) and nonvolatile organic carbon (hydrocarbons in combustion exhaust and secondary organics formed by photochemistry). In many urban and nonurban areas, these species are the most abundant fine particles, after sulfates. Secondary organic particles form by oxidation of primary organics by a cycle that involves ozone and nitrogen oxides. Atmospheric reactions of nitrogen oxides yield nitric acid vapor (HNO<sub>3</sub>) that may accumulate as nitrate particles in the fine or coarse modes. Most atmospheric sulfates and nitrates are water-soluble and tend to absorb moisture. Hygroscopic growth of sulfate-containing particles markedly affects their size, reactivity, and other physical properties which influence their biological and physical effects.

The relative proportions of particles of different chemical composition and size ranges can vary greatly in ambient air, depending upon emission sources from which they originate and interactions with meteorological conditions, e.g., relative humidity (RH) and temperature. Particles from combustion of fossil fuels or high-temperature processes, e.g., metal smelting, tend to fall in the fine (<2.5  $\mu$ m) or small coarse mode (<10  $\mu$ m MMD) range; those from crushing or grinding processes, e.g., mining operations, tend to be mainly in the coarse mode (>2.5  $\mu$ m), with a substantial fraction in excess of 10  $\mu$ m.

Another important distinction concerning airborne particles is the broad characterization that can result from different methods commonly used for routine monitoring purposes. The most commonly used methods for collection and measurement of airborne particles were described in U.S. EPA (1982a). As noted there, differences in measurements obtained from various instruments and methods used to measure PM levels have important implications for derivation of quantitative dose-response relationships from epidemiologic studies and for establishing air quality criteria and standards. It is generally not practicable to discriminate on the basis of either particle size or chemical composition when assessing particulate matter data from routine monitoring networks. Characteristics of the collected samples are dependent on the types of sources in the vicinity, weather conditions and sampling procedures. Difficulties that result and limitations of measurements were also discussed in detail in the 1982 EPA criteria document (U.S. EPA, 1982a).

When considering measurements of airborne particles it is essential to specify the method used and to recognize that results obtained with one method

and under a given set of conditions are not necessarily applicable to other situations. For example, attempts have been made to relate findings based on smoke measurements (that relate mainly to dark-colored characteristics of particles from incomplete combustion of coal or other hydrocarbon fuels) to situations involving total suspended particulate matter (TSP) or size-specific fractions thereof (measured directly in terms of weight). Because the former (smoke) methods were used in many early epidemiological studies and the latter are now more often used for monitoring purposes in many countries, conversion from one type of measurement to the other would be desirable, but for reasons noted below, there can be no generally applicable conversion factor. Comparative evaluation of the two methods has been undertaken at numerous sites (Ball and Hume, 1977; Commins and Waller, 1967: Lee et al., 1972), but the results emphasize that they measure different qualities of the particulate matter and cannot be directly compared with one another (U.S. EPA, 1982a).

Sampling airborne particles is a complex task because of the wide spectrum of particle sizes and shapes. Separating particles by aerodynamic size provides a simplification by disregarding variations in particle shape and relying on particle settling velocity. The aerodynamic diameter of a particle is not a direct measurement of its size but is the equivalent diameter of a spherical particle of specific gravity which would settle at the same rate as the measured particles. Samplers can be designed to collect particles within sharply defined ranges of aerodynamic diameters or to simulate the deposition pattern of particles in the human respiratory system, which exhibits a more gradual transition from acceptance to exclusion of particles. High-volume (hi-vol) samplers, dichotomous samplers, cascade impactors, and cyclone samplers are the most common devices with specifically designed collection characteristics. These samplers rely on inertial impaction techniques for separating particles by aerodynamic size, filtration techniques for collecting the particles and gravimetric measurements for determining mass concentrations. Mass concentrations can also be estimated using methods that measure an integral property of particles such as optical reflectance, and empirical relationships between mass concentrations and the integral measurement can be used to predict mass concentration, if a valid physical model relating to the measurements exists and empirical data verify the model predictions.

The hi-vol sampler collects particles on a glass-fiber filter by drawing air through the filter at a flow rate of  $\sim 1.5~\text{m}^3/\text{min}$ , and is used to measure

total suspended particulate matter (TSP). The hi-vol sampler has cutpoints of  $\approx 25~\mu m$  at a wind speed of 24 kph and 45  $\mu m$  at 2 kph. Although sampling effectiveness is wind-speed sensitive, no more than a 10 percent day-to-day variability occurs for the same ambient concentration for typical conditions. The hi-vol is one of the most reproducible particle samplers in use, with a typical coefficient of variation of 3 to 5. One major problem associated with the glass-fiber filter used on the hi-vol is formation of artifact mass caused by the presence of acid gases in the air (e.g., artifactual formation of sulfates from  $SO_2$ ), which can add 6 to 7  $\mu g/m^3$  to a 24-h sample. The hi-vol has been the sampler most widely used in the U.S. for routine monitoring and has yielded TSP mass estimates used in many American epidemiological studies.

Hi-vol samplers with size-selective inlets (SSI) have recently been developed which collect and measure particles  $\leq 10~\mu m$  or  $\leq 15~\mu m$ . Except for the inlet, these samplers are identical in design and operation to the TSP hi-vol. Versions are now being used in epidemiologic health effects studies, and several models are being evaluated for possible routine monitoring use.

The dichotomous sampler is a low-volume gravimetric measurement device which collects fine ( $\leq 2.5~\mu m$ ) and coarse ( $\geq 2.5~\mu m$  to  $\leq 10~or~15~\mu m$ ) ambient particle fractions. The sampler uses Teflon filters which minimize artifact mass formation. The earlier inlets used with this sampler were very wind-speed dependent, but newer versions are much improved. Because of low sampling flow rate, the sampler collects submilligram quantities of particles and requires microbalance analyses, but is capable of reproducibility of  $\pm 10~percent$  or better. The method, however, has only begun to be employed on any major scale to generate size-selective data on PM mass assessed in relation to health effects evaluated in epidemiological studies.

Cyclone inlets with cutpoints around 2 µm have long been used to separate the fine particle fraction, can be used with samplers designed to cover a range of sampling flow rates and are available in a variety of physical sizes. Applications of cyclone inlets are found in 10- and 15-µm cutpoint inlets for both dichotomous and hi-vol samplers. Samplers with cyclone inlets could be expected to have coefficients of variations similar to those of the dichotomous or SSI hi-vol samplers, and until recently have also found only limited use in epidemiological studies of PM health effects.

Cascade impactors have been used to obtain mass distribution by particlesize. Because care must be exercised to prevent errors (e.g., those due to

particle bounce between stages), these samplers are normally not used as routine monitors. A study by Miller and DeKoning (1974) comparing cascade impactors with hi-vol samplers showed inconsistencies in mass collections by the impactors.

Samplers that derive mass concentrations by analytical techniques other than direct weight have been used extensively. One of the earliest was the British smokeshade (BS) sampler, which measures the reflectance of particles collected on a filter and uses empirical relationships to estimate mass concentrations. These relationships are more sensitive to carbon concentrations than mass (Bailev and Clayton, 1980) and hence are very difficult to interpret as either total or size-selective PM mass present in the atmosphere. The BS method and its standard variations typically collect PM with an  ${\simeq}4.5~\mu m$   $D_{50}$ cutpoint under field conditions, with some particles ranging from 7 to 9 µm at times being collected (McFarland et al., 1982). Thus, even if larger particles are present in the atmosphere, the BS method collects mainly fine-mode and small coarse-mode particles. The BS method neither directly measures mass nor determines chemical composition of collected PM. Rather, it measures light absorption of particles indicated by reflectance from a stain formed by particles collected on filter paper. Reflectance of light from the stain depends both on density of the stain, or amount of PM collected, and optical properties of collected PM. Smoke particles composed of elemental carbon in incomplete fossil-fuel combustion products typically make the greatest contribution to darkness of the stain, especially in urban areas. Thus, the amount of elemental carbon, but not organic carbon, in the stain tends to be most highly correlated with BS reflectance readings. Other nonblack, noncarbon particles also have optical properties which can affect the reflectance readings, but usually with negligible contribution to optical absorption.

Because the relative proportions of atmospheric carbon and noncarbon PM can vary greatly from site to site or from one time to another at the same site, the same absolute BS reflectance reading can be associated with very different amounts (or mass) of collected particles or even with very different amounts of carbon. Site-specific calibrations of reflectance readings against actual mass measurements from collocated gravimetric monitoring devices are therefore mandatory in order to obtain credible estimates of atmospheric concentrations of particulate matter based on the BS method. A single calibration curve relating mass or atmospheric concentration (in  $\mu g/m^3$ ) of particulate

matter to BS reflectance readings obtained at a given site may serve as a basis for crude estimates of the levels of PM (mainly particles <10  $\mu$ m) at that site over time, so long as the chemical composition and relative proportions of elemental carbon and noncarbon PM do not change. However, the actual mass or smoke concentration at a given site may differ markedly from values calculated from a given reflectance reading on either of the two most widely used standard curves (the British and OECD standard smoke curves). Thus, much care must be taken in interpreting the meaning of any BS value reported in terms of  $\mu$ g/m³, and such "nominal" expressions of airborne particle concentrations are not meaningful unless related to direct determinations of mass by gravimetric measurements carried out at the same geographical location and close in time to the BS readings.

The AISI light transmittance method is similar in approach to the BS technique, collects particles with a  $D_{50}$  cutpoint  $\cong 5.0~\mu m$  aerodynamic diameter, uses an air intake similar to that of the BS method, and has been used for routine monitoring in some American cities. Particles are collected on a filter-paper tape periodically advanced to allow accumulation of another stain, opacity of the stain is determined by transmittance of light through the deposited material and tape, and results are expressed in terms of optical density or coefficient of haze (CoH) units per 1000 linear feet of air sampled (rather than mass units). Readings of COH units are more responsive to non-carbon particles than are BS measurements, but again, the AISI method does not directly measure mass or determine chemical composition of collected particles. Attempts to relate COH to  $\mu g/m^3$  also require site-specific calibration of COH readings against mass measurements determined by a collocated gravimetric device, but the accuracy of such mass estimates are subject to question.

Since the hi-vol method collects particles much larger than those collected by BS or AISI methods, intercomparisons of PM measurements by the BS or AISI methods to equivalent TSP units, or vice versa, are very limited. For example, as shown by several studies, no consistent relationship exists between BS and TSP measurements taken at various sites or at the same site during various seasons. One exception is the relationship observed between BS and TSP during severe London air pollution episodes when low wind-speed conditions caused settling out of larger coarse-mode particles. Because fine-mode particle predominated, TSP and BS levels (in excess of  $\sim 500~\mu \text{g/m}^3$ ) tended to converge as expected if mainly fine-mode particles were present.

Many analytical techniques are available to determine chemical properties of particles collected on a suitable substrate. Most of the techniques, such as those for elemental sulfur, have been shown to be more precise than the analyses for gravimetric mass concentration. Methods are available that provide reliable analyses for sulfates, nitrates, organic fractions, and elemental composition (e.g., sulfur, lead, silicon), but not all analyses can be used for all particle samples because of factors such as incompatible substrates or inadequate sample size. Results can be misinterpreted when samples have not been appropriately segregated by particle size and when artifact mass is formed on the substrate rather than collected in particulate form, e.g., positive artifacts likely in nitrate and sulfate determinations (as noted below).

# 1.2 PHYSICAL/CHEMICAL PROPERTIES OF SULFUR OXIDES AND THEIR TRANSFORMATION PRODUCTS AND AMBIENT MEASUREMENT METHODS

The only sulfur oxide that occurs at significant concentrations in the atmosphere is sulfur dioxide, one of the four known gas-phase sulfur oxides (sulfur monoxide, sulfur dioxide, sulfur trioxide, and disulfur monoxide). As discussed in U.S. EPA (1982a), sulfur dioxide is a colorless gas detectable by taste at levels of 1000 to 3000  $\mu g/m^3$  (0.35-1.05 ppm). Above 10,000  $\mu g/m^3$  (3.5 ppm), it has a pungent irritating odor.

As also discussed in U.S. EPA (1982a),  $SO_2$  is mainly removed from the atmosphere by gaseous, aqueous, and surface oxidation to form acidic sulfates. Gas-phase oxidation of  $SO_2$  by the hydroxyl (OH) radical is well understood; not so well understood, however, is oxidation of  $SO_2$  by hydroperoxyl ( $HO_2$ ) and methyl peroxyl ( $CH_3O_2$ ) radicals. The ready solubility of  $SO_2$  in water is due mainly to formation of bisulfite ( $HSO_3$ -) and sulfite ( $SO_3$ -) ions, which are easily oxidized to form acidic sulfates by reacting with catalytic metal ions and dissolved oxidants. Sulfur dioxide reacts on the surface of a variety of airborne solid particles, such as ferric oxide, lead dioxide, aluminum oxide, salt, and charcoal.

Sulfur trioxide  $(SO_3)$ , which can be emitted into the air directly or result from reactions mentioned earlier, is a highly reactive gas. In the presence of moisture in the air, it is rapidly hydrated to form sulfuric acid. In the air, then, it is sulfuric acid in the form of an aerosol that is found

rather than  $\mathrm{SO}_3$ , and it is generally associated with other pollutants in droplets or solid particles of widely varying sizes. The acid is strongly hygroscopic, and droplets containing it readily take up further moisture from the air until they are in equilibrium with their surroundings. If any ammonia is present, it reacts with sulfuric acid to form various ammonium sulfates, which continue to exist as an aerosol (in droplet or crystalline form, depending on the relative humidity).

The sulfuric acid may also react further with other compounds in the air to produce other sulfates. Some sulfates reach the air directly from combustion or industrial sources, and near oceans, sulfates exist in aerosols generated from ocean spray. As discussed in U.S. EPA (1982a), sulfate particles fall mainly in the fine-mode (<2.5  $\mu$ m) size range. These particles, in the presence of moisture in air, combine with water to form coarse-mode aerosols (i.e., >2.5  $\mu$ m).

Many sulfur compounds are present in the complex mixture of urban air pollutants. Some are naturally occurring and some are manmade. Total biogenic sulfur emissions in the United States have been estimated to be in the range of 5 to 6 million metric tons annually. Additional contributions from coastal and oceanic sources may also be significant. Anthropogenic (manmade) sources are estimated to emit about 26 to 27 million metric tons of  $SO_{\chi}$  (mostly  $SO_{2}$ ) annually in the United States. Most manmade sulfur oxide emissions are from stationary point sources; over 90 percent of these are  $SO_{2}$  and the rest are sulfates.

Once SO<sub>2</sub> is emitted into the lower atmosphere, maintenance of a tolerable environment depends on the ability of wind and turbulence to disperse the pollutants. Factors affecting the dispersion of SO<sub>2</sub> from combustion sources include (1) temperature and efflux velocity of the gases, (2) stack height, (3) topography and the proximity of other buildings, and (4) meteorology. Some of the SO<sub>2</sub> emitted into the air is removed unchanged onto various surfaces, including soil, water, grass and vegetation. The remaining SO<sub>2</sub> is transformed into sulfuric acid or other sulfates by various processes in the presence of moisture, and these transformation products are then removed by dry deposition processes or by precipitation. The relative proportion of SO<sub>2</sub> and its transformation products resulting from atmospheric processes varies with increasing distance from emission sources and residence time (age) in the atmosphere. With long-range transport (over hundreds or thousands of kilometers), extensi

transformation of  $SO_2$  to sulfates occurs, with dry deposition of acidic sulfates or their wet depositon in rain or snow contributing to acidic precipitation processes.

The most commonly used collection and measurement methods for sulfur oxides were described in the 1982 EPA criteria document (U.S. EPA, 1982a). A clear understanding of the underlying bases and limitations of particular methods is essential for adequate interpretation of epidemiological studies discussed later. If  $\rm SO_2$  were the only contaminant in air, all measurement methods for that gas would give comparable results, indicating the true concentration of  $\rm SO_2$ . In typical urban environments, however, other pollutants are always present and although sampling procedures can be arranged to minimize interference from particulate matter by first filtering the air, errors still arise due to other gases and vapors. Thus, variations in specificity and accuracy of methods must be taken into account in comparing results from various studies.

Methods for measurement of  $SO_2$  include (1) manual methods, which involve collection of the sample over a specified time period and subsequent analysis by a variety of analytical techniques, and (2) automated methods, in which sample collection and analysis are performed continuously and automatically. In the most commonly used manual methods, the analyses of the collected samples are based on colorimetric, titrimetric, turbidimetric, gravimetric, x-ray fluorescent, chemiluminescent, and ion exchange chromatographic measurement principles.

The most widely used manual method for determination of atmospheric  $SO_2$  is the West-Gaeke pararosaniline method. An improved version of this colorimetric method, adopted in 1971 as the U.S. EPA reference method, can measure ambient  $SO_2$  at levels as low as 25  $\mu g/m^3$  (0.01 ppm) with 30 min to 24 hr sampling time. The method has acceptable specificity for  $SO_2$ , if properly implemented; however, samples collected in tetrachloromercurate(II) can undergo temperature-dependent decay leading to the underestimation of ambient  $SO_2$  concentrations. A variation of the method uses a buffered formaldehyde solution for sample collection, reducing the temperature-dependent decay problem. Certain American epidemiological studies employed the West-Gaeke or other variations of the pararosaniline method.

A titrimetric (acidometric) method, whereby  ${\rm SO}_2$  is collected in dilute hydrogen peroxide and the resultant  ${\rm H}_2{\rm SO}_4$  is titrated with standard alkali, is

the standard method mainly used in Great Britain and by the Organization for Economic Cooperation and Development (OECD). The method requires long sampling times (24 h), is subject to interference from atmospheric acids and bases, and can be affected by errors due to evaporation of reagent during sampling, titration errors, and alkaline contamination of glassware. It has been used to provide aerometric SO<sub>2</sub> estimates reported in many British and European epidemiological studies.

Some other methods use alkali-impregnated filter papers for collection of  $\mathrm{SO}_2$  and subsequent analysis as sulfite or sulfate. Most involve extraction prior to analysis; but nondispersive x-ray fluorescence allows direct measurement of  $\mathrm{SO}_2$  collected on sodium carbonate-impregnated membrane filters. These methods have not been widely used for routine air monitoring or epidemiological studies.

Two of the most sensitive methods for measuring  $SO_2$  are based on chemiluminescence and ion exchange chromatography. With the former,  $SO_2$  is absorbed in a tetrachloromercurate solution and then oxidized with potassium permanganate; oxidation of the absorbed  $SO_2$  is accompanied by chemiluminescence detected by a photomultiplier tube. With the latter, ion exchange chromatographican be used to determine ambient levels of  $SO_2$  absorbed into dilute hydrogen peroxide and oxidized to sulfate, or  $SO_2$  absorbed into a buffered formaldehyde reagent. These methods have not yet been widely employed for routine monitoring uses.

Sulfation methods, based on reaction of airborne sulfur compounds with lead dioxide paste to form lead sulfate, have been used both in the United States and Europe to estimate ambient  $SO_2$  concentrations over extended time periods. However, data obtained by sulfation methods are affected by many physical and chemical variables and other interferences (such as wind speed, temperature, and humidity); and they are not specific for  $SO_2$ , since sulfation rates are also affected by other airborne sulfur compounds (e.g., as sulfates). Thus, although sulfation rates (mg  $SO_3/100 \text{ cm}^2/\text{day}$ ) have been converted to rough estimates of  $SO_2$  levels (in ppm), these cannot be accepted as accurate measurements of atmospheric  $SO_2$  levels. This is notable here because lead dioxide gauges provided estimates of  $SO_2$  data used in some pre-1960s British epidemiological studies and also in some American epidemiologic studies.

Automated methods for measuring ambient SO<sub>2</sub> levels have been widely us for air monitoring. Some early continuous SO<sub>2</sub> analyzers, based on conductivit

and coulometry, were subject to interference by many ambient air substances. More recent commercially available analyzers using these measurement principles exhibit improved specificity for SO<sub>2</sub> through incorporation of sophisticated chemical and physical scrubbers.

Continuous SO2 analyzers that use flame photometric detection (FPD), fluorescence, or second-derivative spectrometry are now commercially available. The FPD method involves measurement of the band emission of excited SO, molecules formed from sulfur species in a hydrogen-rich flame and can exhibit high sensitivity and fast response, but must be used with selective scrubbers or coupled with gas chromatographs to achieve high specificity. Fluorescence analyzers detect characteristic fluorescence of the SO2 molecule when irradiated by UV light, have acceptable sensitivity and response times, are insensitive to sample flow rate, and require no support gases. However, they can be affected by interference due to water vapor (quenching effects) and certain aromatic hydrocarbons and must employ ways to minimize such effects. Secondderivative spectrometry can provide highly specific measurement of SO2 in the air, with continuous analyzers based on this principle being insensitive to sample flow rate and requiring no support gases. U.S. EPA has designated continuous analyzers based on many of the above principles (conductivity, coulometry, flame photometry, fluorescence, and second-derivative spectrometry) as equivalent methods for measurement of atmospheric SO<sub>2</sub>.

Two main methods have been used to measure total water-soluble sulfates collected on filters along with other suspended particulate matter. With the turbidimetric method, samples are collected on sulfate-free glass fiber or other efficient filters, the sulfate is extracted and precipitated with barium chloride, and the turbidity of the suspension is measured spectrophotometrically. Samples are normally collected over 24-h periods by hi-vol sampler. However, no distinction can be made between sulfates and sulfuric acid present in the air and collected on the filters; and some material present as acid in the air may be converted to neutral sulfate on the filter during sampling. With the methylthymol blue method, samples are collected as in the turbidimetric method and the extract is reacted with barium chloride, but the barium remaining in solution is then reacted with methylthymol blue and the sulfate determined colorimetrically by measurement of uncomplexed methylthymol blue. This modification allows the procedure to be automated, but the same limitations as noted

for the turbidimetric method apply, including lack of distinction between sulfates and sulfuric acid.

As for sulfuric acid, no fully satisfactory method exists for its measurement in the presence of other pollutants in the air, but some procedures exist for examining acidic properties of suspended particles or acid aerosols in general. Almost all of the strong acid content of ambient aerosols consists of sulfuric acid (H2SOA) and its partial atmospheric neutralization product, ammonium bisulfate ( $NH_4HSO_4$ ); however, ammonium sulfate [ $(NH_4)_2SO_4$ ], the final neutralization product, is only weakly acidic. Nitric acid  $(\bar{\text{HNO}}_3)$  and hydrochloric acid (HCl) are other strong acids found in the ambient air (mainly as vapors or, when incorporated into fog droplets, as constituents of acid aerosols). Ambient air acidic aerosol concentrations can be expressed in terms of  $\mu$ mols  $H^{+}/m^{3}$  or as  $H_{2}SO_{A}$  equivalent in  $\mu$ g/m<sup>3</sup> (at 98  $\mu$ g/ $\mu$ mol). Unfortunately, no systematic surveys of average acid aerosol concentrations in United States airsheds were available at the time the 1982 EPA criteria document (1982a) was prepared, nor is such systematic survey information available for more current acidic aerosol levels. However, Lioy and Lippmann (1985) have recently sum marized some of the highest levels reported for recent years in North America, including levels in the range of 20 to 30  $\mu g/m^3$   $H_2SO_4$  (1 hr mean). This is in contrast to the highest level (680  $\mu$ g/m<sup>3</sup> H<sub>2</sub>SO<sub>4</sub> 1 hr mean) recorded in the United Kingdom in London in 1962 and even higher levels almost certainly present during earlier London air pollution episodes.

#### 1.3 KEY AREAS ADDRESSED IN EMERGING NEW HEALTH EFFECTS DATA

Important new health effects information has emerged in three main areas since preparation of the 1982 EPA criteria document and addendum: (1) new data which permit more definitive characterization of respiratory tract deposition patterns for inhaled particles of various size ranges, e.g., fine-mode (<2.5  $\mu m$ ) vs. larger coarse mode particles (>2.5  $\mu m$ , <10  $\mu m$ , <15  $\mu m$ , etc.); (2) new reanalyses of certain key British epidemiology studies, which used BS methods for measuring PM levels, and additional new epidemiologic studies, employing other non-gravimetric or gravimetric PM measurement methods, that assess healt effects associated with exposures to PM and SO  $_{\rm X}$  in contemporary urban airsh of the 1970s and 1980s; and (3) new controlled human exposure studies which

more precisely define exposure-response relationships for pulmonary function decrements and respiratory symptoms due to acute  ${\rm SO}_2$  exposure.

#### CHAPTER 5. EXECUTIVE SUMMARY

In general, studies published in the scientific literature since 1981-82 support many of the conclusions reached in the earlier criteria review (U.S. EPA, 1982a,c). Some of the key findings emerging from the present evaluation of the newly available information on health effects associated with exposure to PM and  $SO_{\nu}$  are summarized here.

#### 5.1 RESPIRATORY TRACT DEPOSITION AND FATE

Studies published since preparation of the earlier criteria document (U.S. EPA, 1982a) and the previous addendum (U.S. EPA, 1982c) support the conclusions reached at that time and provide clarification of several issues. In light of previously available data, new literature was reviewed with a focus towards (1) the thoracic deposition and clearance of large particles, (2) assessment of deposition during oronasal breathing, (3) deposition in possibly susceptible subpopulations, such as children, and (4) information that would relate the data to refinement or interpretation of ancillary issues, such as inter- and intrasubject variability in deposition, deposition of monodisperse versus polydisperse aerosols, etc.

The thoracic deposition of particles  $\geq 10~\mu m$   $D_{ae}$  and their distribution in the TB and P regions has been studied by a number of investigators (Svartengren, 1986; Heyder, 1986; Emmett et al., 1982). Depending upon the breathing regimen used, TB deposition ranged from 0.14 to 0.36 for 10- $\mu m$   $D_{ae}$  particles, while the range for 12- $\mu m$   $D_{ae}$  particles was 0.09 to 0.27. For particles 16.4  $\mu m$   $D_{ae}$ , a maximally deep inhalation pattern resulted in TB deposition of 0.12. While the magnitude of deposition in various regions depends heavily upon minute ventilation, there is, in general, a gradual decline in thoracic deposition for large particle sizes, and there can be significant deposition of particles greater than 10  $\mu m$   $D_{ae}$ , particularly for individuals who habitually breathe through their mouth. Thus, the deposition experiments wherein subjects inhale through

a mouthpiece are relevant to examining the potential of particles to penetrate to the lower respiratory tract and pose a potentially increased risk. Increased risk may be due to increased localized dose or to the exceedingly long half-times for clearance of larger particles (Gerrity et al., 1983).

Although experimental data are not currently available for deposition of particles in the lungs of children, some trends are evident from the modeling results of Phalen et al. (1985). Phalen and co-workers made morphometric measurements in replica lung casts of people aged 11 days to 21 years and modeled deposition during inspiration as a function of activity level. They found that, in general, increasing age is associated with decreasing particulate deposition efficiency. However, very high flow rates and large particulate sizes do not exhibit consistent age-dependent differences. Since minute ventilation at a given state of activity is approximately linearly related to body mass, children receive a higher TB dose of particles than do adults and would appear to be at a greater risk, other factors (i.e., mucociliary clearance, particulate losses in the head, tissue sensitivity, etc.) being equal.

# 5.2 SUMMARY OF EPIDEMIOLOGIC FINDINGS ON HEALTH EFFECTS ASSOCIATED WITH EXPOSURE TO AIRBORNE PARTICLES AND SO

Newly available reanalyses of data relating mortality in London to short-term (24-h) exposures to PM (measured as smoke) and  $SO_2$  were evaluated and their results compared with earlier findings and conclusions discussed in U.S. EPA (1982a). Varying strengths and weaknesses were evident in relation to the different individual reanalyses evaluated and certain questions remain unresolved concerning most. Regardless of the above considerations, the following conclusions appear warranted based on the earlier criteria review (U.S. EPA, 1982a) and present evaluation of newly available analyses of the London mortality experience: (1) markedly increased mortality occurred, mainly among the elderly and chronically ill, in association with BS and  $SO_2$  concentrations above  $1000 \, \mu \text{g/m}^3$ , especially during episodes when such pollutant elevations occurred for several consecutive days; (2) the relative contributions of BS and  $SO_2$  cannot be clearly distinguished from those of each other, nor can the effects of other factors be clearly delineated, although it appears likely that coincident high humidity (fog) was also important (possibly in providing

conditions leading to formation of  $H_2SO_4$  or other acidic aerosols); (3) increased risk of mortality is associated with exposure to BS and  $SO_2$  levels in the range of 500 to 1000  $\mu g/m^3$ , clearly at concentrations in excess of ~700 to 750  $\mu g/m^3$ ; and (4) less certain evidence suggests possible slight increases in the risk of mortality at BS levels below 500  $\mu g/m^3$ , with no specific threshold levels having yet been demonstrated or ruled out at lower concentrations of BS (e.g., at 150  $\mu g/m^3$ ) nor potential contribution of other plausibly confounding variables having yet been fully evaluated.

In addition to the reanalyses of London mortality data, reanalyses of mortality data from New York City in relation to air pollution reported by Ozkaynak and Spengler (1985) were evaluated. Time-series analyses were carried out on a subset of New York City data included in a prior analysis by Schimmel (1978) which was critiqued during the earlier criteria review (U.S. EPA, 1982a). The reanalyses by Ozkaynak and Spengler (1985) evaluated 14 years (1963-76) of daily measurements of mortality (the sum of heart, other circulatory, respiratory, and cancer mortality), COH,  ${\rm SO_2}$ , and temperature. In summary, the newly available reanalyses of New York City data raise possibilities that, with additional work, further insights may emerge regarding mortality-air pollution relationships in a large U.S. urban area. However, the interim results reported thus far do not now permit definitive determination of their usefulness for defining exposure-effect relationships, given the above-noted types of caveats and limitations.

Similarly, it is presently difficult to accept findings reported in another new study of mortality associated with relatively low levels of SO<sub>2</sub> pollution in Athens, given questions regarding representativeness of the monitoring data and the statistical soundness of using deviations of mortality from an earlier baseline relatively distant in time. Lastly, a newly reported analyses of mortality-air pollution relationships in Pittsburgh (Allegheny County, PA) was evaluated as having utilized inadequate exposure characterization and the results contain sufficient internal inconsistencies, so that the analyses are not useful for delineating mortality relationships with either SO<sub>2</sub> or PM.

Of the newly-reported analyses of short-term PM/SO $_{\rm X}$  exposure-morbidity relationships discussed in this Addendum, the Dockery et al. (1982) study provides the best-substantiated and most readily interpretable results. Those results, specifically, point toward decrements in lung function occurring in

association with acute, short-term increases in PM and SO<sub>2</sub> air pollution. The small, reversible decrements appear to persist for 1-2 wks after episodic exposures to these pollutants across a wide range, with no clear delineation of threshold yet being evident. In some study periods effects may have been due to TSP and SO<sub>2</sub> levels ranging up to 422 and 455  $\mu$ g/m³, respectively. Notably larger decrements in lung function were discernable for a subset of children (responders) than for others. The precise medical significance of the observed decrements per se or any consequent long-term sequalae remain to be determined. The nature and magnitude of lung function decrements found by Dockery et al. (1982), it should be noted, are also consistent with: observations of Stebbings and Fogelman (1979) of gradual recovery in lung function of children during seven days following a high PM episode in Pittsburgh, PA (max 1-hr TSP estimated at 700  $\mu$ g/m³); and a report by Saric et al. (1981) of 5 percent average declines in FEV<sub>1 O</sub> being associated with high SO<sub>2</sub> days (89-235  $\mu$ g/m³).

In regard to evaluation of long-term exposure effects, the 1982 U.S. EPA criteria document (1982a) noted that certain large-scale "macroepidemiological" (or "ecologic" studies as termed by some) have attracted attention on the basis of reported demonstrations of associations between mortality and various indices of air pollution, e.g., PM or SO<sub>X</sub> levels. U.S. EPA (1982a) also noted that various criticisms of then-available ecologic studies made it impossible to ascertain which findings may be more valid than others. Thus, although many of the studies qualitatively suggested positive associations between mortality and chronic exposure to certain air pollutants in the United States, many key issues remained unresolved concerning reported associations and whether they were causal or not.

Since preparation of the earlier Criteria Document (U.S. EPA, 1982a) additional ecological analyses have been reported regarding efforts to assess relationships between mortality and long-term exposure to particulate matter and other air pollutants. For example, Lipfert (1984) conducted a series of cross-sectional multiple regression analyses of 1969 and 1970 mortality rates for up to 112 U.S. SMSA's, using the same basic data set as Lave and Seskin (1978) for 1969 and taking into account various demographic, environmental and lifestyle variables (e.g., socioeconomic status and smoking). Also, the Lipfert (1984) reanalysis included several additional independent variables: diet; drinking water variables; use of residential heating fuels; migration; and SMSA growth. New dependent variables included age-specific mortality rates

with their accompanying sex-specific age variables. Both linear and several nonlinear (e.g., quadratic or linear splines testing for possible threshold model specifications) were evaluated.

It became quite evident from the results obtained that the air pollution regression results for the U.S. data sets analyzed by Lipfert (1984) are extremely sensitive to variations in the inclusion/exclusion of specific observations (for central city versus SMSA's or different subsets of locations) or additional explanatory variables beyond those used in the earlier lave and Seskin analyses. The results are also highly dependent upon the particular model specifications used, i.e. air pollution coefficients vary in strength of association with total or age-/sex-specific mortality depending upon the form of the specification and the range of explanatory variables included in the analyses. Lipfert's overall conclusion was that the sulfate regression coefficients are not credible and, since sulfate and TSP interact with each other in these regressions, caution is warranted for TSP coefficients as well.

Ozkaynak and Spengler (1985) have also newly described results from ongoing attempts to improve upon previous analyses of mortality and morbidity effects of air pollution in the United States. Ozkaynak and Spengler (1985) present principal findings from a cross-sectional analysis of the 1980 0.\$. vital statistics and available air pollution data bases for sulfates, and fine, inhalable and total suspended particles. In these analyses, using multiple regression methods, the association between various particle measures and 1980 total mortality were estimated for 98 and 38 SMSA subsets by incorporating recent information on particle size relationships and a set of socioeconomic variables to control for potential confounding. Issues of model misspecification and spatial autocorrelation of the residuals were also investigated.

The Ozkaynak and Spengler (1985) results for 1980 U.S. mortality provide an interesting overall contrast to the findings of Lipfert (1984) for 1969-70 U.S. mortality data. Whereas Lipfert found TSP coefficients to be most consistently statistically significant (although varying widely depending upon model specifications, explanatory variables included, etc.), Ozhaynak and Spengler found particle mass measures including coarse particles (TSP, IP) often to be non-significant predictors of total mortality. Also, whereas Lipfert found the sulfate coefficients to be even more unstable than the TSP associations with mortality (and questioned the credibility of the salfate coefficients), Ozkaynak and Spengler found that particle exposure measures

related to the respirable or toxic fraction of the aerosols (e.g., FP or sulfates) to be most consistently and significantly associated with annual cross-sectional mortality rates. It might be tempting to hypothesize that changes in air quality or other factors from the earlier data sets (for 1969-70) analyzed by Lipfert (1984) to the later data (for 1980) analyzed by Ozkaynak and Spengler (1985, 1986) may at least partly explain their contrasting results, but there is at present no basis by which to determine if this is the case or which set of findings may or may not most accurately characterize associations between mortality and chronic PM or  $\mathrm{SO}_{\chi}$  exposures in the United States. Thus conclusions stated in U.S EPA (1982a) concerning ecologic analyses still largely apply here in regard to mortality PM/SO $_{\chi}$  relationships.

The present Addendum also evaluated a growing body of new literature on morbidity effects associated with chronic exposures to airborne particles and sulfur oxides. In summary, of the numerous new studies published on morbidity effects associated with long-term exposures to PM or SO,, only a few may provide potentially useful results by which to derive quantitative conclusions concerning exposure-effect relationships for the subject pollutants. A study by Ware et al. (1986), for example, provides evidence of respiratory symptoms in children being associated with particulate matter exposures in contemporary U.S. cities without evident threshold across a range of TSP levels of ~25 to 150  $\mu g/m^3$ . The increase in symptoms appears to occur without concomitant decrements in lung function among the same children. The medical significance the observed increased in symptoms unaccompanied by decrements in lung of function remains to be fully evaluated but is of likely health concern. Caution is warranted, however, in using these findings for risk assessment purposes in view of the lack of significant associations for the same variables when assessed from data within individual cities included in the Ware et al. (1985) study.

Other new American studies provide evidence for: (1) increased respiratory symptoms among young adults in association with annual-average  $SO_2$  levels of ~115  $\mu$ g/m³ (Chapman et al., 1983); and (2) increased prevalence of cough in children (but not lung function changes) being associated with intermittent exposures to mean peak 3-hr  $SO_2$  levels of ~1.0 ppm or annual average  $SO_2$  levels of ~103  $\mu$ g/m³ (Dodge et al., 1985).

Results from one European study (PAARC, 1982a,b) also suggest the likelihood of lower respiratory disease symptoms and decrements in lung function in adults (both male and female) being associated with annual average  $SO_2$  lavels ranging without evident threshold from about 25 to 130  $\mu g/m^3$ . In adultion that study suggests that upper respiratory disease and lung function decreases in children may also be associated with annual-average  $SO_2$  levels across the decrease range. Further analyses would probably be necessary to determine whether or not any thresholds for the health effects reported by PAARC (1982a,b) exist within the stated range of annual-average  $SO_2$  values.

# 5.3 SUMMARY OF CONTROLLED HUMAN EXPOSURE STUDIES OF SULFUR OTOXIDE HEALTH EFFECTS

The new studies clearly demonstrate that asthmatics are much more sensitive to  $SO_2$  as a group. Nevertheless, it is clear that there is a broad range of sensitivity to  $SO_2$  among asthmatics exposed under similar conditions. Recent studies also confirm that normal healthy subjects, even with moderate to heavy exercise, do not experience effects on pulmonary function due to  $SO_2$  exposure in the range of 0 to 2 ppm. The minor exception may be the analystace of the unpleasant smell or taste associated with  $SO_2$ . The suggestion that asthmatics are about an order of magnitude more sensitive than normals is thus confirmed.

There is no longer any question that normally breathing asthmatics performing moderate to heavy exercise will experience  $SO_2$ -induced broad-hoconstriction when breathing  $SO_2$  for at least 5 min at concentrations less than 1 ppm. Durations beyond 10 min do not appear to cause substantial worsening of the effect. The lowest concentration at which bronchoconstriction is clearly worsened by  $SO_2$  breathing depends on a variety of factors.

Exposure to less than 0.25 ppm has not evoked group mean changes in responses. Although some individuals may appear to respond to 50, concentrations less than 0.25 ppm, the frequency of these responses is not demonstrately greater than with clean air. Thus individual responses cannot be raised upon for response estimates, even in the most reactive segment of the population.

In the SO<sub>2</sub> concentration range from 0.2 to 0.3 ppm, six chamber exposure studies were performed with asthmatics performing moderate to heavy exercise. The evidence that SO<sub>2</sub>-induced bronchoconstriction occurred at this tomas tration with natural breathing under a range of ambient conditions was equivocal. Only with oral mouthpiece breathing of dry air (an unusual breathing moder under

exceptional ambient conditions) were small effects observed on a test of questionable quantitative relevance for criteria development purposes. These findings are in accord with the observation that the most reactive subject in the Horstman et al. (1986) study had a PCSO $_2$  (SO $_2$  concentration required to double SRaw) of 0.28 ppm.

Several observations of significant group mean changes in SRaw have recently been reported for asthmatics exposed to 0.4 to 0.6 ppm SO<sub>2</sub>. Most if not all studies, using moderate to heavy exercise levels (>40 to 50 L/min), found evidence of bronchoconstriction at 0.5 ppm. At a lower exercise rate, other studies (e.g., Schachter et al., 1984) did not produce clear evidence of SO<sub>2</sub>-induced bronchoconstriction at 0.5 ppm SO<sub>2</sub>. Exposures which included higher ventilations, mouthpiece breathing, and inspired air with a low water content resulted in the greatest responses. Mean responses ranged from 45 percent (Roger et al., 1985) to 280 percent (Bethel et al., 1983b) increase in SRaw. At concentrations in the range of 0.6 to 1.0 ppm, marked increases in SRaw are observed following exposure. Recovery is generally complete within approximately 1 h although the recovery period may be longer for subjects with the most severe responses.

It is now evident that for  $SO_2$ -induced bronchoconstriction to occur in asthmatics at concentrations less than 0.75 ppm, the exposure must be accompanied by hyperpnea. Ventilations in the range of 40 to 60 L/min have been most successful; such ventilations are beyond the usual oronasal ventilatory switchpoint.

There is no longer any question that oral breathing (especially via mouth-piece) causes exacerbation of  $SO_2$ -induced bronchoconstriction. New studies reinforce the concept that the mode of breathing is an important determinant of the intensity of  $SO_2$ -induced bronchoconstriction in the following order: oral > oronasal > nasal.

A second exacerbating factor strongly implicated in recent reports is the breathing of dry and/or cold air with  $SO_2$ . It has been suggested that the reduced water content and not cold, per se, could be responsible for much of this effect. Airway drying may contribute to the  $SO_2$  effect by decreasing the efficacy of  $SO_2$  scrubbing by the surface liquid of the oral and nasal airway. Drying of airways peripheral to the laryngopharynx may result in decreased surface liquid volume to buffer the effects of  $SO_2$ .

The new studies do not provide sufficient additional information to establish whether the intensity of the  ${\rm SO}_2$ -induced bronchoconstriction depends upon the severity of the disease. Across a broad clinical range from "normal" to moderate asthmatic there is clearly a relationship between the presence of asthma and sensitivity to SO2. Within the asthmatic population, the relationship of SO<sub>2</sub> sensitivity to the qualitative clinical severity of asthma has not been studied systematically. Ethical considerations (i.e., continuation of appropriate medical treatment) prevent the unmedicated exposure of the "severe" asthmatic because of his dependence upon drugs for control of his asthma. determination of sensitivity requires that the interference with  $\mathrm{SO}_2$  response caused by such medication be removed. Because of these mutually exclusive requirements, it is unlikely that the true SO<sub>2</sub> sensitivity of severe asthmatics will be determined. Nevertheless, more severe asthmatics should be studied. Alternative methods to those used with mild asthmatics, not critically dependant on regular medication, will be required. The studies to date have only addressed the "mild to moderate" asthmatic.

Consecutive SO<sub>2</sub> exposures (repeated within 30 min or less) result in a diminished response compared with the initial exposure. It is apparent that this refractory period lasts at least 30 min but that normal reactivity returns within 5 h. The mechanisms and time course of this effect are not clearly established but refractoriness does not appear to be related to an overall decrease in bronchomotor responsiveness.

From the review of studies included in this addendum, it is clear that the magnitude of response (typically bronchoconstriction) induced by any given  $SO_2$  concentration was variable among individual asthmatics. Exposures to  $SO_2$  concentrations of 0.25 ppm or less, which did not induce significant group mean increases in airway resistance also did not cause symptomatic bronchoconstriction in individual asthmatics. On the other hand, exposures to 0.40 ppm  $SO_2$  or greater (combined with moderate to heavy exercise) which induced significant group mean increases in airway resistance, also caused substantial bronchoconstriction in some invididual asthmatics. This bronchoconstriction was associated with wheezing and the perception of respiratory distress. In several instances it was necessary to discontinue the exposure and provide medication. The significance of these observations is that some  $SO_2$ -sansitive asthmatics are at risk of experiencing clinically significant (i.e., Symptomatic) bronchoconstriction requiring termination of activity and/or medical

intervention when exposed to  $S0_2$  concentrations of 0.40 ppm or greater when this exposure is accompanied by at least moderate activity.

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# YELLOWSTONE VALLEY CITIZENS COUNCIL

419 Stapleton Building Billings, Montana 59101

February 4, 1987

TO: Natural Resources Committee

RE: H. B. 534

On Monday night the Billings' City Council considered a position statement supporting the application of the federal air quality standards. Discussion revealed serious reservations on the part of the council members. The final conficus specifically removed reference to any support for the federal standards, but did support a negotiated settlement of the air quality issue.

The vote was nine to one.



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# YELLOWSTONE VALLEY CITIZENS COL

February 4, 1987

419 Stapleton Building Billings, Montana 59101

TO: House Natural Resources Committee

RE: House Bill 534

Much has been said about the economics of this issue.

Unfortunately, the focus has been misdirected! The economic scope is greater than the limited business interests of six

Billings' industries. The considerations must take into account the total business olimate of Billings en well anothe entire state of Montana. It is important to note that only Yellowstone County is, and has been, unable or unwilling to meet the state standard for sulfur dioxide. This bill would case the air quality standards for all of Montana, allowing previously compliant industries to emit 50% more \$002. Are we to place the entire state's air quality in jeopardy to accommodate the motives of a few industries in Billings?

One statewide industry which would be affected is tourism. The travel industry in Montana in 1984 was the second largest basic industry employer. An estimated 20,000 full time equivalent jobs can be attributed to travel. In 1983 non-resident tourists spent \$127,000,000. And why do tourists come to Montana? Precisely because they perceive that we have an abundance of natural resources and are committed to protecting those resources. That includes air and water quality which exceeds that found "back home". When it comes to environmental

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quility file federal standards are not good enough for us.
Visitors expect better; tourism deserves better.

Second the Billings area is basically meeting the federal standards for SO2. this bill would essentially legalize the status quo for Billings' air quality. Included in the status quo is an air quality ranking for Billings second only to Pittsburgh in sulfur diexide. Pespite all the self righteous protests from the Chamber of Commerce, the fact remains that our worst site was second to Pittsburgh's worst site... period. There would be a cap on industrial expansion since the ambient SO2 concentration is very near the federal limit. Without emission improvements the refineries would be restricted to operating at their present output of about 75% capacity. The status quo also includes a frequent odorous haze trapped over Billings between the cliffs.

In a recent story from Denver, as reported in the Billings Gazette on November 24th, "business leaders say the Brown Cloud is the biggest economic problem they face". The cloud is a highly visible and nexious mantle of dirty air. To companies and individuals looking into the prospects of moving there, the Brown Cloud is well known... and that is very bad for business. The board chairman of the Denver Chamber of Commerce conceded it was "clear...[that their] image as a polluted city makes convention planners, tourists and new businesses reconsider coming". We do not want to see Billings succumb to a Brown Cloud syndrome.

While the public's attention has been manipulated to focus

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on the of weilers of jobs due to industrial compliance with air quality of ordereds. Americans spent 70 billion dollars to control pollution. Reported in the Wall Street Journal last year was the conclusion of the Washington consulting firm - Management.

Information Services - that 167,000 jobs were created in 1985 in the pollution-control industry. Those are jobs in an industry that this bill is discouraging. It is as if Rep. Hannah wants to keep the pollution-control business out of Montana.

Everything I have said so far is true and without regard to the viability of the industries in question. An unbiased appraisal of their intentions is hard to come by. I would cautiously suggest that Exxon, and most recently Montana Power, have engaged the ostentatious tactic of playing to well founded concerns of legislators for the states' economic malaise. I believe that threats to close are an unfortunate disservice to everyone working for a solution. The threats polarize the participants and distract from the real issues. While Montana Power made the front page of the newspaper with predictions of closure, they never mentioned the well established procedures through the Public Service Commission of passing unavoidable operating costs along to the consumer. Montana Power has no competition that it must undersell. If Exxon were to install equipment to meet the state standard for SO2, the cost could be, using their figures, 10 to 20 million dollars. Such a cost, amortized over only five years would add less than a penny per gallon of refined product to their cost. That doesn't seem unreasonable, even if passed along to the consumer.

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Prist for last November's election. Per Addr informally polled his instituents on this issue. As he reported, 70% of the respondents believed that "we can maintain our air quality standards and obtract new businesses." Further, 76% thought that "we can maintain our air quality standards and keep existing jobs"! I believe that this represents a general attitude.

Yellowstone Talley Citizens Council does not want or expect any industries to close due to air quality requirements. If the state standard is kept and if the administrative process is allowed to work through the Board of Health, we are optimistic that an equitable solution is possible. H.B. 534 is not equitable and I urge you to abandon it.

Scott L Fraser
YVCC Chair

# montana public health association

The MPHA opposes HB 534. The MPHA supports the right to breathe clean air. Although the effects of SO<sub>2</sub> are controversial, we can testify to some facts. In the two-year study by Pemberton & Goldberg in 1954, high sulfur dioxide standards were consistently correlated with higher bronchitis death rates in 35 county boroughs analyzed. A 1970 study (Lawther, Walker & Anderson), demonstrated exacerbation, or worsening, of pre-existing disease as concentrations of smoke and sulfur dioxide increased. Verma's 1969 study associated an increase in daily respiratory absences in white-collar workers with increased daily increases in sulfur dioxide and particulate concentrations. This demonstrates the need for daily monitoring.

Experimentally exposed humans react to sulfur dioxide by constricting, or narrowing of airways. While some particles may be cleared by sneezing, deposits in the lower lungs remain. Acids are irritants and inhaled acids interfere with normal host defenses. Sulfur dioxide may be oxidized to sulfur trioxide when it comes in contact with water. Sulfuric acid is one of the strongest, most corrosive chemicals known.

The fact that we have done little research on acid rain in Montana does not mean that it doesn't exist. Acid rain does not only involve environmental or ecological changes, it changes the influence of other substances on man. The effects of human exposure to lead, cadmium and other metals through pathways such as soil and water change.

The recent Conference on Health Effects of Acid Precipitation strongly concluded that further study regarding appropriate levels of sulfur dioxide is imperative. We know so little about the phenomenon that cumulative effects may exist. Latent diseases carry the highest mortality rates.

We have the technology to remove sulfur compounds from industrial flue gases. The U. S., in 1986, spent \$32.4 million on research and clean-up of environmental and chronic disease through the CDC budget alone. Can the State of Montana afford to be so hindsighted? Further, does the State of Montana wish to gamble with the health of its citizens?

To: Natural Resource Committee

From: Carolyn M. Hamlin, MPHA President

DATE 4487 HB 534

4 Februar 1997

Natural Resources Committee re H. B. 534

Proponents of Rep. Hannah's approach have frequently asked that those who favor a more stringent state ambient air quality standard should prove that the federal standard is unhealthy. There have been studies indicating that sulfur dioxide is harmful in concentrations below .03 parts per million. Unfortunately, such studies are often inconclusive. Even the well studied effects of smoking can be countered by some who say those studies are inconclusive. In fact, the tobacco industry can still provide "expert" witnesses to confirm that smoking is not harmful to your health.

that .03 ppm SO2 is safe; rather it indicates that, as in many long term cause-and-effect toxicity studies, it is very difficult to establish conclusions satisfactory to everyone.

They ask us to prove that .03 is unhealthy? We ask them to prove that .03 is safe, that it provides an adequate margin of safety for all Montanans. They can not!

Paul Berg
Yellowstone Basin Sierra Club Group

# #

# AMERICAN LUNG ASSOCIATION OF MONTANA

Christmas Seal Bldg. — 825 Helena Ave. Helena, MT 59601 — Ph. 442-6556

EARL W. THOMAS
EXECUTIVE DIRECTOR

EXH!BIT(13)
DATE_ 2.1.87
HB_FSA

I AM EARL THOMAS, EXECUTIVE DIRECTOR OF THE AMERICAN LUNG ASSOCIATION OF MONTANA.

I OPPOSE HOUSE BILL 534 BECAUSE IT WEAKENS OUR CLEAN AIR STANDARDS. OUR CONSTITUTON

STATES THAT THE STATE AND EACH PERSON SHALL MAINTAIN AND IMPROVE A CLEAN AND HEALTHFUL

ENVIRONMENT FOR MONTANA FOR PRESENT AND FUTURE GENERATIONS. THIS BILL WILL NOT

MAINTAIN OR IMPROVE CLEAN AIR BUT IN FACT WEAKEN IT.

SULFUR DIOXIDE IS PRODUCED IN PETROLEUM REFINERIES. SULFUR DIOXIDE AFFECTS US ALL BECAUSE IT RESTRICTS THE FLOW OF MUCUS, WHICH THEN POOLS UP AND BECOMES INFECTED RESULTING IN COLDS, FLU, PNEUMONIS AND MORE SERIOUS LUNG AILMENTS SUCH AS BRONCHITIS.

A STUDY DONE BY ROBERT HALVORSEN & MICHAEL RUBY IN 1981 CONCLUDED THAT REDUCING THE AVERAGE CONCENTRATION OF PARTICULATE OR SULFUR DIOXIDE AIR POLLUTION BY ONE MICROGRAM PER CUBIC METER WOULD PRODUCE MORTALITY HEALTH COST BENEFITS WORTH BETWEEN \$10 AND \$25 PER PERSON PER YEAR. A SIMILAR REDUCTION IN SULFATE POLLUTION WOULD BENEFIT EACH AMERICAN BETWEEN \$75 AND \$150 PER YEAR.

WE ESTIMATE THAT 75% OF ALL LUNG DISEASE CAN BE PREVENTED YOUR VOTE NO ON HOUSE BILL 534 WILL PREVENT LUNG DISEASE.



# The Montana Environmental Information Center Action Fund

• P.O. Box 1184, Helena, Montana 59624 EXHIBI(#06)443-2520(14)

February 4, 1987 House Natural Resources Committee RE: HB 534 DATE 2487 HB 534

Mr. Chairman, members of the committee, for the record my name is Rick Meis. I represent the members of the Montana Environmental Information Center.

We strongly oppose HB 534. Sulphur dioxide poses a serious threat to human health, real and personal property, agriculture, and forestry. This committee must not forget that the specific industries in Billings do not exist in a vacuum. It is bad public policy to lower state air quality standards for one area of the state.

Montana is a unique state of special beauty. We do not want the air pollution levels of Pittsburgh, Los Angeles, Appalachia or the Four Corners area. As we approach our Centennial year of statehood, we can look back on our distakes. Corporate sampulation by the Anadonda Company is feash in our sinds. To varying degress, out-of-state can clied interests of semy companies are still operating immegable the state. The potential is still have. We must not allow history to report itself.

Montana's Abbient Air Quality Standards were not set abble filly in a few hours by a handful of people. These standards took over two years to develop involving statewide public hearings, and thousands upon thousands of pages of documentation, study, and testimony. These standards should not be taken lightly. They were set carefully in order to protect human health. They are a fair response to our constitutional right to a clean and healthful environment. MEIC supports this right.

Much progress has been made throughout Montana in achieving a cleaner level of operation by industry. That is good for business in Montana. The best example is the Columbia Falls aluminum plant. The Anaconda Comapany was forced to modernize the plant in order to meet air quality standards. Had it not been modernized, the plant would be unable to compete in the world market now and would be forced to close. It would be unfair to those "good citizen" industires who have invested significant capital in their plants in order to comply with the law, to give up now and

Feb 4

EXHIBIT\_(15)

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HB\_524

Test many on 45 534

Mr. Charman and members of the committee :

My name is Tom Tully and I have lived in Billings for the past 2 yrs. My family ranches in the Bull Wither. I no. of Blys, and I have lived within 50 mi of Blys for most of the past 25 yrs.

of am here to strongly expects passage of 48 534 not on technical grounds, but simply as a concerned and increasing by outraged citizen.

Subjectively speaking it is my opinion that air quelity in Blys, especially as regards to alor, is some of the worst in the state. So bed, in fact, that on particularly described days on the right atmospheric conditions, pollution from the Blys area can be smelled and seen in the Bull Mts, some 25 to 80 mi nouth of the source area.

d have absenced over the past 25 yes a serveral worsening of the air quality in the Bllss area; there I am opposed to any weakening of air quality standards for what ever reason, considering that existing standards are apparently inadequete to maintain, let alone improve, present air quelity.

Heale you For Tully 832 Builington

# NORTHERN PLAINS RESOURCE COUNCIL

Field Office Box 858 Helena, MT 59624 (406) 443-4965

Main Office 419 Stapleton Building Billings, MT 59101 (406) 248-1154

EXHIBIT (16)
DATE 2.4.87

Field Office

Glendive, MT 59330

(406) 365-2525

Box 886

Testimony before House Natural Resources Committe in opposition to HB 534 February 4, 1987

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE, FOR THE RECORD, MY NAME IS RUSS BROWN AND I WORK FOR THE NORTHERN PLAINS RESOURCE COUNCIL. WE ARE TESTIFYING IN OPPOSITION IN OPPOSITION TO HB 534.

MR. CHAIRMAN, THE DOCUMENTS WE HAVE PASSED OUT CONTAIN PERTAINENT SUMMATIONS FROM THE FINAL AMBIENT AIR QUALITY EIS, AND THE OFTEN QUOTED, THOUGH IT IS NOT SUPPOSED TO BE QUOTED OR CITED, "SECOND ADDENDUM TO AIR QUALITY CRITERIA FOR PARTICULATE MATTER AND SULFUR OXIDES (EPA, JULY 1986).

WE ENCOURAGE THE COMMITTEE TO READ THIS INFORMATION CAREFULLY FOR SEVERAL REASONS.

FIRST, YOU ARE BEING ASKED TO PASS LEGISLATION THAT WOULD LOWER A HEALTH RELATED STATE STANDARD. THIS STANDARD HAS BEEN ON THE BOOKS FOR 20 YEARS. THOUSANDS OF PAGES OF RESEARCH AND COMMENTS AND HUNDREDS OF HOURS OF TESTIMONY HAVE GONE INTO REAFIRMING THESE STANDARDS!!!!! YOUR DECISION ON REP. HANNAH' BILL COULD EFFECT THE HEALTH OF NUMEROUS MONTANAS. YOU SHOULD HAVE THE OPPORTUNITY TO REVIEW AT LEAST SOME OF THE DATA AND RATIONAL FOR ADOPTING STATE STANDARDS, WITH A MARGIN OF SAFETY, STRICTER THAN THE FEDERAL STANDARDS.

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE, AS YOU REVIEW THE LITERATURE BEFORE YOU, WE ASK YOU TO CONSIDER NPRC'S CONTENTION THAT THE ISSUE IS FAR TO COMPLEX TO BE DECIDED AFTER ONLY SEVERAL HOURS OF TESTIMONY. FOR THIS REASON, WE SUPPORT REP. MILES BILL THAT WOULD TAKE THIS ISSUE AND REMAND IT TO THE ADMINISTRATIVE PROCESS WHERE IT CAN BE DISCUSSED, REVIEWED AND HAVE DECISIONS MADE ON ITS MERITS AND IN THE LIGHT OF FEDERAL RULEMAKING.

NPRC testimony in opposition to HB 534

EXHIBIT.	(16)
DATE	2.4.87
HB 53	

Mr. CHAIRMAN, AS AN AGRICULTURALLY BASE ORGANIZATION, NPRC IS DEEPLY AWARE OF WHAT THE LOSS OF JOBS MEANS TO THE MONTANA ECONOMY, BUT THIS IS NOT A JOBS BILL. THE MONTANA DEPARTMENT OF HEALTH HAS NEVER LEVIED A FINE OR THREATENED TO SUE INDUSTRY FOR AMBIENT AIR VIOLATIONS. IN FACT THE STATE AND NPRC HAS CONTINUED TO WORK WITH INDUSTRY T DEVELOP A PROGRAM THAT WOULD PROTECT HUMAN HEALTH, AND NOT BE PUNITIVE OR BURDENSOME TO YELLOWSTONE COUNTY INDUSTRY.

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE, THE QUESTION BEFORE YOU IS WHETHER YOU FEEL QUALIFIED TO SET A HEALTH STANDARD (which in the case of the 24 hr. standard Rep. Hannah in the June special session wasn't going to change due to health related impacts) ECONOMIC AND ENVIRONMENTAL BLACKMAIL.

WE THANK YOU FOR THE OPPORTUNITY TO COMMENT.

Russ Brown

# DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES



TED SCHWINDEN, GOVERNOR

COGSWELL BUILDING

# STATE OF MONTANA:

HELENA, MONTANA 59620

House Bill 534

EXHIBIT (16)

DATE 2.4.87

HB 5.34

Testimony by

Montana Department of Health and Environmental Sciences

Before

1987 Montana Legislative Session

House Committee Natural Resources

February 4, 1987

EXHIBIT. (16)
DATE. 2.4.87
HB 534

The Montana Department of Health and Environmental Sciences (department) appreciates the opportunity to present testimony regarding House Bill 534 introduced by Representative Hannah. The department has carefully reviewed the bill and is presenting this testimony as an opponent to its adoption.

The bill proposes to change Montana's ambient air quality standards for sulfur dioxide from their current value to those adopted by the Environmental Protection Agency (EPA). The table below provides a chart of the existing and proposed sulfur dioxide standards. The department opposes this action because the administrative processes set up to implement these standards have not yet been completed and the health effects data supports the existing standards.

# Ambient Air Quality Standards Sulfur Dioxide Comparisons

	Montana <u>Standards</u>	EPA Standards	Proposed by HB 534
1 - Hour	0.50 *	None	No Change
3 - Hour	None	0.50 **	No Change
24 - Hour	0.10 **	0.14 **	0.14 **
Annual	0.02	0.03	0.03

Units are in parts per million (ppm)

The remainder of this testimony will be divided into sections which are designed to discuss various aspects of the bill.

<sup>\*</sup> not to be exceeded more than 18 times per year

<sup>\*\*</sup> not to be exceeded more than 1 time per year

EXHIBIT.	(16)
DATE	2.4.87
HB 53	4

### HEALTH EFFECTS - GENERAL

Few air pollutants have received as much attention in regard to their health effects as sulfur dioxide. Despite these intense investigations, the decision on the appropriate standard remains the subject of debate and interpretation. It would be easy to provide the committee with several hundred pages of discussion on the results of these many studies. In the interest of time, however, it would be better to provide only a very brief summary of the effects of sulfur dioxide on human health.

In order to give the committee an appreciation for the amount of data that rightfully should be reviewed before making a decision that will impact Montana's residents, we have provided four tables attached to the back of this testimony. These tables provide a summary of the studies that have been conducted relating to sulfur dioxide and their outcome. We ask that you at least quickly review these tables in order to gain an appreciation for the complexity of the problem.

In most air pollution investigations, two types of studies are usually conducted: clinical and epidemiological. Clinical studies are usually short term studies of the effects of sulfur dioxide on specific human or animal subjects. Results from these clinical investigations provide the core of information necessary to adopt short term standards such as the 1-hour and 24-hour values. Epidemiological studies are investigations into a large population of people and how they have reacted to various air pollution levels over time. Epidemiological investigations provide most of the evidence in support of long term standards such as the annual standard.

Most of the epidemiological evidence has been gathered in larger cities. London and New York are often used in these investigations. Effects have been observed at annual concentrations as low as .03 ppm, especially when accompanied by other pollutants, but most studies have focused on areas with annual concentrations in the range of .04 to .07 ppm. These health studies generally show increased mortality rates from respiratory diseases or an increased prevalence of respiratory diseases and respiratory ailments such as coughing.

In regard to the 24-hour averaging period, studies in the United States and Europe have indicated that health effects do occur at concentrations as low as .08 to .11 ppm when accompanied by moderate to high levels of particulates. The health studies which are applicable to this averaging period show a decrease in lung functions, especially among children, and worsening health among sensitive individuals such as asthmatics and atopics (allergy related ailments).

EXHIBIT (16)

DATE 2.4.87

HB 534

In the past few years a large amount of data has been collected in regard to very short term exposures (5 minutes to 6 hours). Most of these clinical studies were conducted by exposing certain individuals to varying amounts of sulfur dioxide. Many of these studies indicate a significant increase in airway resistance among exercising asthmatics during 5 to 10 minute exposures varying from 0.20 to 0.40 ppm. A similar response was noted for resting asthmatics at a concentration of approximately 0.75 ppm. This research indicates that the current federal 3-hour and Montana 1-hour standards are probably not protecting the health of asthmatics.

It is important to keep in mind that all of the studies reviewed by the department during the adoption of the ambient air quality standards only identify a range of concentrations where health effects are likely to occur. That range is generally accepted to lie somewhere between .03 and .06 ppm (annual average); and .08 and .20 ppm (24-hour average). In light of these uncertainties, the department recommended that the Board of Health and Environmental Sciences (board) choose a level in the lower range of the above values or with some margin of safety: 0.02 for the annual average and 0.10 for the 24-hour average. Dr. Mike Morgan, Public School of Health at the University of Washington, summarized this position in his testimony to the board when he stated:

"From the summaries of chronic morbidity, described as increased prevalence of chronic respiratory symptoms. increased work absences, decreased ventilatory function and increased incidence of lower respiratory infections, is expected when sulfur dioxide exceeds 100 to 120 micrograms per cubic meter (.04 to .05 ppm), annual average when accompanied by a like amount of particulate matter. Acute morbidity, described as increased minor respiratory illness, increased asthma attacks and worsening of chronic obstructive lung disease, is expected when sulfur dioxide exceeds 200 to 250 micrograms per cubic meter (.08 to .10 ppm), twenty four hour average and accompanied by like concentrations of particulate matter. Since the proposed standards for the State of Montana for the corresponding time periods are 52 and 260 micrograms per cubic meter respectively, there is no or little margin of safety. Thus, based upon the two reviews cited, which reflect a consensus of scientific opinion, the proposed standards are not overly stringent in meeting the goal of protecting human health" (emphasis added)

(16) 2.487 534

# HEALTH STUDIES - BILLINGS

It is of interest to note that at least one major health study has been conducted in the Billings area. The study was part of a statewide effort to determine if air pollution levels found in Montana have an impact upon the health of its populace. The study was funded by the 1977 and 1979 legislatures and involved the assistance of numerous organizations and doctors.

The study was entitled the "Montana Air Pollution Study" (MAPS) and was administered by the department. Numerous local organizations gave much of their time to provide a quality product. In addition, the department sought the advice of national experts to insure its success. Many Montana doctors were also consulted including several pulmonary physiologists. The project officer for the health effects portion of the study was Dr. Kit Johnson.

MAPS included many investigations into health effects, air monitoring, meteorology, computer modeling, etc. What are of interest in this matter are the results of lung testing (pulmonary function) of school children in the Billings and Lockwood area. During the school year ending in June 1979, 171 children from Lockwood and 139 children from parochial schools in Billings were tested. Following parental permission, pulmonary function readings were taken for these children during the fall, winter and spring. The testing applied only to children in the third, fourth and fifth grades. This age group was chosen since a high degree of cooperation can be obtained and because they are too young to have begun heavy smoking.

In order to determine if there was an air pollution effect on the children, the results of these tests were compared to children of the same age group in Great Falls. Great Falls was chosen as a comparison city since it has a large data base and has the least amount of air pollution among the MAPS cities (Missoula, Anaconda, Butte, Billings, Colstrip, and Hardin).

The results of the lung tests are displayed in the following table. Although the data is fairly technical, one can summarize the readings by noting that in 6 of the 18 comparisons, the children of Great Falls performed better than their counterparts in Billings. The MAPS investigators conducted lengthy follow-up analyses to determine if variables other than air pollution might account for this difference. These other variables included education, smoking in the home, disease exposure, home heating sources, etc. The MAPS researchers concluded that the difference between Great Falls and the other communities was attributable to air pollution, not the other factors.

What is of particular interest in this study is that children in one community of Montana had poorer lung abilities than children in another community due to air pollution. The report concluded that air pollution was indeed having an impact upon Montana's population.

The department concludes, therefore, that a decision by the legislature to continue with the status quo for Billings may not serve the best interest of all of its residents.

# Comparison of Lung Testing

## % Difference Between Lung Tests of Various Communities Great Falls as a Reference

		Fa	11	W-	inter		Spring		
	FVC	FEV1	FEF	FVC	FEV1	FEF	FVC	FEV1	<u>FEF</u>
FEMALES									
Anaconda	-4.1%	-5.1%	-7.6%	-2.0%	-3.4%	-7.6%	-3.0%	-4.2%	-10.4%
Billings	0.6	0.1	0.7	-2.0	-2.8	-4.2	-1.5	-2.4	-4.0
Butte	-0.8	-0.8	-1.1	-0.8	-1.6	-5.2	0.7	0.1	-3.3
Missoula	2.1	2.0	1.1	-1.3	-1.5	-1.1	-1.5	-2.2	-4.3
MALES									
Anaconda	-0.2	-1.4	-6.5	0.6	-1.1	-6.1	0.5	-1.3	-7.7
Billings	7.4	1.8	2.6	-2.4	-3.0	-4.6	-2.5	-3.5	-3.7
Butte	-2.0	-1.7	-5.0	-0.4	-2.0	-7.6	-0.4	-2.0	-6.3
Missoula	-1.0	-0.8	-4.7	-0.2	-0.9	-2.6	-2.8	-4.3	-9.3

FEV1 = Forced Expiratory Volume (The amount of air breathed out in one second)

FEF = Forced Expiratory Flow rate (The amount of air exhaled during the middle half of the test. This parameter measures the speed at which air can be expelled.)

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### TIMELY AND APPROPRIATE ACTION

The department believes that the adoption of this bill is neither timely nor appropriate. The bill proposes to amend the ambient standards in the middle of an ongoing administrative process. It is appropriate that the board of health and environmental sciences (board), the body that adopted the air quality standards in the first place, be given an opportunity to implement those standards in a fair manner.

The adoption of an air quality standard is, as you might suspect, a very lengthy and complicated process. The standards are not adopted by simply reviewing the available clinical and epidemiological evidence. Other considerations must be addressed. These include:

- a. What is the level of apparent health response?
- b. What is the accuracy of the monitoring data for each of the studies (especially important in epidemiological data)?
- c. What population needs protection? Do you want to protect only "healthy" individuals or "sensitive" individuals (those with respiratory problems such as asthma, bronchitis, etc.)? If you want to protect sensitive individuals, then what portion of this population do you wish to protect?
- d. What are the possible unknown effects due to the uncertainties in study design? (A failure to not find an effect at one concentration does not conclude that no effect exists.)
- e. What is the significance of the health responses?
- f. Based upon the uncertainties noted above, sensitivity of the population and significance of the health response, what margin of safety should be applied to protect the targeted population?

The board has undertaken a significant effort to look at these questions. The standards were adopted only after lengthy public hearings and testimony. In fact, this action by the board took more time and effort than any other air quality matter discussed previously by the board.

The department respectfully submits that the Legislature simply does not have the time to make this same evaluation. This duty and its implementation should remain the province of an independent board since it has been created specifically for this purpose and has the time necessary to insure a fair implementation.

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# BILLINGS AIR QUALITY

The sulfur dioxide levels found in Billings far exceed those found in the rest of the state. The Colstrip area, for example, has readings which are between 10 and 100 times less than the Billings area. In addition, the Billings area industries are essentially without air pollution controls for sulfur dioxide despite the fact that until about a year ago the oil industry was enjoying record prosperity.

For interest, the table below shows the approximate sulfur dioxide <u>emissions</u> from various industries throughout the state.

<u>Area/Facility</u>	<pre>Emissions (tons/year)</pre>
Billings / Laurel Colstrip (all units) East Helena (ASARCO) Missoula (Stone)	39,000 7,000 28,000 2,000
Total Statewide	81,000+

The department also compared the <u>ambient</u> air quality data in Billings with 70 major U.S. metropolitan areas. The comparison was between Billings' highest recorded site and the highest recorded site in the other cities. Only the Pittsburgh area had sulfur dioxide readings exceeding those found in Billings. The following is a table of some of this information:

<u>Area</u>	1984 Annual Average (Parts per Billion)
Billings / Laurel Chicago Denver Detroit Los Angeles Newark New York	26 17 11 14 10 15 24
Pittsburgh	35

Based upon the information above, it is not unreasonable to try to improve the quality of air in Billings. Its ranking with other major cities could be substantially improved.

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### CONCLUSION

The department is convinced that it is appropriate to continue to have the board be the body which adopts and implements ambient air quality standards. They are the only body that can spend the necessary time to study and implement appropriate standards.

Sufficient health data exists to conclude that the existing Montana ambient air quality standards are reasonable to protect the public health. We is of the opinion that the recent EPA health data tends to indicate the need for a 24-hour standard of .10 and indicates a more stringent 1-hour standard is probably necessary.

In view of the ongoing administrative process and the health data presented, the department recommends this bill receive a "do not pass" recommendation.

The department stands ready to respond to questions or comments.

Thank you for your time and patience.

CONCLUSIONS FROM STUDIES RELATING HEALTH EFFECTS TO ACUTE EXPOSURE TO AMBIENT AIR LEVELS OF  $\mathrm{SO}_2$ 

	dley (1964)	·	dley		ussman	pengler AH TAD	534	4.87
Reference	Martin and Bradley (1960); Martin (1964)	Mazumdar <u>et al</u> . (1981)	Martin and Bradley (1960)	Mazumdar <u>et al</u> . (1981)	Mazumdar and Sussman (1983)	Ozkaynak and Spengler (1985)	Hatzakis <u>et al</u> (1986)	Lawther (1958); Lawther <u>et al</u> . (1970
Observed Effect	Clear increase in daily total mortality or excess mortality above 15 day moving average	Analogous increase in daily mortality	Some indication of increases in total daily mortality	Analogous indication of increased mortality	No statistically significant increase in mortality in relationship to SO <sub>2</sub>	Mortality was statistically correlated with SO <sub>2</sub> , COH and B <sub>ext</sub>	Estimated a threshold for SO <sub>2</sub> mortality effects at slightly below 0.06 ppm	Worsening of health status
Exposure Time	15 day	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour
Pollutant Concentration	1000 ug/m <sup>3</sup> BS and 0.38 ppm SO <sub>2</sub>	1000 ug/m <sup>3</sup> BS and 0.38 ppm SO <sub>2</sub>	500-1000 ug/m <sup>3</sup> BS and 0.19-0.38 ppm S0 <sub>2</sub>	750 ug/m $^3$ BS and 0.29 ppm $\mathrm{SO}_2$	Typical of Pitts- burgh during 1972-1977	Typical of New York City during 1963-1976	Typical of 1975- 1982 in Athens, Greece	250-500 ug/m <sup>3</sup> BS and
Subjects	Elderly & persons with pre-existing respiratory or cardiac disease during 1958-1959 in London	General population during 1958-59 and 1971-72 in London	General population during 1958-59 in London	General population during 1958-59 and 1971-72 in London	General population in Pittsburgh in 1972-1977	General population in New York City in 1963- 1976	General population	Chronic bronchitis patients in London during

Reference	Lawther <u>et al</u> . (1970)	Dockery <u>et al</u> . (1982)	Mazumdar and Sussman (1983)	Van der Lende <u>et al</u> . (1975)	Cohen <u>et al</u> . (1975)	Dassen <u>et al</u> . (1986)
Observed Effect	No detectable effects in most bronchitics, but worsening health status among a select group of highly sensitive bronchitics	2-6% reduction in lung function	Statistically significant association between hospital admissions for all age groups and COH and SO <sub>2</sub>	Decreased lung function	No observed threshold of increased rate of asthma attack	Decrease in lung functions
Exposure Time	24 hour	24 hour	24 hour	24 hour	24 hour	24 hour
·	$250~\mathrm{ug/m}^3~\mathrm{BS}$ and $0.19~\mathrm{ppm}~\mathrm{SO}_2$	$272~\mathrm{ug/m}^3~\mathrm{TSP}$ and $0.11~\mathrm{ppm}~\mathrm{SO}_2$	$0.0-3.5$ COH and $0.0-0.14$ ppm $\mathrm{SO}_2$	88 $\log/m^3$ BS and 0.08 ppm $SO_2$	$150~{ m ug/m}^3~{ m part.}$ 0.07 ppm ${ m SO}_2$	$200-250 \text{ ug/m}^3 \text{ TSP} \\ 200-250 \text{ ug/m}^3 \text{ RSP} \\ 0.08-0.10 \text{ ppm } \text{SO}_2$
Subjects	Chronic bronchitis patients in London during 1967-1968	School children	General population	General population	Asthma patients	Children

# TABLE 2

# CONCLUSIONS FROM STUDIES RELATING HEALTH EFFECTS TO CHRONIC EXPOSURE TO AMBIENT AIR LEVELS OF $\mathrm{SO}_2$

Subjects	Pollutant Concentration	Exposure	Observed Effect	Reference
General population	Historical concentra- tions typical of England and Wales	Annual	Positive correlation between mortality rates and ${\rm SO}_2$ and and §S	Lave and Seskin (1970, 1972 and 1977)
General population	Typical of 404 U.S. counties	Annual	Consistent but variable associa- tion between mortality in some age groups (increasingly more positive with age) and sulfates	Mendelsohn and Orcutt (1981)
General population	$160~\mathrm{ug/m}^3~\mathrm{BS}$ and $0.04~\mathrm{ppm}~\mathrm{SO}_2$	Annual	Increased death rates from lung cancer and bronchitis	Wicken and Buck (1964)
Children	$230 \text{ ug/m}^3 \text{ BS and} \\ 0.07 \text{ ppm } 80_2$	Annual	Increased frequency of lower respiratory symptoms and decreased lung functions	Lunn (1967 and 1970)
Children	138 ug/m³ TSP and 12 ug/m³ sulfate and 0.01 ppm SO <sub>2</sub>	Annual	Increased respiratory disease	Hammer (1977)
General population	$100~{ m ug/m}^3~{ m BS}$ and $0.04~{ m ppm}~{ m SO}_2$	Annual	No observed threshold for increased respiratory disease	Lambert and Reid (1970)
Children	127 ug/g <sup>3</sup> TSP and 13 ug/m <sup>3</sup> sulfate and 0.01 ppm SO <sub>2</sub>	Annual	Decrease in lung function	Chapman et al. (1976)
General population		Annual	Regression coefficients for mortality relationships with air pollution variables are quite unstable	Thiobdeau et al. 7. (1980)

Subjects	Pollutant Concentration	Exposure Time	Observed Effect	Reference
General population	Historical concentra- tions typical of England and Wales	Annua l	Re-analysis of Lave and Seskin's work and could not substantiate their findings	Lipfert (1984)
<b>General populati</b> on	Typical of 404 U.S. counties	Annual	No link between air quality and mortality in relation to TSP, $50_2$ , and $80_2$	Selvin <u>et al</u> . (1984)
Elderly	$0.19$ - $0.76$ ppm $\mathrm{SO}_2$	Annual	Significant difference in mortality from chronic bronchitis and bronchial asthma	Imai <u>et al</u> . (1986)
Children	Typical of six Eastern and Midwestern cities	Annual	The frequency of chronic cough was significantly associated with TSP, TSO <sub>4</sub> and SO <sub>2</sub> . No change in lung function.	Ware <u>et ai</u> . (1986)
Adult women	0.04 ppm ${\rm SO}_2$	Annual	Increased risk of wheeze	Schenker <u>et al</u> . (1982)
Adults	0.04 ppg SO <sub>2</sub> 14 ug/m sulfate	Annual	Increased prevalence of cough and phlegm	Chapman et al. (1983)
Children	$28 \text{ ug/m}^3 \text{ TSP}$ 0.02 ppm $80_2$	Annual	Increased prevalence of cough and phlegm	Dodge (1983)
Children	0.04 ppm SO <sub>2</sub>	Annual	Increased prevalence of cough but no effect in lung function	Dodge (1985)
General population	0.03 ppm <sub>3</sub> SO <sub>2</sub> and 243 ug/m <sub>3</sub> pārt. and 145 ug/m <sup>3</sup> NO and 61 ug/m <sup>3</sup> NO <sub>2</sub>	Annual	Children - SO, concentrations are associated with upper respiratory disease systems Children and Adults - SO, concentrations are correlated with reduced lung functions Adult Females - SO, concentrations are associated with lower respiratory disease Adult Males - SO, concentrations are associated with cough expectoration and lower respiratory disease	DATE 2.4.87  (1854, b)  (1982a, b)  (1982a, b)

		i		
	Pollutant	Exposure		
Subjects	Concentration	Time	Observed Effect	Reference
General population	0.06 ppm Sg and	Annual	No observed increase in non-	CEC (1983)
			אמערון ור ומומ מואשאש	

SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF NORMAL MALES TO  $\mathbf{SO}_2$ 

TABLE 3

Subjects	Pollutant Concentration	Exposure Time	Observed Effect	Reference
Normal males	5 ppm 50 <sub>2</sub>	10 minutes	Two subjects had severe coughing and wheezing	Frank <u>et al</u> . (1962)
Normal males	$^{1}$ ppm $^{50}_{2}$	15 minutes	Decrease in lung function	Snell and Luschinger (1969)
Exercising males	$6.75~\mathrm{ppm}~\mathrm{SO}_2$	30 minutes	Decrease in lung function	Bates and Hauzucha (1973)
Exercising males	0.37 ppm S0 <sub>2</sub> + 0.37 ppm 6zone + particles (?)	30 minutes	Decrease in lung function	Hauzucha and Bates (1975)
Normal males	1.8 micron sul- furic agid mist 10 ug/m	5 minutes	Increased airway resistance	Toyama and Nakamura (1964)

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TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO SO2

Conc.	Durat ion	Number of Subjects*	Exposure Mode	Exposure Status	Observations	Comments	References	f
0. 1 ppm	a min.	<b>&amp;</b> ·	Oral- mouthpiece 22°C OX RH AM < 1	Hyperventilation to V <sub>E</sub> = 51 l/min	Ventilation rate needed to increase SR by 80% over resting baseline shifted by 3.8 1/min (7%) less than that needed for comparable HIB in dry air.	Symptom data not reported. Suggests marginal decrease in hyperventilation needed to produce HIB in dry air. Health significance unclear.	Sheppard et al. (1984)	1 -
<u>.</u>	0.2 ppm 5 min.	83	Chamber- 23°C 85% RH AH = 17.5	Exercising V <sub>E</sub> = 48 1/min	No significant change in SR, FVC, PEFR, V mp25378 Buer exercise control, mp353184 statistically significant increase in overall symptom score but not for any one symptom.	No measureable physiologic changes with possible in- crease in symptom scores of uncertain significance.	Linn et al. (1983b)	
<u>.</u>	0.2 ppm 5 min.	œ	Chamber- 5°C 1) 50% RH AH = 3.4 2) 85% RH AH = 5.8	Exercising V <sub>E</sub> = 50 l/min	No significant changes in SR FEV, FVC, SG over exercise control for either RH level. Suggestion of small increase in symptoms but no statistics given.	No measureable enhancement of $50_2$ response for $5^\circ C$ , $50\%$ RH. Symptom score results of uncertain significance.	Linn et al. (1984)a	
<b>a</b>	0.25 ppm 10 to 40 min.	10	Chamber- 23°C 70% RH AH = 14.4	Exercising V <sub>E</sub> = 35 1/min	No significant changes in R <sub>M</sub> , FEV <sub>1</sub> , HEf <sub>40</sub> , with small (4X) <sup>M</sup> change in V <sub>0</sub> s <sub>0</sub> No clear increase in W <sub>0</sub> s <sub>0</sub> Mo clear of increased response in 2 of 10 subjects.	Indicates no effect. Changes even in sensitive subjects of uncertain health significance.	Schachter et al. (1984)	(84)
<b>E</b>	0,25 ppm 5 min.	1) 19 2) 9	Chamber 23°C 0.P. = 7.6°C (36% RH) AH = 7.4	Exercising 1) $V_c = 60$ 1/min estimated (750 kpm-min) 2) $V_c=80-90$ 1/min estimated (1000 kpm-min)	With 750 kpm/min exercise, increase in SRaw in 50 <sub>2</sub> (mean = 134%) signif. greater than clean air (mean = 77%). At 1000 kpm/min, no sig. diff. between 50 <sub>2</sub> and clean air.	Effects at this level small or non-existent in comparison to heavy exercise alone. No symptoms reported. Response highly variable. Suggests 0.25 close to threshold for bronchoconstriction.	Bethel et al. (1985)	·
<b>4</b>	0.25 ppm 10 min. to 75 min.	28	Chamber 26°C 70% RH AH = 17.1	Intermittent exercise (3 10 minute periods) V <sub>E</sub> = 42 l/min	No significant changes in SR, TGV, resistance impedence for any of measurement periods. No significant changes in symptoms.	No measurable physiological or symptoms changes seen with .25 ppm 50 <sub>2</sub> at this exercise level.	Roger et al. (1985)日 四 	DATE_
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TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED MITH EXPOSURE OF ASTHMATICS TO SO. (CONTINUED)

Conc. Duration	Number of on Subjects	Exposure Mode	Exposure Status	Observations	Comments	References
0.25 ppm 3 min.	<b>60</b>	Oral- mouthpiece 22°C 0% RH AH = <1	Hyperventilation to V <sub>E</sub> = 51 1/min	Ventilation needed to increase SR by 80% over resting base-life shifted to 5.6 l/min (10%) less than that needed for comparable HIB in dry air.	Symptom data not reported. Suggests small decrease in exercise needed to produce HIB in dry air. Health significance unclear.	Sheppard et al. (1984)
0.3 ppm 5 min.	. 54	Chamber 80% RH 1)-6°C 2) 7°C 3) 21°C 1) AH = 2.5 2) AH = 6.2 3) AH = 14.7	Exercising V <sub>E</sub> = 50 l/min	At-6°C, SR increased 94% in air and 105% iff%502.  At 7°C SR increased 59% in air and 87% iff%502.  At 21°C SR increased 28% in air and 59% in 502. Increase in symptom scores at all temperatures slightly greater in 502 than in air.	Significant main effects at 0.3 ppm not reported. Symptom score changes generally mild and of uncertain significance to health. Under test conditions, results indicate \$0_2 and moist cold air effects are additive or less than additive.	Linn et al. (1984)b
0.4 ppm 5 min.	33	Chamber 23°C 85% RH AH = 17.5	Exercising V <sub>E</sub> = 48 1/min	Increased SRaw in SO <sub>2</sub> (69%) sig. diff. than increase in clean air (35%). Significant decrements in V (25-75) (mean=10%), but no significant changes in FEV. Significant increase in overall symptom categories increased significantly. One subject required medication to relieve distress.	Indicates moderate bronco- contriction. Overall symp- tom changes mild, but in at least one subject responses suggestive of clinical sig- nificance.	Linn et al. (1983)b
		5°C 1) 50% RH 2) 81% RH 1) AH = 3.4 2) AH = 5.8	V <sub>E</sub> = 50 1/min	graphical depiction) and symptom score over exercise alone. Symptom score increase clearly larger for 50% RH than for 81% RH.	Significance of SG and FEV, at 0.4 ppm not reported; indicates subjective response enhanced for dryer cool air even when measure of functional changes comparable to moist air.	DATE 2.4 HB 534

Conc.	Duration	Number of Subjects	Exposure Mode	Exposure Status	Observations	Comments	References
0.4 ppm	S min.	80	Chamber	Exercising	Apparent increase in SR W (from	No stat. for SR <sub>aw</sub> changes.	Linn et al. (1984)a
0.5 ppm	10 to 40 min.	10	Chamber 23°C 70% RH AH = 14.4	Exercising V <sub>E</sub> = 35 l/min	No significant changes in R. FEV, MEF 40 with small (med) = 6% decrement in VBASQ: No clear increase in symBASAs. Suggestions of increased FEV, response in 2 or 3 subjects.	Indicates minimal constriction for group at this exercise rate.	Schachter et al. (1984)
0.5 ppm	0.5 ppm 5 min.	10	Chamber 23°C 41% RH AH 8.4	Exercising V = 60 l/min estimated (750 kpm-min)	Increase in SRaw in SO <sub>2</sub> (mean = 23GK) sig. diff. than increase in clean air (mean = 39K). Substantial variability in subjects; one showed eight-fold increase	Indicates substantial SO <sub>2</sub> induced bronchoconstriction at high exercise rate and mod. RH. No symptom data reported but extent of SR changes suggestive of ciffical significance.	Bethel et al. (1983)a
0.5 ppm 5 min.	رة ج	<b>5</b>	80% RH, 23°C 1) Face mask 2) Mouthpiece 3 AH = 16.5	xercising / win / VE = 27 1/min / VE = 41 1/min / VE = 61 1/min / VE = 61 1/min	Facemask exposure: No stat. sig. mean change in SR with air or 502 at low or mod. exercise rate. For high exercise increase in SR in clean air (25%) compared to mean baseline SR . Percent ventilation breathed or 301 for the three exercise rates were:  1) 50%, 2) 52%, 3) 61%.	Indicates SO <sub>2</sub> induced constriction enhanced by increased work rate, with protection afforded by oronasal (vs. oral) breathing greater at mod. than at high exercise rates. Asthmatics with rhinitis or other nasal blockage breathe more through mouth and appear at greater risk to SO <sub>2</sub> effects.	Bethel et al. (1983)b
					Mouthpiece exposure: No sig. mean change in SR for low exercise rate With moderate exercise, increased SR in SO <sub>2</sub> (231%) sig. larger than clean air (5%). With high exercise, increased SR in SO <sub>2</sub> (306%) sig. larger than exercise in SO <sub>2</sub> (306%) sig.		

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TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO SO<sub>2</sub> (CONTINUED)

Conc.	Ouration	Number of Subjects	Exposure Mode	Exposure Status	Observations	Comments	Refer	References	
0.5 ppm	30 min. rest 10 min. exercise	<b>5</b>	22°C 75+X RH AH = 14.6+	Mouthpiece 5-6 x rest V <sub>E</sub>	Mouthpiece exposure: FEV.o decreased, -15% (-4% in air); R increased 47%; V wax75 decreased -30, -35%max50* Max75	Indicates that mouthpiece breathing exacerbates the effect of $50_2$ in asthmatics.	Koenig et al. (1983)b	(1983)	م ا
		7		Facemask 5-6 x rest V <sub>E</sub>	Facemask: No significant changes.				
0.5 ppm	30 min. rest 20 min. exercise	10 22°C (14-18 yr) 75% RH AH = 14	22°C -) 75% RH AH = 14.6	Mouthpiece 43 1/min exercise	Increase in nasal resistance of 32%, but not significant. FEV, decrease -24%, V NASO -46%; V Nax75 -56%. R PREPEASED 60%.	Indicates SO <sub>2</sub> may cause increased nasal resistance in asthmatics, which may result in more oral breathing and	Koenig et al. (1985)a	(1985)	•
				Facemask	Significant increase in masal resistance of 30%. FEV, decreased -16% Vmax50, Vmax75 -26%	consequently more broncho- constriction.			
0.5 ppm	0.5 ppm 10 min. to 75 min.	788	Chamber 26°C 70% RH AH = 17.1	Intermittent exercise (3 10 min. periods)	Increased SR in SO <sub>2</sub> (93%) sig. larger than Elean air (47%). SR increase after second and third exercise periods sig. less than after first ex. period. No signi-	Extent of effects are decreased after short-term repeated exercise. Broad degree of sensitivity to SQ <sub>2</sub> with about 25% of subjects	Roger et al. (1985)	(1985)	
					ficant changes in FVC, FEV <sub>1</sub> , FEF Group mean symptoms for 20 subjects not sig. increased. Substantial variability in subjects, with one showing 11-fold increase in SR and requiring medication to reffere pronounced symptoms.	showing a 100% increase in SR Symptoms in at least one subject of clear clinical significance.		HB	EXHIBIT.
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TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PUI MONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO  ${\rm SO}_2$  (CONTINUED)

Duration	Subjects	Mode	Status	Observations	Comments	References
a min., repeated 3 times in succession and 30 min. intervals, again after 24 hrs and 1 week later		Oral- mouthpiece 23°C 82% RH AH = 16.9	Hyperventilation (varied for each subject)	Sig. increase in SR $(\ddot{x}=104\ddot{x})$ after first 3 min. EXposure.  After 30 min. rest, second response sig. but smaller $(x=35\ddot{x})$ ; response after third exposure still smaller $(\ddot{x}=30\ddot{x})$ . SR increase at 24 h. $(\ddot{x}=83\ddot{x})$ and $\ddot{1}$ week $(\ddot{x}=129\ddot{x})$ not sig. diff. from increase after first 3 min. exposure.	Indicates repeated esposures to SO <sub>2</sub> can induce tolerance to brunchoconstrictive effects of SO <sub>2</sub> over a short period (>30 min) but not for longer periods.	Sheppard et al. (1983)
0.5 ppm 3 min.	~	Oral- mouthpiece 1) 23°C 77% RH 2) -11°C, "Dry" 1) AH = 15.8 2) AH < 1	Hyperventilation to "Threshold" Ve for each subject (30-50 1/min)	By design, increases in SR or symptoms not sig. for $SO_2$ MW warm, humidified air or cold dry air alone. Sig. increase in $SR$ ( $\kappa = 222K$ ) for combination of $SO_2^2$ and cold dry air. Six of seven subjects report wheezing and/or shortness of breath; two asked for medication. Symptoms not good indicator of of measured $SA_{aw}$ .	Indicates that airway cooling, drying can increase 50, associated bronchoconstriction in hyperventilating asthmatics. Suggests synergism for these combinations.	Bethel et al. (1984)
e in .	<b>7</b> 2	Chamber 80% RH 1) -6°C 2) 7°C 3) 21°C (1) AH = 2.5 (2) AH = 6.2 (3) AH = 14.7	Exercising V <sub>E</sub> = 50 l/min	Increased SR in SO <sub>2</sub> sig. greater than in cleaffair for all three temps. At -6°C, SR increased 94% in air and 187% in SU <sub>2</sub> . At 7°C, SR in air and 207% in SO <sub>2</sub> . At 21°C, SR increased 20% in air and 150% PR Symptom scores sig. greater in SO <sub>2</sub> than in air at all three temperatures.	Suggests that the bronchconstrictive effects of cold air and 50, combine in an additive or less-than-additive fashion. Some suggestion of cold air-50, interaction in total asthmascore. SR changes suggestive of clinical significance at all temperatures.	DAT HB.

TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO SO. (CONTINUED)

			DATE 2.4
References	Linn et al. (1983b)	Mackney et al.(1984)	HB 554
Comments	Indicates bronchoconstriction Lir Functional changes, symptoms indicate clinical significance.	Indicates that recovery is Hac complete for most subjects within Ih of SO <sub>2</sub> + exercise- induced bronchoconstriction.	Indicates oronasal breath- ing ameliorates broncho- constrictive effects of 50 <sub>2</sub> , but less effective against symptoms. Functional changes and symptoms indicate clinical significance.
Observations	Increased SR in SO <sub>2</sub> (120%) sig. greater than an (36%). Significant decline in FVC (mean = 13%), FEV <sub>1</sub> (mean = -13%), PEF <sub>2</sub> x = -26%). Sig. increase iHext61s symptom score; number of subjects with increased symptom score (21 of 23), and positive reading on discomfor meter (12 of 23), and in 4 individual symptom categories (cough, substantial irritation; wheating and chest tightness). Three subjects required medication to relieve symptoms. No apparent effects next day or week.	No clean air control. With 50 <sub>2</sub> , SR increased 20% after exercise (SR increased 32.2% in second series With no spirometry). Symptom scores increased after exercise. SR and symptom scores were not sighlficantly elevated after 1h of recovery in 50 <sub>2</sub> .	In clean air, SR increased 54% by either oronasay or mouthplece breathing. In 502, SR increased 186% oronasal breathing and 31% by mouthplece. Decline in FVC, FFV, PEFR, and V 25-59 increase in symptom score, both routes. SR increase sig. greater for oral exposures; symptoms and other functional measure changes greater for oral, but not sig. so.
Exposure Status	Exercising V <sub>E</sub> = 48 1/min	Exercising 45 1/min	Exercising V <sub>E</sub> = 40 I/min
Exposure Mode	Chamber- 23°C . 85% RH AH = 17.5	Chamber 22°C, 85% AH = 16.5	Chamber 23°C, 90% RH 1) oralnasal 2) mouthpiece AH = 18.5
Number of Subjects	23	ų	ສ
Duration	5 min.	a 3h 10 min. exer. at beginning	0.75 ppm 10 min.
Conc.	0.6 ppm	0.75 ppm 3h 10 20 20 20 20 20 20 20 20 20 20 20 20 20	0.75 pp

# TABLE 4. SUMMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTIGMATICS TO ${ m SO}_2$ (continued)

5 min. 22 Chamber Exercise SR changes in clean air ranged 220K RH, BOXRH E 20 1/ain 178 4 to 1.4	Conc.	Duration	Number of Subjects	Exposure Mode	Exposure Status	Observations	Comments	References	nces
Total 6 hr 14 Chamber Exercise After correction for clean air and clear air and bear (18-3) 22°C 50 1/min 100 on the early day 1, laterday choconstriction is less than 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday choconstriction is less than 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday 2. No day, separated by Sh 100 on the early day 2, laterday 2. No sig. Indicate bronchoconstriction is less than 100 on the early day 2, laterday 2. No sig. Indicate bronchoconstriction is less than 100 on the early day 2, laterday 2. No sig. Indicate bronchoconstriction is less than 100 on the early day 2, laterday 2. No sig. Indicate bronchoconstriction is less than 100 on the early day. Indicated by Sh 100 on the early day 2, laterday 2. No sig. Indicate bronchoconstriction is less than referent is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than referent is less than 100 on the early day. Indicated by Sh 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction is less than 100 on the early day. Choconstriction i	0.6 ppm		22	Chamber 21°C, 38°C 20% RH, 80%RP AH = 3.7, 14. @ 21°C AH = 9.3, 37. @ 38°C AH = 9.3, 37.	xercise E = 50 l	Changes in clean air ranged from -4x to +12x. With SO <sub>2</sub> , at 21°C SR increased 206% with dry and 159% with humid air, while at 38°C SR increased 89% in dry air and 39% in humid air.	Indicates the importance of airway drying as an exacerbating factor in the induction of SO <sub>2</sub> -bronchoconstriction.	Linn et al. (1985a)	85a)
24 Chamber Exercising At 5°C, increased SR with SO <sub>2</sub> 85% RH VE = 50 1/min (182%) sig. greater than clean air 1) 5°C 2) 22°C 2) 22°C 2) 22°C 3) AH = 16.5  And total symptom scores much 2) AH = 16.5  By fincte as SO <sub>2</sub> effects, but any increase SO <sub>2</sub> effects, but under these conditions, enclean air (27%). Lower respiratory hancement is inconsistent and and total symptom scores much 2) AH = 16.5  By Chamber Exercising Significant increase in SR and Suggests that under these conditions, sorted at this temperature.  By Chamber Exercising Significant increase in SR and conditions, SO <sub>2</sub> response for both humidities (graphical apparently not enhanced by humidities at this temperature.  Chamber Homidity of cool air which has a low water conference at this temperature.  Chamber Homidity of cool air which has a low water conference at this temperature.	.6 ppm		14 ve (18-33) in	Chamber 22°C 85% RH AH = 16.5	Exercise 50 1/min	After correction for clean air EIB, SR increased 136, 120, 147, 100% on the early day 1, late-day 1, early-day 2, late-day 2. No difference between times or days.	Indicates that refractory period for 502-induced bronchoconstriction is less than 5h.	Linn et al. (1984c)	84c)
Chamber— Exercising Significant increase in SR and Suggests that under these $5^{\circ}C$ $V_E=50$ l/min symptom scores over exercise alone conditions, $50_{\rm z}$ response 1) $50\%$ RH for both humidities (graphical apparently not enhanced by 2) $81\%$ RH Pilot study depiction). No sig. diff. between lower humidity of cool air 1) AH = 3.4 humidities at this temperature. which has a low water 2) AH = 5.8	.6 pps		52	Chamber- 85% RH 1) 5°C 2) 22°C 1) AH = 3.4 2) AH = 16.5	Exercising V <sub>E</sub> = 50 l/min	At 5°C, increased SR with 50 <sub>2</sub> (182%) sig. greater than clean air (38%). At 22°C, increased SR with 50 <sub>2</sub> (132%) sig. greater than clean air (27%). Lower respiratory and total symptom scores much greater in 50 <sub>2</sub> than in clean air.	Suggests bronchoconstrictive effects of cold, moist air may increase SO <sub>2</sub> effects, but under these conditions, enhancement is inconsistent and not significant). Symptoms, SR. changes suggestive of clffical significance at both temperatures.	Linn et al. (1984a)	(**)
	.6 pp	S Bin.	<b>&amp;</b>	F == " "	Exercising V <sub>E</sub> = 50 1/min Pilot study	Significant increase in SR and symptom scores over exercise alone for both humidities (graphical depiction). No sig. diff. between humidities at this temperature.	Suggests that under these conditions, SO <sub>2</sub> response apparently not enhanced by lower humidity of cool air which has a low water content already.	Linn et al. (1984a)	842)

TABLE 4. SUMZYARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO SO2 (CONTINUED)

= -64 MFL 40 (MEAN = -664), yax50 (x = -112), and RAW (x = 402). Wax50 after exposure. Apparent large increase in lower airway symptom complaints. Wide variable responses among subjects.  FEV 10 (-23%), V yx50 (-51%), V yx75 (-61%), R (+71%); Recovery wax35 (-61%), R (+71%); Recovery wax35 (-61%), R (+71%); Recovery wax35 (x = -24%), ME 40 (mean = 27%), V (x = -22%), and RAW (x = -54%), MA 50 sig. decrements persist 10 min. Three subjects apparently non-responsive (based on FEV) even at this conc. (based on FEV) even at this conc.		Ve = 33 //min = -64 AFF of (x = -112), a No sig. disconnected for signal disco		Mouthpiece 5-6 x rest VE (30-50 1/min)  Exercising VE = 35 1/min  1.4
gx50 (-51% Recovered to 5 ppm - 1 ppm - 2 ppm	,		Mouthpiece 5-6 x rest V 6-6 (30-50 1/min) Exercising VE = 35 1/min	22°C Mouthpiece 75% RH 5-6 x rest V AH = 14.6 (30-50 1/min) Chamber- Exercising 23°C VE = 35 1/min AH = 14.4
ges in FEV RAW (x = -1 Ls persist Apparent ed increas omplaints. Lly non-re every seth	Significant changes in FEV, (mean = -14%), WEF40 (mean = 27%), V (x = -22%), and RAW (x = -54%), max50 (x = -64%), and RAW (x = -54%), max50 and Gerements persist 10 min. After exposure. Apparent large concentration-related increase in lower airway symptom complaints. Three		er Exercising V <sub>E</sub> = 35 1/min 14.4	Chamber Exercising 23°C V <sub>E</sub> = 35 1/min 70% RH AH = 14.4
SOX FEV	subjects apparently non-responsive (based on FEV,) even at this conc., with at least one very sensitive subject showing > 50% FEV, decline.	subjects apparent (based on FEV.) ( with at least one subject showing )	with at least on subject showing ?	with at least one subject showing ?
SR afte bud responding to the state of the s	Sig. decrease in SR after all 3 exercise periods but response decreases with time. First Exercise: Increased SR in SO <sub>2</sub> (190%) sig. greater than dir (47%) Second Exercise: Increased SR in SO <sub>2</sub> (147%) sig. greater than air (34%) Ihird Exercise: Increased SR in SO <sub>2</sub> (110%) sig. greater than air (30%). Group mean symptom analysis for 20 subjects showed sig. increase in shortness of breath and chest discumfort. Substant, variability in subject response; one unable to go beyond 35 min. point.	Sig. decrease in exercise periods creases with time Increased SR in greater than Mir Exercise: Increased (147%) sig. great Phird Exercise: 1 502 (116%) sig. great (30%) sig. great for 20 subjects so in shortness of b discumfort. Subscient response: go beyond 15 min.	Chamber- 26°C 70% RH IN.1 creases with time AH = 17.1 greater than dir Exercise: Increased SR in greater than dir Exercise: Increased SR (147%) sig. great Third Exercise: 1 502 (116%) sig. great (30%) sig. great for 20 subjects so in shortness of b discomfort. Subsective subject response: go beyond 15 min.	H 17.1

TABLE 4. SUFMARY OF RESULTS FROM CONTROLLED HUMAN EXPOSURE STUDIES OF PULMONARY FUNCTION EFFECTS ASSOCIATED WITH EXPOSURE OF ASTHMATICS TO SO<sub>2</sub> (CONTINUED)

Conc.	Duration	Number of Subjects	Exposure Mude	Exposure Status	Observations	Coasents	References
J. 0 ppm	1) 10 mins., reported 3 times in succession with 15 minute intervals 2) 30 min. continuous exercise	2. 10	Chamber 26°C 70% RH AH = 17.1	Intermittent Exercise V <sub>E</sub> = 41 1/min	First Exercise: Significant increase in total SR (x = 172%). Second Exercise: Sry. increase in total SR (x = 137%. Increase in total SR (x = 137%. Attenuation with time occurred in 40 it of 10 subjects. Continuous Exercise: Sig. increase in total SR (x = 233%) after 30 minutes	Indicates mechanism responsible for apparent tolerance to repeated short-turm exposures to 50 <sub>2</sub> does not reduce response to continuous exercise for comparable time periods.	Kehrl et al. (1936)
. 25 to 2 ppm	10 minutes, different days	. 23	Chamber 26°C 70% RH AH = 17.1	Exercise V <sub>E</sub> = 42 I/min	Concentration response relationships for four exposures interpolated for each subject to determine $PC(SO_2)$ , the $SO_2$ concentration producing a $100\%$ increase in $SR$ over exercise in clean air. Cumulative plot shows $25\%$ of subjects with $PC(SO_2) < 0.5$ ppm, median $PC(SO_2)$ was $0.75$ ppm, and about $20\%$ of subjects have a $PC(SO_2)$ of $> 1.95$ ppm.	Reflects additional analyses M of data from first exposure period in experiment reported in Roger et al. (1965). Quantifies variability in response among asthaatics for functional changes of potential clinical significance. Suggests effects of concern in some subjects may extend to near 0.25 ppm.	Hortsman et al. (1986)
. 125 to 2 ppm	3 minutes doubling exposures succession with no breaks	e : .	Oral- mouthpiece 1) -20°C 0% RH 2) 22°C 72 RH 3) 22°C 70% RH 1) AH <1 2) AH <1 2) AH <1 3) AH = 13.6	Hyperventilation to V <sub>f</sub> = 30 to 40 1/mif	By design, SR increase for clean air alone not sig. Concentration response relationships for 4 to 5 exposures interpolated for each subject to determine PC100, the SO2 concentration producing a 100% increase over resting baseline. Mean PC100 for differing conditions were: Dry Cold Air - 0.51 ppm; Dry Warm, Air - 0.60 ppm; Humid Warm Air = 0.87 ppm; PC100 for humid warm Air = 0.87 ppm; pc100 for humid warm air sig. greater than for dry warm (which were not sig. differmeanth other	Nature of doubling concentra- Stions may have affected PC100 estimates. Results quantify wide variability among subjects. Indicates very dry air potentiates SO <sub>2</sub> bronchuconstriction regardless of temperature.	Sheppard et al. (1984)

AH = absolute humidity = g  $H_20$  vapour/m<sup>3</sup> of air.

g/m³ = mg/t.

HIB = Hyperventilation Induced Bronchoconstriction

Testamony presented by Grace Edwards (Windy (tiduson))
Chair/ Yellowstone County Commissioners EXHIBIT (17)
BHES Public Hearing 1/16/87
DATE 2.4.87

нв.534

I have no formal prepared testimony and I thought I would just sort of tell you where I was in the context of which I looked at the setting of the Montana ambient air quality standards. The Montana Clean Air Act had been passed. We were charged with providing the ambient The Department -- the Board was charged with standards. setting them and the Department was charged with recommending, and the Department prepared the environmental impact statement. At that time, the national standards had been EPA had them and the standard, of course, was at .03 for sulfur dioxide. My reasoning went somewhat like this. That standard was set as a reasonable achievement level We were talking about air that was extremely nationally. polluted in some areas, the heavily industrialized areas, East Coast, West Coast, the mid-west, the Great Lakes area, Gulf of Mexico. And yet, the national standard was set at a fairly stringent .03, and it appeared to be working. The vastest expanse of Montana's airshed was nowhere near .03 It wasn't close to parts per million of sulfur dioxide. It seemed to me that if we accepted the federal level, that we would in fact be giving carte blanche to industry, business, whatever, to significantly degrade the quality of Montana air and that was untenable to me and I'm sure to the other members of the Board as well. So we set it at .02. We also had some really wrenching decisions to make on the economic/environmental issue. Now, to me, a good economy

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includes a clean environment, as our Constitution says, and A good environment certainly must include a vice verse. favorable, a good economic basis. In setting the standard as .02, we considered not only what you call your normal, healthy, vigorous, young or middle-aged -- I won't get into exactly what what number I think that is -- person. considered the people who were elderly, people who were, for one reason or other, ill, who might have decreased lung capacity, and people who were sensitive, perhaps asthmatic, bronchitis. At any rate, we just kind of grouped all of those people together and called them the sensitives and decided that if we were going to fall off one way or the other, we would fall in the direction of additional protection for public health and welfare. We also thought that .02 was a reasonable standard, since almost no area of We also knew that the technology Montana was at that level. for controlling SO, was available, that it was not impossible task. The figures that we had at the time of the impact upon industries did not seem to be unreasonable. were also willing, and I would like to say that I remain so, to work with our industries to get them into a timeframe to go step by step so that the economic impacts on them would not hit them all at once. I think we were anxious to see a good faith effort on their part and in return, we would give them a good faith effort to understand, to be fair, to give it the proper publicity and the feeling of cooperation and partnership with them, but to continually work toward compliance of the standard. And it was rather disappointing

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EXHIBIT (17)

DATE 24.87 )

HB 534 )

that we got into a rather lengthy argument about the model, the study, you know, even questioning of the data, because that really seemed to be sort of aside from the main thing, which was to clean up the air in the Yellowstone Valley. Ours was obviously the worst, even in 1979. And we're still ready to do that. I don't think the answer is change the standard. That would negate years of work and a lot of commitment and a lot of money on the part of everyone. And I guess I would venture to say that if as much money and time and effort had been spent in getting right at cleaning up in 1980, that in these seven years we would probably have reached compliance and this wouldn't even be an issue. And I guess that's all I have to say. Thank you for your patience.

Montana Association of Churches

MONTANA RELIGIOUS LEGISLATIVE COALITION • P.O. Box 745 • Helena, MT 596

EXHIBIT (18)

DATE 2.4.87

HB.534

February 3, 1987

WORKING TOGETHER:

MISTER CHAIRMAN AND MEMBERS OF THE HOUSE NATURAL RESOURCES COMMITTEE:

American Baptist Churches of the Northwest

I am Mignon Waterman and I am speaking on behalf of the Montana Association of Churches.

American Lutheran Church Rocky Mountain District

The Montana Association of Churches supports the protection of the environment through air standards that adequately protect Montanans from air pollution.

Christian Church (Disciples of Christ) in Montana

The effects of air pollution fall disproportionately on children, the elderly and those already in poor health for other reasons. The primary purpose of air pollution control is the protection of human health.

Episcopal Church Diocese of Montana

We support the Montana Constitution's guarantee that "all persons have a right to a clean and healthful environment." (Declaration of Rights, Article 2; Montana Constitution)

Lutheran Church in America Pacific Northwest Synod

When these standards were adopted, the primary concern was one of health; the Montana Association of Churches hopes that when you make your decision on HB534, health will remain your primary concern.

Roman Catholic Diocese of Great Falls-Billings

Roman Catholic Diocese of Helena

United Church of Christ MT-N.WY Conference

United Methodist Church Yellowstone Conference

Presbyterian Church (U.S.A.)
Glacier Presbytery

Presbyterian Church (U.S.A.) Yellowstone Presbytery

EXHIBIT (19)

DATE 2.4.87

HB 534

League of Women Voters of Montana Joan Toole, Helena Harriett Meloy, Helena

Natural Resource Committee, 2/4/87

HB 534 (Hannah)

Position: LWVMT is opposed to HB 534, an act to lower the SO2 emission standards.

The League of Women Voters has lobbied extensively for national legislation to control acid rain and toxic air pollutants. The National Academy of Sciences, in a study done in 1981, labelled SO2 as the primary cause of acid rain. We also worry about its effect on human health.

It doesn't make a lot of sense for Montana to go backwards as the evidence piles up to support the damage SO2 does to vegetation, surface waters, and materials. We know that we need more people to come to Montana to enjoy our pristine country – our lakes, streams, and forests. Why would we take a chance on ruining our best drawing card for an improved economic climate?

We urge the committee to give a "do not pass" to HB 534.



P.O. BCX 2127 926 CENTRAL AVENUE GREAT FALLS, MONTANA 59403 (406) 761-4434

February 5, 1987

TO: House Natural Resources Committee
Cascade County Legislative Delegation

FROM: Roger W. Young, President

# SUBJECT: SO2 AIR QUALITY STANDARDS HB 534

The Board of Directors of the Great Falls Area Chamber of Commerce supports the passage of HB 534 which would cause federal standards to apply in Montana to ambient air quality for sulfur dioxide.

We believe that passage of this legislation would be good for the Montana economy because it would help to preserve continued operation of not only Billings' refineries. It may also make it easier for the Montana Refining facility in Great Falls to grow and expand, should expending market conditions dictate. New missions at Malmstrom Air Force Base and the likelihood that major oil and gas fields will be discovered in the Overthrust Belt along the Rocky Mountain Front, may make additional refining capacity in Great Falls necessary.

Certainly clean air is an absolute must for each town and city in our state, however, it is our understanding that the federally established standards, when met, assure that high air quality will be obtained. It is in the best interest of job retention, and possible expansion, that Montana's ambient air quality standards not be in excess of federal requirements.

EXHIBIT	(21)
DATE &	2.4.87
HR 534	

# PART C-PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY

#### SUBPART 1

#### **PURPOSES**

Sec. 160. The purposes of this part are as follows:

(1) to protect public health and welfare from any actual or potential adverse effect which in the Administrator's judgment may reasonably be anticipated to occur from air pollution or from exposures to pollutants in other media, which pollutants originate as emissions to the ambient air), notwithstanding attainment and maintenance of all national ambient air quality standards;

(2) to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seasheres, and other areas of special national or regional natural, recrea-

tional, scenic, or historic value;

(3) to insure that economic growth will occur in a manner consistent with the preservation of exist-

ing clean air resources:

(4) to assure that emissions from any source in any State will not interfere with any portion of the applicable implementation plan to prevent significant deterioration of air quality for any other State: and

#### Part 1

#### General Provisions and Administration

75-2-101. Short title. This chapter shall be known and may be cited as the "Clean Air Act of Montana".

History: En. Sec. 1, Ch. 313, L. 1967; R.C.M. 1947, 69-3904.

- 75-2-102. Policy and purpose. (1) It is hereby declared to be the public policy of this state and the purpose of this chapter to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state.
- (2) It is also declared that local and regional air pollution control programs are to be supported to the extent practicable as essential instruments for the securing and maintenance of appropriate levels of air quality.

(3) To these ends it is the purpose of this chapter to:

- (a) provide for a coordinated statewide program of air pollution prevention, abatement, and control;
- (b) provide for an appropriate distribution of responsibilities among the state and local units of government;
- (c) facilitate cooperation across jurisdictional lines in dealing with problems of air pollution not confined within single jurisdictions; and
- (d) provide a framework within which all values may be balanced in the Public interest.

History: En. Sec. 2, Ch. 313, L. 1967; R.C.M. 1947, 69-3905.

# DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

AIR QUALITY BUREAU

TED SCHWINDEN, GOVERNOR

COGSWELL BUILDING



HELENA, MONTANA 59620

September 19, 1986

Hugh Zackheim Environmental Quality Council Capitol Station Helena, MT 59620

Dear Hugh:

This letter serves as a response to your inquiries of Sept. 17 regarding alternative sulfur dioxide control measures for the Billings/Laurel area.

If one assumes the Montana annual ambient sulfur dioxide (SO<sub>2</sub>) standard is changed to the federal standard of 0.03 parts per million (ppm), the department believes that emission standards would still be necessary to achieve compliance with the Montana 24-hour ambient standard of 0.10 ppm. The reason for this lies in a review of the existing data. Data collected over the past 5 years indicates compliance with the annual standard (0.03), but continuing non-compliance with the 24-hour standard (0.10). It is clear, therefore, that changing the annual standard to 0.03 will not solve the non-compliance problems with the Montana 24-hour standard.

Your second question requests information about what emission reductions would be necessary to achieve compliance with the 24-hour standard. The department has reviewed the data from 1981 through 1985 to determine the source contributions of the six industries. We have made the following general conclusions:

1. The peak 24-hour concentrations range from .15 to .22 ppm. These larger peak values seem to be tied to malfunctions at the Conoco refinery. These malfunction problems must be solved if attainment of the standards is expected.

Hugh Zackheim Page Two September 19, 1988

> if the malfunction problems are solved, the estimated 2. range of peak 24-hour concentration is between .12 and .15 ppm. Compliance with this standard must be achieved from reductions among several industries. The department took the approach that the ennual source apportionment for the 24-hour violations were the same as the annual. This is based upon our review of the 24-hour violations over the past five years.

The data submitted in the department's discussion paper discusses compliance with the 24-hour standard under the assumption of 2. above. He believe, therefore, that the proposed withrostives would also be appropriate for the 24-hour standard. There may, however, be other mechanisms to obtain compliance with the short-corm standard that we have not considered. The methods of compliance would need further study by ourselves and the industries involved prior to any definitive statement.

We hope this provides you with the information you requested. The information presented in the Sept. Il discussion paper is a good first cut for the reductions necessary to attain compliance with the 24-hour ambient air quality standard.

> Sincerely, That well.

larold W. Robbins

Chiat

# Exxon reduces emissions

By PAUL J. HOLLEY Of The Gazette Staff

Operational changes at Exxon USA's Billings refinery have cut sulfur dioxide emissions by 15 percent, company officials said Wednesday.

But, they cautioned that further SO2 reductions to meet state air-quality standards could make the relinery unprofitable.



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The SO2 reduction procedure, in use since Dec. 29, is estimated by Exxon to cost \$100,000 a year.

"Our goal is to reach a tapid and equilable solution to the Billings air quality concerns," Henry Hubble, Exxon refinery manager told process working a news conference.

The method, which Exxon officials said they expect will reduce the refinery's SO2 output by 2,000 tons per year, uses a record stripper unit to remove hydrogen culfide from waste water created during the refining process

Instead of emitting SO2 by burning off the hydrogen culfide, the material is now piped to nearby Montana Suffur & Chemical Co. for preovery.

Erron genuctions reduction is a chromed by state regulators, but Hal Pobbins, glate Air Quality Bureau chief. gold the effort won't improve the overall air quality.

We're not ungrateful We're pleased that anyone would voluntarily reduce emissions," he said, "The downside is, we're leeking for a long term solution."

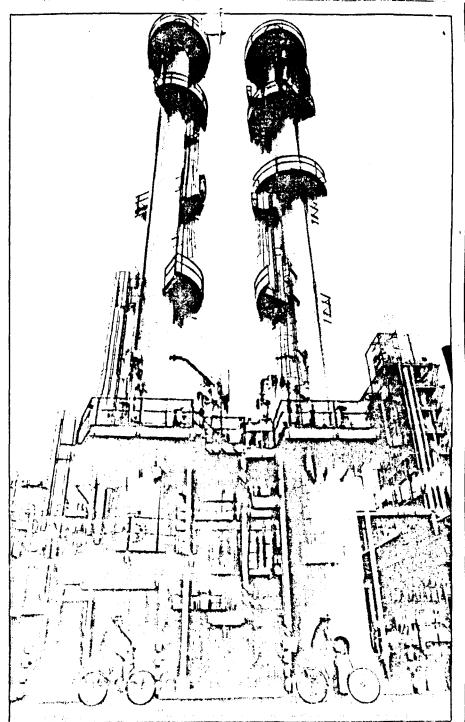
The state Board of Health will meet Friday in Helena to discuss ways to reduce SO2 emissions in the Billings area.

Affected industries, including Exxon, two other refineries, a sugar mill, a power plant and Montana Sulfur, have said that they would like to see Montana adopt a less stringent federal standard for SO2 emissions. The SO2 output of the Yellowstone Valley industries is within the federal standard.

The state standard basn't been

Robbins said that the state SO2 emission standard and industry compliance is "all up to negotiation."

The state wants industries to take



These "stripper" towers are used to reduce sulfur-dioxide emissions at the Billings Exxon refinery.

air quality, he said.

Hubble said that it would cost Exxon \$8 million to cut its SO2 emissions by another 15 percent and meet the state standard.

"The primary concern is we don't just compete with refineries in Montana, we compete with refineries elsewhere in the country," he said. "If other refineries don't have to comply with the same standards we do, it places us at a significant competitive disadvantage,"

Hubble, however, stopped short of predicting the refinery's closure if the state chooses to enforce the SO2 standard.

"I don't want to come off as

# Bikes save time

Sometimes the simplest methods are the most successful.

Workers at the Billings Exxon refinery use balloon-tired, singlespeed bicycles to scurry about the pipework jungle.

Tim Schug, the refinery's environmental affairs coordinator, said the bicycles have proven to be a reliable form of transportation. The refinery keeps several bicycles n hand for on-site use

# **LOCKWOOD SCHOOLS**

ELEMENTARY AND JUNIOR HIGH SCHOOL

District 26 — Yellowstone County

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June 11, 1986

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CHAIRMAN

CHARLENE GUSTAFSON

LA VONNE DEENEY

BUS. MGR.-CLERK

WARD SWANSER

JUDY JOHNSON

JOYCE DEANS

Rep. Tom Hannah State Capitol Capitol Station Helena, Mt. 59620

Dear Mr. Hannah;

I have attached inforamtion showing what the total Lockwood District tax levies were Fy 86 and the amount that Exxon paid in year 1985-86.

FY 86 LOCKWOOD S.D. #26 TOTAL DISTRICT TAX LEVIED \$951,171.92 - (see source A)

FY 86 EXXON'S TOTAL TAXES LEVIED FOR S.D. #26 ..... \$495,449.09 - (see source B)

NOTE: EXXON PAID 52% OF LOCKWOOD S.D. #26 TOTAL TAXES IN 1985-86.

I have attached the following source:

- LOCKWOOD S.D. #26 DISTRICT BUDGET FY'86 FUND REPORT
- YELLOWSTONE COUNTY TREASURER "DISTRIBUTION WORK SHEET" В.

#### NOTE:

DISTRIBUTION WORK SHEET FOR EXXON 1985-86 TAXES:

TOTAL TAXES \$2,066,954.89

**BREAKDOWN:** 

Library 26,234.91 110,540.21 Road 495,449.09 S.D. #26 LOCKWOOD 353,794.65 H.S. #2 BILLINGS 992,503.85 COUNTY AND STATE LOCKWOOD TRANSPORTATION 88,432.18

Attached are copies of Yellowstone County Treasurer "Distribution Work Sheet" for BN and Montana Sulphur and Chemical.

If you need additional inforamtion, call me.

Sincerely,

La Vonne Deeney Business Manager/clerk MPC sees three possible options for our Corette plant, which might meet this emission reduction contained in Alternative 1. They are:

- 1. Installation of a scrubber. This is a very costly option -- both from the capital cost and annual operating cost standpoint. Costs and limitations of this option are discussed under Alternative 3, the 70 percent reduction case. For both this nominal 30 percent alternative and the 70 percent reduction alternative, the scrubber option is considered unacceptable. Limited space around the existing unit and the need for off-site waste disposal add substantially to the design problems and cost of the flue gas desulfurization retrofit.
- 2. Permanent reduction of load by approximately 1/3 of the rated capacity of the unit would reduce the  $SO_2$  emissions by the same fraction. The loss in generating capacity would be 60 MW. Loss of this much generation would cost approximately \$46 million

in annual levelized dollars over an 18-year period to purchase from off-system sources and would not be an acceptable long-term solution.

3. Switch fuels from Colstrip Rosebud seam to a lower sulfur coal. IN its analysis of the draft proposed rules, MPC searched for lower sulfur coal and did not locate any viable supply source in the State of Montana that could meet existing boiler requirements and the coal sulfur level necessary to meet the proposed sulfur dioxide emission limitation. However, lower sulfur fuels are currently being mined in Wyoming. The Rosebud seam coal, when burned, generally produces sulfur dioxide emission in the 1.4 to 2.0 lb SO<sub>2</sub>/MMBTU range. One specific Wyoming coal we looked at would produce between 0.6 and 1.1 lb SO<sub>2</sub>/MMBTU. Depending on how the daily emission rate is computed, even this low sulfur coal

might not be an option. Should the coal change become necessary, test burns to prove the alternate fuel's acceptability in the present station would be required. The economic costs to entities other than MPC for switching fuel from a Montana source to Wyoming are as follows and represent those costs accumulated over a 20-year period, which is approximately the remaining economic life of the J. E. Corette plant:

- 1) The State of Montana would lose approximately \$25 million in Coal Severance Taxes;
- 2) Loss of Gross Proceeds Taxes would be \$3.8 million;
- 3) Loss to the State of Montana of 1/2 of associated Federal Coal Royalties -- \$3.8 million;
- 4) Loss of Resource Indemnity Trust Tax -- \$330,000;
- 5) Loss to a Montana supplier, Western Energy Company, of coal sales in excess of \$120 million;
- 6) Loss to the private sector for support goods and services -- \$25 million;
- 7) Direct employment -- \$9.4 million;
- 8) Indirect employment -- \$6.4 million; and
- 9) Loss of corporate and Individual Income Taxes on direct and indirect employment.

From these figures, one sees the economic impacts of the coal switch are significant to the State of Montana and go beyond the totals of coal taxes, jobs, and direct expenditures. The impacts would reach into and affect all sections of Montana's economy.

agricultural and governmental purposes in the Helena valley. The offhand statement in the EIS that "the increased energy demands would be small" is obviously a gross distortion of the truth.

Concerning the possiblility of meeting the proposed standards, the company said:

...We, of course, have not had an opportunity to investigate the cost of meeting such stringent requirements since we are only now obtaining the information necessary to assess the costs of meeting the emission limits set by the Board of Health last November. As noted, our present estimates of the costs of meeting those limits and the related OSHA arsenic standard is approximately \$130,000,000. We are fearful, however, that the additional costs of lowering SO2 emissions by the additional 90% ERT says will be necessary to meet the proposed state standards will be so substantial as to destroy the economic viability, not only of the smelter, but of Anaconda's entire Montana copper operation.

...we suggest that the EIS's consideration of the economic impact of the proposed standards on Anaconda is so faulty that it should be completely revised. We further suggest that a realistic consideration of the economic impact of the proposals on Anaconda, alone, should cause the Bureau to reconsider them and to propose instead the federal ambient air quality standards for  $\mathrm{SO}_2$  in view of the failure of the EIS to demonstrate their need to protect human health and vegetation.

In discussing the impact of the proposed standards on the company's position within the mining and smelting industry in general, it said:

Monferrous mining and smelting is obviously one of Montana's major industries. The EIS recognizes that Anaconda, alone, employs 5% of Montana's work force in its copper operations. Montana's copper mining and smelter industry must compete with copper mines and smelters operating in other states. Aside from Montana, the bulk of the copper smelting industry in this country is located in the states of Arizona, Utah, Tennessee and Texas. Each of those states has adopted the federal ambient air quality standards for SO2. Significantly, the EIS fails to make mention of this fact and does not list the standards of any of these states in Table B-I of Appendix B. Obviously, if Montana adopts the proposed ambient air quality standards which are more stringent than those in effect in those states, Montana's copper industry will not merely be placed at a competitive disadvantage; rather, its ability to continue in operation will be placed in jeopardy. This can hardly have the effect of promoting the economic development of Montana, since it could result in the loss of 4,500 Montana jobs.

Labor unions in the Butte-Anaconda area and the Anaconda Chamber of Commerce also voiced concerns over the possible impacts of implementing the

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