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THE STATE OF SOUTH CAROLINA
In The Court of Appeals

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SC Court of Appeals

APPEAL FROM SPARTANBURG COUNTY
Court of Common Pleas

Jean H. Toal, Circuit Court Judge

Appellate Case No. 2017-002611
Case No. 2016-CP-42-1592

Beverly Dale Jolly and Brenda Rice Jolly, ... Respondents,

v.

General Electric Company, et al., ... Defendants,

Of whom Fisher Controls International LLC and Crosby Valve, LLC are the .... Appellants.

RECORD ON APPEAL
VOLUME VI

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have a lot of documents. Did you work in areas where people were removing asbestos gaskets from Crosby valves at McGuire during the outages and shutdowns that occurred there?
A Yes, ma'am.
Q One or two or can you estimate how many Crosby valves we're talking about?
A I didn't go by and count them, but I was in the vicinity, you know. And I was there -- chances are I was there.
Q How many valves at McGuire plant, for instance?
A A good many. That's all I can say. I can't go back and count them right now. I can't go back and recall them. You know, there were a good many.
Q How about this, lots or little?
A I'd say kind of in between, you know.
Q Okay. We're going to have Mr. Taylor here. Do you know Mr. Taylor, David Taylor?
A I think so, yes.
Q Okay. That was my next question. When there would be outages and shutdowns --
A Yes, ma'am.
Q -- how many Duke Power and other contractor folks were on-site doing work?
A I'd say they bring in 2,000 people. It would be a

lot of people. You wouldn't believe it. It was 1,600 to 2,000, yes.

Q So did you know everybody's names that worked on outages and shutdowns?

A No, just my immediate crew that I love and work with.

Q Same question for Fisher. Mr. Jolly, did you work in the areas in the ways that you've described when asbestos-containing gaskets were removed from Fisher valves at McGuire?

A Yes, a lot of Fisher valves, too. I remember that too.

Q A lot of Fisher valves?

A Yes, yes, yes.

Q And was the --

A I remember the Crosby and the Fisher, a lot of them, yes. But I'm not saying how many. I can't tell you how many. I'd say a lot of them, yes.

Q If the business of Crosby is to make safety and relief valves for these plants, are those the type of valves that your work caused you to work on in terms of those valves?

A Definitely. Definitely, yes, ma'am.

Q And did you also -- you told us about McGuire, and we have that, but you mentioned these other plants,

Oconee and Catawba.
Let's take Oconee. During this time period, 1980 to '84, did you work at Oconee?
A Oh, yes, ma'am.
Q And tell the jury why.
A Well, we were on the -- '80 to '84?
Q '80 to '84 when you were a mechanical inspector.
A Yes, yes, yes.
Q Why would you be at Oconee if you were at McGuire?
A I was primarily at McGuire, then we went to -- they would loan us out to Oconee, you know, because during an outage, they didn't have enough inspectors. And they brought all these people in, might be 1,600 or 2,000 vendors, and everybody working on all these flanges and valves, and they just needed other inspectors. And we would go to Oconee too. We would go down there and stay in a hotel and work on the flanges and whatever mechanical they needed. We did it, yes, ma'am.
Q And was your work the same, Mr. Jolly, at Oconee in terms of the mechanical inspection and being there while removing the gaskets?
JURY FORELADY: Your Honor, is it okay --
THE COURT: Just one moment. Let me get down over there where I can hear you and where the court reporter

can hear you as well.

JURY FORELADY: I didn't know if it was okay to ask whether we've heard enough of the testimony.

THE COURT: Certainly it is. Have you heard enough?

JUROR: Yes, we've heard enough.

JURY FORELADY: I didn't know if that's okay.

THE COURT: Perfectly okay. All right. Now, just one moment. Let's be organized here about this. We have got procedures, so have a seat for a minute, please, ma'am. Thank you.

All right. Maxey, Mr. Ruth, if would you first take our alternates. So the alternates first.

(WHEREUPON, the alternate jurors exited the courtroom at 7:12 p.m.)

THE COURT: Thank you very much. All right.

And now, jury, you may retire to your jury room.

JURY FORELADY: Thank you so much.

(WHEREUPON, the jury exited open court at 7:12 p.m.)

THE COURT: All right. Any comments or questions? I dismissed the jury, and I should not have done that before I asked y'all whether it was okay if they said they heard what they needed to hear.

Do you have any dilemmas, plaintiff?

MS. McVEY: No, ma'am.

THE COURT: Defendant?

MR. BOUCH: Move for a mistrial, Your Honor. They requested that it be read in its entirety. It's extremely prejudicial to stop in the middle of the direct. We move for a mistrial.

THE COURT: All right. One moment, please. One moment.

Here is the thinking that I'm having or the question that I'm wrestling with. The jury asked that they -- as we heard from our chief bailiff, they initially inquired that they wanted to hear about job description and work with valves.

I then asked that they go back and get more specific about it. And that is, first, they wanted the testimony of Mr. Jolly. Then they narrowed it down to job description and valves.

I looked at the testimony. It seemed to me that discussion of valves was all through it, so I made the determination we would read it all. It's the jury's request that the testimony be read, but I'm mindful of what Mr. Bouch is saying, and so what I am going to do is this. I'm going to hear from plaintiff first.

Do you have any thoughts, Ms. McVey?

MS. McVEY: I do, Your Honor. They, obviously, had a piece of testimony they had in mind that they wanted to hear about his work on valves.

THE COURT: That's correct.

MS. McVEY: And that's what they attempted to articulate. If the defendants feel there is some piece of cross that they need to respond to what they just heard --

THE COURT: They're asking to read it all.

THE COURT: But the jury doesn't want that. They don't have to sit through unwanted testimony unless there's something specific the defendants can point to --

THE COURT: Well, their argument, as I understand it, is an argument about completeness, that if the jury hears one thing, whether the jury wants to or not, completeness dictates that they hear all of it. And in a super abundance of caution, I'm going to agree with them, and I'm going to ask Mr. Ruth to tell the jury that I'd like them to come back in and that you bring the alternates in as well.

THE BAILIFF: All right, Your Honor.

THE COURT: Before I do anything else, I am going to deal with Mr. Bouch's motion for a mistrial. And I'm referring to the case of the State against Russell Carl Carlson. This is an opinion of the court of appeals, 2005, and it deals, in part, with whether the judge was required to -- was required to make the jury review the victim's entire testimony beyond what the jury requested.

And at Page -- at 363 S.C. 586, this is Roman Numeral III of the opinion, "Replay of testimony during jury deliberations." The defendant challenged the trial court's decision not to require the jury to review DeWitt's -- this is the victim's -- entire testimony. We affirm.

"During deliberations, the jury requested to rehear DeWitt's testimony. The trial judge granted the request. The poor sound quality, however, required the court reporter to read the solicitor's question before replaying the answers.

"The trial judge recessed the reading and stated we would come back and conclude this at a time after you finish your supper. The jury sent back an oral message to the court through the bailiff that it would consider whether to hear the remainder of the testimony after the break. The jury never requested to hear the remaining testimony.

"After the verdict was returned, counsel for the defendant moved for a new trial arguing that only a portion of the direct examination of the victim had been replayed and none of the cross-examination. Counsel for the other defendant joined in the motion.

"The trial court denied the motion, noting that the playback had been a laborious and cumbersome process and, finally, the decision not to continue was within the jury's discretion. The trial judge, within his discretion, may permit the jury, at their request, to review in the defendant's presence testimony after the beginning of deliberations. *State vs. Plyler*, South Carolina Supreme Court 1980. The extent of the review is within the trial court's discretion, which is to be exercised in light of the jury request.

"The facts of the case sub judice are similar to those in *Plyler* when the jury asked the testimony of a key witness to be read back to them, and upon the conclusion of the direct testimony, informed the court that the jury had heard all they desired. The tape was stopped, and the jury returned to their deliberations.

"Defendant's motion that the jury be required to hear the cross-examination was denied by the trial judge. Our supreme court affirmed, holding, 'The court is not required to submit evidence to the jury for review beyond that specifically requested but may, in its discretion have the jury review other evidence related to the factual issue so as not to give undue prominence to the evidence requested.'"

And there are a bunch of other cases, *State vs. Summers*, a good many others where the supreme court found no abuse of discretion between -- by cutting it off at certain points leaving it in the jury's discretion. And based on that opinion, unless you can point out to me some tremendous unfairness that will result, I am going to let the jury's decision stand and send them back -- tell them we're not going to read any further.

But I do want to have you point out, if you can, anything that you think creates a tremendous unfairness.

MR. BOUCH: Yes, Your Honor. At the -- within several pages being read, examination, what we've gone through, substantial parts of that were retracted by Mr. Jolly on cross-examination.

THE COURT: You're going to have to point them out to me.

MR. BOUCH: Well, Your Honor, it's a little tough.

THE COURT: Yeah, it is tough, but I've got a precedent here clear as a crystal bell and speaks directly to this situation. And the supreme court has said the jury gets to pick. I'm kind of putting a little bit of a gloss on that to even encourage you to indicate where you think there's some unfairness.

I don't think that's really the test. The test, as I view it from what this opinion says, is the jury gets to decide what they want to hear played back.

You point it out to me and be specific.

MR. BOUCH: I'm going to do the best I can, Your Honor, if you let me.

Beginning on Page 113, beginning at Line 20 continuing over to the complete Page 114. We've got Page 17, line 5.

THE COURT: Wait a minute. Wait a minute. 113.

MR. BOUCH: And 114.

THE COURT: So far I see nothing on 113, 114 that is at variance with or withdrawing answers given on direct.

Point me to the next one.

MR. BOUCH: 115, 116.

THE COURT: Hang on. I see nothing in any of that testimony where Mr. Jolly has withdrawn from the answers he gave on the direct that was read.

Give me the next one.

MR. BOUCH: 117, 118.

THE COURT: Just a second.

THE COURT: I see nothing in any of that that withdraws from the testimony that was just read to the jury.

MR. BOUCH: 128 and 129.

THE COURT: I see nothing in either of those pages that withdraws from the direct testimony which has been read.

MR. BOUCH: Well, Your Honor, we disagree and we have excepted and ask for a mistrial.

THE COURT: Mistrial is denied on the basis of the cases cited. I think I've cited enough authority to indicate why I am respectfully denying the mistrial, both because appellate cases indicate that it's the jury's request that's a controlling factor, and number two, I am ruling that the mistrial be denied because I have examined the testimony that defense contends is at variance with or withdrawing from the testimony given on direct which was read, and I have determined that that testimony does not withdraw so that there is no confusion or unfairness, as I see it. So that's my ruling.

And what I would like you to do -- anything else?

MS. McVEY: No, ma'am.

THE COURT: Very good. All right.

Mr. Ruth, tell the jury they may continue their deliberations.

THE BAILIFF: Yes, ma'am.

(WHEREUPON, court in recess, pending verdict, from 7:26 p.m. until 8:40 p.m.)

(WHEREUPON, the jury entered open court at 8:40 p.m.)

THE COURT: There we are. Please be seated, ladies and gentlemen of the jury.

Madam Forelady, I understand the jury may have a verdict.

Mr. Bailiff, will you please bring the verdict to me.

THE COURT: All right. Madam Clerk -- Mr. Bailiff, take the verdict to the clerk.

Madam Clerk, will you publish the verdict.

THE CLERK: Yes, Your Honor.

In the State of South Carolina, County of Spartanburg, in the Court of Common Pleas for the Seventh Judicial Circuit, the case of Beverly Dale Jolly and Brenda Rice Jolly, plaintiffs, versus Fisher Controls and Crosby Valves, defendants, case action Number 2016-CP-42-1592.

Negligence. We, the jury, find that Defendant Fisher Controls, International, LLC, was negligent and its negligence was a proximate cause of Plaintiff Dale Jolly's injury and damages. Yes.

Number 2: We, the jury, find that Crosby Valve, LLC, was negligent and its negligence was a proximate cause of Plaintiff Dale Jolly's injuries and damages. Yes.

We, the jury, find the plaintiff, Dale Jolly, was negligent and his negligence was a proximate cause of his injuries and damages. No.

Strict liability. Number 4: We, the jury, find the defendant, Fisher Controls International, LLC, is strictly liable for selling products that proximately caused injury to Plaintiff Dale Jolly. No.

Number 5: We, the jury, find the defendant, Crosby Valve, LLC, is strictly liable for selling products that proximately caused injury to plaintiff Dale Jolly. No.

Implied warranty. Number 6: We, the jury, find the defendant, Fisher Controls, breached the implied warranty in selling its products and its breach was a proximate cause of Dale Jolly's injury and damages. Yes.

We, the jury, find Crosby Valve, LLC, breached implied warranty in selling its products and its breach was a proximate cause of Dale Jolly's injuries and damages. Yes.

Number 8: If you answered "yes" to any of Questions 1, 2, 4, 5, 6, or 7, please state the amount of actual damages that have been proven by the greater weight of the evidence: $200,000, Dale Jolly's damages; $100,000, Brenda Jolly's loss of consortium damages.

Number 10: If you answered "yes" to Question 1 and/or Question 2, please answer Question 10. We, the jury, by unanimous vote, find by clear and convincing evidence that the conduct of the following defendant or defendants were willful, wanton, or reckless:

Crosby Valve: No.

Fisher Controls International: No.

Signed by Foreperson Anna Kay McMakin, Juror Number 106, dated August 3, 2017.

Your Honor, this is your verdict.

THE COURT: Thank you very much.

Will the plaintiff or defendant have the jury polled?

MR. BOUCH: Yes, please.

THE COURT: You want the jury polled?

MR. BOUCH: I think as a group you can ask them if it's their verdict. They don't need to stand up and say it.

THE COURT: Ladies and gentlemen of the jury, will you each indicate was the verdict as read your verdict, and is it still your verdict. If this is the case, raise your right hand.

Very good. Thank you so much.

Ladies and gentlemen of the jury, this completes your services on this case. We thank very much for the careful attention you have paid. This has been a huge sacrifice for good people, working people that have a lot of other things going on in their lives.

I've got some excuses here, and I'm going to sign those in a minute for distribution to those of who you need them. So if, after we finish, you can retire to your jury room for a minute to be sure we take care of all the details we need.

But you're dismissed, and this will get you off the hook for jury service for several years. So that's a good thing, too. Thank you again for your service to the people of the state, to the people of Spartanburg County, and to the litigants in this case. You're dismissed.

(WHEREUPON, the jury exited open court at 8:47 p.m.)

THE COURT: All right. Ladies and gentlemen, it is my perception that no further activity would be needed other than the making of motions, given the verdict that has been rendered.

Plaintiff.

MS. McVEY: No, Your Honor. I don't believe there are any other motions today. We, of course, would like to make some posttrial motions, including a motion for additur, and I know we'll have ten days to do that, but I didn't want to waive our right by not requesting it.

THE COURT: Exactly. We know that we have our ten-day situation facing us, and we've talked about that. I would expect to receive all the posttrial motions within the ten-day period. I will have them. Your time will then be protected, and I'll consult with both sides to see when a convenient time would present itself to hear these motions. And, quite honestly, I may do that in either Columbia or Charleston, if y'all think about whether that will be okay.

MS. McVEY: That would be fine with the plaintiffs.

MR. BOUCH: Perfectly fine, Your Honor. And we also will have some motions on 59(b) within ten days.

THE COURT: Understood. And while I'll just expect to receive those, and, of course, the time, the biggest important time to target to hit in filing them, efiling them. Once you do that, you know, I'll get them. But the efiling just makes it so much easier. You will hit the target if you efile it at one minute to midnight on the last day. That's what I love about efiling, so that will take care of it.

Ladies and gentlemen, it has been an extreme honor and pleasure for me to resume a seat that I held so long ago as a lawyer in your place. I didn't try cases with the robe. I tried cases like you do, as a lawyer. And it's really been a great professional honor to be with you in this case. Thank you so very much, and good luck to all of you, and I look forward to hearing what I'm sure will be very thoughtful posttrial motions from both sides. Good bless and Godspeed.

MS. McVEY: Thank you, Your Honor.

MR. BOUCH: Thank you, Your Honor.

(WHEREUPON, proceedings concluded at 8:52 p.m.)

END OF REQUESTED TRANSCRIPT OF RECORD

Certificate of Reporter

I, Diane L. Marcengill, Official Court Reporter for the Tenth Judicial Circuit of the State of South Carolina, do hereby certify that the foregoing is a true, accurate, and complete transcript of record of a portion of the proceedings had and evidence introduced in the trial of the captioned case, relative to appeal, in the Circuit Court for Spartanburg County, South Carolina, on the 3rd day of August 2017.

This transcript may contain quoted material. Such material is reproduced as read by the speaker.

I do further certify that I am neither of kin, counsel, nor interest to any party hereto.

November 3, 2017

Diane L. Marcengill

Diane L. Marcengill, RPR, CRR
Circuit Court Reporter

State of South Carolina	)	In the Court of Common Pleas
	)	Seventh Judicial Circuit
County of Spartanburg	)	2016-CP-42-1592

Beverly Dale Jolly, and Brenda Rice Jolly, Plaintiffs, vs. General Electric Company, et al., Defendants.	)	Transcript of Record

September 20, 2017
Columbia, South Carolina

B E F O R E:

The Honorable Jean Hoefer Toal, Judge

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Circuit Court Reporter

I N D E X

E X H I B I T S

NO.	DESCRIPTION	I.D.	EVID.

No exhibits were introduced during proceedings.

TRANSCRIPT OF RECORD

(Whereupon, the proceedings were commenced at 9:28 a.m.)

THE COURT: We shall proceed. And let me tell you how I would like to proceed, if it pleases y'all. I would like to start with the motion for new trial additur because it influences some other things that will be either dealt with or don't have to be dealt with in quite the same way, depending on what the rulings are on that motion.

This is a motion by plaintiff for new trial additur, a-d-d-i-t-u-r. And Ms. McVey is the moving party. So, Ms. -- Ms. McVey, you may proceed.

MS. MCVEY: Good morning, Your Honor. Thank you for having us and accommodating us here in Richland County.

Your Honor, as you will recall in the trial of this case, the hotly contested issues were the extent of Mr. Jolly's exposure to the Fisher and Crosby valves and the causation of his mesothelioma from that exposure. The jury resolved those issues in the plaintiffs' favor. They found that both Fisher and Crosby were negligent, and they found that they breached the -- breached the warranty.

The issue of Mr. Jolly's damages were never really contested. The evidence of medical expenses were never contradicted. The evidence of pain and suffering, loss of enjoyment of life, mental anguish, those were never contradicted. Loss-of-consortium damages were never contradicted. And as you know, the jury in this case returned a verdict for $200,000 for Mr. Jolly and $100,000 for Mrs. Jolly for her loss-of-consortium clam.

And as you are well aware, the trial court can grant a motion for additur. And that is done when the verdict is merely inadequate. And in order to do that, the Court needs to have compelling reasons to do so. And so what I'd like to do today is give you some compelling reasons why you should grant an additur.

As you know, the jury was instructed on four different categories of damages. For Mr. Jolly, it was his pain and suffering, his loss of enjoyment of life, and his mental anguish. For Mrs. Jolly, it was her loss of consortium.

As you will recall, Mr. Jolly was diagnosed in January of 2016 with mesothelioma at the age of 71. At that time he had fluid in his lungs that had to be drained. He had to have a biopsy of the tissue to diagnose the mesothelioma.

He underwent three rounds of chemotherapy, which were described by the witnesses in this case as -- as very difficult for him. His feet were swollen so much from the chemotherapy that couldn't walk. He was so sick that he lost 45 pounds. And you and the jury saw pictures of Mr. Jolly before his diagnosis and after his diagnosis, and it was a start contrast.

He also had a massive surgery, where, in order to get to the lining of his lungs, they took out one of his ribs. They spread his rib cage apart. They scraped the tumor from the lining of his lungs.

His daughter, Tracy Pavlish, will -- you will recall, testified that he was in unbelievable pain following this surgery. He was in the hospital for some period of time. And even when he was released, he was released with a drainage tube in his back.

After he was home for two days at home, he was sick. He fell. He was taken back to the hospital. And he was diagnosed with blood poisoning.

He was treated in the hospital and then discharged, not to home, but because he was so weak and sick, to a rehabilitation facility. He -- after much rehabilitation, he was able to walk again. But he was on a walker, and he was on oxygen.

At home he could not go to the bathroom by himself. He could not care for himself in any way. He was visibly weak and sick, and he could not breathe without supplemental oxygen.

And he got better. And that was good news; the jury heard about that. But then he got a diagnosis that the cancer had come back. And the testimony was, from Tracy

Pavlish and his wife, that he was devastated by this recurrence of this cancer.

And the Court saw, when Mr. Jolly testified, that he was visibly weak. He was very thin, he had trouble breathing, and he was in pain.

There were not many treatment options left for Mr. Jolly when he -- when the cancer came back. And so the jury heard about the future treatment that he needed to undergo.

He was undergoing, at the time of trial, immunotherapy. And Mr. Jolly testified that that immunotherapy brings him to his knees; it's so hard on him. He has no strength and needs to take pain medication multiple times a day. You saw him, when he testified, that he was having trouble breathing and he was in pain.

It is uncontested in this case, by both the defense and the plaintiffs and their experts, that the mesothelioma will kill Mr. Jolly. That's uncontested in this case.

And Dr. Crapo testified about what that will look like for Mr. Jolly as he goes forward. The mesothelioma -- this is from Dr. Crapo, now, the defense expert. The mesothelioma will cause significant pain. It will require heavy doses of narcotic medication to try to control that pain.

He will experience significant breathlessness. The disease will increasingly cause his inability to breathe. And the disease will cause wasting, meaning he will essentially starve to death.

Dr. Crapo agreed that there will more hospitalizations; that he will become completely incapacitated and unable to care for himself, even as to the tasks of daily living. He will need supplemental oxygen, and he will eventually need hospice care and require 24-hour-a-day, round-the-clock nursing care. Dr. Crapo testified it will be a bad death.

Dr. Frank, the plaintiffs' expert, testified that all of Mr. Jolly's medical treatment that he had gone through and is currently undergoing was medically necessary. He testified that he had seen medical bills from before his surgery of $142,000.

Dr. Frank testified -- and I quote -- With the kind of extensive treatment and surgery he's had, clearly, hundreds of thousands, even to a million dollars or more. He would be on the high end because of the things he's had, meaning the treatments that he's had.

Dr. Frank testified, when crossed by Mr. Bouch, that it would not be unreasonable for the cost of Mr. Jolly's treatment to be a million dollars. This testimony was not contested. I think the only thing that was contested is: Is that Philadelphia prices, or is that South Carolina prices?

And that's the economic damages. But maybe the even bigger damages in this case are the noneconomic damages here. Mr. Jolly testified at time of his diagnosis, he was still working for a private contractor at the Duke facilities.

And he was working, he said, not because he had to, but because he loved it. He loved the people he got to work with. He loved his job. And that diagnosis forced him to stop.

You will recall, when Mr. Jolly was asked on the stand, how this cancer has changed his life, he said -- he could only say it was hard and it was hurting him. And then he broke down. He put his hands on his head. He couldn't go on.

So Fisher and Crosby have noted that he didn't testify about his loss of consortium. It's not because he didn't have those losses or these damages. He physically couldn't do it. It was too -- he was too overwrought to continue with that testimony.

But his mental anguish was evident for all of us to see. The testimony from his daughter and from his wife was that Dale was heartbroken over this diagnosis and that this diagnosis and this disease took away his active life. The testimony was that after he went to work all day, he loved to come home, eat dinner, and then he went out to his garden. And he either cut the grass or he worked in that three-acre garden. His garden fed not only his family, but it fed his friends and it also fed the local Meals on Wheels. He had so much in that garden.

His wife testified they could no longer go to church or have friends over because he is just too weak to do it. You heard testimony from the daughter that the seven grandchildren are the loves of his life. And he tried to each all of them to say his -- their first word, which was "Papa." He only -- he was only successful with getting two of the grandkids to do that.

You heard testimony that his daughter, Allison, and her two boys live with them and that he helps care for them. You heard testimony that Brad and his two boys live within walking distance, right across the garden.

They are an incredibly close family. And every year, before this diagnosis, he paid for the whole family to go on this beach vacation. And since that, he's not been able to go. It has changed his life. The physical changes you heard and saw about were that he looks like a much older version of himself and he now spends most of his time at doctors' visits.

The loss-of-consortium claim for Mrs. Jolly, that was, I thought -- and the Court heard -- equally as compelling.

The jury heard testimony about how Mr. and Mrs. Jolly had been married for over 51 years; that even when he was sick, he tried to bring her coffee in bed.

You heard testimony that Brenda was really scared when the diagnosis first came. But when he did all this horrific treatment and got better, she was hopeful. And then when -- when the cancer came back, she was petrified.

You heard that she put her own health on the back burner to take care of Dale. And when she was up at Duke, after taking him to his immunotherapy, that she suffered a heart attack. And Dale, who was took weak to drive, drove her to the hospital.

Her losses are extraordinary. He has been her best friend for 51 years.

Your Honor, as you know, the case law is clear that the trial court can grant an additur when you find the verdict to be merely inadequate. And in this case, the verdict was inadequate, based on the evidence the jury heard.

There is compelling reasons to grant additur in this case. And the appellate courts give great deference to the trial court to do that, because you were there to evaluate the witnesses, to evaluate the testimony.

And the courts have said the trial judge possesses a better-informed view of the damages because you could witness them. And as you know, the standard on appeal is abuse of discretion.

The most recent case on additur, as you know, is *Riley v. Ford*. And in that case, a sheriff deputy was ejected from the car and killed. He filed a product liability against Ford, the manufacturer of the vehicle, and the driver -- the defendant driver.

Prior to trial he settled with the defendant driver for the policy limits of 25,000. And at trial the survival claim was dismissed and the jury decided the wrongful-death claim. The jury awarded $300,000.

In that case, Judge Early found that there was compelling evidence -- and that's listed in that opinion what kind of evidence that was -- that there had been $228,000, I think, or $268,000 in economic damages put up. The jury awarded 300. The judge found that there was compelling evidence to add to that verdict, and he added 600,000, for a total of $900,000.

The Court of Appeals disagreed and reversed Judge Early. It was appealed to the Supreme Court, where you know the Supreme Court agreed with Judge Early and found that Ford, like the defendants in this case, did not actively contest the estate's damages, but instead focused its efforts on the issues of liability. There were compelling -- there was compelling evidence of significant damages.

You have, Your Honor, the ability to grant this verdict. The testimony in this case is that the jury only awarded a fraction of Mr. Jolly's damages. And *Riley* is instructive on this issue.

And I wanted -- I -- I think you've read now both the *Garvin* and the *Seay* orders. And those are both asbestos cases. *Garvin* was tried here in Richland County; *Seay* was tried up in Spartanburg.

In the *Garvin* case, the verdict was $11 million in actual damages for Mr. Garvin and 1 million loss-of-consortium damages for Velda Garvin. And the defendants in that case moved for remittitur. And Judge Hill granted that remittitur.

The *Garvin* case is a little different in that Mr. Garvin had testicular mesothelioma. And the evidence at trial was that he had some amount of medical costs. I think past was 150 and future was between 150 and 300. I may have those numbers off a little bit.

And the testimony at trial in that case was that there was a 50 percent chance that this cancer had been cured. It's one of those rare mesos -- testicular mesotheliomas that can be cured.

And Judge Hill said, you know, the pain and suffering for Mr. Garvin, that 11 million is too high. So he reduced it down to 1.5 million for Mr. Garvin. And for Velda Garvin, he left alone her $1-million loss-of-consortium claim.

In the *Seay* case, it was a wrongful-death case. But there was similar testimony about the types of damages that Mr. Jolly underwent and the types of treatment that Mr. Jolly underwent.

In that case, the jury awarded $2 million in survival; $5 million in wrongful death; and $5 million in loss of consortium. And in that case, as you've now read, Judge Hill did not remit the verdict.

Here, the plaintiffs are really only asking you for a 1-to-1 ratio; in other words, a million dollars in economic loss for Mr. Jolly, a million dollars in noneconomic. So we're asking you to add to the verdict of 200,000 for Mr. Jolly to 2 million.

For Mrs. Jolly, we are asking you to give her half of his noneconomic damages, like the jury did in this case. You know, they awarded her $100,000. We're asking you to add to her verdict, from $100,000 to $500,000.

The case law allows you to do that when the verdict is inadequate. The evidence in this case shows that the jury verdict was inadequate.

And, Your Honor, the jury cannot find that the defendants' actions and their products caused Mr. Jolly's cancer. And they found that. They found that the defendants' products caused Mr. Jolly's cancer, which required all this extensive medical interventions and then declined to credit the uncontested evidence of his medicals or the value of his care.

And, Your Honor, that's what we're asking you to do today.

THE COURT: All right.

MR. BOUCH: Your Honor, I ---

THE COURT: Mr. ---

MR. BOUCH: --- I -- I learned, after three weeks, to let Mr. Reid do the talking.

THE COURT: Good. Mr. Reid?

MR. REID: Thank you, Your Honor. May it please the Court?

THE COURT: This is Mr. Phillip Reid, counsel for the defendant.

MR. REID: Your Honor, I'd like to start with the medical part of this case. I think that's important because it's part of the $200,000 that the jury awarded to Mr. Jolly.

As we noted in our brief -- and I'll -- I'll try not to repeat our brief too much. But there were no medical bills submitted. There were no medical records submitted to the jury. The jury was informed by Dr. Frank, who had not treated Mr. Jolly, that he had seen some bills that were about $142,000.

And I think what is -- what I've tried to do over the last few weeks is put myself in the jury members' shoes and figure out how I would have determined medical bills in this case. And I think it's fair to conclude that the jury probably felt it had to speculate about those -- that aspect of the case.

Medical bills are easily obtainable. Dr. Frank said he'd seen some. So the jury was entitled to ask where are they and how much did these particular surgeries cost.

As -- as we've set forth in our brief, it was apparent in some instances that Dr. Frank was guessing. For instance, he -- I don't think he ever said this case would cost a million dollars. He very generally said some cases do. He talked about a particular surgery that Mr. Jolly had had in terms that really identified that Mr. Frank hadn't seen any bills relating to that.

That brings me to the *Tarrants* case, which we've cited in our brief, and I think is instructive. That's the 6th Circuit case where a widow whose husband had died of mesothelioma was claiming $52,000 in medical bills, but at trial had submitted no medical bills; called an expert physician, who said he'd seen a list of some bills. The list wasn't produced. And the jury awarded one-fifth of what she was asking for.

And the 6th Circuit affirmed that, saying in light of the lack of any documentation, the jury was well within its rights to award that amount and that that there was no basis for additur in that case. And I think that that's important, particular in conjunction with the fact that the plaintiffs did not ask for a verdict which had separate damage questions.

There were no separate questions for medical bills or other economic damages and pain and suffering. So I think it's fair to conclude that the balance of that award reflects pain and suffering, the -- the majority of it then -- and those other noneconomic elements that Mr. Jolly sought.

With respect to that, certainly, there are verdicts, the *Seay* case and *Garvin* case among them, where juries have come to much higher numbers. But as the Court observed during this trial, we had a very attentive jury. We had a jury deliberate for five hours.

They heard all the evidence. There's nothing to suggest they ignored anything. They simply came up with a number that the plaintiffs don't like here. But that number is within the range of what is an appropriate verdict in this type of case.

We've cited some -- I think two or three decisions in recent years from other jurisdictions, where juries have awarded slightly more or less than was awarded to Mr. Jolly here. In fact, I think all three of them, now that I think about it, were lesser awards: 128,000 in one; 50,000 in another; and another five-figure number in the third case.

So as the Court knows, there have to be compelling reasons to change the jury's verdict. And verdicts are entitled to substantial deference. And I think, with the attentive jury we had here, with jury members like that young man who was working at Dollar General, making $10 an hour or whatever he was making and working nights, this jury's effort should not be ignored. It should be affirmed.

One last thing: There -- you know, the evidence presented at trial was all heard by the jury, of course. I think the Court has to look at it in the light most favorable to the verdict.

There were a couple things -- and these are just minor matters. There was testimony about Mrs. Jolly having a heart attack. But there was no -- you know, the -- the jury was entitled to believe that that was not related to Mr. Jolly's mesothelioma, in a situation where there was no doctor making a connection and given the fact that most heart attacks derive from physical causes, not emotional distress.

I do want to comment on Mrs. Jolly's claim as well. Again, $100,000 was the award to her. In that part of our brief addressing that, we cited half a dozen or more cases with similar awards, cases from Connecticut, California, places where, typically, juries come back with much higher verdicts than they do here. And I think that sum for her loss-of-consortium claim is also well within reason and ought to be affirmed by this Court.

THE COURT: Thank you, Mr. Reid. Ms. McVey, in response?

MS. MCVEY: I -- I really don't have anything -- other in response, unless there's something I can answer for you.

THE COURT: All right. Okay. Here's what we're going to do. I'm going to go on and make a ruling on this so that we can proceed to the other matters that we're going to deal with here.

I rely primarily on the case you cited, Mr. Reid and Mrs. McVey, *Riley v. Ford*. Justice Kittredge's opinion gives us a good deal of direction about what is proper in these matters.

And as I look at this case and what was presented in evidence, I don't think the $142,000 in medical bills is disputed. There was testimony to that figure. There wasn't any attempt to cross-examine about it. So I take the $142,000 as established well enough by the testimony to be a fair representation of what his medical bills were as he came into the courtroom.

With a $200,000 verdict, if medical bills were awarded, that left only $58,000 to compensate for pain and suffering, loss of enjoyment of life, and mental anguish. I believe that that award is not consistent with the evidence presented, with respect to these elements of damage.

And I am going to grant additur, with respect to Mr. Jolly's damages, because of my concern about the amount of damages with respect to pain and suffering, and also because of my concern about the future medical expenses. The only evidence presented, with respect to future medical expenses, was Dr. Frank's testimony that he could well imagine at least $1 million in medical expenses for this case.

I know y'all characterize -- the defense characterizes that a little bit differently from the way I have characterized it. But I think that is a fair characterization of what the testimony showed.

So my concept is this: I believe that the verdict should be addited -- if I can kind of use that colloquial term -- in the amount of -- for Mr. Jolly in the amount of $1,580,000.

And I'll tell you how I arrive at that. One million represents, in my mind, past and future medical expenses for Mr. Jolly. And $580,000 represents what I believe to be a compelling case for noneconomic damages.

The jury awarded, in my way of looking at the verdict, around $58,000. I intend to increase that by a multiple of 10. And therefore, that is how I arrive at an actual-damage verdict in this case. Of course, there are no punitive damages. But that is how I arrive at an additur of $1,580,000 for Mr. Jolly.

Of course, we are going to have to discuss issues of setoff and so forth. That will be done as we move on down the line.

With respect to Mrs. Jolly, I believe Ms. Jolly made a very compelling case for lost wages and loss of companionship and the physical injuries she suffered during her care of Mr. Jolly, which was not simply her emotional situation, but the physical exertion that she had to put forward to care for Mr. Jolly as he went from a person in very good health to a person who was in an extreme stage of invalid existence at the time the case was tried.

I believe that the $100,000 verdict is inadequate to compensate for her claim of loss of consortium and inadequate under the instructions that the jury was given about how to calculate that award. So I would raise her damages to $290,000.

And I calculate that by taking the noneconomic damages and awarding her half of the noneconomic damages. And that is how I arrive at the figure that I have set forth.

Now, again, there will have to be some discussion of setoff. And that'll be done when we get to the setoff motions. But that would mean a total award of 290, plus $1,580,000. And that is the additur that I will grant in an order to be developed later.

But I wanted to give you the benefit of that as we move forward so that we can know the landscape we're looking at as we talk about these other issues. And when we talk about these other issues, parties -- each party may be dissatisfied with what I have done. And please know that you will be reserving all rights, with respect to your disagreement with the additur I have granted, as you make your other arguments about related matters of setoff and the like and arguments that a judgment *non obstante veridicto* ought to be granted.

So you're not waiving anything by my giving you the benefit of what I'm going to do with additur, nor have I, in making that ruling, foreclosed the notion that I may grant the JNOV. It's just we're taking these things sequentially, and I wanted to get this one out of the way at the beginning.

All right. Now, I suppose the next one probably ought to be the defendants' motion for a judgment *non obstante veridicto*. So we will begin with that. Mr. Bouch?

MR. BOUCH: Once again, Your Honor, I continue my string and let Mr. McLeod do this one.

THE COURT: Good. Mr. McLeod, I'll be glad to hear from you at this time.

MR. MCLEOD: Your Honor, as far as our JNOV motion, we're prepared just to rely on the briefs. We've heard these arguments numerous times over the course of trial and then again at the end of trial. We're satisfied to rely on our briefs.

We don't believe the evidence was sufficient to -- to withstand the jury's verdict for all the reasons that we went over during the trial, including the expert testimony not being reliable and all of the same grounds that we've argued before. So we're happy just to rely on our briefs on that. Thank you.

THE COURT: Thank you, Mr. McLeod. Ms. McVey?

MS. MCVEY: Your Honor, I'm happy to respond to any other than issues they raise, which were a lot of them. I -- you have heard them a lot of times at this point. But if you're -- I'm happy to respond to any issue you would like me to.

THE COURT: Well, I calculate that at this moment as we stand here, I have probably ruled on these issues at least three times and, in some cases, maybe more times than that. But in fairness to defendants, because I want their record to be clear about these matters, I will briefly, using as my template, the listing of the grounds as they are contained in Defendant Fisher Controls and Crosby Valve's memorandum in support of their joint motion for JNOV.

The grounds are listed beginning at page 2. There are nine in number. And I will briefly touch on them, just so you will have something. And after I have touched on these grounds ---

(Off the record briefly.)

THE COURT: All right. I'm going to just click through these things as quick as I can. But please make notes, parties. And if there's anything you wish to add or elucidate as I click through these things, why, at the end of each one, will you just signal me that you want to be heard and you will be heard.

All right. Number 1 is: "Plaintiffs' failure to warn claims (in both negligence and breach of warranty) fail because the potential hazards of asbestos allegedly used in connection with Defendant's products were open and obvious, and additionally because they were known to Mr. Jolly."

I don't believe the evidence supports knowledge by Mr. Jolly, particularly at the beginning of the times that he

-- early in his career when he, for about four years, as I recall it, worked very directly with those who were opening and repairing flange gaskets and things of that nature. I don't believe the evidence supports knowledge or open or obvious hazards.

But in addition to that, the evidence supports very strongly the notice and knowledge on the part of the two defendants, Fisher and Crosby, at -- at the times specified in the evidence that these companies were well aware during that time by means of industry knowledge and publications, by means of OSHA activity and by means of their own communications, that -- about the potential hazards of asbestos and how their products, their valves and flanges and gaskets, were -- were used when they were installed in a customer, as they were for Duke in this matter. So I would not grant on that ground.

This -- the second is: "Fisher and Crosby are protected from liability on all of Plaintiffs' claims by the sophisticated intermediary doctrine."

The jury was charged on sophisticated intermediary. And I anguished about that, I can tell you. I think there's arguments both ways about whether to charge it.

But following the dictates of *Lawing v. Univar* and other cases, I made a decision that sophisticated intermediary was charged. It was charged to the jury. The jury received argument that that doctrine would absolve defendants' liability and, by its verdict, the jury rejected that argument.

And therefore, I do not believe it's grounds for JNOV because the evidence certainly was, at the very least, conflicting on that issue and it was up to the jury to make the decision.

The third grounds: "Plaintiffs' claims fail as a matter of law because they failed to show that the Fisher and Crosby valves Mr. Jolly encountered were essentially in the same condition at the time of the exposure and injury as when they left the hands of the Defendants."

The -- there was plenty of evidence to the effect that these valves were in the same condition when received and put into use as they were when they left Crosby. The jury, again, was charged on this issue and had the opportunity to sort through the conflicting evidence on this subject and make a decision. And its decision was negative to the defendants, and I would not disturb it on that basis.

Fourth: "Plaintiffs' failure to warn claims also fail because they did not show that Defendants' alleged failure to warn was the proximate cause of their injuries, as Plaintiffs failed to offer any evidence that Mr. Jolly would have heeded a warning, and in fact the uncontroverted evidence demonstrates the opposite."

The evidence was, at the very least, conflicting. And it -- there is one view of the evidence that would suggest that Mr. Jolly would definitely have heeded warnings and did so when, ultimately, the -- Duke changed its procedures to provide for respirators and other safety equipment in connection with the very work which he was observing and doing at the time when he contracted the mesothelioma.

With respect to proximate cause, proximate cause was well explored. And there was plenty of evidence to suggest that these valves could not operate and the flange gaskets could not operate without asbestos or some kind of gasketing; that asbestos gasketing was in common use at the time. It was part of the specifications in these two valve companies' kin. It was part of the order sheet when orders were made to these two companies for parts for these valves.

The evidence was certainly enough to support the jury's conclusion that it was negligent to -- for these asbestos valves to be -- these asbestos gaskets to be used and that the only way to remove them at the time that he was exposed was to chip away at them or pull them off with wire brushes or vibrating brushes and that that's what was done. It put asbestos dust into the air. And the cumulative effect of that was to cause Mr. Jolly's mesothelioma.

There certainly was conflicting evidence. But there was plenty of evidence from which the jury could make that determination.

Five: "Plaintiff make -- failed to make -- meet their burden of proof as to their design defect claims (again, in both negligence and breach of warranty) because they did not present evidence of an alternative, feasible design, or meet the required showing under the risk/utility test set forth in *Branham v. Ford Motor Company*."

I believe that the evidence -- that there was evidence in the record from which the jury could conclude that there were other alternatives, other alternative materials that could be used and ultimately were used, in the gasketing of these valves sold by these two defendants. So it was a matter of conflicting evidence. The jury was instructed on design defect, and it made the conclusions, rejecting that -- this argument by defendant. And I would not disturb their verdict.

It's No. 6: "Plaintiffs' negligence claims failed as a matter of law because they did not present evidence of the applicable standard of care or evidence that Fisher and Crosby deviated from the applicable standard of care."

Both sides presented a good deal of evidence regarding the issue of standard of care. The jury chose to render a verdict that rejected defendants' view of what the standard of care was accept the version put forward by plaintiff. So I would not disturb the verdict.

Number 7: "Defendants are entitled to judgment as a matter of law because there was no evidence whatsoever showing that they manufactured, sold, or otherwise placed into the stream of commerce any of the asbestos-containing products to which Mr. Jolly was allegedly exposed on a regular and frequent basis."

That's the bare-metaled fence. I rejected that in motions and plenty of discussion, both pretrial and during the trial.

Gasketing was absolutely necessary in order to use the product that was manufactured by these two valve makers. And asbestos gaskets were the gaskets that were used and specified at that time by everyone concerned, both the valve manufacturers and Duke. And they were well aware that gasket -- the gasketing that would be used in this particular locale was asbestos gasketing.

The -- the -- the defendants have chosen till this very good day to continue to say that there is absolutely nothing wrong with their valves and that there was no asbestos and it never caused any harm. The evidence was very conflicting on this point. But the idea that it -- that you're only responsible for the bare metal is not something that finds acceptance in the jurisprudence around the country. It's something that I did not agree with, nor have other judges, particularly Judge Hill, who tried these cases many times before I did.

And therefore, I would not disturb the verdict of the jury. They were well instructed on the standard of care and what must be proved to show the standard of care.

Eight: "Plaintiffs failed to establish that Mr. Jolly's injury was proximately caused by these Defendants' products because the only specific causation testimony they offered was scientifically unreliable, inconsistent with the law, and therefore it should have been excluded."

These arguments were made before the expert testimony was advanced. There was conflicting testimony on causation. And the defendants certainly offered a significant body of scientific information from expert witnesses concerning causation.

The jury had evidence from their own experts contrary and was well instructed on what needed to be proved to show causation. This particular disease can only be caused by asbestos. The jury was -- had that information before it. And it concluded that there was a showing of causation sufficient to find liability of the part of these two defendants, and I would not disturb it.

And finally, plaintiffs -- Number 9: "Plaintiffs failed to prove causation under the *Henderson/Lohrmann* standard, because they did not make the requisite showing of regularity, frequency, and proximity."

Again, I tried to carefully follow the dictates of those two cases, so instructed the jury in that regard. The evidence was conflicting on these points. But there were several witnesses who indicated that the exposure was a substantial factor in the contraction of mesothelioma by defendant and that there was regularity, frequency, and proximity, particularly in a period of four years that was the focus of a lot of the discussion about Mr. Jolly's exposure.

So I would -- I think the jury was properly instructed, had conflicting on these points, and adequate instruction on the law. And I would not disturb the verdict.

So that is, just for the record -- I know we've argued these points many time. But if there is anything that either party would like to offer in addition, I'll turn first to you, Ms. McVey.

MS. MCVEY: No, Your Honor. Thank you.

THE COURT: Mr. Reid?

MR. REID: No, Your Honor.

THE COURT: Mr. McLeod?

MR. MCLEOD: No, Your Honor.

THE COURT: Very good. All right. We've disposed of the JNOV motion, then, and it is denied in full.

And we next would turn to -- I guess, before we move for setoff, we should pursue the motions that deal with the disclosure of information regarding the settlements. So that is -- well, we do have the motion for election of remedies. I think perhaps we ought to go on and discuss that first. We want to get through the complexion of the various reasons for liability first.

So if -- does that suit everyone to first go to that election-of-remedies matter?

MR. REID: Sure.

MS. MCVEY: Yes, ma'am.

THE COURT: Very good. All right. That is, of course, a motion by defendants. Mr. McLeod, are ---

MR. MCLEOD: Yes, Your Honor. Again, we'll rely on our pleadings. We think the law is pretty clear on this: that they -- the jury got several causes of actions sent -- sent to them to decide. They came back; ruled against the defendants for breach of implied warranty and negligence. And we think it's appropriate at this point for the plaintiffs to have to choose which cause of action to award damages under, pursuant to numerous cases, including *Inman* and *Imperial* case.

THE COURT: All right. Ms. McVey?

MS. MCVEY: Your Honor, it -- I don't think this is the type of case where this is a necessity to choose your remedy. It is true that there were three different causes of action. There was negligence, strict liability, and warranty. The jury found for us on the negligence and warranty cases.

But only one amount was sought. And only one amount was received. There are no inconsistent remedies for the plaintiff to choose from. You know, where I've seen this come up if you have a -- a insurance bad-faith case, you've got a breach-of-contract case and you've got a tort action for bad faith negligence. Sometimes that can result in inconsistent verdicts.

Here, that's not the case. Your Honor, if the jury had awarded punitive damages that was applicable to the negligence claim, maybe we have to do it then. But in this case, only one recovery was sought; only one was obtained. I don't believe there's a necessity for us to choose a remedy.

THE COURT: All right. Mr. McLeod, in reply?

MR. MCLEOD: Your Honor, they're different causes of action. It -- it is understandable that -- that they -- the jury did not find that we were reckless and willful. And there -- that would not have been proper under implied warranty anyway. We still believe that -- that the plaintiffs should have to choose which remedy to ---

MR. BOUCH: Your Honor ---

MR. MCLEOD: --- to collect under.

MR. BOUCH: Your Honor, the ---

THE COURT: Mr. Bouch?

MR. BOUCH: --- elements of each cause of action -- I hate to interrupt. The -- the elements of each cause of action are different. And to the extent an appellate court may look at this and may look particularly in right -- in light of Your Honor's JNOV ruling as to those individual elements of those causes of action, we think it appropriate that the plaintiffs choose. Because if not, it leaves a -- a -- a -- an appellate court to speculate. And -- and we end up coming back. And I believe that it's perfectly ---

THE COURT: Just one ---

MR. BOUCH: --- appropriate.

THE COURT: --- moment.

(Off the record briefly.)

THE COURT: Excuse me, Mr. Bouch.

MR. BOUCH: That's all right. I just ---

THE COURT: Go right ahead.

MR. BOUCH: I -- just -- just that -- that the -- the -- the elements of -- of -- of each cause of action are different. And the analysis, if -- if -- if this case goes -- goes further, will have to be different. And -- and I think it -- the reason that I think the plaintiffs have --

have to elect their remedy is so a court can analyze those elements separately and independently. And that -- that's all I wanted to add.

MR. MCLEOD: Uh-huh.

THE COURT: Thank you, Mr. Bouch. Ms. McVey, in reply?

MS. MCVEY: Your Honor, just briefly. And with the election of remedies is the act of choosing between inconsistent remedies allowed by law to prevent double recovery. That's -- that's why we do it. That's why that action is out there.

Here, there's only one recovery. And the jury was charged: You can find for the plaintiff on any of these three causes of action, and you will award one set of damages. There's no reason to elect a remedy. Because there's no inconsistent remedies for the plaintiff to choose from.

THE COURT: All right. I think the jurisprudence makes it clear that there's a lot of difference between the election of remedies and the election of causes of action. And quite honestly, defense's argument is mostly about the causes of action. And that's not really the focus of an election of remedies. An election of remedies is about the damages.

Here, these are two verdicts for breach of implied warranty and negligence. And the damage is the same in each. There is no inconsistency. There's no addition. There's -- the jury did not find willful and wanton conduct leading to the need to have a bifurcated trial on punitive damages.

We did not go there because the jury was queried on conduct. And their verdict reflected that they did not find the predicate necessary for an additional remedy that would be inconsistent with the with the remedies that they did make.

They did not find for the strict-liability cause of action. They found simply for the negligence and breach-of-implied-warranty cause of action. So I would deny the motion for election of remedies and unnecessary in this matter.

All right. Now, does that take care of everything structurally until we get to the settlement amounts and the setoff?

MS. MCVEY: It -- it does, Your Honor. The only thing that happened during trial that I'm not sure we ever did is the defendants wanted an order -- remember we had this whole thing about Rule 45, could we subpoena the party to trial, that whole issue?

And you guys wanted an order during trial. And I thought I circulated one, but I may not have in the craziness that happened. And I think you guys wanted a separate ruling on that, though I've got orders I can hand out ---

THE COURT: All right.

MS. MCVEY: --- so we can ---

THE COURT: Well -- well, why don't you hand them out and let me look at them, and let's see if that is something that we need to do to complete what was done at trial ---

MS. MCVEY: And we ---

THE COURT: --- before ---

MS. MCVEY: --- may not have to do it today.

THE COURT: --- before ---

MS. MCVEY: But I ---

THE COURT: --- we move ---

MS. MCVEY: --- just wanted to ---

THE COURT: --- to this additional question.

MR. REID: Your Honor ---

MR. MCLEOD: Your Honor, I -- if I may, Your Honor?

THE COURT: Yes, sir.

MR. REID: This may be a -- a good time for Ms. McVey to hand this up. I was going to suggest that we take a ten-minute break before we address ---

THE COURT: Oh.

MR. REID: --- those last ---

THE COURT: Sure.

MR. REID: --- two issues ---

THE COURT: That ---

MR. REID: --- so I ---

THE COURT: --- that makes ---

MR. REID: --- can consult ---

THE COURT: --- a lot ---

MR. REID: --- with my ---

THE COURT: --- of sense.

MR. REID: --- colleagues.

THE COURT: That's good. Let's take a ten-minute break, let y'all have a chance to look at this, and then we'll reconvene. So it's about ten of eleven at this -- no. My -- is that clock right? It's -- okay.

MR. MCLEOD: 10:20.

THE COURT: I see it now. All right. Why don't we reconvene here at 10:35.

MR. REID: And ---

MR. BOUCH: If ---

MR. REID: --- thank you, Your Honor. Just because it's pertinent to what we'll discuss at break, I just wanted to confirm: On that first -- on -- on the additur motion, I understand the Court's ruling to be that the new numbers are 1.58 million for Mr. Jolly and 290,000 for Mrs. Jolly.

THE COURT: That is correct.

MR. REID: So -- all right. I ---

THE COURT: That is correct.

MR. REID: I just wanted to make sure that wasn't in addition to what the jury ---

THE COURT: No, no ---

MR. REID: --- awarded.

THE COURT: --- no.

MR. REID: So ---

THE COURT: No. That is the new ---

MR. REID: Okay.

THE COURT: --- award.

MR. REID: Thank you.

THE COURT: That's the additured award. I think that's the way I'm supposed to do it now. That's the way we always told -- told them to do it, is don't talk about how much you're adding; talk about what the new award is.

MR. REID: All right. Thank you.

(Whereupon, a recess was taken from 10:20 a.m. until 10:33 a.m.)

THE COURT: Your Honor, on this proposed order ---

THE COURT: Just -- just one second, Mr. Bouch. I need to get it in front of me. Yes, sir. You may proceed.

MR. BOUCH: You know, Your Honor has already ruled. And it's kind of water under the dam, so I'm not so sure there is need for a separate written order. Insofar it is six pages, we'd like at least a couple days to look at it and -- and reply, if the Court thinks it's necessary, which we don't.

THE COURT: Well, you are the ones who were very, very insistent that we have a written order. And so we're going to have a written order.

The only change I would make in it, as I look at it right now, is on the very first page. It's the second sentence. And it says: "For the reasons set forth below, the defendants' motion to quash should be and is therefore" -- strike that word "quash" and put "denied."

MS. MCVEY: Okay.

THE COURT: And other than that, the order is, I think, a fair setting forth of the reasons I expressed. This is a hotly contested issue. I think it -- if any appeal is taken, the -- I think this will be of some help to the review court. And therefore, I intend to sign the order.

But certainly, Mr. Bouch, I will give you a week to take a look at this thing and see. So why don't you all communicate with me by five o'clock next -- what is today, Wednesday?

MR. BOUCH: Why -- why -- why don't we do it this way, Your Honor: Go ahead and sign the order. If we need to make a motion to reconsider, we will in ---

THE COURT: Very good.

MR. BOUCH: --- ten days. And then, if ---

THE COURT: And that ---

MR. BOUCH: --- not, then I ---

THE COURT: --- that's good. And, Ms. McVey, if you could make that one change and then submit it to me, you can just e-mail it to me.

MS. MCVEY: Yes, ma'am.

THE COURT: I'll sign it and file it.

MS. MCVEY: I'll do it. Thank you.

THE COURT: Or I'll send it back to you to file ---

MS. MCVEY: Perfect.

THE COURT: --- or whatever. Okay. All right. That's -- deals with that.

And I think I -- now we are at settlement and setoff. And I suppose we should start with the joint motion for production of plaintiffs' settlements and payments with all third-party tortfeasors. I think that's the first one pending, Mr. Bouch.

MR. BOUCH: Your Honor, I'll -- I'll -- I'll -- I'll start with this. This has been an elephant in the room in these cases for many years. And as has been -- been remarked, the only people that these settlements are secret from are other defendants because every plaintiffs' lawyer I know in the country knows exactly how much people pay and

-- and in what cases.

While the plaintiffs have been somewhat candid in the past -- and I make no reflection on Ms. McVey -- we've run into trouble before on representations and in terms of the releases. And we believe we are -- should be permitted to see them.

We, of course, are perfectly willing to make them attorney-eyes-only. We consent to a protective order. We will not share them with our clients, depending on the terms of these releases, whether they operate as a complete or partial release. And of course, as the Court knows, lurking out there are the additional million-dollar-plus claims Mr. Jolly has against the 80-plus bankruptcy trusts, which have not -- deliberately have not been utilized yet but undoubtedly will.

We believe we are entitled to -- to -- to see those -- those releases and calculate those amounts. But again, we'll be glad -- recognizing that certain -- certain parties wish their amounts to be confidential, we'll be glad to restrict it to attorneys only.

THE COURT: All right, Ms. McVey.

MS. MCVEY: Your Honor, we have represented to Mr. Bouch and to the Court the total amount of settlements in this case. The defendants are not entitled to how much each individual paid. There's no compelling reason to do that. And we have agreed that these settlements are confidential.

And the reason that these settlements are confidential is because it's important to the defendants and it's important to the plaintiffs. And it gives some privacy as to the amount of the -- the claim paid. If the shoe was on the other foot and Fisher and Crosby had settled, I can assure you they would not want the amount they paid to be given to the other defendant -- the trial defendant.

The settlement documents, many of them don't contain specific amounts in there. They may say for $5 or for whatever. I'm happy, if the Court wants us to, if our representation -- you want something more than that, I'm happy to provide them -- if you order to me to so I don't breach any confidentiality -- to give those to you to review in-camera. But I don't think these defendants are entitled to that information.

THE COURT: All right. Now, Mr. McDonald, representing Daniel and Union Carbide ---

MR.'MCDONALD: That's correct, Your Honor.

THE COURT: All right, sir. You may ---

MR. MCDONALD: Just -- just very briefly, Your Honor, we would sort of join in the plaintiffs' approach to this. Our settlement agreements are confidential. We don't want somebody in an Illinois case next week to say, "You paid blank dollars on a case in South Carolina." We don't want our friends down in Charleston at Motley Rice to say, "You paid so much in the Jolly case and so I need so much in this case."

It becomes a floor. And as much as we enjoy our friends at Fisher Controls, we don't necessarily want them to know in the next case where we sit in the courtroom together what setoff they might enjoy because there could be some gamesmanship there. So we would suggest an in-camera review by the Court.

We're happy to cooperate to verify amounts, things like that. My understanding is that's what Judge Hill did in the *Seay* case, is took an in-camera review and confirmed the amounts and then reported the total to the defendant.

(Whereupon, Mr. Early stood.)

THE COURT: Not yet, Mr. Early. Mr. Phillips ---

MR. PHILLIPS: Yes, ma'am.

THE COURT: --- on behalf of Anchor Darling ---

MR. PHILLIPS: Anchor Darling Valve Company. My firm also settled this Jolly case on behalf of Georgia-Pacific Corporation, Your Honor, Grinnell Corporation, ITT Corporation, and Goulds Pump Company.

THE COURT: All right. Grinnell, ITT, and who?

MR. PHILLIPS: Goulds, G-o-u-l-d-s, Pump Company.

THE COURT: All right.

MR. PHILLIPS: And I was going to sort of embrace Mr. Bouch's approach. He had indicated -- we settled these cases with confidentiality agreements, no doubt about it.

What Mr. Bouch had indicated that these -- if these settlements -- amounts were disclosed with attorney eyes only in a protective and an -- an agreement they will not be shared with the clients, certainly, under those conditions, if -- as long as it's going to be protected within this case, that's okay with us.

THE COURT: All right. All right. Now, Mr. Early had not previously identified himself, but Mr. Early ---

MR. PHILLIPS: Get in front of the bar.

THE COURT: --- come around to the bench. This is ---

MR. PHILLIPS: Come on, Will.

MR. EARLY: Sorry, Your Honor. Will -- Will Early on behalf of R.T. Vanderbilt, Your Honor. We are a settling defendant as well. And I would join in Mr. McDonald's approach.

We would ask that if anything, if Your Honor would be able to look at the number, and that is exactly what Judge Hill did in the *Seay* case, because I argued the posttrial motion in the *Seay* case in this same manner. So ---

THE COURT: And -- and, Mr. Early, you are representing who?

MR. EARLY: R.T. Vanderbilt, one settling defendant in the Jolly case. Thank you.

THE COURT: All right. Anyone else on defense side?

MR. BOUCH: Your Honor, I -- I just do one in reply. And it is more -- more of a policy argument, Your Honor.

If we are truly in the resolution business, much as the explanation for justifying insurance coverage be produced in virtually every case to -- to foster dispute resolution, this is very much akin to that. We -- we would like to see what is out there and why, whether these are full or partial releases, how far they go. They may not go anywhere. We don't know.

But I think, in order for us, not only in this case, but -- but to go forward, to how to -- how -- how to advise our clients, the -- these should be public. And -- and the Court -- while the Court's final rule on -- on protective orders two or three years ago excluded settlement agreements when they addressed whether parties could have things sealed by the Court, I think the definite feeling of both the state and federal courts in South Carolina was the burden should be on those seeking confidentiality to justify it substantially, as -- as opposed to having them released for a proper request. And that's my only reply, Your Honor.

THE COURT: All right. Ms. McVey, in response?

MS. MCVEY: Your Honor, just briefly, the purpose of them getting the information is to determine what the setoff is. It is not for them to take this information in the Jolly client [sic] so they can go and advise their clients. That's not the purpose of this. The purpose is to -- to take my representation to the Court of $2.2 million and verify that.

And, Your Honor, you can do that. That's what Judge Hill did in the *Seay* case. That's what he's done, I -- I believe, in every case where this has come up.

It's -- it's not -- it discourages settlement to let the last remaining defendant know what everybody else paid. There's no compelling reason to give him that information.

THE COURT: All right. All right. Confidentiality of settlements has had a very checkered history in South Carolina. And I recall well the joint efforts of then-Chief Justice Toal and then-Chief Judge Joe Anderson to come to some accommodation between the federal and state courts in this state with regard to confidentiality.

But I think what has evolved from that is this: The thought that we certainly didn't eliminate confidential settlements by the orders we elucidated. But what happened was when parties submit their settlements to the Court for court activity and court approval, they become subject to public revelation.

But when parties choose to settle controversies privately and are not submitting those -- those agreements for review, approval, or enforcement by the trial court, then a different situation obtains. And at the present time, I'm not being asked and have not been asked to approve any settlements, to examine any settlements. So I -- as I sit here today, I know nothing about the details of any settlements.

The only activity in which I have engaged sporadically is to dismiss defendants when they ask to be dismissed and plaintiff agrees that they shall be dismissed. So that's the posture the trial Court is in with respect to these settlement matters.

It makes no difference to the setoff activity in which we will engage pursuant to the jurisprudence of our highest court and the statute involve as to who paid what. It only makes a difference as to what the total amount received in settlement -- received in settlement -- by plaintiff is.

The statute makes it clear that what we are talking about is amounts received in settlement prior to rendering of the verdict in this case. And that is the composite of setoff to which my adjudication will be directed.

And that means a couple things: first of all, that the individual amounts make no difference, only the global amount. I don't feel the need to verify the amount recited in pleadings signed by the plaintiffs' counsel of

$2,200,000 as the amount of settlement unless there is some real uncertainty as to whether the plaintiffs have been honest with the Court that that is the amount received in settlement.

They have, on their oath as counsel -- and I know these counsel and know them to be honorable, just as I know the defense counsel to be honorable. If they indicate that that is the amount of settlement, then I'm inclined to accept that as a representation, just as I rely on so many representations made by counsel on both sides, in connection with this case.

So that's where I am. I don't feel the need, as I sit here, to examine in-camera any particular documents. I will say that unless I'm told differently, I -- my understanding is that the $2.2 million -- $2,220,000 received in settlement proceeds by the plaintiff at this time does not include an application to the bankruptcy trust for any funds. And therefore, the -- whatever may happen with the bankruptcy court is not a matter within my pen because the statute says matters received, settlements received before the imposition of a verdict and the rendering of a verdict in this case.

So I don't think I've got any authority to get into the bankruptcy trust. And the other thing that strikes me about the bankruptcy trust, although I realize that there are cases all over the block about this issue, is that these are almost in the nature of collateral-source funds. And I don't think they are included in the language of the statute that talks about setoff.

Now, that's preliminarily the way I feel about it. And if anybody has anything further, what I'm prepared to do is accept the representation to counsel, unless I'm told that there is some uncertainty or hesitancy about that -- to accept the representation of counsel that that represents the settlement amounts to the penny. And I am inclined to not move any further on any amounts that may be received in the bankruptcy trust, unless I am told that those matters -- those funds have already been received -- applied for and received by the Jollys.

So first of all, I turn to Ms. McVey before defendant weighs in on this matter. Ms. McVey, can you assure the Court, as an officer of the Court, that $2,220,000 represents the entire amount of proceeds received in settlement on behalf of the Jollys at the present time?

MS. MCVEY: Yes, Your Honor, with one exception. There was one bankruptcy trust filed after the verdict.

THE COURT: After the verdict?

MS. MCVEY: After the verdict.

THE COURT: All right.

MS. MCVEY: And, I mean, I can tell you the amount of that. It was a small amount.

THE COURT: You -- you may tell me.

MS. MCVEY: So that amount was $17,850.

THE COURT: All right.

MS. MCVEY: And that was after the verdict.

THE COURT: All right.

MS. MCVEY: No other funds have been applied for or received.

THE COURT: All right. And that was 17 ---

MS. MCVEY: 17,000 ---

THE COURT: --- thousand ---

MS. MCVEY: --- 850 dollars.

THE COURT: --- 850 dollars.

MS. MCVEY: And, Your Honor, that was filed for -- well, I don't have the exact date. Yeah ---

THE COURT: But ---

MS. MCVEY: --- I do.

THE COURT: --- received after the award of this verdict?

MS. MCVEY: It was filed for after the verdict and received in September, this month. Was filed ---

THE COURT: So filed ---

MS. MCVEY: --- for after ---

THE COURT: --- after the verdict and received after the verdict, obviously. All right. Mr. McLeod?

MR. MCLEOD: Your Honor, I just wanted to make one point. The statute says "amount of money received or to be received."

THE COURT: Well, there's no amount received -- to be received because they made no application. As we stood in the courtroom when the verdict was rendered, they had not made any application for those funds. So I don't believe those -- that $17,850, which is not a large sum, but I don't believe it qualifies.

Now, you -- you know, my betters may disagree. And that is a matter we'll certainly have to see about if y'all want to appeal on $17,850. Then, of course, you have every right to do so.

But I do not plan to take that amount of money into consideration in determining the amount of setoff. And I do intend to rely on the representation made by counsel with respect to the $2,220,000 in proceeds to the penny that she indicates have been received on behalf of the Jollys.

Do you have any further observations about that money?

MR. MCLEOD: Just so the record's clear, Your Honor, we believe that the future bankruptcy-trust claims that will be made on behalf of the Jollys -- the money received is -- is received for the same injury and, pursuant to the statute, we're entitled to have the judgment set off for those amounts as well, pursuant to the language of the statute.

THE COURT: All right. And ---

MR. MCLEOD: And the common law, Your Honor.

THE COURT: All right. And -- just one moment here. In relying on 15-38-50, I agree that Fisher and Crosby are entitled to a setoff by the total amount of money received by plaintiff from any alleged tortfeasor. But I believe the $2,220,000 encompasses the entirety of that, these other funds having been received and applied for after the rendering of the verdict, so just -- so my ruling is clear for you for appellate purposes.

MR. MCLEOD: Thank you, Your Honor.

THE COURT: All right. Now, we come to the setoff itself.

(Off the record briefly.)

THE COURT: All right. Now, we come to setoff. And I'll begin, of course, with defendant who requests setoff. Mr. Reid?

MR. REID: Thank you, Your Honor. Your Honor, may I approach the bench? I have some authority, which I'd like to give the Court, and I have a copy for ---

THE COURT: Certainly.

MR. REID: --- Ms. McVey.

THE COURT: Certainly.

(Whereupon, Mr. Reid and Ms. McVey conferred.)

THE COURT: Thank you, sir.

MR. REID: Thank you. Your Honor, in their response to our motion, the plaintiffs acknowledge the propriety of a setoff. And to cut to the chase here, one issue the Court will need to deal with is this: The claimants have said that they have allocated their receipt of this $2.2 million one-third to Mr. Jolly, one-third to Mrs. Jolly, and one-third to future claims.

And the authority I've given to the Court and Ms. McVey, in short, stands for the point that there is no amount to allocate to future claims because when a claimant has brought suit and has gotten to judgment, the -- there -- there is no right to bring a wrongful-death suit. So there are no future claims that can be made.

The authority specifically that I've given the Court starts with the *Quattlebaum* case. That's a 1988 decision from the U.S. District Court here in Columbia, where the Court considered a -- an asbestos-related action and the claimant had brought a claim -- that the decedent had brought a claim of his own for personal injury in 1976, later died. His widow brought wrongful-death action. And the Court said that it was barred because at the time of the plaintiff's death, the statute of limitations has -- had expired on the personal injury and it wasn't revived by the fact there's a separate wrongful-death statute.

The second document I've given the Court is the *Estate of Stokes* case, where the Supreme Court, Your Honor, included -- cited the *Quattlebaum* case with approval. And the -- the point of those cases is to say that if there is no claim that the ill person, had they lived, could bring, there's no basis for a wrongful-death action.

The other authority I've given the Court includes the Restatement of Judgments. Section 45 and 45 stand for the proposition that a judgment in an underlying personal-injury action forecloses a survival action, which is Section 45, and forecloses a wrongful-death action, which is Section 46.

So, Your Honor, my point is that 2.2 million has to be allocated between the claims we have in this case, because there are no future claims to be had. That's one point.

The other point is this: Where the Court has this morning informed us what it believes the appropriate division to be as between the two claims, the math, very briefly, is about 85 percent to the claim of Mr. Jolly, including his medical bills, and about 15 percent to Mrs. Jolly. If that 2.22 million is divided or allocated with the same percentages -- and this is rough math; I didn't do it precisely. But it would be an allocation of about 1,887,000 to Mr. Jolly's claim, 333,000 to Mrs. Jolly's claim.

Both of those numbers exceed what the Court has said are the appropriate verdict amounts for the damage awards. And therefore, we believe the -- those sums should be entirely set off by the funds received to date by the plaintiffs.

THE COURT: All right. Ms. McVey?

MS. MCVEY: Yes, ma'am, Your Honor. As we've discussed, the total setoff in this case is $2,220,000. The defendants are only entitled to setoff for claims that were tried to verdict. And so the two claims that were tried to verdict in this case were the personal-injury damages of Mr. Jolly and the loss-of-consortium damages for Mrs. Jolly.

Claims that were not tried to verdict were the wrongful death or any other future claims. And so you, as the Court, have to make a determination how to allocate the settlement after we determine the allocation.

And *Riley v. Ford*, we -- we've discussed in terms of the additur, addresses the issue of allocation as well. And what *Riley* said is: Despite a defendant's entitlement to setoff, whether at common law or under 15-38-50, any reduction in the judgment must be from a settlement for the same cause of action. Thus where settlement involves more than one claim, the allocation of settlement proceeds between various causes of action impacts the amount a nonsettling defendant is entitled to for this verdict."

Your Honor, in *Riley*, as you will recall, they settled with the defendant driver. And there was a survival and wrongful-death claim. They allocated $20,000 for the survival claim and $5,000 for the wrongful-death claim.

At trial the only claim that went to verdict was the wrongful-death claim. And the Court of Appeals, when they first heard it said: No. That's not right. We got to make it $5,000 for survival and $20,000 for the wrongful death.

And the Supreme Court said: No, no. That was an error. That was an error.

We believe the Supreme Court said -- Justice Kittredge said: "It was error to disturb the settling party's agreed-upon allocation solely because the appropriation may have been advantageous to the estate."

And in *Riley* the Supreme Court said: We're not going to look at percentages. They -- they frowned on the approach taken by Mr. Reid.

The Supreme Court said: "A plaintiff who enters into a settlement with a defendant gains a position of control and acquires leverage in relation to a nonsettling defendant. This posture is reflected in the plaintiff's ability to apportion the settlement proceeds in the manner most advantageous to it. Settlements are not designed to benefit nonsettling third parties. They are instead created by settling parties in the interests of these parties.

"If the position of a nonsettling defendant is worsened by the terms of the settlement, this is the consequence of a refusal to settle. A defendant who fails to bargain is not rewarded with the privilege of fashioning and ultimately extracting a benefit from the decision of those who do."

That was the Supreme Court in *Riley*, a 2015 case. Your Honor, internally, we have allocated the settlements, the $2.22 million as follows: one-third for Mr. Jolly's claims; one-third for Mrs. Jolly's claims; and one-third for the release of future claims.

And so, Your Honor, if that allocation is upheld, which we believe it should, that would mean that one-third is $733,000 -- $733,333.33 to each of the three claims -- Mr. Jolly's personal-injury claims; Mrs. Jolly's loss of consortium; and the future wrongful-death claims -- which were released as part of the settlement with the defendants.

THE COURT: All right. So what you're arguing, then, Ms. McVey, is, doing the math as you do it, I have additted and granted an additted verdict for Mr. Jolly in the amount of $1,580,000.

MS. MCVEY: And we -- we would subtract from that, as the setoff for Mr. Jolly, $733,333.33. And I can do that math.

MR. REID: Theile, is it 740?

THE COURT: And I got a calculator that ---

(Off the record briefly.)

MS. MCVEY: It's 740 ---

THE COURT: It's -- isn't 740?

MS. MCVEY: Did I do the math wrong? I may have done the math wrong.

THE COURT: I think you did the math wrong.

MS. MCVEY: Okay. Hold on. I'm sorry.

THE COURT: I -- I think it's ---

MS. MCVEY: You're right. You're right. I'm sorry.

THE COURT: So isn't it 740?

MS. MCVEY: It is.

THE COURT: Away from ---

MS. MCVEY: --- 1.58.

THE COURT: So that would be 840 for Mr. Jolly, right?

MS. MCVEY: That's right.

THE COURT: All right. And then, Mrs. Jolly received an award of 290, right?

MS. MCVEY: Yes, ma'am.

THE COURT: And since the -- the third that was received in the allocated award was 740, she would not receive any additional award in this matter ---

MS. MCVEY: That's correct.

THE COURT: --- correct?

MS. MCVEY: Yes, ma'am.

THE COURT: Well, that is the way my calculator shows it. The methodology, of course, defendants do not agree with. But it -- are we together on what our calculators show?

MS. MCVEY: Yes, ma'am.

MR. REID: We agree with the math, Your Honor.

THE COURT: All right. Well, then, I -- I certainly will hear from defense now, Mr. Reid.

MR. REID: Your Honor, a couple of points: One is this -- again, I have to emphasize this allocation to future claims should not be permitted for two reasons. One is there's no client currently in a wrongful-death case. The plaintiff is a personal representative or an estate, neither of which exists at this point.

And furthermore, in -- consistent with the authority we've presented to the Court, there will not be a basis for a wrongful-death claim. And what I've mentioned already is driven home by Section 15-51-60, which says that: "The provisions of the Wrongful Death Act shall not apply to any case in which the injured person has, for such injury, brought action which has proceed to trial and final judgment before his or her death."

So that ---

THE COURT: Well ---

MR. REID: --- 700 and ---

THE COURT: --- you know, Mr. Reid, that is good argument, except for one thing. Defendants chose to contract with the plaintiff in a different way. They chose to contract with the plaintiff to be released from liability on this matter, not only by paying certain amounts in respect to the sued-upon claims, but also in-court choses of action that they chose to settle in the manner that Ms. McVey has explained.

That is something they are -- these defendants are permitted to do. They don't have to do it. It's all a voluntary thing. But they chose to compose their matters in such a way that the defendant could allocate the -- that the plaintiff could allocate the proceeds as they have.

And Judge Kittredge's -- Justice Kittredge's opinion for the Court in *Riley v. Ford* makes it abundantly clear that nonsettling defendants do not get to have a voice in how settling defendants have composed their matters with plaintiff. And the fact that they may have paid for something that you think will never exist, they have made -- may have paid for an in-court right that has not been pursued in court. But there are plenty of agreements that are made between parties to settle their differences that are not the result of matters having -- of what has been brought in court but the way they choose to compose their disagreements.

Now, explain to me how I can go behind that in light of what Justice Kittredge said for the Court in *Riley v. Ford*.

MR. REID: I believe, at the time of trial in *Riley*, there were -- were both a survival and a wrongful-death action. There will never be a wrongful-death action here, because we'll have a judgment that forecloses any claims. We've essentially tried the same case with the same ---

THE COURT: But they ---

MR. REID: --- elements ---

THE COURT: --- settled before any of that occurred. And they chose to settle on the basis that they chose to settle on. And that's exactly what Justice Kittredge elucidates: that you don't get to, after the fact and after the fact of your verdict, have a voice in whether they bought a pig in a poke or -- or -- or whatever they did.

They chose to settle on that basis. And plaintiff chose to extract an agreement that allocated on a certain basis. And you're just simply not at that table.

MR. REID: But we think the facts of *Riley* are different and that, on the circumstances here, that entire 2.22 million should be allocated.

THE COURT: I understand.

MR. REID: I -- I've made my arguments. I -- I understand you disagree.

One other thing I -- it would, I think, again echo why we're -- we ought to be able to see the releases -- and I know that horse is out of -- already out of the barn and you've ruled. But we ought to have the ability to look at and confirm with our client -- not tell them the details, but let them know that, in fact, these releases address the situation that you've articulated existed in *Riley* or that that -- that is the -- the foundation for your ruling. We'd like to see those documents just so we can confirm whether or not they accomplish that.

THE COURT: As an officer of the Court, Ms. McVey has represented to the Court two things: Number one, that the total proceeds received prior to verdict were $2,220,000 from all settling defendants. She has also represented to the Court, both in written filings and in her recitation here today, that those settlements allocated proceeds on the basis of one-third to Mr. Jolly, one-third to Mrs. Jolly, and one-third in satisfaction of future claims for wrongful death benefits.

And unless you have some reason to contest that representation, I will accept it as an accurate representation of what the agreements contained. There are all sorts of competing projections that are made by other settling defendants, as represented by the remarks of Mr. McDonald, Mr. Phillips, and Mr. Early.

I am a judge that is going to be dealing with many more of these cases. I will see what I think is -- is necessary for me to see to make these rulings.

But I approach with reluctance examining matters in-camera that cannot then be recited upon the record for fear of disturbing some of the confidentiality agreements that have been entered into between these settling parties and plaintiff. If I thought for one moment that plaintiff was in any way misrepresenting what has occurred, I would feel differently. But I know you share my complete trust in Ms. McVey to accurately tell us what has occurred. And on that basis, unless you give me some grounds for believing otherwise, I am going to stay with the allocations I've made on the basis I have indicated.

Do you have anything further that would indicate any uncertainty about allocations, as well as total amounts received before verdict?

MR. REID: Your Honor, I have found Ms. McVey a pleasure to work with. I don't have any doubts whatsoever about her integrity.

I do know that in today's climate, it's important to be able to tell clients, "I've seen something; I can confirm it. You have my word, as your lawyer, that this is accurate." That's ---

THE COURT: Well, of course ---

MR. REID: --- a fundamental ---

THE COURT: --- you're not going to see it any under circumstances, since I've ruled that -- that these matters will remain confidential. About the only thing you could do is to tell them that I've seen them and verified them.

Ms. McVey, let me hear from you one more time.

MS. MCVEY: Your Honor, I am -- I understand Mr. Reid's point of view. And -- and I understand him wanting to tell the client that I verified this. I am happy -- if -- if it would make his life easier ---

THE COURT: Do you have anything in the courtroom today that ---

MS. MCVEY: I don't ---

THE COURT: --- could be submitted?

MS. MCVEY: I don't. But I can -- I'm happy to e-mail it to you or -- or bring it over or whatever you think is -- is best. I mean, I'll -- I -- I don't want to hide anything. I just don't think that they're entitled to the individual settlement ---

THE COURT: I ---

MS. MCVEY: --- stuff.

THE COURT: I am sensitive to your position, Mr. Reid, and yours, Mr. Bouch, and yours, Mr. McLeod, because these counsel, national counsel, and the others involved who haven't, as we have, sat through the trial of this case may need a little convincing.

Here's what I will do: I will -- Ms. McVey, could you come to my chambers this afternoon and bring me something that I can look at that verifies what we have talked about in terms of: (1) the total amount; and (2) allocation?

MS. MCVEY: I believe so, Your Honor. I don't have it in-house, but I -- I -- I've got most of it. So I just ---

THE COURT: I ---

MS. MCVEY: --- have to ---

THE COURT: --- I would ---

MS. MCVEY: --- collect it all.

THE COURT: --- not like it to be e-mailed to me because that, again, creates a possible paper record that ---

MS. MCVEY: Okay.

THE COURT: --- I don't think we need to create. But what I will do is this: I'm going to have a submitted order projected anyway. So I will personally examine these materials, hopefully this afternoon in my chambers, to verify what has been represented in court, Mr. Reid. And if there's any hesitation on my part after I've seen what I've seen, I will call you back together.

MR. BOUCH: I guess, Your Honor, the fact that -- I've been writing releases in these cases for almost 40 years. And I've never had one where I agreed that the plaintiff can allocate specifically between either claims, causes of action, or future damages. And the only claim -- and I understand your -- the Court's ruling.

But I'll put out that the -- the -- Your Honor, in granting additur, noted that the Court charged the jury on future damages, on future claims, which was represented in the jury's verdict. And I understand Your Honor's feeling about that verdict. But the idea that ex-post -- or postverdict, an allocation can be had on a cause of action that does not exist and, quite frankly, may not exist -- and I realize the testimony in this case was Mr. -- Mr. Jolly has a cancer that in most cases is fatal.

Next month I'm arguing a case called *Phillips v. Abex* in the 4th Circuit. Mr. Phillips -- we tried that case in Asheville two years ago. Mr. Phillips was diagnosed in 2007 of mesothelioma.

THE COURT: Well, Mr. Bouch ---

MR. BOUCH: He -- he ---

THE COURT: --- I -- I ---

MR. BOUCH: --- he -- he ---

THE COURT: --- Mr. Bouch, I -- Mr. Bouch ---

MR. BOUCH: --- Mr. ---

THE COURT: --- let me just ---

MR. BOUCH: --- Jolly ---

THE COURT: --- cut you ---

MR. BOUCH: --- could be ---

THE COURT: --- off there.

MR. BOUCH: --- run over by a cab tomorrow.

THE COURT: Mr. Bouch, let me just say this to you.

MR. BOUCH: Yeah.

THE COURT: Each case kind of stands on its own bottom.

MR. BOUCH: I understand, Your Honor.

THE COURT: And what I've got is this case in front of me. This is not an allocation made postverdict. The allocation was made between the plaintiff and defendants -- settling defendants. Y'all chose not to settle. These allocations were made before the verdict.

I will verify that the allocations that were made were the third/a third/a third that has been described and the amount. The setoff is something that I'm making now, relying on the allocations that have been recited.

But this is no postverdict allocation by the plaintiff. These matters were arrived at by agreement before the verdict.

MS. MCVEY: Your Honor ---

MR. BOUCH: Your ---

MS. MCVEY: --- let me ---

MR. BOUCH: --- Your Honor, let me make it very clear, as I started out, by saying in the 40 years ---

THE COURT: I -- that ---

MR. BOUCH: --- of drawing ---

THE COURT: Mr. ---

MR. BOUCH: --- releases ---

THE COURT: --- Mr. -- Mr. Bouch ---

MR. BOUCH: --- in these ---

THE COURT: --- please ---

MR. BOUCH: --- cases ---

THE COURT: --- don't make that kind of argument to me. I know you're very experienced. And why, I'll celebrate my ---

MR. BOUCH: You ---

THE COURT: --- 50th year at the bar next year. That just doesn't have anything to do with what we're talking about here.

MS. MCVEY: Well, but let ---

MR. BOUCH: The typical ---

MS. MCVEY: --- me ---

MR. BOUCH: --- release does not contain the allocation ---

THE COURT: I ---

MR. BOUCH: --- Your Honor.

THE COURT: --- I ---

MR. BOUCH: That's my point.

THE COURT: I'm sorry. But I will verify in a way that satisfies me that Ms. McVey has honestly represented what the in-house allocation that they have made is. And that is all I can do.

If I have any doubts about that after I look at what she shows me, then that'll be another thing.

MS. MCVEY: And ---

MR. BOUCH: Understand ---

MS. MCVEY: --- Your Honor ---

MR. BOUCH: --- Your Honor.

MS. MCVEY: --- just to be clear, the release doesn't contain the allocation. The release contains a release of the personal injury, the loss of consortium ---

THE COURT: You all ---

MS. MCVEY: --- and the ---

THE COURT: --- have chosen to allocate ---

MS. MCVEY: That's right.

THE COURT: --- those funds in the bookkeeping that you make of the Jollys' funds, as they have been received by you, to the three accounts you have described. I understand that perfectly. That's what you said in your filings.

MS. MCVEY: Okay.

THE COURT: And I understood that remark.

MS. MCVEY: Okay. Just wanted to make sure I ---

THE COURT: So I -- I ---

MS. MCVEY: --- was clear.

THE COURT: --- I understand that. They just disagree that that can be done that way.

But that was done that way at the time these funds were received, which was before verdict, as I understand. And *Riley v. Ford* indicates that you have the ability to do that, as I read that case.

MR. BOUCH: I understand that, Your Honor. My point is: These settling defendants didn't do it when they entered into it.

And your prior articulation of your reasoning indicated that these defendants, when they settled, consented to the allocation. And they didn't.

THE COURT: The defendants didn't make the allocation, as I understand it. They transmitted the proceeds to plaintiff and the -- for plaintiffs' allocation in any way the plaintiffs saw fit.

Had they wanted to dictate an allocation, they could have done that. And in my almost 50 years, I have seen allocated settlements that make it -- that, in the settlement, allocate.

When they are not allocated, the plaintiff is free to allocate them to the various pots of money they are holding for plaintiff. And that is, I think, what happened here. And that is what happened, as I understand it, in *Riley v. Ford*.

Now, they chose to make the allocations there on the basis of causes of action that were being tried at that time or were elucidated in the pleadings. Plaintiff has chose to make those allocations on the basis of settlements that were made before the matter was tried by settlement -- by settling defendants who settled at that time.

So I think we all understand where we are. You just disagree with the methodology I am using to make the setoffs. And that's fine. My ---

MR. BOUCH: Thank you ---

THE COURT: --- betters ---

MR. BOUCH: --- Your Honor.

THE COURT: --- will review that at some point, I feel sure, if you -- if your clients decide that this is something they want to take up. And that's perfectly okay.

MR. BOUCH: Thank you, Your Honor.

THE COURT: All right, sir.

MR. BOUCH: That's all I got.

THE COURT: All right, sir. Anything else, Ms. McVey?

MS. MCVEY: No, Your Honor.

THE COURT: All right. Now, what else do we have?

MS. MCVEY: I think that's the last motion. And -- and I don't -- have you ruled on this -- I mean, I think you have, but just formally ruled on what the setoff is?

THE COURT: Yes. I have ruled that the setoff is: with regard to Mr. Jolly, it -- the total amount of the verdict as addited is $1,580,000 of actual damage to Mr. Jolly. That amount, for setoff purposes, will be reduced by $740,000, which is one-third of the previously received amounts of $2,220,000, leaving a balance of $840,000 to be paid by these defendants as their -- as the amount paid in verdict.

With respect to Mrs. Jolly, the total amount of her verdict is $290,000. That is less than her third of the amounts received from previous settlements. And therefore, she will receive nothing additional by means of the $290,000 verdict, which I have rendered in this case, because the amount to be set off against exceeds the amount of verdict here.

And so the total amount to be paid by the defendants in this case is $840,000.

Now, there is one little hanging chad. And I don't know how y'all want to pursue that. We still have an outstanding motion for sanctions.

Now, Ms. McVey, what's your position on that?

MS. MCVEY: Your Honor, at this point we would waive our motion for sanctions.

THE COURT: Very good. I just want the record to reflect that we've disposed of that. The motion for sanctions was requested in connection with the deposition of Dr. Oury. And that motion has now been withdrawn, so no need for the Court to rule upon it. The motion is dismissed.

MS. MCVEY: Thank you, Your Honor.

THE COURT: Now, anything else we have?

MR. BOUCH: Nothing from defendant, Your Honor.

THE COURT: What's that?

MR. BOUCH: Nothing from the defendant, Your Honor.

THE COURT: Very good. Ms. McVey?

MS. MCVEY: No, Your Honor.

THE COURT: All right. Ms. McVey, I want you to prepare an order that reflects the rulings that have been made today. What kind of time do you think you need for that?

MS. MCVEY: I don't think it'll take me too long. Could I have two weeks, though, just ---

THE COURT: Certainly.

MS. MCVEY: --- to be ---

THE COURT: Certainly.

MS. MCVEY: --- sure? Okay.

THE COURT: Two weeks from today, you will transmit a copy to your opposing counsel and to me, and do that by e-mail. And then I'll take a look at it and we'll try to receive, Defendants, your comments. I'll give you a week, after you have received, to transmit to me your comments.

And, Ms. McVey, you can indicate whether you have anything further to say about it ---

MS. MCVEY: Okay.

THE COURT: --- in which case I'd appreciate a pretty immediate response.

MS. MCVEY: I can do that.

THE COURT: And then I will deal with the matter and pass an order that reflects the rulings made today.

So the rulings made today are tentative rulings. The time for appeal will run after I find my -- file my final order in this matter. So just so you know, you are protected until the order is actually filed. And then your time for appeal will begin to run.

MR. BOUCH: Thank you, Your Honor.

THE COURT: Anything else?

MS. MCVEY: No, Your Honor.

THE COURT: Thank you very much. I enjoyed trying the case with you. And I look forward to receiving these matters.

Ms. McVey, how about you e-mail me and indicate to me whether we can get together this afternoon ---

MS. MCVEY: Okay.

THE COURT: --- examine whatever we need to examine to verify what it is we're supposed to verify.

MS. MCVEY: Absolutely. I just have to get it one place, so I'll -- I'll ---

THE COURT: Very good.

MS. MCVEY: --- work hard to do that.

THE COURT: All right.

MS. MCVEY: Thank you.

THE COURT: Thank you very much.

MR. REID: All right.

MS. MCVEY: Thank you.

(Whereupon, the proceedings were concluded at 11:22 a.m.)

--- END OF TRANSCRIPT OF RECORD ---

CERTIFICATE

I, THE UNDERSIGNED MARYANN S. NEVERS, CERTIFIED VERBATIM REPORTER - MASTER, CERTIFICATE OF MERIT, OFFICIAL COURT REPORTER FOR THE EIGHTH JUDICIAL CIRCUIT OF THE STATE OF SOUTH CAROLINA, DO HEREBY CERTIFY THAT THE FOREGOING IS A TRUE, ACCURATE, AND COMPLETE TRANSCRIPT OF RECORD IN THE HEARING OF THE CAPTIONED CAUSE, RELATIVE TO APPEAL, IN THE CIRCUIT COURT FOR SPARTANBURG COUNTY, SOUTH CAROLINA, ON THE 20TH DAY OF SEPTEMBER, 2017.

I DO FURTHER CERTIFY THAT I AM NEITHER OF KIN, COUNSEL, NOR INTEREST IN ANY PARTY HERETO.

MARYANN S. NEVERS, CVR-M-CM

COLUMBIA, SOUTH CAROLINA

SEPTEMBER 22, 2017

1934

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National Safety Council

Incorporated

TWENTY-THIRD ANNUAL
SAFETY CONGRESS

Cleveland, Ohio

October 1 to October 5, 1934

The Cleveland, Carter and Statler Hotels

Publication Plan

THE TRANSACTIONS of the Twenty-third Annual Safety Congress, National Safety Council, 1934, are published in two volumes. The first, containing the General Sessions, the Special Subject Sessions, and the Industrial Section Sessions, is presented herewith. It is supplemented by a smaller volume containing the sessions of the Street and Highway Traffic Section, the Child Education Section, and Home Safety.

The large volume is being sent automatically to the Industrial members of the Council; the smaller volume is sent automatically to members who are believed to be chiefly interested in those sessions. It may also be secured on request by other Council members.

For the benefit of many members who have found it advantageous to distribute copies of these TRANSACTIONS to supervisors, foremen and others among their personnel, who may keep them for continuous reference, the following quantity prices are quoted: 1 to 10 copies of the large volume, $1.50 each; 11 copies and over, $1.25 each. Copies of the smaller volume, $.50 each.

THE PLAN OF PUBLICATION is the same as that followed for the last three years. It is a condensed record. The papers of each session or division of the Congress have been assembled, edited with care and discernment to eliminate extraneous matter and abbreviate the less essential portions, and the concise remainder is presented for study and reference. Although not "complete" in the sense that every word is reproduced, it is an interesting and valuable record which emphasizes the memorable parts of each paper or address. The original manuscripts are on file in the Council Library, available for additional reference as desired.

Although the National Safety Council endeavors to eliminate from discussion at its conventions matters which are not pertinent to its purposes or which are contrary to its policies, the Council cannot accept responsibility for the views expressed either in the papers presented or the discussions thereon.

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TWENTY-THIRD ANNUAL SAFETY CONGRESS
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Dust in Industry

FRIDAY AFTERNOON SESSION

October 5, 1934

The session devoted to a discussion of Dust in Industry was called to order by Dr. E. G. Meiter, Director, Industrial Hygiene Laboratory, Employers Mutual Liability Insurance Co., Milwaukee, who presided. Dr. Meiter briefly welcomed the delegates and then introduced the first speaker.

Types of Dust That Cause Occupational Diseases

By LEROY U. GARDNER, M.D.

Director, Saranac Laboratory for the Study of Tuberculosis, of the Edward L. Trudeau Foundation, Saranac Lake, N. Y.

The speaker said in part: Experience has demonstrated that the lung tissues can tolerate very large amounts of most kinds of foreign dust particles without serious interference with function. The lung may be intensely pigmented by colored dusts with no evidence that respiration is impaired. But dusts composed, in whole or in part, of silica have been shown to be dangerous because they stimulate the growth of the connective tissues of the lungs and bring about the formation of scar tissue. This destroys the normal elasticity of the organ which is necessary for respiration and it thickens the delicate membranes so that a free interchange of gasses is impeded. Fortunately, these results only follow the prolonged inhalation of very large quantities of silica.

Experiments have demonstrated that the injection, of silica into the tissues of animals kills the cells where the substance lodges and excites an inflammation. When healing takes place a very dense and characteristic kind of scar tissue forms. Most non-siliceous dusts produce no inflammation and very little scar. It has been shown that such changes do not follow the injection of silica unless the particles are very fine, three microns or less in diameter, and unless enough of them localize in one area. With larger particles the rate of reaction is so slow that little change occurs within a year. As a general rule, the finer the particles, the more rapid the cellular response. The reaction to fine silica begins within four or five hours and it continues for a period of years.

If the silica is combined with bases in the form of silicates, it rarely produces such active and progressive changes. The silicate of magnesium, asbestos, does cause the formation of scar tissue in experimental animals and in the human lung, but most other silicates are not generally recognized as irritating. Recently it has been claimed that a hydrated silicate of aluminum and potassium, called sericite, is responsible for most of the cases of silicosis. This silicate, a transformed feldspar, is often associated with quartz and it has been identified in the lungs of persons suffering from silicosis. However, at least two types of sericite have failed to excite significant changes when injected into animals. Experiments with this substance are still in progress. Kaolin, an alumino-silicate of potash, has also produced quite characteristic changes in the lungs of rabbits. But our present knowledge does not permit us to assume that silicates as a class will produce serious tissue damage.

Most observers now believe that uncombined silica, or quartz, is poisonous to the tissues because it is slowly dissolved in the fluids of the body. Certainly the majority of the experimental observations suggest a chemical injury, but it is difficult to understand how enough of such an insoluble substance as quartz could be dissolved within eight hours to produce a well marked, acute inflammation. If solubility were the only factor one should discover a more active response after the injection of the more readily soluble silicates, but such is not the case. Formerly it was held that silica produced its effect mechanically. The hard sharp quartz particles were believed to abraid the lung surfaces and excite the formation of scar tissue as a manifestation of healing. This theory is no longer tenable for when animals are injected with other hard, sharp particles like diamond, carborundum or aluminum oxide, there is no inflammation and practically no formation of scar tissue. Ultimately it may be shown that the irritation of silica is due to some unrecognized property possibly related to its atomic structure.

When quartz particles are inhaled they produce three specific effects which are not excited by any other type of dust yet studied. They alter the behavior of the pulmonary phagocytes; they stimulate the formation of circumscribed nodules of scar tissue; and they subsequently increase the susceptibility of the lung to infection, especially tuberculous infection.

Phagocytes that ingest too many quartz particles are killed by this irritating substance. As the cells die they liberate their burden and several new phagocytes come out to take it up again. By a repetition of this process enough phagocytes accumulate so that many of them ingest only a few particles. Under such circumstances the stimulus is not strong enough to kill but merely accelerates the motility of the cells. They naturally tend to leave the air spaces, enter the lymphatic vessels and accumulate in the lymph nodes. This process becomes more rapid under the influence of the irritating silica and very considerable numbers of particles are consequently localized in the nodes.

After six or eight years the quartz in the nodes has caused a marked overgrowth of the fibrous elements in these structures. Ultimately the reaction develops to such an extent that the node is entirely replaced by a mass of coarse, glassy scar tissue fibres, often several times as large as the original node. Such nodules encroach upon and compress the lymphatic vessels. The drainage system of the lung is choked and effective removal of subsequently inhaled dust is gradually diminished. Dust now accumulates around the lymph vessels and sheets of scar tissue develop in this location.

These preliminary changes do not constitute the disease, silicosis; they involve only the lymphatic system. The respiratory tissues are not appreciably affected. In good stereo X-ray films these preliminary changes may be visualized as a thickening and beading of the shadows cast by the blood vessels together with a widening of the shadow of the root of the lung. The blood vessels are thickened because the most important lymphatic vessels course through their walls. The beading is due to the minute nodules of silicotic scar tissue in the lymph nodes within the lung. The root shadow is widened because of the silicotic reaction in the lymph nodes in this location.

If still more dust is inhaled it can no longer be effectively carried off through the lymph vessels. The phagocytes now carry it into the walls of the air spaces. Often the cells group themselves in nodules but sometimes they are scattered. In these locations the silica again stimulates the formation of scar tissue. The result is a general thickening of the septa between the spaces and nodulation throughout the functional portion of the lung. This change seriously interferes with function as interchange of gas cannot take place through the thickened walls of the air spaces and the tissues lose their normal elasticity. Less involved air spaces dilate and their walls stretch, producing the condition known as emphysema, which is also incompatible with effective respiration.

With the formation of silicotic nodules in the functioning parts of the lung the disease, silicosis, is said to begin. On the X-ray film such nodules cast clear cut, round shadows. As they increase in number and size they blot out the formerly accentuated linear shadows of the blood vessels. In a well marked case both lung fields may be thickly seeded with hundreds of such sharply defined, rounded, nodular shadows. Where there is emphysema, often at the bases, no markings are visible and the film appears black.

The condition of silicosis is a progressive one and it continues to develop after a man has left his dusty occupation. Serious results only follow, however, when he leaves with many nodules in the lung tissue itself. As such nodules increase in size they replace important functional elements. Obviously the continued growth of only a few nodules situated in the lymphatic system could have little effect other than to increase the obstruction already present.

The serious part of silicosis is its frequent complication by tuberculosis. This may arise from reactivation of a pre-existant latent infection or it may result from a new infection from without. The danger of infection increases with the amount of silicosis present. The course of the infection in the silicotic is usually chronic and it often fails to produce characteristic symptoms for months or years after its onset. Many times it is accidentally discovered in routine X-ray examination of groups of active workmen. However, evidences of disability are much more marked in silicotic individuals with infection than in those with uncomplicated disease. Occasionally tuberculosis may run a very acute course in the silicotic subject but this is also true in other persons. The cause of the susceptibility of the silicotic lung to tuberculosis is not perfectly understood, but it would seem that the action of the silica on the tissues creates a medium favorable for the growth of the bacteria. The tubercle bacilli multiply and a slowly progressive tissue reaction ensues, but the usual clinical symptoms of tuberculosis are often held in abeyance for a long time because the chances for absorption of poisonous products of infection are minimized by the obstructed lymphatic system. It is also possible that some of these poisons may be absorbed on the silica particles, as Cummins has suggested. Ultimately the infection gains the upper hand, symptoms develop and death from tuberculosis ensues.

The only other type of dust which is generally recognized as a cause of severe pulmonary injury is asbestos, a silicate of magnesium. This substance is fibrous in character and is more readily soluble than quartz. Apparently the protective upper respiratory mechanisms seem inadequate to prevent the inhalation of many such fibres and even quite long ones may penetrate into the finer bronchial tubes. These structures have irregularities in their walls which seem to hold the fibrous dusts. In this location the asbestos particles are surrounded and ingested by phagocytes. The cells do not seem to be particularly irritated for they are not especially numerous nor do they migrate rapidly into clumps as in the case of phagocytes dealing with quartz. Apparently most of them carry their burden of asbestos fragments directly into the walls of the tubes in which they lie. The mildly irritating dust sets up a proliferation of the connective tissue cells in the walls resulting in collar-like thickening of the tubes. Contraction of the new connective tissue narrows or closes the tube and thereby shuts off the ingress of air to the more peripheral air spaces. These spaces then collapse, a condition known as atelectasis. This in itself is a cause of fibrosis or scarring of lung tissue. The result is a fibrosis of numerous relatively small areas in the lung due to the collar-like constricting fibrosis about many small terminal bronchial tubes. The lymphatic system seems to play little part in disposing of asbestos dust and insignificant amounts of this dust are found in the lymph nodes.

Not a few cases of asbestosis die of tuberculosis or bronchopneumonia but the prevalence of the former infection is probably much less common than in silicosis. Surveys of large groups of asbestos workers fail to reveal such a high incidence of tuberculosis as found in similar studies on silica workers.

The inhalation of unusual amounts of non-siliceous dusts apparently fails to produce significant alterations in the lung. It is of course possible that injurious ones may ultimately be discovered, but none are recognized today. The non-siliceous particles enter the lung and are ingested by phagocytes as in the case of quartz. The cells are not stimulated to move very rapidly and as a consequence many of them remain within the air spaces for a long time. Some, particularly those con-

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taining relatively few particles, make their way into the lymphatic system and accumulate in the lymph nodes. In sufficient concentration, or perhaps because they are mixed with small amounts of silica, they set up a low grade, non-progressive chronic inflammation. But this reaction results only in a little thickening in the lymph nodes and about the lymphatic vessels. The lung tissue may be variously pigmented, black from coal or red from iron, but there is no formation of scar tissue that interferes with function. The susceptibility to tuberculosis of the person with such pigmentation is not increased but it is apparently quite definite that pneumonia is unduly prevalent in coal miners and that chronic bronchitis results from the inhalation of cement. The X-ray films of men working in non-siliceous dusts shows either nothing at all or a more or less marked accentuation of the linear shadows cast by the blood vessels. This, of course, is due to the chronic inflammatory changes about the lymphatic trunks in walls of blood vessels.

The effects of mixtures of free silica and non-siliceous materials are less clearly defined and should receive more serious attention. It would seem unwise to assume, as has been done in the past, that the non-siliceous substances serve only as inert diluents and that only the quartz component of a dust is of significance. Experimental and clinical data are accumulating which suggest that at least some other dusts may materially modify the action of quartz, both in its capacity to produce nodular fibrosis in the lungs and to increase the susceptibility to tuberculosis. For example, animals inhaling heavy concentrations of a mixture of equal parts of pure silica and hematite dust for eight hours a day over a period of 14 months have shown not even the slightest indication of nodule formation in the lung, whereas pure quartz dust, inhaled for only two hours a day, produces definite nodulation. It also seems to be true that animals inhaling such a mixture are much less susceptible to tuberculosis than those exposed to pure quartz. In the case of the human iron miner, some lungs show definite silicotic nodulation, others only a very few nodules and many no nodules at all. All exhibit heavy deposits of iron particles with a cellular connective tissue reaction. When these findings can be correlated with chemical analysis of the lung tissues and the approximate amount of rock work which these miners have performed, some relationship between the exposure to silica and the fibrous nodule formation may be established. Tuberculosis in these iron miners is apparently less prevalent and much less severe than in men exposed to pure silica. What has been said of iron miners is also probably true of foundry workers and coal miners. It is generally accepted that men in the latter occupation have less tuberculosis than the average for the age period; Cummins believes that they have the infection but that it is so atypical and benign in its manifestations that it escapes diagnosis.

Mention should also be made of mixed dusts like certain slates and granite containing large amounts of free silica in combination with silicates. Experimentally these substances behave atypically and do not produce nodular fibrosis unless there is complicating infection. The same may also be true in human beings. Unquestionably such dusts are capable of producing typical silicotic nodules and they predispose to tuberculosis. From a theoretical standpoint they should receive much more intensive study to clarify our views on the whole subject. At the present time it appears that the action of their quartz component is modified and partially neutralized by the other substances which they contain.

Using Exhaust Systems and Respiratory Equipment To Protect Workers Exposed to Dust

By STUART W. GURNEY and DAVID S. BEYER

Liberty Mutual Insurance Company, Boston

The speaker said in part: A number of our states have had references to dust elimination in their labor laws for a good many years, but no state has as yet thoroughly enforced these laws. The codes of five states which we investigated provide that grinding, buffing and polishing wheels should be exhausted, although two of the states exempt from these provisions wheels on which water is used.

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This seems ill-advised, since a study
Winslow and Greenburg has shown th
means eliminate the dust hazard.
It may be remarked that, with err
give a higher velocity at the point of
one; but this alone is not a measure
Wisconsin has adopted the principle
particles of respirable size per cubic
primarily interested in, to keep the d
will not be harmful.
These variations and conflicting pre
eral lack of authoritative standards.
are now being taken by the American
basis for such codes. There are two
Ventilation Code Committee, sponsored
tilating Engineers, and the Exhaust
national Association of Industrial Ac
arranged to appoint sub-committees
cleaning, chromium plating, granite c
addition, a Sub-Committee on Fundame
Maintenance of Exhaust Systems will
The two most important consider
1. Velocity of air flow; 2. Arrangeme
ness to the dust source, shape, etc.).
Many an installation that is otherw
fully merely because there is not eno
a series of tests that were conducted
F. Hatch, Department of Industrial
a machine used in dressing stone was
flow through the hood of 230 cubic fe
million dust particles in the surroundi
a little over 250 cubic feet per minute
million, a marked improvement. As
in dust concentration was relatively slo
feet per minute to bring the dust concen
per cubic foot, which was considered
It is accordingly possible sometim
factory and, if the remainder of the
up the blower or adding a larger one.
Another very important considerati
as close as possible to the source of
further away from the inlet is really s
ciples involved. It should be rememb
haust pipe or air duct in operation,
from behind the opening. As we move
drops very rapidly, so that even at
velocity may be less than 10 per cent
most important consideration to keep i
of in designing exhaust systems. It is
inches in diameter with which the p
dust from a distance of several feet. In
the entrance to the inlet may be negli
Still another important consideratio
is the addition of a flange. The effe
would flow in from behind the openin
Thus the efficiency of the system is u
haust extended appreciably, without l
adding to the expense of keeping up
There are also other consideration
air cannot be "pulled" from a distanc
the point in question, but it can be "p

ble distance. This principle may be used advantageously in directing the dust toward the opening of the exhaust inlet and thus getting the desired results with a lower exhaust velocity and power consumption than would be required if suction alone were depended upon. This principle has been applied effectively in drilling material containing asbestos, where the exhaust inlet is placed at one side of the drill and a small air jet at the opposite side of the drill, blowing across the table turns the particles that would fly out from this side and directs them back into the exhaust system. It is also being applied to foundry shake-out work.

Other considerations in designing exhaust systems include the elimination of unnecessary bends or curves, the provision of clean-out doors, and the proper construction of joints. Where there is a general ventilating installation and one or more exhaust systems, care must be taken to see that they do not conflict with each other.

After an exhaust system has been installed it should be tested by taking actual dust counts to see that the dust is really being cut down to the desired point, and such counts should be taken at intervals after the installation has been made, to see that it is still functioning properly.

The fact that the dust particles that cause the trouble are so small that they are invisible under ordinary conditions (less than 10 microns or 1/2500th of an inch in diameter) often makes it hard to convince the practical plant manager that there is any dust present; it also makes it impossible to tell, without the use of special instruments, whether the completed exhaust system is actually removing the dust.

It might seem like an insult to one's intelligence to say that after an exhaust system has once been installed it should be maintained in good operating condition. However, the numerous cases one encounters in the plants where this obvious necessity is not carried out, indicates that it is really one of the major considerations in connection with the elimination of dust or fumes. Cases are not unknown where the blower has in some manner become reversed so that the air is being ejected and diffusing the dust, rather than drawing it in; other instances where the efficiency of the system has been lowered or its value nullified by clogging up, disconnection or wearing out of the piping, etc., are all too common.

One concern, of which the writers have knowledge, has a "U" tube permanently installed in one of its main exhaust systems so that the foreman or safety man can tell at a glance whether there are any changes that would indicate a break-down in the system. All such installations should have regular inspections by some competent person as a routine part of their upkeep.

It will be sufficient here to discuss respiratory equipment very briefly. The simplest form of this equipment is the filter respirator. Such respirators have a definite value for temporary use such as sweeping up, cleaning out bins, shoveling materials, etc., but they require careful fitting and constant supervision to see that they are being properly used.

It is our opinion after watching the sincere efforts in a number of plants to enforce the use of these respirators, that it is rather impracticable to require them to be used on full-time operation. One notices the men, under these conditions, surreptitiously pushing the respirator aside and gasping in free air like a fish out of water. Certainly, if they are to be used any considerable length of time, frequent rest periods should be allowed where the men can get out into the free air for a few minutes refreshment.

There are also the large air-fed helmets, with which most of us are familiar, used for sandblasting, etc., which have been carried to a high state of perfection for the purposes to which they are adapted.

We believe, however, that much more use could be made advantageously of the type of apparatus that lies midway between the filter respirator and the air-fed helmet, namely, the light, air-fed respirator which covers the nose and mouth and leaves the rest of the face exposed. With a light hose attachment, this device offers considerable freedom of movement, and if air outlets were supplied so the hose could be quickly transferred from one outlet to another it would seem to be practicable to use them over a considerable area. They afford the advantages of a pure air supply without excessive weight and without the restriction to breathing that is imposed by the filter respirator.

The Medical Supervision

By W. J. Mc

Assistant Medical Director, Metrop

The speaker said in part: The h
sure with the physical and chemical n
dusts are soluble or slightly soluble in
proportional to the toxicity of the con
are examples of poisonous dust. Oil
on the skin and mucous membranes and
Chromic acid and alkalies are example
probably harmful effect of dusts arisi
of dusts which are insoluble or very di
harmful pathological lung conditions.
and fibrosis producing dusts. The ins
as cotton, jute, hemp, etc., are non-fib
dusts are limited, so far as we have
dusts, such as free silica, crystalline s
Of the fibrosis producing dusts, those
admittedly the most important becau
dusts distinctly predisposes the indivi

The effectiveness of dust control
dusts can be determined only by car
exposed under the guidance of compet
accrue to the employer and employee,
of all applicants for employment, as w
engaged, would indicate very careful
control of sickness. Such a procedu
applicant already physically or menta
for a condition either not associated
vious employment. The applicant's
and by keeping record of his subseque
sponsibility for injuries and sickness nc

The applicant is protected from e
ill adapted which, if undertaken, mig
his health. For example, an applic
work in a certain dusty occupation, if
convert an inactive tuberculosis into
at least seriously impairing the appli
Whereas the same applicant if assig
posure, might be expected to continue
tion. The examination of applicants
are already employed from the risks
and various acute respiratory and oth
by a new applicant.

Many of the younger individuals
ceived a thorough physical examinati
fects from which they suffer. As a
are located which may be removed or
damage, thereby increasing the efficie
and finally chronic diseases. Furthe
cases of the heart, kidneys, and a l
discovered and the applicant referred
otherwise might have been postponed

Of even more importance than th
the periodic examination and care of
cedure serves to check the efficiency
occupational diseases. It offers the n

large groups of workers by discovering early not only occupational diseases, but many other conditions that go undiscovered until the worker is acutely ill or becomes disabled. If the various contagious conditions go unrecognized others become infected, thereby causing serious economic loss, as well as endangering the health of a group of individuals.

The information obtained from physical examinations affords the medical supervisor the opportunity to make certain that employees are engaged in suitable work out of which they are getting maximum results, to correct the effects of undue exposure to harmful environmental conditions, and generally to lessen all occupational hazards. As a public health measure, it is impossible to over-estimate the value of periodic examinations in establishing interest in sickness prevention.

The set-up of a proper program for medical control of workers exposed to dust depends upon the number of employees involved and individual plant conditions. A series of articles under the title of "The Medical Department Manual" by Dr. Hart E. Fisher, appearing in current numbers of "Industrial Medicine," gives a comprehensive account of the organization and operation of a medical department.

1. The establishment of a medical department with adequate facilities and medical personnel who have qualified in the field of industrial medicine. A process analysis of all operations in the plant should be made and the medical supervisor should list all possible health hazards and familiarize himself with their physiological effects. If necessary, he should conduct research studies to determine the harmful effects of new substances introduced into plant processes about which little is known. In cooperation with other departments, he should investigate the extent of the hazards and devise measures of control.

2. The routine examination of all applicants for employment. The procedure should include a detailed history of the applicant's previous illnesses and accidents classified under (a) diseases of childhood, (b) general infectious diseases, (c) respiratory diseases, (d) venereal diseases, and (e) accidents and resulting physical defects. A detailed history of previous occupations engaged in is very important. A mere statement of the type of industry in which the applicant was engaged has slight value, if any. The exact duties performed in each occupation should be noted and information ascertained as to the probable length of exposure to hazardous substances. After the history has been taken and a photograph for identification purposes (if part of routine) is made, the applicant should be directed to the examining room where he is instructed to remove his clothing for physical examination. This examination should be made as complete as is considered necessary to determine the applicant's physical condition.

If the applicant has been or will be exposed to dusts which induce lung diseases, an X-ray picture of the chest is an important part of the examination. This part of the examination may be referred to an experienced roentgenologist, as the value of this method of diagnosis depends upon the type of pictures taken and the experience of the reader who interprets them. The examining physician also may need additional information obtained by laboratory analyses of the blood, sputum, and the urine. These aids to diagnosis should be provided or made available when desirable.

3. The rating and placement of applicants. In cooperation with the personnel department, the applicant should be rated and placed, not only on his training and past experiences, but also on his physical and mental abilities to fill vacancies occurring from time to time. The record of his physical and mental examination should be the confidential property of the medical department.

4. Periodical physical examinations. The frequency of periodical examinations necessarily must depend upon individual circumstances according to the need for such examinations as determined by the supervising physician. Where physical examinations are made for the first time, the employees of long standing should be given ample explanation of the benefits of such examinations and be given assurances that their jobs are secure.

5. Provision for the disabled. Employees who develop disabilities during the course of employment should be re-assigned to occupations which will not interfere with or aggravate the disability, or they should be provided for in other ways.

ADJOURNMENT

The Dust Hazards in Industry

By DR. R. R. SAYERS

Medical Officer in Charge, Office of Industrial Hygiene and Sanitation, United States Public Health Service, Washington, D. C.

The speaker said in part: Realizing the importance of the dust problem in [illegible]stry, the United States Public Health Service in cooperation with the Bureau [of] Mines began its first study of the health of workers in dusty trades in 1914, [in] the mines of Joplin, Missouri; and later, in 1923, the Public Health Service [in]augurated a series of dust studies. These later studies were all conducted in the [sam]e manner in order to permit as detailed a comparison as possible between the [diff]erent investigations.

Briefly, these methods of study may be divided as follows: (1) examination to [dete]rmine the general physical condition of the workers under observation; (2) [spe]cial physical examination to determine the prevalence of specific diseases of the [resp]iratory system and the lung pathology resulting from exposure to the particular [dus]t hazard; (3) record of the nature and severity of the disabling illnesses; (4) [ana]lysis and detailed study of the occupational environment; (5) occupational [mor]tality statistics relating to the specific dust; and (6) autopsies.

The first six intensive investigations carried out by the Service dealt with the [hea]lth of workers exposed to dusts in a cement plant, granite cutting industry, [anthr]acite and bituminous coal mining, silverware manufacturing plant, cotton cloth [manu]facturing, and in municipal street sweeping. Brief studies were later conducted [in] certain slate, granite, marble and talc quarries, while more recently a rather [exte]nsive study of the health of anthracite coal miners was completed.

These six dust studies showed that the workers in the granite cutting plants [who] were exposed to the highest dust concentrations were found to suffer from an [exc]ess of pulmonary tuberculosis after 15 years or more of exposure and developed [silic]osis from 2 to 10 years. In the group exposed to a lesser amount of dust, [silic]osis developed only after prolonged exposure, with no excess of tuberculosis. [It w]as found that a close relationship existed between the degree of dust exposure [and] the extent and severity of the pulmonary damage. Anthracite coal miners [suff]ered from dyspnoea and other signs of pneumoconiosis and experienced a high [rate] of respiratory sickness; in addition, an excessive mortality from influenza-[pneu]monia and possibly tuberculosis was found. Bituminous coal miners experi[ence]d a generalized fibrosis of the lungs and an excess mortality from influenza [and] pneumonia. Cement workers showed some signs of early pneumoconiosis with [an e]xcess of diseases of the upper respiratory tract. On the other hand, workers [in th]e cotton cloth and silverware manufacturing plants and municipal street sweepers [wer]e negative for respiratory conditions and other illnesses when compared with [the] general industrial population.

[R]ock Drilling. For five years the United States Bureau of Mines studied lead [and] zinc miners in the Tri-State District, Oklahoma. The ore here is high in free [silic]a. Of the 7,722 men examined, a group of 1,647, or 21.3 per cent, was definitely [diag]nosed as having silicosis, not including those diagnosed as having tuberculosis. [T]he men diagnosed as having first-stage silicosis had worked an average of [ ] years, but those men starting in the mines after 40 years of age worked an [aver]age of only 5 years.

[T]he work of rock drilling in subway and tunnel construction in New York [is] in some respects similar to that of some of the activities in the hard rock [mine]s at least in so far as the manner in which dust is evolved, the type of [dust] and the resultant hazard. Recently the result of a study of rock drillers, [blast]ers and excavators was reported by the New York Tuberculosis and Health [Assoc]iation. An examination of 208 rock drillers, blasters and excavators showed [that] 118, or 57 per cent of the men had silicosis in various stages of progression. [The] exposure of most of these men (75 per cent) had been for 20 years or more.

[S]andblasting. No study of the health of sandblasters has been reported in the [Unit]ed States, however, a study of the dust exposure of sandblasters was recently [compl]eted by the United States Public Health Service in cooperation with the

National Safety Council. This investigat[ion] of the dust and degree of the exposure. This study also brought out the fact that [ ] safety, provided properly designed and we[ ]

Diatomaceous Silica Workers. Most [ ] from studies made both in industry and [ ] silica in the form of quartz. Such studie[s] pottery trades, hard rock drilling, etc. [ ] existence that are not crystalline in natu[re] Santa Barbara County, California, there [ ] silica deposit in the world. This subst[ance] silica. Recently an examination was ma[de] employed less than 1 year, 1 to 2 year[s] All of the workers were Mexican laborer[s] determinations, social and medical historie[s] Dust determinations were also made but [ ] feature revealed by the examination was [ ] Eighty-four per cent of the workers wer[e] It was found that 40 men showed signs [ ] moderately advanced stage and 6 in the [ ] among workers with a history of exposu[re]

Dust Hazard in the Granite Quarry [ ] granite quarrying is not so dangerous a[s] sheds; quarry work is done outdoors a[nd] much dust exposure. However, certai[n] pneumatic tools, which are usually asso[ciated] quantities of dust. It was thought that [ ] quarry might cast some light on our pr[ ] radiographic nature of 63 quarriers was [ ] also obtained. The dust determinations s[ ] (drillers) were exposed to many times [ ] present time. Drillers were the only [ ] Half of these workers with an exposure [ ] the 5 men with more than 20 years [ ] This study suggests that quarry driller[s] from pulmonary tuberculosis as do pneu[ ]

Effect of Inhaled Marble Dust. Th[e] inhalation of marble dust appear to be [ ] stone dust containing a high percentage [ ] study made by us among marble worker[s] inhaled in concentrations averaging abou[t] produced a mild bilateral, linear fibro[sis] examined, no serious lung changes were [ ] the dust, even after many years of expo[sure] The marble dust under consideration con[sists of] dolomite, with no silica present.

Dust Hazard in Abrasive Industry. [ ] industry and for this reason the effect [ ] manufacture or preparation of these pr[oducts] 1929 and again in 1931, Dr. Clark of [ ] made investigations of workers exposed [ ] produced in the manufacture of grinding [ ] of 13 years there were proportionately [ ] culosis among those working in the ab[rasive] where no abrasive dust occurred. In P[ ] occurrence of over 100 cases of alleged [ ] in which the dust consisted of 99 per ce[nt]

Exposure to Silicate Dust. It has [ ] composed of silicates (combined silica), the form of quartz), was innocuous. [ ] become cognizant of the hazards of sili[ ] f the lungs caused by the inhalation of asbestos dust, has already been described ...ch in its clinical and roentgenographic manifestations by investigators in other ...untries, but to date no studies have been reported in the United States. Cement ...ust, which contains about 22 per cent combined silica, has been studied, and the ...ects of the inhalation by workers has been discussed here. In March, 1933, ...ressen, of the United States Public Health Service, reported the results of a ...udy conducted among tremolite talc and slate workers. The slate dust to which ...hese workers were exposed consisted mainly of silicates, there being less than ... per cent of quartz in the dust. The talc was a hydrous calcium-magnesium silicate ...cing 45 per cent talc and 45 per cent tremolite, with no quartz present. The ...esults of the study seemed to indicate a relationship between the amount of dust ...haled and the effect of this dust on the lungs of workers.

Statistical Studies. Recently, Lanza and Vane estimated that there are some ...ousand workers engaged in the mining, quarrying and manufacturing industries ... this country in which an exposure to silica dust to a harmful degree is en...tailed. Their analysis of mortality experience of twelve life insurance companies ...r the period 1915-1926 showed that the actual mortality from respiratory tuber...ulosis among the silica exposed persons was about three times that of a non-...lica dust group. If one considers their data for certain occupations in metal ...ines and granite and sandstone quarries, occupations known to be exposed to ...igh concentrations of hazardous dusts, then the comparison is more striking, since ...e actual deaths among these workers was found to be ten times that of the ex-...pected deaths. More detailed statistics on occupational mortality as reported by the ...egistrar-General of England and Wales (1921-1923), and summarized by Britten, ...ow the high rate of 1,886 per 100,000 for tin and copper miners, while the rate ...r "all occupied and retired males" was only 150. Other occupations with silica ...xposure showed an excess.

From the evidence just presented concerning the injurious effects produced by ...e inhalation of certain dusts, it is apparent that a knowledge of the properties ...f a given dust which determine its capacity to produce pulmonary pathology is ...ential. Numerous investigations of the industrial dust problem indicate that ...ese properties are the chemical and mineralogical composition of the dust, its ...ncentration in the industrial atmosphere, and its particle size.

In an earlier portion of this discussion evidence was presented which indicated ...at a close relation existed between morbidity and mortality rates from various ...spiratory diseases and the exposure to certain dusts in industry. In the study ... the dust hazard in the granite cutting industry, it was definitely proved that ...ere is a direct relation between the magnitude of the dust exposure and sickness ...d death resulting from tuberculosis. It is quite evident, as a result of these ...udies, that the remedy of the dust evil lies in the effective removal or suppression ... the dust to concentration considered safe. However, no set rules may be estab-...lished for the mechanical protection to be instituted in an attempt to control indus-...al dust. Specific conditions encountered in a plant will determine the type of ...otection to be employed.

The protection of workers against certain dusts known to be toxic may at ...mes be accomplished by the substitution of a non-toxic material for the toxic one. ...e example of such a procedure is the possible use of a metallic or other type ... artificial abrasive for sand in the sandblasting process in those operations in ...ich it is not essential to use sand, a substance high in quartz content. Again, ... mechanical enclosure of the dust-creating process also serves to protect the ...rker. An excellent illustration of this type of protection is afforded by the ...dern sandblast barrel used in the cleaning of small objects. Sometimes it is ...ssible to protect the worker by the substitution of wet for dry processes, as wet ...illing instead of dry. In one instance, in the granite cutting study previously ...ntioned, an operator using a diamond point tool worked the stone wet; the ...sulting dust amounted to 22 million particles per cubic foot. The same operator ...s then requested to work the stone dry; as a result, the amount of dust reached ... high figure of 45 million particles per cubic foot. In the weaving of asbestos ...th it has been possible to reduce the amount of dust in the air by wet weaving ... one-fourth of the amount present when the process is conducted by dry methods. ...other example of this procedure in allaying dust is the use of a spray of water

in leyner and jack-hammer drilling in... dust trap is now finding much favor in...

The Kelly trap consists of a metal... at the rock surface. No attempt is m... rock or between the trap and the dri... stream and is carried into an exhaust... dust particles through openings betwe... is prevented by the air seal produced... trap under actual working conditions... worker's breathing zone may be kept... cubic foot with a 60 cubic foot per min... trap is a step forward in the program... work, such as in mines and subways, ... of compact dust disposal equipment.

In certain cases, such as in the sandb... the practical safeguard to the worker... of the positive air pressure type. In... tioned, it was found that when from 5... per minute are supplied to the helmet,... ever, one must always bear in mind th... be the dust determination of the air wi... quantity of the air supply itself.

In most dusty processes, however, t... are by the use of properly designed e... instances it is difficult, costly, and at ti... the dust in the vicinity of a worker,... amount of a certain dust which the ai... Such information can be made availabl... Public Health Service. For example,... dust at the breathing level of about 10... free silica).

Studies of dust removal devices used... work was conducted showed that a k... measured by an anemometer at the fac... dust at the breathing level to an amount...

A word should be said concerning ... It has already been shown that in the... in sandblasting, it is important to have... 6 cubic feet of dust-free air per min... With reference to respirators of the filte... in the design of an efficient and comf... value are standard methods for the t... tection devices. Drinker advocates te... which the respirator is to encounter, th... and under actual industrial conditions... agency should conduct such tests and... work being done on a cost basis. The... a schedule for testing and approving re...

I wish to stress the importance of... the dust hazard. Good housekeeping sh... lated dust about a workroom but sh... dust removal devices and respiratory... of all dust suppression equipment shou... industry rather than the casual attentio...

Report of the No...

The chairman called for the report... and new officers for the section to ser... and elected as follows:

Safety Section, A R A -- Steam Railroad Section, N S C

Chairman—C. L. LaFountaine, Great Northern Railway Co., St. Paul, Minn.
First Vice-Chairman—H. A. Parish, Chicago & North Western Railway, Chicago.
Second Vice-Chairman—W. H. Failing, Central Railroad of New Jersey.
Secretary—J. C. Caviston, American Railway Association, New York City.

A complete report of these sessions is published by the American Railway Association in a booklet entitled, "Proceedings of the Fourteenth Annual Meeting of the Safety Section, Cleveland, Ohio, October 2-4, 1934." Copies of the booklet are available from the Association of American Railroads, N. Y. C. The following is a condensed record.

TUESDAY MORNING SESSION

October 2, 1934

The opening session of the Safety Section, American Railway Association—Steam Railroad Section, National Safety Council was called to order by Chairman C. L. LaFountaine, Great Northern Railway, St. Paul, Minnesota, who presided. The invocation was delivered by L. G. Bentley, Chesapeake and Ohio Railway. The report of the Secretary, J. C. Caviston, New York City, in which he outlined briefly the activities of officers and standing committees during the last year, was read and approved. The Chairman then presented his annual report.

Annual Report of the Chairman

By C. L. LA FOUNTAINE

Great Northern Railway, St. Paul, Minn.

The speaker said in part: Let us go back for a moment to the resolution adopted at our annual meeting in 1924, which set a goal calling for reduction, based on the 1923 record, of 35 per cent in casualties to employees on duty, Class I railroads, by pacts under traffic, as more and more is deposited, until eventually the wheels of a passing train are lifted up and over the rail. Highway repairmen operating road-scrapers are sometimes careless or ignorant of these dangers. Track foremen should make it their duty to advise all such persons of the possible consequences of this dangerous practice.

So far very little has been said about inspections. It is, however, by regular and careful track inspections that incipient dangers may best be found and corrected. The trackmen, the foremen and the supervisors should train most carefully the men upon whom they are to rely. With sections rapidly becoming larger and longer, it is not always possible for the foreman to supervise his gang and also patrol his track. The track inspector therefore becomes the first line of defense. He must be able to think clearly and rapidly in whatever emergency may arise, always remembering that the safety of the train service rests in his hands.

Moreover, the foreman himself must be ready at all times of high wind, heavy rain, or any unusual weather conditions to patrol his track, and to him is given the power to preserve the lives of passengers and trainmen, and to him is given the privilege of speeding up the wings of transportation.

WEDNESDAY MORNING SESSION

October 3, 1934

Report of Committee on Prevention of Highway Crossing Accidents

By H. A. ROWE

Manager, Claims Department, Delaware, Lackawanna and Western Railroad, New York City

The speaker said in part: The report of this committee for the year 1933 again shows a slight reduction in the number of accidents and fatalities at railroad highway crossings and a substantial reduction in the number of injuries for the fifth consecutive year since the year 1928. The record is as follows:

Year	Accidents	Fatalities	Injuries
1928	5,800	2,568	6,667
1933	3,235	1,511	3,697
Reduction	2,565 (44%)	1,057 (41%)	2,970 (44%)

Casualties during the four months of June, July, August and September in the Careful Crossing Campaign, compared with the same period, 1928 to 1933, inclusive, were as follows:

Year	Accidents	Fatalities	Injuries
1928	1,790	858	2,092
1929	1,827	749	2,140
1930	1,371	640	1,505
1931	1,103	496	1,196
1932	899	432	1,022
1933	990	491	1,124

It will be noted that automobile registration in 1933 was 23,827,290, and represents an increase of 1.4 per cent over the preceding year; this is quite comparable with the number of automobiles registered in the peak year of crossing accident casualties.

Gasoline consumption, which is a fair barometer of automobile use, was 16,025,-562,000 gallons during the year 1933; which is an increase of a trifle less than 2 per cent over the preceding year. The increasing use of smaller cars with greater mileage per gallon of gasoline, indicates that the traffic over and across railroad tracks was fully equal to that of 1932.

which one is to train another. In safety it is knowledge of safe practices. These are shown by the causes of accidents and by job analysis. When safe practices are reduced to writing they are usually called rules, or at least they are equivalent to rules. Therefore, if all safe practices in any occupation were reduced to rules and if complete obedience to such rules were secured, it would insure complete immunity from accidents from man failure. This means that the first step in safety is to provide adequate rules; the second step is for local officers and supervisors (the teachers) to know and understand the rules; and the third step is to see that the employees know, understand and obey the rules. In consonance with these observations, the following items are presented for the consideration of the Safety Section as some of the essential elements in an effective safety program:

1. A comprehensive set of safety rules outlining the safe ways of working.
2. A practical, working understanding of the rules or safe practices by all local officers, supervisors and employees, to be assured by suitable examinations.
3. Invariable obedience to all rules, violations not resulting in accidents representing the same degree of culpability as when accidents do result from such violations.
4. Definite and not perfunctory observations by local officers and supervisors to detect violations of safety rules and formal report of violations detected as a requirement of management.
5. Formal disciplinary action on proven violations, with entry on discipline record covering every case.
6. A monthly and cumulative record of the violations of rules or unsafe practices detected by each local officer and supervisor, and a monthly summary by departments for divisions and system.
7. All accidents, regardless of how trivial, shall be reported and investigated promptly to determine cause, responsibility and disciplinary action to be taken where responsibility is shown.
8. Investigation should invariably develop an answer to these two questions: (a) Was accident due to the violations of a rule? (b) If not, should a rule be provided?

TUESDAY AFTERNOON SESSION

October 2, 1934

The "Green Book"

By LEW R. PALMER

Secretary, Committee of Award, Railroad Employees' National Safety Contest and Conservation Engineer, Equitable Life Assurance Society, New York City

The speaker said in part: The year 1933 ended the ten year period of the Railroad Employees' National Safety Contest as set up by the National Safety Council and recorded in the respective issues of the "Green Book."

A constant study of railroad safety contest records during a period of ten years has established what I believe to be a fundamental fact: that it is necessary to break down our entire Class I railroad exposure into a sufficient number of competing groups so that there will not be too wide a variation between the man-hour exposure of the largest group contender as compared with the man-hours of the smaller contenders in the same group; otherwise, the larger unit, with its more uniform casualty rate, will be handicapped by the more widely fluctuating rates of the smaller contenders; for it is generally recognized that under normal conditions the greater the man-hour exposure the more uniform the casualty rates are year by year.

For that reason, the revised plan suggested for the 1934 Railroad Employees' National Safety Contest includes six groups for standard Class I railroads and two groups for switching and terminal roads, it being a matter of record in connection with switching and terminal roads that a great deal more interest has been developed in our annual contest since these roads were given what was considered a fighting chance for competitive honors.

in this safety movement. But I now realize what it means to me, and you can rest assured that never again will I do that kind of work without my goggles on."

That is some more supervision. Notice the results. Don't think for a moment that I am deprecating punishment for non-enforcement of rules. Safety rules should be adopted and they should be rigidly enforced by whatever methods are necessary to cause the employee to comply with them. But enforcement is only a part of supervision.

Here is some more supervision that brought good results. On the Wabash Railway this year we laid 60 miles of new 110-pound steel. We had a gang of 115 or 120 section men engaged in that work. About the time they started this work we happened to have a division safety meeting within four or five miles of where this camp was. The supervisor, a Mr. Watkins by name, loaded his fellows up and brought them in to the safety meeting.

I was there and I told them just how to do their job without anybody getting hurt. About three months later, they completed that job, and not a single man had been injured.

WEDNESDAY AFTERNOON SESSION

October 3, 1934

Interesting Employees in Looking After Their Own Safety

By J. CLYDE MIXON

Chief Clerk to General Superintendent, Northern Division,
Atlantic Coast Line Railroad Company, Savannah, Ga.

The speaker said in part: One of our South Carolina philosophers, Bob Quillan, once said: "If we would pray more often for common sense, we would not have to pray for rain." Expand that thought for yourselves. Safety is common sense in action.

"Interesting employees in looking after their own safety" is but another way of saying, "Sell the idea of safety to your men." Before one can sell anything to someone else one must sell oneself. You may be sure that in a section where there is a poor safety record it is primarily the result of the indifference of a supervisory officer, or the result of his inability to sell the idea to his men and keep them sold on it.

We must keep everlastingly at this proposition of safety. A wise man who lived in the Orient once said: "Nothing is ever definitely finished among men, for each thing stops only to begin again." We can put that down as a law of nature. It has been said that "eternal vigilance is the price of safety", and that is quite true. We must constantly drive home the doctrine of safety mindedness.

If the supervisor is indifferent, there isn't anything to do about it but "decapitate" him, and the sooner the better, because it is an indication not only of narrowness but of his unworthiness to be a leader of men and a representative of enlightened management.

It should not be difficult to get men interested in looking after their own safety. The first law of nature, the law of the jungle, the law of self-preservation, is or should be invoked by every worker. It requires some time, however, for men to be sold on this idea—that they must look after themselves. There is also, of course, the appeal to a man's higher nature, the duty he owes to his family, then to his fellow workers and the public whom he serves.

But I want to approach this subject largely from the angle of responsibility and the opportunity of the supervising officer. It thrills me sometimes when I think of the opportunities the supervising officers—the foreman, the master mechanic, the trainmaster, the superintendent—have if they exert themselves as the leaders of the men working under their supervision. What an opportunity this man has to accom-

SAFETY AND HEALTH
STANDARDS

*For Contractors
performing Federal Supply
Contracts under the
Walsh-Healey Public Contracts Act*

UNITED STATES DEPARTMENT OF LABOR
MAURICE J. TOBIN, *Secretary*

Wage and Hour and Public Contracts Divisions
WM. R. McCOMB, *Administrator*
WASHINGTON, D. C.

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U. S. DEPARTMENT OF LABOR

OFFICE OF THE SECRETARY

WASHINGTON

The progress and achievements that have been evident in the field of industrial safety have been a source of satisfaction to both State and Federal Governments. It is generally recognized, however, that there is still a sizeable job to be accomplished and the Department of Labor desires to lend all possible assistance to industry in continuing this progress toward maintenance of safe and healthful work places.

The standards in this bulletin are minimum standards only, and have been developed primarily as a guide to contractors in complying with the safety and health provisions of the Walsh-Healey Public Contracts Act. I am fully aware that many States and industrial establishments have developed codes and standards that are broader and more comprehensive. It is good to know that these higher standards will be applied in most establishments with Government contracts. Where safety has lagged behind the general progress, I trust that this bulletin will prove useful as a beginning in the development of standards and programs designed to improve the safety and health of workers in those areas and industries.

I have therefore arranged to have copies of this bulletin made available upon request. They may be obtained from any of the Wage and Hour and Public Contracts Divisions offices throughout the country.

Maurice J. Tobin

Secretary of Labor

FOREWORD

The Walsh-Healey Public Contracts Act requires that contracts entered into by any agency of the United States Government for the manufacture or furnishing of materials, supplies, articles, and equipment in any amount exceeding $10,000 must contain, among other provisions, a stipulation that "No part of such contract will be performed nor will any of the materials, supplies, articles, or equipment to be manufactured or furnished under said contract be manufactured or fabricated in any plants, factories, buildings, or surroundings or under working conditions which are insanitary or hazardous or dangerous to the health and safety of employees engaged in the performance of the contract * * *."

This booklet contains three parts: Part I sets out the principal factors which have induced managements to install systematic safety programs and lists the basic day-by-day accident prevention practices employed; parts II and III set out the minimum safety and health standards, respectively, which will be applied by the Secretary of Labor and the Administrator of the Wage and Hour and Public Contracts Divisions in determining whether, in specific cases, Government contracts are being performed under safe and sanitary conditions as required by section 1 (e) of the act. These standards are based to a large extent on standards approved by the American Standards Association and safety and health codes adopted by a number of States, and generally represent what have been shown by industrial experience to be reasonable minimum standards for safety and health.

Changing industrial processes and materials may introduce new safety and health hazards which require constant attention if a realistic preventive program is to be carried on. Space limitations of this bulletin permit compilation only of those standards relating to safety and occupational health problems which are commonly met by employers, and preclude inclusion of materials relating to uncommon hazards or situations. The measures to be taken to meet uncommon hazards should be reasonable in the light of the circumstances. Further, these standards are not in any way intended to limit or supersede State or local safety and occupational health codes, and where such codes provide stricter or more exact standards, compliance with such higher standards will be deemed compliance with the Public Contracts Act.

Some of the types of work discussed in this bulletin involve hazardous occupations for which higher minimum ages are provided under State child labor laws or the child labor provisions of the Fair Labor Standards Act than under the Walsh-Healey Public Contracts Act. The higher age limits prescribed for such hazardous occupations under such other laws are not superseded or modified by the safety standards contained in this bulletin.

The failure to maintain proper safety and health standards in the performance of contracts subject to the Public Contracts Act constitutes a breach of contract which may provide the basis for cancellation of the contract, and makes the party responsible for such breaches subject to the ineligible list sanctions provided in the act.

These standards were prepared by the Bureau of Labor Standards in cooperation with the Wage and Hour and Public Contracts Divisions and the Office of the Solicitor, and checked for adequacy and suitability for use in the States with representatives of typical State labor departments. Assistance on the sections concerning occupational health requirements was furnished by the Division of Industrial Hygiene of the U. S. Public Health Service. We wish to take this opportunity to thank these officials for their assistance in making this publication possible.

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PART I.—SAFETY AND HEALTH PROGRAMS PAY DIVIDENDS

Hard, cold statistics on industrial accidents in the United States tell a tragic and revealing story. These figures deal with the number of people killed and injured in industrial accidents. Sometimes figures are used to estimate the billions of dollars that are lost by management and by workers and their families as a result of accidents.

But there are no statistics on the human suffering, sorrow, and misery which follow deaths and injuries into the homes of American workers, even though the human tragedy which stalks after industrial accidents affords the most impelling reason for intelligent safety programs.

Although the most important consideration in any safety program is the safety and well-being of the worker and the protection of his family from want, another driving force behind industrial safety programs is the cost of accidents in terms of money and human resources—a tragic economic waste.

A third reason for undertaking good safety programs applies primarily to contractors performing on certain Government supply contracts of $10,000 or more subject to the safety requirements of the Walsh-Healey Public Contracts Act. Part I represents in briefest form basic information drawn from the day-by-day practice of managements whose safety performance deserves top-grade ranking in terms of the elimination of employee injuries. While more information could well have been included, this presentation was purposely limited to a few major items for greater emphasis.

A. ACCIDENT COSTS

Accidents are expensive. They constitute a serious wastage of our human and material resources. Substantial savings of both can be made by preventing accidents. They can be prevented by appeals to the emotions and by persistent day-by-day effort to enlist on the side of safety the ever-present desire and necessity that every management has for reducing waste.

Everyone can easily see that accident costs are wholly waste. It is not so easy to see how large are these wastes. Compensation and medical costs (spoken of as direct costs) are obvious. It has, however, taken careful studies by experienced cost accountants and industrial executives to show how large are the other costs (spoken of as indirect costs). It is now clear that on the average the indirect costs of accidents in industry are not less than four times the direct costs. The items of cost that are likely to be present in each case of accidental injury are:

1. Compensation.
2. Medical expense.
3. Lost time of injured employee.
4. Lost time of fellow employees who stop work:
   - *(a)* To aid injured worker.
   - *(b)* Out of sympathy or curiosity.
   - *(c)* For other incidental reasons.
5. Time of foreman, executives, or other staff personnel:
   - *(a)* Assisting injured employee.
   - *(b)* Investigating cause of accident.
   - *(c)* Arranging for continuance of injured employee's work.
   - *(d)* Selecting, training, or breaking in new employee.
   - *(e)* Preparing accident report.
   - *(f)* Attending hearings on injury (serious or contested cases).
6. Lost production due to upset, shock, or diverted interest of workers.
7. Lost production due to stoppage of machine or process in charge of injured person.
8. Damage to machine, equipment, or material directly occasioned by the accident.
9. Spoiled product or material due to emotional upset of fellow workers.
10. Lessened effectiveness of injured employee for a period after his return to work.
11. Business or good will lost through failure to fill order on time, lost bonuses, payment of forfeits for nondelivery, etc.
12. Legal expense, court fees, expense of preparation of case, settlements, judgments, etc., in cases contested at law.
13. The employer's share of the loss and expense to society in each case of death or continued loss in earning power.

B. MANAGEMENT'S PART IN HEALTH AND SAFETY

Safety work in industry must begin at the top. Since every kind of work that men do involves some degree of hazard, each produces its share of injuries. But by the proper attention to safety almost all injuries can be prevented in any kind of work and in any occupation. Management's desire to eliminate injuries should be strong enough to make their prevention a vital part of all activities. Prevention must receive continuous attention along with such matters as cost, quality, and production.

Very briefly, the more important definite things that the management should do to prevent accidents may be set down as follows:

1. Provide safe plant and equipment.
2. Safeguard all machinery.
3. Place no new machinery or equipment in operation unless full attention has been paid to its safety.
4. Plan and arrange all processes and operations with careful attention to safety.
5. Maintain a system of inspection to discover correctible hazards.
6. Maintain safety-minded supervision.
7. Train, educate, and stimulate its employees to follow safe methods of work and take a sincere interest in the safety of themselves and their fellow workers.
8. Investigate all accidents to determine how best to prevent a recurrence.
9. Make a full report to the proper authorities of all cases of injury.

C. THE WORKER'S PART IN HEALTH AND SAFETY

Safety is everybody's business. Every employee should, of course, be always alert to the possibilities of injury. Management can do only part of the job. Each worker should faithfully cooperate with his management in all safety programs. Some of the ways in which his help is most necessary are:

1. Faithfully using all safeguards provided.
2. Studying and carefully following safety rules and safety instructions.
3. Working earnestly on safety committees or other safety activities to which he may be assigned.
4. Seeking always for the safe way of working on each job or activity.
5. Watching out always for the safety of his fellow men.
6. Reporting all hazardous conditions of which he learns.

D. HEALTH AND SAFETY COMMITTEES

A safety committee when properly set up and maintained can be an extremely effective tool for accident prevention. The functions of such a committee should include the responsibility for periodic inspections of the plant; review and approval of inspection reports; analysis of causes of accidents for the purpose of submitting recommendations to prevent recurrence of similar accidents; instructing new employees or workers transferred to unaccustomed tasks to the hazards of their work, and promoting the education of all employees in safety practices. The committee should meet at least monthly and keep a written record of the number and nature of its recommendations; the number carried out; the number incompleted; and the number not acted upon. The members of the committee should be selected from the various departments and should be changed at regular intervals.

The advisable committee set-up depends chiefly upon the size of the establishment but other factors have a bearing, such as the progress that has been made in safeguarding the plant when committee work is started, the size and relationship of the various departments or plant units, the type of business (manufacture, construction, transportation, public utilities, etc.). However, at least the following fundamentals should be met in forming the committee or committees decided upon:

(a) Each committee should be so made up as to have standing appropriate to its field of work. For instance, a main or governing committee should include such key executives as master mechanic and production manager. A workers' committee should be made up of members well known to and having the respect of their fellow workmen.

(b) The committee membership should encompass the maximum in knowledge of the methods, practices, and conditions in the plant, undertaking, or group represented.

(c) The committee should be as small as is consistent with the above requirements. A committee of three functions more effectively than one of five. The larger the committee the more the debate and the less the action.

When a committee is formed, certain matters of policy and procedure should be definitely set forth in writing. Written instructions should cover at least:

(a) Scope of committee activity.
(b) Extent of committee authority.
(c) Procedure as to:
  (1) Time and place of meetings.
  (2) Frequency of meetings.
  (3) Order of business.
  (4) Records to be kept.
  (5) Attendance requirements.

A committee will take its work seriously in proportion to management's attitude toward it.

A management that sets up a committee to accomplish a specific purpose, makes it clear that it wants results and gives effective executive supervision to its activities, will get satisfactory results therefrom. Effective committee conduct of safety work in the absence of executive leadership is possible only when committee members have unusual initiative and determination to advance the cause of safety. In such instances they often convert the nonsafety-minded management. Sometimes the "salesman" of safety, failing to arouse adequate management interest, can accomplish his purpose by getting a safety committee organized and aid it to plan a program that will interest the top management, thus at the same time getting safety work started.

E. ACCIDENT INVESTIGATION

It is obvious that every case of disabling injury should be carefully investigated to find out how to prevent a recurrence. In theory every accident, whether it yields an injury or not, should be investigated also, but this would involve such a heavy volume of work that few managements would find it practical. Good practice is to investigate all cases of disablement, all other happenings involving the probability of serious injury, and cases of repeated injury to an individual.

The investigations must be made by persons who are intelligent, painstaking, and keenly safety-minded. Usually an accident has more than a single cause. A combination of circumstances was necessary to bring it about. The employer should try to correct every condition or circumstance that might lead to injury. He should particularly not be content to stop with finding the human fault or failure that was involved, for in almost every case, both a material and a human fault will be found. If the material fault or lack is corrected, the human fault or lack usually fails to produce injury. Of course, effort should be made to correct the human fault also. Usually correction of the material or mechanical fault involves expense so that the constant temptation is to blame the individual at fault and let the matter end there. That is not in the best interests of safety, and the tendency to take that course must continuously be resisted.

F. ACCIDENTS ARE PREVENTABLE

An excellent definition of "accident" is that it is an "unexpected occurrence," that is, unplanned for or unforeseen. Occasionally, human injury is involved and we have an accidental injury which is what we really mean when we say "accident." If each bit of work done in industry could be properly planned and then carried out exactly as planned, there would be no unexpected occurrences and therefore no human injuries. Numerous establishments, large and small, in each branch of industry have by planning, foresight, and care eliminated at least 9 out of every 10 injuries that otherwise would have been suffered by their workers and have profited by so doing.

PART II.—REQUIREMENTS

Records of Injury Frequency Rate

Every person who is or shall become a party to a Government contract which is subject to the provisions of the Walsh-Healey Public Contracts Act and the regulations thereunder, or who is performing or shall perform any part of such contract subject to the provisions of such act or regulations, shall maintain injury frequency rates as defined herein and such rates shall be calculated quarterly on a calendar basis commencing the first of January of each year.

Such records shall be kept on file for at least three years after the date of entry thereon and shall be made available for inspection by authorized representatives of the Secretary of Labor.

Frequency Rate

Injury-frequency rates are the primary measures of the incidence of work injuries. The lack of comparability inherent in simple injury totals, arising from variations in employment and operating time, is overcome by expressing the injuries in terms of a standard unit of exposure. By definition, the standard comparison injury-frequency rate is the average number of disabling work injuries per million employee-hours worked. Expressed as a formula it is:

$$\text{Frequency Rate} = \frac{\text{Number of disabling injuries multiplied by } 1{,}000{,}000}{\text{Total number of employee-hours worked}}$$

What Injuries To Count

A disabling work injury is defined as any injury incurred in the course of and arising out of employment, which:

(1) Results in death, or

(2) Results in any degree of permanent physical impairment, regardless of whether or not any time is lost from work, or

(3) Renders the injured person unable to work at any regularly established job, which is open and available to him, throughout the hours of his regular shift on any day after the day of injury, including Sundays, holidays, and days on which the plant is shut down.

The injuries described in items 1 and 2 of this definition are commonly spoken of as "death cases" and "permanent disability" cases. Death cases usually are readily identified. Permanent disabilities likewise are usually easy to identify. It is necessary, however, to remember that permanent disabilities include not only all injuries involving the amputation of any part of the body, but also all injuries which result in the complete or partial loss of use of any body part or function of the body. For example, the partial loss of vision or a permanently stiff arm resulting from a poorly healed fracture would be counted as permanent impairments just as you would count an injury involving the amputation of a finger or a foot. Most permanent disability cases involve the loss of considerable time. Occasionally, however, there are hardy individuals who experience a minor permanent disability, such as the amputation of the end of a finger, and return to work on the same day or the following day. Regardless of the fact that no recorded time was lost, these cases should be counted if there actually is any residual permanent impairment of any body part or body function.

The third category of disabling injuries is referred to as "temporary-total disabilities." They are "temporary" disabilities because they do not result in death or any form of permanent impairment. In other words, they are injuries from which the injured person eventually recovers with no lasting ill effects. At the same time, they are "total" disabilities because they render the injured person totally unable to work at any regular job for a period of time equivalent to at least one full shift on any day after the day of injury. The important things to remember in connection with these injuries are: (1) Time lost on the day of injury is not considered in determining whether or not an injury is disabling; (2) the inability to work must continue throughout the hours of the worker's regular shift on at least one day; but, (3) this inability to work may occur on any day after the injury, not necessarily on the next day, and not necessarily on a day on which he would normally be expected to work.

The reference in the definition to a regularly established job means that you are not permitted to exclude an injury from the count of disabling injuries if the injured person returns to a specially created easy job which was designed simply to get him back to work without loss of time.

It should also be noted that under the definition of a disabling injury the reportability of an injury for injury-statistics purposes is in no way related to the eligibility of the injured person for workmen's compensation payments. In case of doubt as to whether or not an injured person is able to work, the attending physician's decision is final.

Establishments participating in the Bureau of Labor Statistics' quarterly work-injury survey and retaining on file copies of each completed report on Form BLS 1417 or 1417-A will be considered as complying with the requirement regarding the maintenance of injury-frequency rates.

For every-day use, the frequency rate affords the best measure of performance because each accident might easily, "but for the grace of God," have been very serious or fatal, and therefore the constant effort must be to prevent every injury, not just the more serious ones. The following example shows how to figure the frequency rate.

During 1949 eighteen lost-time injuries occurred in a certain machine shop. The number of man-hours worked during the year totaled 216,000. What was the frequency rate? Substituting these numbers in the frequency rate formula we get:

$$F = \frac{18 \times 1{,}000{,}000}{216{,}000}$$

which gives a frequency rate of 83 plus. That is, the men in the shop suffered 83 lost-time injuries for every million man-hours they worked.

If the figure for man-hours is not available, a close enough estimate can usually be made by multiplying the average number of workers by the hours worked per week and the number of weeks worked for the period for which the frequency rate is being calculated.

Some people prefer to think of the frequency rate in terms of how long a person may expect to work on the average without getting hurt. If, in the above example, the shop worked a 40-hour week 50 weeks during the year, each man worked 2,000 hours in the year, and therefore in order to put in 216,000 hours there must have been an average of 108 men working. The 18 injuries averaged among these 108 men means that every sixth man was disabled during the year. Another way of putting it is that, on the average, each man could expect to be disabled once in 6 years. That is a very high injury rate for even the most hazardous work. Numerous plants in all branches of industry maintain frequency rates below 10 and often times below 5. A worker in a plant having a frequency rate of 5 is fortunate indeed for on the average he can expect to work three lifetimes—a whole century—for each disabling injury he suffers. He is undoubtedly much safer when at work than when not at work.

(For full detailed information on determining frequency rates see "American Standard", *Method of Compiling Industrial Injury Rates,* Z16.1.[1])

B. BUILDINGS AND EQUIPMENT

1. **Buildings.**—Buildings and all appurtenances thereto, including bridges, towers, balconies, runways, and platforms, should be structurally safe to prevent collapse.

2. **Floors.**—*(a)* No floor or platform should be so loaded as to have a factor of safety of less than four. That is, the weight placed upon a floor or platform should not exceed one-fourth of the breaking strength of the platform or floor.

(b) Floors, other than those resting directly on solid ground, when used for storage or for operations that might lead to overloading should be clearly posted to show maximum safe floor loads.

(c) All floor surfaces should be kept clean and dry and maintained in a smooth and reasonably nonslippery condition free from holes or projections that might cause tripping.

(d) Where the type of operation necessitates working on wet or slippery floor areas, such areas should be protected against slipping by the use of mats, grates, cleats, or other high friction floor coverings.

(e) Safe means of access, suited to conditions, should be provided to every overhead point to which employees are called upon to go in connection with their employment. Materials or objects should not remain unnecessarily on the floor surface in such places as will subject employees to the hazard of falls.

3. **Floor openings, wall openings, and elevated platforms.**—Floor openings, wall openings, and elevated platforms where there is a possibility of persons or material falling through should be provided with standard railing and toe boards, or with wood or metal covers. Where guard rails are advisable refer to Standards for *Railings, Toeboards, and Guards* as specified under Part II E, Machine Guarding.

4. **Stairways or Steps.**—*(a)* Riser height and tread width should be uniform in any given flight of stairs. Variations in riser height should not exceed 1/8 inch in the stair as constructed. Variation due to wear should not be allowed to exceed 1/4 inch. Riser height should not be over 8 inches and tread width exclusive of nosing not less than 9 inches. Preferred dimensions are: riser 7 inches, tread 11 inches plus 1 inch nosing, and width not less than 36 inches.

(b) Every stairway or steps of four or more risers should be equipped with a substantial smooth handrail from 30 inches to 36 inches high, measured vertically from the nose of the tread and placed on the left-hand side as one mounts the stair and on the open side, if any. If 5 feet or more in width, or open on both sides, the stairs should have a handrail on each side.

(c) Interior stairways or steps which are more than 8 feet wide should be divided by center rails into widths of not more than 8 feet nor less than 3 feet 8 inches.

(d) Exterior stairways or steps should have a handrail at each side, and if the stairway or steps are more than 88 inches wide, one or more intermediate handrails should be provided.

(e) Railings on open sides of stairways or steps should be provided with an intermediate rail at midheight, or with vertical members having a maximum spacing of 11 inches.

(f) Every stairway or steps should be maintained in good repair, free from protruding bolts, screws, and nails, and unnecessary material, dirt, and slippery conditions. Treads should be renewed when the surface, including the nosing, shows wear to the extent of 1/4 inch or more.

(g) Stairways should not be used for storage purposes, and any equipment should be so located that its presence or use will not unnecessarily obstruct or interfere with free passage.

(h) All metal treads should have a surface which will reasonably prevent slipping.

5. **Elevators.**—*(a)* Elevator inspection by a recognized elevator inspection service will be acceptable as evidence of satisfactory installation and maintenance. Hoistways, hatchways, elevator wells and wheel holes should be securely fenced, inclosed, or otherwise protected. (For details, see American Standard Safety Code for Elevators, Dumbwaiters, and Escalators.)

(b) Elevator machinery, electrical apparatus, or system wiring should be properly installed, guarded, and inspected.

6. **Illumination.**—Illumination adequate to permit all work activities to be carried on safely should be provided and maintained during all work periods. Minimum standards for illumination should be in conformance with the "American Standard," Recommended Practice of Industrial Lighting.

7. **Aisles and passageways.**—*(a)* Permanent aisles and passageways should be kept clear and in good repair. Where, due to lack of proper definition, such aisles and passageways become hazardous, they should be clearly defined by painted lines, curbings, or other methods of marking.

(b) Where industrial trucks are in customary use, one-way traffic aisles should be at least 2 feet wider than the widest vehicle. Two-way traffic aisles should be at least 3 feet wider than twice the width of the widest vehicle.

(c) There should be no obstructions across or in aisles that might cause tripping.

[1] Published by American Standards Association, 70 E. 45th St., New York City.

8. **Ladders.**—*(a)* Full compliance with the applicable provisions of the "American Standard", Safety Code for Wood Ladders, A14.1, is recommended.

(b) Rung spacing on each fixed ladder should be uniform. This includes the space between the top rung and the landing measured vertically from the top rung. Rungs of all ladders should be uniformly spaced, firmly secured and maintained in a sufficiently tight condition to prevent turning or other motion. Bent rungs of metal fixed ladders should be promptly replaced or repaired. Clearance at the back of rungs of fixed ladders should not be less than 6½ inches measured horizontally from any object.

(c) Fixed ladders should be secured with sufficient firmness and in such manner that they will be free from visible motion under normal conditions of use. Hand holds should be provided at the top of each fixed ladder so arranged that a person using them can conveniently retain a secure hold with either hand when stepping from the top rung of the ladder to the landing point or the reverse. Side rails should extend above landings at least 3 feet. No fixed ladder should have a slope outward, that is, from the vertical toward the climber, unless such sloping ladder or sloping part thereof is properly caged. Ladders in disrepair should be promptly repaired or removed from use.

(d) In the use of portable straight ladders, practicable precautions should be used. Every step ladder should be equipped with a spreader of a type that locks when the ladder is opened to hold it securely in the open position. Portable steps and saw horses should be of substantial construction with parts firmly secured and maintained in a safe state of repair.

9. **Overhead work.**—*(a)* Every overhead job that may have to be done in an establishment should be carefully considered and a safe means of doing it provided.

(b) Some of the more common "overhead" jobs with means of safeguarding are given below:

(1) *Nature of job.*—Devices that require only infrequent attention normally consisting of only simple servicing or adjustments. Examples: Valves in steam, air, or other supply lines; pressure reducers; overflow or other high level storage tanks; liquid level indicators; gauges; natural draft ventilators.

Suggested safeguards. — Portable ladders: Feet suited to floor surface; ladder of correct length, strength, and condition conveniently available, firm support (at top), security (of position), safety in placing ladder, safety of man on ladder (position, clearance from moving parts, electrical conductors, steam pipes, etc.).

Good practice provides fixed ladders or stairs to such equipment wherever reasonably possible.

Good design eliminates overhead locations to the maximum practicable extent.

(2) *Nature of job.*—Devices that require rather frequent (as weekly) servicing usually involving only minor attention or adjustment. Examples: Ring oiler (or equivalent) bearings, induction motors, storage tanks, exhaust fans.

Suggested safeguards.—Railed and toeboarded platforms reached by stairs should be provided wherever space and location permits. Fixed ladders are preferable to stairs steeper than will give a 10 inch rise and 8 inch tread (pitch about 51°). Where location prevents stair or fixed ladder, provide portable railed step or portable ladder suited to the purpose with hooks fixed to the rails to engage suitable supports at the platform.

(3) *Nature of job.*—Apparatus that requires daily or more frequent servicing. Examples: Control devices as governors, regulators, recorders, sight glasses, etc.

Suggested safeguards.—Every such point should be accessible by a platform and stair. In some cases they can be serviced from the floor. Example: Use of telescope to read thermometers on tall apparatus.

(4) *Nature of job.*—Equipment that requires relatively infrequent attention but which involves major cleaning or maintenance and repair work. Examples: Electric overhead traveling cranes (overhauling), steam boilers (retubing, cleaning tubes), stills, fractionating columns, digesters, etc.

Suggested safeguards. — Railed and toeboarded platforms reached by stairs wherever possible. Particularly in crane overhauls such platforms cut the cost of the work, result in better maintenance, and reduce the hazard, thus justifying very substantial expenditures for the platform. If fixed platforms are not practicable, provide substantial "knock-down" scaffolding (railed and toeboarded) kept for the purpose. In some cases wheeled platforms (wheels arranged to lock) are convenient.

(5) *Nature of job.*—Apparatus out of doors. (Assignable to above classes but listed here because of the special hazards due to wind, ice, cold, etc.) Example: Sprinkler tanks, oil storage tanks, derricks, coal unloaders, dust collectors, advertising signs, flood lights.

Suggested safeguards.—All outdoor tanks should be equipped with fixed ladders and self-draining platforms (if needed) to give safe access to manholes, etc. Means of access to bearings, etc., on derricks and coal unloaders must be suited to conditions. Never omit ladder rails or allow ladder to have reverse slope; provide adequate hand holds and foot supports.

(6) *Nature of job.*—Maintenance activities, as window cleaning and reglazing, paint-

ing, replacing lights, painting masonry, oiling, and other work on overhead shafting.

Suggested safeguards. — Window cleaning equipment should conform to the "American Standard," Safety Code for Window Cleaning.

Long spout oil cans can be used instead of ladders. The practice of oiling running overhead machinery is rarely carefully planned. When done from a crane, a railed platform should be provided and careful precautions taken to guard against insufficient clearance. Extension fittings should be used to give adequate clearance from moving parts.

10. **Housekeeping and order.**—*(a)* Satisfactory control requires careful consideration of such factors as tonnage and volume of materials to be handled, the amounts required at the successive steps of the process, allowance of the spaces necessary, and the methods to be used in handling and transporting the materials and articles.

(b) Methods of piling should be worked out for each class of materials or articles. Points commonly of importance are:

(1) *Height of pile.*—This is dependent upon the character of the material and the consequent danger of toppling, the means used in piling and removal, the traffic nearby, and interference with sprinkler operation. When the nature of the material is suitable, it should be so piled as to be interlocking.

(2) *Strength of support.*—Allowable floor loads should be posted.

(3) *Evenness of support and its continued stability.*—This condition often exists in yard piling where uneven ground or moisture may cause toppling, and on first floors or in basements where floors may slope or flooring sag.

(4) *Location.*—Aisle traffic or the presence of work benches or machines may make it necessary to limit the height of material to be piled in a safe manner.

(5) *Piling small articles.*—Containers suited to the nature of the articles are commonly used. These usually take the form of wheeled or truck pick-up containers that receive the articles from work bench or machine. A useful modification for such articles are small cans or trays that themselves may be stacked.

(6) *Pipe or other long stock.*—Suitable racks aid handling. Projecting ends should be protected by location, railings, or barriers.

(c) Remove, or bend over in such a manner as to make them harmless, all projecting nails in kegs, barrels, boards, or boxes allowed to remain about the work place.

(d) Waste disposal provisions should be made for the orderly collection and disposal of all scrap debris, empty bottles, etc.; special provisions suited to the nature of the substance in question should be made for the disposal of poisonous and obnoxious substances.

11. **Yards and grounds.**—In plant yards and grounds, safety measures include:

(1) Proper drainage.

(2) Clearance signs to warn of limit clearances.

(3) Derails and bumper blocks.

(4) Traffic control signs to warn pedestrian, vehicular, and railroad traffic.

(5) Proper coverings or rails for open pits, tanks, vats, ditches, etc.

12. **Materials.** — *(a)* Materials, wherever stored, should be piled, stacked, or racked in a manner designed to prevent tipping, falling, collapsing, rolling, or spreading. Racks, bins, planks, sleepers, bars, strips, blocks, and sheets should be used where necessary to make the piles stable. Materials and objects that are stored in overhead places should be secured so that they will not fall and cause injury to persons below.

(b) All hazardous chemicals should be distinctively marked to indicate their nature.

13. **Compressed Gases.**—*(a)* Cylinders containing compressed gases should not be unduly exposed to the heat of stoves, radiators, or furnaces. Where cylinders are stored in the open, they should be protected from accumulations of snow and ice and from the sun where high temperatures occur.

(b) Heat increases the pressure within the cylinder, or it may melt the fusible safety plugs, which in acetylene cylinders melt at a temperature of approximately 210° to 220°F. Should a valve become frozen, it should be thawed out with warm (not scalding) water. Open flames should not be used for this purpose under any circumstances.

(c) Cylinders should preferably be stored in an upright position. In many plants, cylinders are held upright by straps or chains to prevent their falling over. This is particularly important with acetylene cylinders.

(d) Empty cylinders should be plainly marked EMPTY, and the valves should be closed. The empty cylinders should be segregated from full cylinders and returned to the manufacturer as soon as practicable.

(e) The recommendations of the National Fire Protection Association and State and municipal laws and regulations should be closely observed in regard to the storage of compressed gas cylinders. Cylinders should never be allowed to fall or otherwise receive shock.

14. **Special precautions for oxygen cylinders.**—(a) Great care must be exercised in handling oxygen to prevent contact of oxygen under pressure with oils, greases, organic lubricants, rubber, or other materials of an organic nature in order to prevent explosion. The following recommendations of the Compressed Gas Association should be observed:

(1) Never permit oil, grease, or readily combustible materials to come in contact with oxygen cylinders, valves, regulators, gauges, or fittings.

(2) Never lubricate regulators, fittings, or gauges with oil or any other combustible substance.

(3) Never handle oxygen cylinders or apparatus with oily hands or greasy gloves or rags.

(4) Always clear the particles of dust and dirt from the opening to each cylinder by slightly opening and closing the valve before applying any fitting to the cylinder.

(5) Never permit oxygen to enter the regulator suddenly. Open the valve slowly. When opening the valve, point the face of the gauge on regulator away from the operator.

(6) Never drape an oxygen cylinder with any material such as wearing apparel, rags, etc.

(7) Never use oxygen fittings, valves, regulators, or gauges for any other service except oxygen.

(8) Users should never mix gases of any type in an oxygen or any other cylinder.

(9) Never use oxygen from a cylinder except through a pressure reducing regulator.

(10) Never attempt to use regulators which are in need of repair or cylinders having valves which do not operate properly.

(11) Never attempt to repair defective oxygen equipment unless properly qualified by knowledge and experience.

15. **Flammable liquids.**—Materials such as paints, lacquers, thinners, gasoline, and naptha should be stored and handled with provisions for safety suited to the material and the conditions of its use. They should also be covered or stored in an approved type of safety container suitable to the nature of the material.

16. **Explosives.** — Explosives should be stored in approved type explosive magazines which are bulletproof, ventilated, and located at distances from other buildings as required under the American Table of Quantity and Distance. For details, refer to U. S. Bureau of Mines Information Circular 7307 on "Surface Storage of Explosives" and Information Circular 7380 on "Safe Storage, Handling, and Use of Commercial Explosives."

17. **Spontaneous ignition.**—Proper precautions should be taken in connection with storage of materials which may cause spontaneous ignition. Rooms in which there may be explosive concentrations of dust, gases, or vapors should have explosion-proof electrical fixtures and equipment in accordance with the provisions of the National Electrical Code relating to hazardous locations.

18. **Electrical equipment.**—The following general information should be used in conjunction with the National Electrical Safety Code, National Bureau of Standards Handbook H30:

(a) General protection.—Where practicable, transformers, control boards, and other accessories should be placed in special rooms to which only authorized persons have access. If the use of a separate room is not feasible, enclosures should be built around those parts of electrical equipment having exposed conductors. Enclosures made of metal should be effectively grounded.

Warning signs should be displayed near exposed current-carrying parts and in specially hazardous areas, such as high voltage installations. Signs should be large enough to be read easily and they should be so placed as to be visible from all approaches to the danger zones. They should be displayed in as many languages as needed.

Suitable insulating mats or platforms of substantial construction and providing good footing shall be placed on floors and, if necessary, on the frames of the machines having exposed live parts of more than 150 volts to ground, so that the operator or persons in the vicinity cannot readily touch such parts unless standing on the mats, platforms, or insulating floors.

(b) Grounding.—Fixed equipment or appliances having exposed metal frames should be grounded under any of the following conditions:

(1) If operated at more than 150 volts to ground, regardless of location.

(2) If located where exposed grounded surfaces, as plumbing fixtures or conductive floor and wall can be reached by a person while touching the metal parts of equipment.

(3) If located in hazardous areas.

The grounding of portable equipment should follow that of fixed equipment except (1) electrically heated appliances exempted by administrative authority, and (2) motors if positively guarded under all conditions. It is recommended, however, that motors always be grounded.

(c) Ground connections.—Ground connections should be of copper, and the combined resistance of the grounded wire and the connection with the ground should not exceed 3 ohms for waterpipe connections nor 25 ohms for artificial grounds. The actual ground circuit resistance should be kept as far as possible below the maximum permissible limits.

Where a grounding wire is exposed to mechanical injury, it should be protected by conduit connected at both ends to the grounding wire or by other substantial enclosure. If the enclosure is of metal, it also should be grounded.

(d) Transformers.—These should preferably be located outside of buildings, and surrounded by an enclosure of grounded metal at least 8 feet high. If a building wall forms a

part of such an enclosure, all windows in the wall should be screened or barred.

Transformers inside buildings should be placed in ventilated fireproof vaults having raised sills across the doorways to prevent the escape of leaking oil. Floors and floor drains should be so arranged that oil will quickly collect in drainage or storage systems provided for the purpose. Air vents should be so designed as to close automatically in case of fire. It may be advisable to provide equipment for introducing fire extinguishing material into transformer cases or vaults. Doors to transformer enclosures or vaults should be kept securely locked, and only authorized personnel should be permitted to enter such areas.

(e) Plant wiring.—All wiring should be in accordance with the National Electrical Code and also with local codes or requirements.

(f) Over-current devices.—The safe current-carrying capacity of conductors is determined by their size, the material of which they are made, and the manner in which they are installed. If forced to carry more than the maximum safe load, or limited as to heat dissipation, excessive heating results. Fuses or other over-current devices should be installed in every circuit, and they should be of a size and type that will interrupt the current flow when it exceeds the capacity of the conductor. Protection of this kind, both for personnel and for equipment, is one of the important features of any electrical installation.

(g) Drop and extension cords.—Extension cords should be of a type approved by the Underwriters Laboratories, Inc., and they should be labeled to show that they meet all requirements of the National Electrical Code. They should be inspected regularly. Kinking or excessive bending of the cords should be avoided to prevent breaking of the wire strands. Broken strands may pierce the insulating covering and become shock or short-circuit hazards.

(h) Lamp fixtures and equipment.—For locations where there are flammable gases or dusts, lamps should be installed only in fixtures especially designed to prevent lamp breakage and to prevent ignition of the flammable material. Equipment should be of explosion-proof design.

(i) Maintenance.—Switches should always be tagged or locked in the open position before starting work. If a lock is used for which keys are available to other members of the organization, the switch should also be tagged in such a way as to identify the individual authorized to remove the lock. If two or more employees are working independently on the same circuit, each should affix his own lock or tag to the switch.

When the switch cannot be locked out, especially if it is located in an open work area, it is advisable to station a watchman near the switch to see that it is not disturbed while the work is in progress. Warnings should be given to all operators affected before opening a circuit and again before closing the circuit after the job is completed.

19. **Tools.**—*(a)* Each employer should heed the safe condition of the tools used by his employees, whether furnished by him or by them, and make every reasonable effort to insure that such tools are suited both by safe design and construction to the work to be done.

(b) Each employer should institute and maintain a definite system of tool inspection and repair suited to conditions.

(c) Tools in disrepair should not be used.

(d) All powered tools which might cause injury through continued operation should the operator lose his hold, should be equipped with the so-called "dead man" type of control (or the equivalent) whereby the power is automatically cut off when the operator loses his hold.

(e) Portable electric power tools should be equipped with ground wires to maintain at all times an effective ground on the noncurrent carrying parts of the tool.

C. FIRE PREVENTION AND PROTECTION

1. **Building egress.**—*(a)* All buildings in which persons are employed, or are assembled for any purpose, should be provided with safe and proper ways of egress or means of escape from fire, sufficient for the use of all persons accommodated or assembled within the building. Such ways of egress should be kept free from obstructions, and in good repair and ready for use at all times. (The provisions of the "American Standard," Building Exits Code, A9.1, should be followed.)

(b) All buildings or establishments of two or more stories in height should be provided with more than one way of egress or escape from fire, said ways of egress being so located and in such positions as to prevent the trapping of persons in the building. Such ways of egress may lead to adequately constructed and properly maintained fire escapes on the outside of the building or to inside stairways, provided with proper hand rails, and satisfactory for emergency use. Such stairways should preferably be fire resistant and lead directly to the outside at grade level. All exit doors should swing in the direction of exit, and should open in such manner as not to obstruct passageways or corridors used as way of egress and escape from fire or panic. No chairs or seats, fixtures, chutes, materials, or equipment should block or in any way jeopardize the use of ways and means provided for egress. All exit doors and windows used as means of egress in case of fire

or panic should be so arranged as to be always readily opened from the inside. Locks on doors and windows, if provided, should not require the use of a key to operate from the inside.

(c) All exits or means of egress as above specified should be plainly designated or marked by conspicuous signs or lights to identify the means of escape. Directional signs should be provided where needed. Ladders are not acceptable as fire escapes.

2. **Fire extinguishing equipment.**—*(a)* Equipment suitable to the conditions and hazards involved for the extinguishment of fires should be provided and maintained in an effective operating condition. The importance of a systematic inspection of these devices is emphasized. This equipment includes built-in equipment, such as automatic sprinkler, CO_2, and steam lines. Also hand-operated equipment, such as hose and portable fire extinguishers, sand pails, water barrels and pails and other equipment effectively located, mounted, and maintained.

(b) Aisles leading to, and areas in front of, all fire-extinguishing equipment should be open at all times, free and clear and unobstructed by materials, stock, and equipment of any kind.

(c) Classes of fires and recommended extinguishing equipment. Listed below are various classes of fires and the extinguishing equipment which is recommended in each case:

(1) *Class "A" fires.*—Fires in ordinary combustible materials where the quenching and cooling effects of quantities of water or solutions containing large percentages of water are of first importance.

Recommended extinguishing equipment.—Soda and acid, pump tank extinguishers or water barrels and buckets.

(2) *Class "B" fires.*—Fires in flammable liquids, greases, etc., where blanketing effect is essential.

Recommended extinguishing equipment.—Foam, carbon tetrachloride, CO_2, dry powder pressure-type extinguishers, sand buckets and scoops.

(3) *Class "C" fires.*—Fire in electrical equipment where the use of nonconducting extinguishing agent is of first importance.

Recommended extinguishing equipment.—Carbon tetrachloride, CO_2, dry powder pressure-type extinguishers.

D. PRESSURE VESSELS

1. **Fired pressure vessels**—*(a) Steam boilers.*—The safeguarding of steam-power boilers has been developed to such a high standard that it can be truly said that boiler explosions are entirely preventable, provided that boilers are:

(1) Constructed and installed in accordance with the Power Boiler Code of the American Society of Mechanical Engineers or equivalent standards. (Various States, cities, and the Federal Government have developed codes of similar excellence which, nevertheless, vary in some details from the ASME Code. Insurance companies which insure steam boilers against explosion generally apply the provisions of the ASME Code.)

(2) Operated by personnel whose competence entitles them to hold certificates granted by licensing authorities set up for the purpose.

(3) Regularly inspected by competent inspection personnel.

(b) Heating boilers and miscellaneous small boilers.—Most State boiler codes exempt boilers intended for low pressure (usually below 15 pounds). The violence with which even the smallest boiler can explode should not be underestimated. Every vessel, however small, in which water is heated can, if its normal outlet is closed or plugged up, become in fact a high-pressure steam generator, and, if its strength is exceeded will explode destructively. The recurring explosions of such low-pressure devices indicate a too widespread failure to keep this simple fact in mind. Therefore, the accident preventionist should take careful account of every fired water or steam vessel and make sure that:

(1) It is of safe construction for the pressures involved.

(2) It has adequate means of limitation of pressure, such as:

(a) A safety valve of adequate capacity.

(b) A disk or diaphragm that will fracture at a predetermined pressure.

(3) It is regularly inspected, competently operated, and properly maintained.

(c) Steam cookers, digesters, glue pots, etc.—All pressure vessels to which steam is supplied from an outside source should be designed, insofar as it is practical, for the maximum line pressure. Most of them are not, and on such vessels it is vitally important to install, in addition to the necessary pressure-reducing valve, a safety valve on the vessel itself or on the line between it and the pressure reducer. There should be no means of cutting off or bypassing this safety valve. Inspection and adequate maintenance of the vessel, including regular testing of the safety valve, are vital.

2. **Compressed air machinery and equipment.**—For the detailed operation of this type of equipment refer to "American Standard," Safety Code For Compressed Air Machinery and Equipment; however, the general rules listed below should be applied.

(a) Compressors.—(1) If a power-operated air compressor is driven by other than an electric motor (including those driven by series-wound direct-current motors), a speed governor should be installed on the prime mover to prevent racing of the latter from any cause. Such a speed governor should act independently of the unloader on the compressor.

(2) If the air compressor is engine or turbine driven, an auxiliary control to the governor should be installed to prevent racing when the unloader operates.

(3) Every air compressor should be equipped with an automatic mechanism so arranged that the compressor will automatically stop its air-compressing operation before the discharge pressure exceeds the maximum working pressure allowable under this code on the weakest portion of the system to which the compressor is connected.

(4) If this automatic mechanism is electrically operated, the actuating device should be so designed and constructed that the electrical contact or contacts cannot lock or fuse in a position that will cause the compressor to continue its air-compressing operation.

(b) Switches, and other electrical apparatus.—If the compressor is driven by an electric motor, all electrical switches and other electrical apparatus should be guarded as required by the National Electrical Safety Code and the National Electrical (Fire) Code.

(c) Belt, pulley, gear, and shaft guards.—All belts, pulleys, gears, flywheels, and shafts should be guarded as outlined in Part II E of these standards.

(d) Lubrication.—Specific requirements for lubricating oils are intentionally omitted from these standards. In the operation of air compressors, many of the troubles experienced can be traced to the use of a poor or unsuitable grade of oil in the air cylinders. The importance of good air cylinder oil is generally recognized by the leading manufacturers of equipment and of lubricants and it is therefore suggested that their recommendations be followed.

Air compressor cylinders should be lubricated by means of visible-flow forced-feed lubricators.

Only enough oil should be used to furnish satisfactory lubrication in order to avoid carry-over to intercoolers, aftercoolers, receivers, and other parts of the system.

(e) Cooling.—Where water cooling is used, a visible indication of water flow should be provided.

(f) Operation and maintenance.—(1) Compressor valves should be inspected, checked for broken springs, and tested for tightness frequently and at regular intervals. Leaky valves should be made tight by repair or replacement. Accumulations of carbon or other foreign matter should be removed.

(2) Unloaders and governor controls on air compressors should be inspected at frequent and regular intervals and should be maintained in good working condition. Where emergency (overspeed) stops are installed, such devices should be tested at regular intervals to insure their operation within safe limits of overspeed.

(3) If the compressor is steam driven, the throttle valve should be closed and tagged, and the cylinder drain cocks should be opened, before starting repairs or other work on the compressor.

(4) If the compressor is motor driven, the line switch supplying the motor should be opened and tagged or locked before starting repairs or other work on the compressor.

(5) Under no circumstances should kerosene, gasoline, or other flammable solvents be introduced into the compressor cylinders, the piping, or the receiver. Soapy water or any suitable non-toxic, nonflammable solution may be used for cleaning such portions of the system.

(g) Aftercoolers.—(1) Aftercoolers should be designed to withstand safely the maximum pressure in the air discharge piping.

(2) The advantages to be gained by using aftercoolers are of sufficient importance to warrant consideration of such equipment on at least new installations. Aftercoolers reduce the temperature of the air discharged by the compressor to a point at which most of the moisture and oil vapor condenses and can be removed.

(3) The removal of the moisture tends to prevent water hammer in the air lines. The condensation of oil vapors tends to prevent their being carried over to pipe lines, receivers, and other parts of the systems.

(4) Where pipelines and receivers have become coated with oil because of improper lubrication of the compressor, explosive mixtures of air and oil vapor may be formed at high temperatures. Consequently overheating should be avoided and oil accumulation should be immediately removed.

(5) The use of aftercoolers tends to maintain more nearly uniform air temperatures on the discharge side of the system, thereby minimizing the strains resulting from alternate expansion and contraction of pipelines.

(h) Piping. — (1) *Installation.* — Piping should meet the requirements of the American Standard Code for Pressure Piping. In its installation, adequate provision should be made for expansion and contraction, and to counteract pulsation and vibration. Steam and air piping should be equipped with adequate traps or other means for removing liquid from the lines. Air discharge piping should be so installed that pockets where oil may accumulate are avoided.

(2) *Insulation.*—Steam piping should be adequately insulated where it is exposed to contact.

(3) *Compressor air intake.*—Provision should be made to prevent drawing air containing flammable or toxic gases, vapors, or dusts into the compressor, and to prevent steam, water, or waste of any sort from being blown

or drawn into the compressor intake. No valve should be installed in the air intake pipe to an air compressor.

(4) *Air-discharge piping.*—The air-discharge piping from the compressor to the air receiver should be at least as large as the discharge opening on the air compressor. Because the air-discharge pipe becomes hot, no wood or other flammable material should be permitted to remain in contact with it.

(i) Valves.—(1) Stop valves in the air line between the compressor and the air receiver are not recommended. In every case where a stop valve is so installed, one or more spring-loaded safety valves should be installed between the compressor and the stop valve. The total capacity of such safety valves should be sufficient to limit the pressure in the air discharge piping to 10 per cent above the relieving pressure of the safety valves on the air receiver.

(2) Any stop valve which may be installed in the air discharge piping should be so located that it can be inspected and cleaned at definite regular intervals. Stop valves should preferably be of the gate type and not of the globe type. If a globe valve is used it shall be so installed that the pressure is under the seat and that the valve will not trap condensation.

(3) Every steam-driven air compressor should be provided with a manually operable throttle valve in the steam supply line, in a readily accessible location.

(4) A stop valve should be installed between the air receiver and each piece of stationary utilization equipment at a point convenient to the operator thereof.

(5) A stop valve should be installed at each outlet to which an air hose may be attached.

(j) Receivers.—(1) *Construction.* Air receivers should be constructed in accordance with the 1937 Edition of the A.S.M.E. Code for Unfired Pressure Vessels.[2] The operating pressure should be based on a factor of safety of not less than 5. Inspection openings should be provided in all air receivers 18 inches or more in diameter.

(2) *Installation.*—Air receivers should be so installed that all drains, handholes, and manholes therein are easily accessible. Air receivers should be supported with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. Under no circumstances should an air receiver be buried underground or located in an inaccessible place. The receiver should be located as close to the compressor or aftercooler as is possible in order to keep the discharge pipe short. The receiver should be located in a cool place to facilitate the condensation of moisture and oil vapors.

[2] Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

(3) *Drains and traps.*—A drain pipe and valve should be installed at the lowest point of every air receiver to provide for the removal of accumulated oil and water. Adequate automatic traps may be installed in addition to drain valves. The drain valve on the air receiver should be opened and the receiver completely drained frequently and at such intervals as to prevent the accumulation of excess amounts of liquid in the receiver.

(4) *Gages and valves.*—Every air receiver should be equipped with an indicating pressure gage (so located as to be readily visible) and with one or more spring-loaded safety valves. The total relieving capacity of such safety valves should be such as to prevent pressure in the receiver from exceeding the maximum allowable working pressure of the receiver by more than 10 percent. No valve of any type should be placed between the air receiver and its safety valve or valves.

(k) Working space.—In the location of compressors and related equipment, provision should be made for safe access to all parts of the equipment for operation, maintenance, and repairs.

(l) Aisles.—Aisle space should be adequate, should be independent of work and storage areas, and should be defined by floor markings.

(m) Safety valves.—(1) All safety valves used should be constructed, installed, and maintained in accordance with the A.S.M.E. Code for Unfired Pressure Vessels.

(2) Safety appliances, such as safety valves, indicating devices, and controlling devices, should be constructed, located, and installed so that they cannot be readily rendered inoperative by any means, including the elements.

(3) All safety valves should be tested frequently and at regular intervals to determine whether they are in good operating condition.

E. MACHINERY GUARDING

1. **Railings and toeboards.**—Where standard railings and toeboards are specified in this manual they should conform to the following specifications:

(a) Railings should be 42 inches in height except where otherwise specified and should be equipped with toeboards unless the space between the lower rail and floor is filled with material as specified in "b".

(b) They should be of substantial construction, should be permanently fastened in place, and should be smooth and free from protruding nails, bolts, and splinters. An intermediate rail should be provided between the top rail and the floor, unless this space is filled with substantial wire mesh, expanded metal, or other suitable material.

(c) If constructed of pipe, the inside diame-

ter of the pipe should not be less than 1-1/4 inch.

(d) If constructed of metal shapes or bars, each part should have a cross section at least equal in strength to that of a 1-1/2- by 3/16-inch angle iron.

(e) If constructed of wood, the posts should not be smaller than the sizes commercially known as 2- by 4-inch or 3- by 3-inch. The top rail should be at least as large as the size known as 2- by 4-inch. The intermediate rail should not be smaller than the size commercially known as 1- by 4-inch.

(f) Posts and uprights should be spaced not more than 8 feet apart.

(g) Toeboards should be at least 5-1/2 inches in height and be constructed of wood, metal, metal grill with openings not exceeding 1 inch or other suitable material.

(h) Intermediate rails and toeboards, and top rails which are attached to the side of the posts, should be placed on the side of the posts away from the engine, belt, floor opening, etc., to be guarded, so that any blow or pressure against them will be taken up by the posts instead of tending to push the rails away from the posts.

2. **Guards.** (a) If guards are made of wire mesh, perforated or expanded metal, crossed strips or bars of wood or metal, etc., the width or diameter of the holes should not exceed 2 inches. If parallel strips or bars of wood or metal are used, the space between them should not exceed 1 inch. There should be no openings more than 1/2 inch in width or diameter within 4 inches of any gear, belt, pulley or flywheel, or other dangerous moving part. Wood slats should be smooth and free from splinters, and the holes in perforated or expanded metal should be free from sharp cutting edges.

(b) The supporting frames should be of substantial construction, such as angle iron, varying from 1 by 1 by 1/8 inch to 1-1/2 by 3/16 inch, or iron pipe with inside diameter varying from 3/4 inch to 1-1/2 inch, according to the weight of the filling material, the size of the panels, and the exposure of the guard to collision with trucks, etc. Any panel which measures more than 42 inches in both width and length should be substantially supported across its narrowest dimension at intervals of not more than 42 inches.

(c) The filling material should be bolted, riveted, or otherwise securely attached to the frame in such a manner that no sharp points or edges will be exposed. Bolts should be at least 3/16 inch in diameter and should be spaced not more than 10 inches apart. Flat bars or strips used for clamps should not be smaller than 3/4 by 1/8 inch if of iron, or 1 by 1 inch if of wood. Perforated or sheet metal may be spotwelded to angle iron frames.

(d) The thickness of material used for guards should not be less than is specified in the following table:

Material	A Clearance from moving part at all points	B Largest mesh Opening allowable	C Minimum gauge (U. S. Standard) or thickness
Woven wire	Under 4 inches	½ inch	–#16.
	4–15 inches	2 inches	–#12.
Expanded metal	Under 4 inches	½ inch	–#18.
	4–15 inches	2 inches	–#13.
Perforated metal	Under 4 inches	½ inch	–#20.
	4–15 inches	2 inches	–#14.
Sheet metal	Under 4 inches		#22.
	4–15 inches		#22.
Wood or metal strip crossed	Under 4 inches	½ inch	Wood ¾ inch, metal #16.
	4–15 inches	2 inches	Wood ¾ inch, metal #16.
Wood or metal strip not crossed	Under 4 inches	½ inch width	Wood ¾ inch, metal #16.
	4–15 inches	1 inch width	Wood ¾ inch, metal #16.
Solid wood[1]			

[1] If plywood is used it should be not less than ⅜ inch thick and not less than 3 ply.

(e) Guards should be securely and permanently fastened in place, except as otherwise specifically provided.

3. **Belts, pulleys, etc.**—*(a)* All vertical and inclined belts should be completely enclosed or effectively guarded. However, belts that are 1 inch or less in width need be guarded only to 6 inches from the nip point.

(b) All V-belts regardless of shape, size, position, or running speed should be completely enclosed or effectively guarded.

4. **Vertical and inclined belts.**—*(a)* If the guard is within 4 inches of a belt or pulley, it should extend from the floor or platform level to a height of at least 6 feet. If the guard is within 15 inches but not within 4 inches of the belt or pulley it should extend from the floor or platform level to a height of at least 5 feet except in each case as follows:

(1) If any part of a pulley is more than 5 feet but less than 7 feet above the floor or platform level the guard should extend to the top of the pulley but need not exceed a height of 7 feet above the floor or platform level. This also applies to clutches.

(2) If the top of any pulley is not more than 5 feet above the floor, the guard need not extend above a point midway between the top of the pulley and a height of 5 feet, provided that in no case should it extend less than 42 inches above the floor unless it covers the top as well as all sides of the belt and pulley, in which case there should be no requirement as to height.

(3) If it is an overhead belt, the guard may be a basket or box, suspended from above and extending across the bottom of the pulley and all around the pulley to a height of 6 feet except where the top of the pulley exceeds such height when the guard should extend to the top of the pulley but need not exceed 7 feet.

(b) Where no pulley hazard is involved, a standard railing placed not less than 15 inches or more than 20 inches from the belt, measured horizontally from the top of the railing, will be considered a sufficient guard.

(c) If the belt is inclined, the height of the guard or distance of the guard or railing from the belt should be such that the vertical clearance between the floor and the lower run of the belt at any point outside of the guard or railing, should not be less than 6 feet 6 inches.

5. **Horizontal belts.**—*(a)* Where both runs of the belt are within 7 feet of the floor or platform level, the guard should extend at least 15 inches above the upper run or to a height of 7 feet above the floor. In no case should the guard extend less than 42 inches above the floor, except that if it covers the top as well as all sides of the belt and pulley, there should be no requirement as to height.

(b) Where the upper run of the belt is more than 7 feet above the floor or platform level and the lower run is within 7 feet of the floor, the pulleys should be guarded on sides and outer face to a height of 7 feet above the floor or platform level, and the belt guard between the two pulleys should extend at least 15 inches above the lower run, but need not exceed a maximum of 7 feet and should be a minimum of 42 inches above the floor or platform level unless completely enclosed. Unless the guards extend across the inner face of each pulley to a height of seven feet, the guard for the lower run of the belt should be carried to the same height as the pulley guards at all points within 15 inches horizontally from the inner face of either pulley.

(c) Where pulleys are so located and of such dimensions as to permit passage between the upper and lower runs of the belt, the space between the pulleys should be completely barred or should be provided with a passageway substantially guarded on sides and top and bottom.

6. **Cone pulleys and belts.**—*(a)* Cone pulley belts more than 2-1/2 inches in width should be equipped with mechanical belt shifters and all cone pulley belts should be guarded to a point 3 inches above the nipping point of the belt and pulley and not less than 3 feet 6 inches from the floor or platform where any part of the lower cone is less than 3 feet above the floor or platform level.

(b) Where both upper and lower cones are within 7 feet of the floor or platform level, as for example on some vertical drill presses and other machines and for which conditions are such that mechanical belt shifters are not required and none are furnished, the belt and cone pulleys should be guarded as specified in Part II E 2 above with a hinged self closing section to permit shifting.

(c) All belts regardless of width should be provided with belt shifters when joined together with a metallic or other form of fastener which by construction or wear will constitute a hazard.

7. **Machine control.**—*(a)* Every machine should be equipped with a loose pulley, clutch switch, or other adequate means readily accessible for the purpose of stopping the machine quickly.

(b) Machines on which two or more persons work should be equipped with one or more controls so located that more than one of these persons can quickly disconnect the machine from the source of power.

(c) Machines operated from a number of different places should be provided with readily accessible means for shutting off the power and means of locking controls to protect men working on the machines against unexpected starting.

8. **Belt shifters.**—*(a)* Every set of tight and loose pulleys should be equipped with a permanent belt shifter so located as to be within easy reach of the operator. The belt shifter should be so constructed as to make it impossible for the belt to creep from the loose pulley to the tight pulley.

(b) Every belt shifter should be equipped with an interlocking device which will prevent accidental shifting.

(c) Where overhead belt shifters are not located directly over a machine or bench, the shifting lever should be cut off 6 feet 6 inches above floor level.

9. **Pulleys—Location on shafting.**—*(a)* Every pulley near a shaft hanger, shaft bearing, or other fixed object should be placed so as to allow a side clearance at least 1/2 inch greater than the width of the belt between the pulley and the nearest part of such shaft hanger, shaft bearing, or other fixed object or a guard should be placed adjacent to the pulley to prevent the belt from running off on the side next to the shaft hanger, shaft bearing, or other fixed object.

(b) Where pulleys must be closer together on the shaft than the width of the wider belt plus 1/2 inch, the pulleys should be guarded so that the belt on either pulley cannot run off between the pulleys.

10. **Gears.**—All gears should be solidly enclosed, except that gears without spokes or holes in the web may be guarded by a band guard with flanges extending beyond the root of the teeth.

11. **Keys and keyseats.**—*(a)* Every projecting key in revolving shafting where exposed to contact, should be cut off or enclosed.

(b) Every keyseat in revolving shafting, where exposed to contact, should be filled or enclosed.

12. **Flywheels and shafting.**—*(a) Flywheel guards.*—Flywheels located so that any part is six (6) feet or less above the floor or platform should be guarded in one of the following ways:

(1) *With a standard railing.*—The railing must be placed not less than six (6) inches nor more than twenty (20) inches from the wheel, provided that it should be not less than fifteen (15) inches from the spokes of wheel or projections. If wheel extends into pit or within two (2) inches of the floor, a standard toeboard should be installed. If passage over journal or bearing is necessary, the passageway should be provided with a standard railing and toeboard.

(2) *With an enclosure of sheet, perforated, or expanded metal or woven wire.*—When such guard is placed less than six (6) inches from wheel, it should be not less than six (6) feet high, except if flywheel is less than six (6) feet high, the guard should be not less than the height of the wheel from the floor. In no case should guard be less than three (3) feet six (6) inches high unless wheel is completely enclosed, including the top. Where clearance of guard from flywheel at any point is under four (4) inches, the largest mesh or opening allowable should not be more than one-half (1/2) inch. Where such clearance is from four (4) to fifteen (15) inches, largest mesh or opening allowable should not be greater than two (2) inches.

(3) Flywheels, with smooth rims, five (5) feet or less in diameter, other than wheels having solid web centers, where the preceding methods cannot be applied, should be provided with a disc having a smooth surface and edge attached to the flywheel in such a manner as to cover the spokes of the wheel on the exposed side. The disc may be four (4) inches smaller in radius than the radius of the inner surface of the wheel if it is desired to provide space for bar in turning over the wheel. Keys and other dangerous projections not covered by disc should be cut off or covered.

(4) An adjustable guard may be used where it is necessary to start engine or for making adjustments.

(5) A slot opening for jack bar will be permitted.

(6) Spokes of pulleys, balance wheels, or flywheels other than on a prime mover, the bottom of which is six (6) feet or less above the floor or other working level should be protected by filling in the spokes or by guarding as required for belts.

(b) Shafting.—All exposed parts of transmission shafting six (6) feet or less from floor or working platform should be protected by a stationary casing enclosing shafting completely. Horizontal shafting may be guarded by a trough enclosing sides and top or sides and bottom of shafting as location requires.

Shafting under bench machines should be enclosed by a stationary casing or by a trough at sides and top, or sides and bottom, as location requires. The sides of the trough should come within at least 6 inches of the underside of the table, or if shafting is located near floor, within 6 inches of floor. In every case the sides of trough should extend at least 2 inches below or above the shafting as the case may be.

Revolving shafting and spindles forming part of and integral with individual machines where such part creates a hazard should be enclosed or covered.

13. **Presses.**—*(a) Preferred guarding methods.*—Protection from the dies of every press, except hot-metal presses, should be provided by means of the following:

(1) Complete enclosure, or

(2) Full automatic feed, or

(3) Semiautomatic feed with ram enclosure, or

(4) Limited opening (3/8 inches) between dies.

The maximum width of opening in the enclosure or between the enclosure and working surface shall be not greater than shown in the following table:

Distance of opening from nip point (inches)	*Maximum width of opening (inches)*
0 to 2½	⅜
2½ to 3½	½
3½ to 5½	⅝
5½ to 6½	¾
6½ to 7½	⅞
7½ to 8½	1¼

(b) Alternative guarding methods.—Only in case none of the methods in *(a)* above can be applied, then a device which will reasonably prevent injury by contact with dies should be installed as follows:

(1) A two-hand tripping device for each person engaged in the operation of a single press, so designed and arranged as to prevent tying, wedging, or otherwise securing one handle or button and operating the press with one hand only, or

(2) An interlocking gate guard operated by the tripping device of the press, which interposes a barrier on the front and sides of the ram before the plunger descends and will not permit the press to operate until the hand or hands of the operator have been removed from the danger zone, or

(3) A sweep or gate guard with the sweep arm, or gate interconnected to the ram and so designed and constructed as to sweep the hands of the operator from the die zone as the ram descends; with each single sweep arm provided with a flag or barrier attached thereto so that the operator cannot reach behind the sweep, or

(4) A pull-out protective device attached to the operator's hands or arms and connected to the ram, or outer slide of the press in such a way that the operator's hands or fingers will be withdrawn from the danger zone as the ram or outer slide descends; and designed so that where the open distance between the top of the work and the lower extremity of the punch is less than 2 inches that the multiplying action of this guard should be such that the hands will be withdrawn a safe distance from the nip point during the first quarter of the stroke.

(c) Special hand tools should be accepted only as an accessory to the guards listed herein and not as a substitute for any guard.

(d) Guards which are attached to the ram and which move downward so that the operator's hand or fingers may be caught between the gate and lower die should not be used.

(e) Where the speed of the ram is so slow that the operator might beat the ram on the down stroke after the press has been tripped, no device should be used which permits the insertion of the hands until the completion of the downward stroke without stopping the ram.

(f) Every hand-fed power press should be equipped with: (1) An arrangement which disconnects the treadle or hand-operated lever from the clutch mechanism after each stroke, or (2) A device that will, within its own action, automatically lock the clutch mechanism into place so that the press cannot make a second stroke until the treadle or hand lever is again pressed to its lowest position, or (3) By some other method which will accomplish the result outlined above; unless the danger zone protection is such that the guard remains in its protective position during the second stroke of the press.

(g) Platen presses.—Platen presses with or without mechanical power should be provided with one of the following: (1) An automatic feed which does not require the operator's hand to be placed between the platen and bed, or an automatic stop which will prevent the platen from closing if the hand or hands of the operator are caught between the platen and the bed, or (2) A guard, gate or sweep motion, which will throw the operator's hands out of the way as the press closes. If, of the type which lifts the hands out of the danger zone, the guard should rise at least 4 inches above the platen as the press closes and should descend by gravity or by mechanical means. The guard should be arranged so that it will prevent a shear between the guard and the top of the platen, or (3) Any other device that will prevent the platen from fully closing before the operator's hands are removed from between the platen and the bed.

14. **Abrasive wheels.**—The following standards for the operation of abrasive wheels should be supplemented by the "American Standard," Safety Code for the Use, Care, and Protection of Abrasive Wheels, to insure that full safety measures are taken in their operation:

(a) Handling.—All grinding wheels are breakable and some are very fragile. Great care should be exercised in handling and storage to prevent damage which might cause a wheel to fly apart when brought up to speed. The following rules which are based on experience, should always be observed:

(1) Handle wheels carefully to prevent dropping or bumping.

(2) Do not roll wheels (hoop fashion).[3]

(3) Use trucks or suitable conveyors which will provide proper support for all transporta-

[3] Exemption to (2) and (3): Where it is impractical to comply with (2) and (3) because of large size of wheel, danger of damage when rolling the wheel will be minimized if floor is smooth, clean and free from obstructions. The use of a strip of rubber or cork matting will further reduce the danger.

tion of wheels which cannot be carried by hand.[8]

(4) Stack wheels carefully on trucks. Do not pile heavy castings or tools on top of them, nor permit wheels to topple over.

(b) Storage.—Suitable racks, bins or drawers should be provided to accommodate the various types of wheels used. Wheel storage rooms should not be subject to extreme temperatures, and should always be kept dry.

(c) Inspection.—Immediately after unpacking, all wheels should be closely inspected to make sure that they have not been injured in transit or otherwise. As an added precaution, wheels should be tapped gently (while suspended) with a light implement, such as the handle of a screw driver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked, they should not be used. Wheels must be dry and free from sawdust when applying the test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

(d) Rigidity, supports.—Grinding machines should be sufficiently heavy and rigid as to minimize vibration.

Where practical, the machines should be securely mounted on substantial floors, benches, foundations or other adequate structures.

(e) Guards. — Every stationary abrasive wheel and portable wheels used in stationary position should be equipped with guards of the hood type strong enough to withstand the shock of a bursting wheel. A hood type or band guard strong enough to withstand the shock of a bursting wheel should be used on every portable wheel where the operation and the nature of the work will permit.

(f) Spindle. — The spindle and nut and flange projection, if any, should be guarded.

(g) Mountings and fastenings.—Hoods should be so mounted as to maintain proper alignment with the wheels, and the strength of the fastenings should exceed the strength of the hood.

(h) Dust exhaust provisions.—Hoods on machines used for dry grinding and other operations where dust is produced should have provisions made for connection to an exhaust system. For detailed recommendations reference is made to "American Standard" for Grinding, Polishing and Buffing Equipment Sanitation (Z43).

(i) Exposures permitted.—(1) *Bench and floor stands.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as bench and floor stands should not exceed 90° or one-fourth of the periphery. This exposure should begin at a point not more than 65° above the horizontal plane of the wheel spindle.

Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure should not exceed 125°. This exposure should begin at a point not more than 65° above and extend to a point not more than 60° below the horizontal plane of the wheel spindle.

(2) *Cylindrical grinders.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cylindrical grinding machines should not exceed 180°. This exposure should begin at a point not more than 65° above the horizontal plane of the wheel spindle.

(3) *Surface grinders and cutting machines.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on cutting machines and on surface grinding machines which employ the wheel periphery should not exceed 150°. This exposure should begin at a point not less than 15° below the horizontal plane of the wheel spindle.

(4) *Swing frame and portable grinders.*—The maximum angular exposure of the grinding wheel periphery and sides for hoods used on machines known as swing frame and portable grinding machines should not exceed 180°, and the top half of the wheel should be protected at all times.

(5) *Top grinding.*—In operations where the work is ground on the top of the wheel, the exposure of the grinding wheel periphery should be as small as practicable, with a maximum exposure of 60°.

(j) Exposure adjustment.—Hoods of the type described in (1) and (2) under "Exposure Permitted," where the operator stands in front of the opening, should be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in (1) and (2) should never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top should never exceed 1/4 inch.

(k) Work rests.—Work rests should be kept adjusted close to the wheel with a maximum distance of 1/8 inch to prevent the work from being caught between the wheel and the rest. The work rest should be securely clamped after each adjustment. The adjustment should not be made while the wheel is in motion.

15. **Miscellaneous machine guarding.**—*(a) Revolving, oscillating or reciprocating parts of engines and other machines:*

(1) Every projecting set screw in moving parts, where exposed to contact, should be guarded.

(2) Cranks or crank discs, crank shafts connecting rods, where exposed to contact, should be guarded.

(3) Eccentrics and cams, where exposed to contact, should be guarded.

(4) Machine parts having a reciprocating or oscillating motion such that a shearing or crushing hazard is created should be guarded.

(5) Any moving part of a machine which at any time leaves a space of less than 18 inches between it and any fixed object not a part of the machine, or between it and a moving or stationary part of any other machine should be guarded.

(b) Oiling devices.—All machines lubricated while in motion and having lubricating devices so located as to make it hazardous to reach them should be equipped with an automatic oiling device or some equally efficient means to protect the oiler.

Machines shut down for oiling or maintenance should be marked, locked or otherwise protected so as to prevent starting the machine while such work is in progress.

(c) Projecting parts on shafts.—Every projecting part on a revolving shaft such as a collar, clamp, pin, coupling, oiling device, etc., where exposed to contact (which should include exposure while oiling machinery in motion) should be guarded.

(d) Revolving stock.—All revolving stock projecting from machines should be guarded by pipe enclosure or other means to prevent contact with the stock.

(e) Noise reduction.—It is desirable to reduce to the minimum the noise incident to the operation of machines especially where there are a number placed close to each other.

16. **Fans.**—The blades of every fan open to contact should be guarded in accordance with Part II E of these standards except that fans more than seven feet above the floor or working level need not be guarded providing the blades cease to revolve before any work of a character which would expose any person to contact with such fan is permitted. This standard also applies to the ordinary office fan.

17. **Revolving drums and cylinders.**—*(a)* Revolving barrels, drum or other containers, where exposed to contact should be guarded by an enclosure or standard guard rail in accordance with Part II E of these standards.

(b) Tanning drums, where exposed to contact, should be guarded by an enclosure built in accordance with guarding as specified under Part II E, to a height of 6 feet.

(c) Every drum or other revolving container, which must be loaded or unloaded should be equipped with a brake or lock which will enable the operator to lock the drum while loading or unloading it.

18. **Counterweights, tension weights and springs.**—*(a)* Every counterweight, where exposed to contact, should be enclosed or equipped with a safety chain that will prevent the weight from falling to a distance of less than 7 feet from the floor or working level.

(b) Every tension weight exposed to contact should be enclosed or securely fastened to the tension bar.

(c) All springs should be guarded or otherwise equipped to eliminate any hazard due to breakage of spring or failure of the mounting.

19. **Lathes and automatic screw machines.**—Chucks and face plates should be free from projections, and dogs, if used, should be of the safety type only—circular in shape with no projections beyond the periphery.

Chip guards to catch flying chips, particularly in the case of high speeds used in the softer metals should be provided.

Rotating stock in turret lathes and automatic screw machines should be completely enclosed in pipe long enough to contain the longest stock used.

Suitable shields and oil catchers should be provided to prevent slipperiness from the oil thrown from automatic screw machines.

(a) Drill presses.—All projections on the rotating spindle, and as much of the spindle itself as possible should be guarded.

Spindle drive belts when in range of the operator's head or body, should be guarded against both contact and breakage.

(b) Drop hammers.—Every drop hammer, the operation of which requires the hands to be placed between the dies, should be provided with a positive stop that will prevent the descent of the hammer until the operator's hands are withdrawn.

A shield or screen should be provided for every drop hammer except where guarded by location when the operation is such that sparks or scales are liable to be thrown off.

On every board drop hammer a substantial guard should be provided around the board above the roll to prevent the board falling in case the board breaks or comes loose from the ram.

(c) Planers and shapers (metal).—The spaces between the ways of planer frames should be filled in smoothly with heavy sheet metal to eliminate the shear hazard.

Where clearance from fixed objects is inadequate, men may be caught by the stroke of planer or shaper; in such cases space to allow for the maximum possible stroke should be railed off in such manner as to give protection without creating a shear hazard between the railing and the planer table or the work carried on it.

(d) Metal shears.—There are two main types of metal shears—alligator and squaring. The latter may be either power or foot-operated. All should be guarded.

(1) *Alligator shears.*—These shears are used to cut rods, bars, strap, etc. They are

arranged to run continuously, the material being inserted as the jaw opens. In cutting short pieces the operator is likely to get his fingers under the knife. Also, he may stumble or trip in handling the stock and get caught. Many injuries occur through lack of care in sorting out hard metal which might fly when cut or throw chips from itself or from the knife. If fairly uniform material is handled, mechanical feed can readily be devised. In junk yards, however, this is not feasible. Even in such cases it is usually feasible to guard this machine by running a heavy U-shaped metal strap horizontally around the moving (upper) jaw with the lower edge of the strap just far enough above the cutting edge of the fixed jaw to allow the material to be inserted under it.

(2) *Squaring shears.*—Injuries usually result from the fact that where the operator's foot is on the treadle he is in poor balance, with the added fact that the necessary angle set of the knife is likely, with thick material or a dull knife, to draw the material under it and the operator's hand with it.

Squaring shears either mechanical, foot or hand power, and fed by hand, shall have the knives substantially guarded. This guard may be a fixed barrier, set not more than three-eighths (3/8) inch above the table or the material being sheared. Automatic clamps shall be acceptable as guards when cut-outs are filled in so that the fingers of the operator cannot enter the danger zone.

F. WOODWORKING MACHINES

1. **Band saw or band knife.**—Band wheels of band saws or band knives and all parts of the blade should be enclosed or guarded except the part between the guide and table that is necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than 20 U. S. Standard Gauge. If other material is used, the guard should be of equal strength and firmness.

2. **Band resaw.**—Band wheels of band resaws and all portions of the blade should be enclosed or guarded except the portion between the guide and table that is necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than No. 20 U. S. Standard Gauge. If other material is used, the guard should be of equal strength and firmness. The feed rolls should be enclosed, except such part as may be necessary to feed stock.

3. **Cork cutter.**—*(a) Circular knife type.*—A hood should be provided that will cover the knife at all times to at least the depth of the cutting edge. The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the knife, or it may be a fixed or manually adjusted hood or guard, provided the space between the bottom of the guard and the material being machined does not exceed 3/8 inch at any time.

The exposed parts of the cutter blade under the table should be guarded.

(b) Band knife type.—Band wheels of band knives and all parts of the blade should be enclosed except that part between the guide and the table that is necessary for the thickness of the material being cut. If a metal guard is used, it should be not less than No. 20 U. S. Standard Gauge. If other metal is used, it should be of equal strength and firmness.

4. **Circular rip saws.**—A hood should be provided that will cover the saw at all times to at least the depth of the teeth.

The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the saw, or it may be a fixed or manually adjusted hood or guard, provided the space between the bottom of the guard and the material being cut does not exceed 3/8 inch at any time.

The hood or other guard should be so designed as to prevent a "kick-back" or a separate attachment that will prevent a "kick-back" should be provided. Non-kickback devices should be effective for all thicknesses of materials that are cut.

Except when grooving, dadoing or rabbeting, a spreader should be provided and fastened securely at the rear of saw in alignment with saw blade. It should be slightly thinner than the saw kerf and slightly thicker than the saw disc.

The exposed part of the saw blade under the table should be guarded.

5. **Self-feed circular rip saws.**—A hood or guard should be provided that will cover the saw at all times at least to the depth of the teeth. The hood or guard need not rest upon the table nor upon the material being cut, but should extend to a line not more than 3/8 inch above the plane formed by the bottom of the feed rolls.

The feed rolls should be enclosed, except such part as may be necessary to feed stock.

A spreader should also be provided and fastened securely at the rear of saw in alignment with saw blade, except where a roller wheel is provided back of the saw. The spreader should be slightly thinner than the saw kerf and slightly thicker than the saw disc. Non-kickback dogs shall be provided in front of the saws.

The exposed part of the saw blade under the table should be guarded.

6. **Self-feed band rip saws.**—Band wheels of self-feed band rip saws and all portions of the blade should be enclosed or guarded except the portion between the guide and table that is

necessary for the thickness of the material being cut. If a metal guard is used it should be of not less than No. 20 U. S. Standard Gauge. If other material is used, the guard should be of equal strength and firmness.

The feed rolls should be enclosed, except such part as may be necessary to feed stock.

7. **Circular cross cut saws.**—A hood should be provided that will cover the saw at all times at least to the depth of the teeth.

The hood should automatically adjust itself to the thickness of and remain in contact with the material being cut at the point where the stock encounters the saw, or it may be a fixed or manually adjusted hood or guard provided the space between the bottom of the guard and the material being cut does not exceed ⅜ inch at any time. This rule should not be applied to circular cross cut saws with stationary tables where the saw moves forward when cutting.

Circular cross cut saws with stationary tables where the saw moves forward when cutting should have a hood or guard securely fastened to the table that will cover the saw in all positions. The hood or guard should extend at least two inches in front of the saw teeth, when the saw is in its back position.

The exposed part of the saw blade under the table should be guarded over its entire travel.

8. **Swing cut-off saws.**—A guard should be provided that will cover the saw, and such guard should adjust itself to the thickness of the stock being cut.

There should be an effective device to return the saw automatically to the back of the table when released at any point of its travel.

If a counterweight is used, all bolts supporting the bar and weight should be provided with cotter pins. A bolt should be put through the extreme end of the counterweight bar to prevent dropping of weight, or where the weight does not enclose the rod, a safety chain should be attached to it to prevent dropping.

Limit chains or other positive stops should be provided to prevent the saw from swinging beyond the front edge of the table.

9. **Circular resaws.**—A hood should be provided that will cover the saw at all times, except where the material is being cut.

A spreader should also be provided and fastened securely at the rear of saw in alignment with the saw blade, except where a roller wheel is provided back of saw. The spreader should be slightly thinner than the saw kerf and slightly thicker than the saw disc.

Feed rolls should be enclosed except such part as may be necessary to feed stock.

Non-kickback dogs across the full width of the table should be provided.

10. **Portable circular saws.**—Portable circular saws should be provided with a hood that will cover the saw teeth at all times except where the material is being cut.

11. **Jointer or buzz planers.**—A cylindrical cutting head should be provided.

A guard which adjusts automatically over the cutting head should be provided. All exposed parts of cutting head should be guarded.

Where equipped with automatic feed, the feeding mechanism should be guarded.

Where knives are exposed beneath the table, they should be guarded.

12. **Combination woodworking machines.**—Each point of operation of any tool should be guarded as required for such tool in a separate machine. The drive should be so arranged that only the tool in use would be operating.

13. **Automatic lathes.**—A hood or cover should be provided enclosing the cutter blades, except at the contact points, while the stock is being cut.

14. **Mortising machines.**—Mortising machines, except hollow chisel mortisers, should be provided with thumb stops at each side of the chisel.

15. **Chain mortisers.**—These should be guarded by enclosure on top.

16. **Moulders, matchers, and stickers.**—These should be guarded with hoods or other enclosures that should be so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

17. **Panel raisers.**—Panel raisers should be guarded with hoods or other enclosures so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

18. **Planers.**—Planers should be guarded with hoods or other enclosures so arranged and maintained as to guard effectively all cutting heads and knives.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

19. **Drum sanders.**—The exposed parts of the drum, except that portion where the material comes in contact with the abrasive surfaces, should be guarded.

Feed rolls should be enclosed, except such part as may be necessary to feed stock.

20. **Shapers.**—The cutting heads of wood shapers should be provided with a guard that will prevent the hands of the operator from coming in contact with the knives. This rule need not apply when templates are used, which will effectively keep the operator's hands away from the knives or when shaping stock large enough to accomplish the same purpose.

21. **Tenoners.**—Tenoners should be provided with hoods or other enclosures so arranged and maintained as to guard effectively all cutting parts and saws.

22. **Wood heel turning machines.**—Wood heel turning machines should be provided with a

guard or shield in front of the cutters except while it is necessary to expose a part of the cutter while turning stock.

23. **Stave jointers.**—The upper half of the rotating head or disc carrying the knives of stave jointers should be provided with a cover over the sides and front.

24. **Veneer clipper or slicers.**—Veneer clippers or slicers should be provided with prong guards or shields, both in front and back of the knife, so arranged that the hands of the operator and the man taking away, cannot be caught.

G. CRANES AND HOISTS

1. **Overhead trolleys and monorails.**—Every overhead trolley and every monorail crane should be constructed so as to prevent it leaving the track at any point except that where, because of necessity for removal, trolleys cannot be so constructed, an additional guard rail should be installed which will prevent the trolley from falling if it leaves the tracks. If removable sections are provided in the guard rail, they should be so arranged that they will drop into place by gravity immediately upon release after removal of trolley.

2. **Cranes.**—The recommendations contained herein should apply to power-driven overhead traveling cranes, storage bridges, gantry cranes and portal cranes, and modifications of these types which retain their fundamental features.

(a) Bumpers.—A bumper should be provided at each end of the trolley. It should be fastened to the bridge girder, or, if the rail is prevented from sliding lengthwise, it may be fastened to the rail. A bumper engaging the tread of the wheel should be of a height at least equal to the radius of the wheel. Bumpers engaging other parts of the crane are acceptable.

(b) Buffers.—If there is more than one trolley on the same bridge girders, buffers or cushioning devices should be provided. If there is more than one crane on the same runway, buffers or cushioning devices should be provided at both ends of the bridges.

(c) Fenders.—Bridge trucks and trolley trucks should be equipped with fenders which extend below the top of the rail and project in front of the truck wheels.

(d) Brakes.—Each independent hoisting unit of a crane should be equipped with two braking means except worm-geared hoists, the angle of whose worm is such as to prevent the load from accelerating in the lowering direction.

One brake should be applied directly to the motor shaft or some part of the reducing gear, and may be either electrically operated, or mechanical. The other brake may be either mechanical or electrical. If mechanical it should lock the load when hoisting is stopped, and should also control the speed during lowering so as to prevent undue acceleration. Electric dynamic braking for direct-current and electric braking for alternating-current hoists may be used to control the lowering speed.

Each brake should be capable of sustaining one and one-half times the rated load.

Worm-geared hoists referred to in these standards should have at least one electrically operated or mechanical brake.

On cage-operated cranes with the cage mounted on the bridge girders, a foot brake to properly retard and stop the motion of the bridge should be capable of retarding at the rate of 1 foot per second while full load is being carried.

(e) Lubrication.—Lubricating devices should be arranged so that they can be reached without danger to the oiler. They should also be arranged so that it is not necessary to remove any guards or other parts for lubrication purposes.

(f) Collector wires.—Collector wires should be guarded when they can be readily contacted.

3. **Crane footwalks.**—If sufficient headroom is available on cage-operated cranes, a footwalk should be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the tops of the girders. To give sufficient access to the opposite side of the trolley, there should be provided either a footwalk mounted on the trolley, a footwalk or platform in the building, or a footwalk on the opposite side of the crane at least twice the length of the trolley.

If possible, footwalks should be located so as to give a headroom of not less than 78 inches. Otherwise a headroom of not less than 48 inches may be used.

If it is not possible to provide a headroom of 48 inches or more, footwalks should be omitted from the crane, and a stationary platform built at the edge of the runway to be used by workmen when making repairs, or else a landing stage built alongside the crane when repair work is done.

4. **Cranes—Stairways.**—Every overhead traveling crane operated from a cage should be provided with a stairway or fixed ladder between the cage and the crane footwalk, and between the cage and the floor.

Stairways should be equipped with rigid and substantial metal handrails as described in Part II B and should be at an angle of not more than 50° with the horizontal. A suitable emergency exit should be provided where hazards justify such precautions.

A warning signal such as a gong, siren or bell should be provided on all traveling cranes.

5. **Crane cages—Enclosures.**—*(a) Indoor cranes.*—The cage floor of every indoor overhead traveling crane should be solid except that grating with openings not exceeding ½ inch in

width may be provided where necessary for vision.

The sides of the cage of every indoor overhead traveling crane should be enclosed as follows:

(1) Solid to a height of 42 inches, or

(2) With not less than No. 10 wire screen with mesh openings not greater than 3 inches, to a height of 42 inches, with toeboard, or

(3) With a standard guard rail and toeboard.

(b) Outdoor cranes.—The cage of every outdoor traveling crane should be fully enclosed with windows on three sides of the cage. The windows should give ample vision for operators and may be fixed at the front and back but should have the side windows arranged to open. The door should swing inward or should slide, and should be arranged to close automatically. A temperature reasonably comfortable for the operator should be maintained in cold weather.

(c) Trolley conductors.—Trolley conductors should be so located or so guarded that persons entering or leaving the cage are not likely to come into contact with them.

6. **Hoists.**—*(a) Limit switches.*—Each overhead electric or air-operated hoist motor should be equipped with an effective limit switch so placed and arranged as to disconnect the motor and apply the brake in time to stop the motor before the hook passes the highest point of safe travel.

(b) Brakes.—Each electric or air-operated hoist motor should be provided with an electrically or mechanically operated brake so arranged that the brake will be applied when the power is cut off from the hoist. This brake should have sufficient holding power to sustain not less than one and one-half times the rated load.

The hoisting drum of all hand power hoists should be equipped with an effective brake, and should be provided with a ratchet and pawl of sufficient strength to hold the load in any position.

(c) Capacity marking.—The rated load of each hoist, in pounds or tons, should be legibly marked on the hoist or load block.

(d) Control equipment.—Operating controls should be marked to indicate the resultant direction of travel.

7. **Cables, ropes, and chains.**—Chains, ropes, cables, hooks, rings, slings, and other devices and accessories used for hoisting and lifting should not be subjected to greater working loads than recommended by their manufacturers. They should be frequently inspected and should be renewed when inspection reveals unsafe conditions.

Bolts or nails should not be used to connect, splice, or shorten chains. Knots should not be tied in the chain.

A hoist cable should be considered unsafe and should be renewed when because of broken wires, wear, rust, undue strain, or other cause the strength of the cable becomes reduced 25 percent. Hoist cables will be considered unsafe when upon inspection 10 percent or more of the total number of wires are broken in a length equal to eight diameters of the cable.

Crane hoist cable should be lubricated and inspected at frequent intervals. Proper lubrication adds much to their durability.

PART III—HEALTH REQUIREMENTS

A. MEDICAL SERVICES

1. **Accident and sickness, including first aid.**—*(a) First aid.*—It is the duty of the employer to see that some individual is available, during all periods of plant operation, who has been trained to administer first aid, and to handle the emergencies which may arise out of accidents and injuries to workers.

Employees—ideally all of them—should be encouraged to take the time-tested basic Red Cross course in first aid. Selected employees should be encouraged to take advanced and teachers' courses, if industrial preparation for disaster is to be adequate.

First-aid facilities and services should be used only for the intended purpose of first aid, and should not in any way take the place of necessary experienced care and treatment by a physician.

In the absence of a physician, emergency first aid should be given by the nurse, or in her absence by a trained first-aid worker, under the recommended procedures of the American Red Cross, as authorized and posted by the plant physician.

Where females are employed, cots in adequate number should be provided and so located, placed, or screened as to provide the necessary privacy for those using same.

*Eye first aid.**—Where the workers' eyes are exposed to injurious chemical materials, such as acids, caustics, etc., suitable facilities for quick drenching or flushing of the eyes, such as the fountain-type wash bowl, should be provided *within the workroom,* for immediate emergency use.

Emphasis should be given to the early use of the eye specialist (ophthalmologist), in injuries

*Guide-lines should be established for both emergency and later treatment of eye injury and occupational disease, with the advice of a qualified ophthalmologist. These should include standard criteria for the use of specialist services, and standing orders in writing should be posted governing such services.

to the cornea, and to the deeper structures of the eye. The eye must be regarded as the most exposed, most easily injured, most sensitive, and most valuable of the special sense organs.

It must be considered that the most minor eye injury can most quickly develop the most dangerous complications. Removal of foreign bodies under the lids should be done with extreme care, and removal of particles driven into the cornea (transparent front of the eye), should be done only by the plant physician, if skilled in this work, or by the eye specialist.

B. ENVIRONMENTAL CONDITIONS AND PERSONAL SERVICES

1. **Control of atmospheric contaminants.**—*(a)* Workers shall not be exposed to concentrations of atmospheric contaminants hazardous to health.

The most recent values for maximum concentrations as recommended by the American Conference of Governmental Industrial Hygienists shall be used as a guide in appraising occupational health hazards, and in evaluating controls.

Maximum concentrations shall not be used as the sole criterion for establishing evidence of hazard to health or well-being, but the evaluation of a possible hazard shall also be subject to other pertinent factors, such as the nature of the contaminant, and the frequency and duration of exposure, or clinical evidence of harmful effects.

(b) Control of atmospheric contaminants may be accomplished by any of the following methods:

(i) Substitution of a less toxic material for the material contaminating the workroom atmosphere.

(ii) Exhaust ventilation so that the contaminant is removed from the workroom atmosphere.

(iii) Isolation of the operation, so that the contaminant does not enter the general workroom atmosphere in hazardous concentrations, provided that any worker who is exposed to a health hazard by entering the isolated area shall be furnished personal protection in accordance with the provisions of this code. (See sec. 6, hereafter.)

(iv) Enclosure of the operation, so that the contaminant does not escape into the workroom atmosphere in hazardous concentrations.

(v) Change the process or operating method (such as by wet methods, the use of foams, colloids, etc.), so that the hazard is controlled.

(vi) Increase of general ventilation, so that the contaminant is diluted to a safe concentration.

(c) The most recent values for maximum concentrations as recommended by the American Conference of Governmental Industrial Hygienists should be used as a guide in appraising occupational health hazards and in evaluating control. Maximum concentrations should not be used as the sole criterion for establishing evidence of hazard to health or well-being, but the evaluation of a possible hazard should also be subject to other pertinent factors such as the nature of the contaminant and the frequency and duration of the exposure or clinical evidence of harmful effects. The following are examples:

MAXIMUM ALLOWABLE CONCENTRATIONS

Threshold limit values, adopted April 1950, at Chicago, Ill., American Conference of Governmental Industrial Hygienists

GASES AND VAPORS

[Parts per million; 1 percent=10,000 p. p. m.]

Substance	*P. p. m.*
Acetaldehyde	200
Acetic acid*	10
Acetic anhydride	5
Aceton	500
Acrolein*	0.5
Acrylonitrile	20
Ammonia*	100
Amylacetate	200
Iso-Amyl alcohol*	100
Aniline	5
Arsine	0.05
Benzene (benzol)*	35
Bromine*	1
1,3-Butadiene	1,000
n-Butanol	100
2-Butanone	250
n-Butyl acetate	200
Butyl cellosolve	200
Carbon dioxide	5,000
Carbon disulfide	20
Carbon monoxide*	100
Carbon tetrachloride*	50
Cellosolve	200
Cellosolve acetate	100
Chlorine	1
2-Chlorobutadiene	25
Chloroform	100
1-Chloro-1-nitropropane	20
Cyclohexane	400
Cyclohexanol	100
Cyclohexanone	100
Cyclohexene	400
Cyclopropane (propene)	400
o-Dichlorobenzene	50
1,1-Dichloro-1-nitro ethane	10
1,2-Dichloropropane (propylene dichloride)	75
Dichlorotetrafluoroethane (Freon-114)	1,000
Dimethylaniline	5
Dimethylsulfate	1
Dioxane	100
Ethyl acetate	400
Ethyl alcohol	1,000
Ethyl benzene	200
Ethyl bromide	200
Ethyl chloride	1,000
Ethylene chlorohydrin	5
Ethylene dichloride (1,2-Dichloroethane)	75
Ethylene oxide	100
Ethyl ether	400
Ethyl formate	100
Ethyl silicate	100
Formaldehyde	5
Gasoline	500
Heptane	500
Hexane	500
Hydrogen chloride*	5
Hydrogen cyanide	10
Hydrogen fluoride	3
Hydrogen selenide	0.05
Hydrogen sulfide	20
Iodine	1
Isophorone	25
Mesityl oxide	50

*Recommended lower concentration, but not specific value.

GAS AND VAPORS—Continued

Substance	*P. p. m.*
Methanol	200
Methyl acetate	200
Methyl propanone (pentanone)	200
Monochlorobenzene	75
Monofluorotrichloro-methane (Freon-11)	1,000
Mononitrotoluene	5
Naphtha (coal tar)	200
Naphtha (petroleum)*	500
Nickel carbonyl	1
Nitrobenzene	1
Nitroethane	100
Nitrogen oxides (other than N_2O)	25
Nitroglycerin	0.5
Nitromethane	100
2-Nitropropane	50
Octane	500
Ozone*	1
Pentane	1,000
Pentanone (Methyl propanone)	200
Phosgene	1
Phosphine	0.05
Phosphorus Trichloride	0.5
iso-Propanol	400
Propene (cyclopropane)	400
Propyl acetate	200
Propylene dichloride	75
(1,2-dichloropropane) iso-Propyl ether	500
Stibine	0.1
Stoddard solvent*	500
Styrene monomer	200
Sulfur chloride	1
Dichlorodifluoromethane (Freon-12)	1,000
1,1-Dichloroethane	100
1,2-Dichloroethane (ethylene dichloride)	75
1,2-Dichloroethylene	200
Dichloroethyl ether	15
Dichloromethane	500
Dichloromonofluoromethane (Freon-21)	1,000
Methyl bromide	20
Methyl butanone	100
Methyl cellosolve	25
Methyl cellosolve acetate	25
Methyl chloride	100
Methylcyclohexane	500
Methylcyclohexanol	100
Methycyclohexanone	100
Methyl formate	100
Methyl isobutyketone	100
Sulfur dioxide	10
1,1,2,2-Tetrachloroethane	5
Tetrachloroethylene	100
Toluene	200
Toluidine	5
Trichloroethylene*	100
Turpentine	100
Vinyl chloride	500
Xylene	200

*Recommended lower concentration, but not specific value.

TOXIC DUSTS, FUMES, AND MISTS

[Milligrams per cubic meter of air]

Substance	*Mg./cu. m.*
Antimony	0.5
Arsenic	0.5
Barium	0.5
Cadmium	0.1
Chlorodiphenyl	1
Chromic acid and chromates as CrO_3*	0.1
Cyanide as CN	5
o-Dinitrocresol	0.2
Dinitrotoluene	1.5
Fluoride	2.5
Iron oxide fume	15
Lead	0.15
Magnesium oxide fume	15
Manganese	6.1
Mercury	0.1
Pentachloronaphthalene	0.5
Pentachlorophenol	0.5
Phosphorus (yellow)	0.1
Phosphorus pentachloride	1
Phosphorus pentasulfide	1
Selenium, as Se	0.1
Sulfuric acid*	1.0
Tellurium	0.1
Tetryl	1.5
Trichloronaphthalene	5
Trinitrotoluene	1.5
Zinc oxide fume	15

*Recommended lower concentration, but not specific value.

MINERAL DUSTS

[Million particles per cubic foot of air]

Substance	*M. p. p. c. f.*
Alundum	50
Asbestos	5
Carborundum	50
Dust (nuisance, no free silica)*	50
Mica (below 5 percent free silica)	50
Portland cement	50
Talc	20
Silica:*	
High (above 50 percent free SiO_2)	5
Medium (5 to 50 percent free SiO_2)	20
Low (below 5 percent free SiO_2)	50
Slate (below 5 percent free SiO_2)	50
Soapstone (below 5 percent free SiO_2)	20
Total dust (below 5 percent free SiO_2)	50

*Recommended lower concentration, but not specific value.

RADIATIONS

Material or radiation	*Radiant energy*
Gamma (milliroentgen per week)	300
X-ray (milliroentgen per week)	300
Radon (curies per cubic meter)	**10–8
Thoron (curies per cubic meter)	10–8

**10–8 curies = 870 disintegrations per second = —0.01 microgram radium.

New substances being studied	*Values not established*
Asphalt fumes and dust	Diethylene glycol.
Beryllium (0.005 mg/cu.m.)	Dipropylene glycol.
DDD	Ethylene glycol.
DDT	Propylene glycol.
Ketene	Triethylene glycol.
Monochloromonobromomethane.	

2. **Infectious agents.**—Measures shall be provided to eliminate or control the transmission of infectious diseases through processing or handling industrial products or wastes.

3. **General ventilation and temperature requirements.**—*(a)* Outside air shall be provided to all workrooms at the rate of 15 cubic feet per minute per person, or one and one-half air changes per hour, whichever is greater. In most instances, leakage through walls, doors, and windows will produce at least one and one-half air changes per hour.

(b) Air circulated in any workroom shall be supplied through air inlets arranged, located,

and equipped so that workers are not subjected to air velocities exceeding 200 feet per minute, except under special circumstances.

(c) In appraising and controlling health hazards associated with extremes of temperature and humidity, the most recent report of the Committee on Atmospheric Comfort of the Industrial Hygiene Section of the American Public Health Association is suggested as a guide.

(d) A minimum air temperature of 60° F. should be maintained at all workrooms where work of a strenuous nature is performed, and a minimum air temperature of 65° F. should be maintained in all other workrooms unless prohibited by process requirements.

(e) Air from any exhaust system handling materials listed under section 1, paragraph *(c)*, shall not be recirculated unless the equipment is checked frequently to be certain that its operation is efficient at all times.

4. **Local exhaust ventilation.**—*(a)* The air velocity and/or rate of air flow as hereinafter required through a hood, booth, enclosure, or other point of ventilation, and through the pipes, shall be maintained at all times when the machine or process for which the ventilation is applied, is in operation or use.

(b) The effectiveness of every local exhaust ventilation system shall be judged by:

(i) The ability of the hoods, booths, or other openings to produce a movement of air toward the opening, sufficient to prevent escape of contaminant to the workroom beyond the limits shown in section 1, paragraph *(c)*.

(ii) Air flow through branch and main ducts shall be sufficient to transport the contaminant through the system without settling.

(c) Piping shall be located so as to be accessible for inspection and maintenance.

(d) Air flow equipment including hoods, pipes, fans, motors, and collectors shall be effectively grounded.

(e) Two or more operations involving more than one substance shall not be permitted to be connected to the same exhaust system when a combination of the substances removed may constitute a fire hazard, an explosion hazard, or otherwise dangerous mixture.

(f) Those processes or operations using or generating flammable dusts, gases, fumes, vapors, mists, fibers or other impurities shall be completely protected from all sources of ignition.

(g) The capacity of an exhaust system shall be calculated on the basis of all hoods, booths, and enclosures connected to the system being open except where the system is so interlocked that only a portion of it can be operated at a given time in which case the capacity should be calculated on the basis that all the hoods in the group requiring the greatest volume rate of exhaust are open.

(h) Suitable air inlets shall be provided for replacement of air exhausted.

(i) Exhaust systems handling dusts and discharging to the outer air shall be provided with suitable air-cleaning devices to remove air contaminants prior to the discharge to the outer air except under unusual circumstances.

(j) The discharge from any exhaust system shall be such that no air contamination therefrom will enter any window, door, or other opening of any work space in quantities sufficient to create a health hazard to such space or create a nuisance to surrounding areas.

(k) Collected materials shall be removed at intervals frequent enough to insure that the exhaust system will meet the requirements of section 5, paragraph *(b)* at all times.

(l) Collected materials shall be disposed of in a manner which will not result in a nuisance or health hazard.

5. **Personal protective equipment.**—*(a)* Personal protective equipment shall not be used in lieu of control measures specified in section 1, paragraph *(b)*, except under unusual circumstances where the use of such control measures is impracticable.

(b) Personal protective equipment and/or protective barriers shall be provided whenever substances, radiations, or mechanical irritants are encountered in a manner capable of causing injury or impairment in function of any part of the body through skin and/or mucous membrane absorption.

(c) Personal protective equipment shall be fitted to each exposed worker when the wearing of such equipment is necessary for worker protection, and shall be maintained in an efficient and sanitary condition.

(d) Workers who handle or are exposed to harmful materials in such a manner that contact of work clothes with street clothes will communicate to the latter the harmful substances accumulated during working hours should be provided with facilities which will prevent this contact and also permit the free ventilation or drying of the work clothes while they are not in use. In any plant where it is necessary for both male and female employees to change clothes, separate dressing rooms should be provided.

6. **Eye protection.**—Eye protection should be provided where persons are exposed to any hazard which may reasonably be expected to cause injury to the eyes.

Such hazards are:

(a) Relatively large flying particles.—There are many operations and processes where this hazard occurs. Some of these are chipping, calking, coarse grinding, some riveting operations, and sledging in quarries.

(b) Dust and small flying particles.—There are many operations and processes where this hazard occurs. Some of these are scaling, light

grinding, stone dressing, spot welding, and some woodworking and metal-working operations.

(c) Splashing metal.—There are many operations and processes where this hazard occurs. Some of these are babbitting, casting of hot metal, and dipping in hot metal baths.

(d) Injurious gases, fumes, and liquids.—There are many operations and processes where this hazard occurs. Some of these are encountered in the handling of acids and caustics.

(e) Injurious radiant energy.—There are many operations and processes where this hazard occurs. Some of these are electric arc welding, oxyacetylene and oxyhydrogen welding and cutting, furnace tending, and irradiation with ultraviolet light.

7. **Noise.**—*(a)* Noise should be reduced or eliminated as a means of preventing fatigue or accidents.

(*b*) Some appropriate means of noise reduction are:

(i) Sound absorbing partitions.

(ii) Segregation of the noisy process.

(iii) Provision of appropriate ear stopples to employees affected.

8. **Lunchrooms.**—Separate rooms in which employees may eat their lunches should be provided in plants where employees are exposed to harmful materials in the workrooms. Such rooms should be maintained in a clean and sanitary condition at all times and they should be ventilated, illuminated, and heated properly and adequately.

9. **Housekeeping.**—*(a)* All places of employment, passageways, storerooms, service rooms, machinery, equipment, and supplies shall be kept in a clean and sanitary condition with all unnecessary dust, spillage, and debris removed at regular intervals frequent enough to maintain good housekeeping.

(b) Where wet processes are used, reasonable drainage shall be maintained and false floors, platforms, mats, or other dry standing places shall be provided.

(c) So far as possible, sweeping and cleaning shall be done in such a manner as to avoid the contamination of the air with dust during working hours.

C. SPECIAL SANITATION SERVICES

1. **Drinking water.**—There should be provided in all places of employment, a supply of potable, clean, cool, safe drinking water, approved as to source and supply by the local authority having jurisdiction. The common drinking cup is prohibited.

Drinking facilities readily accessible to all employees, and of a type approved by the local authority having jurisdiction, shall be provided in the ratio of 1 facility for each 100 employees.

When individual drinking cups (to be used only once) are supplied, a suitable container should be provided for the disposal of used cups. Containers for drinking water from which the water must be dipped or poured, should not be allowed.

2. **Toilet facilities.**—Every place of employment should be provided with adequate closets, chemical closets, or privies (separate for each sex), in accordance with the following table, in which the number of persons is the maximum number of each sex employed at any one time on the premises for which facilities are furnished:

Number of persons:	*Minimum number of facilities*
1 to 9	1
10 to 24	2
25 to 49	3
50 to 74	4
75 to 100	5
Over 100	[1] 1

[1] For each additional 30 persons.

Urinals instead of water closets for male employees may be substituted in a ratio of not more than one-third urinals in the above minimum facility schedule.

Where chemical closets are used, they shall be of a type approved by the local health authority, and maintained in a clean and sanitary condition at all times. Janitor service should be scheduled, and frequent.

Privies should not be permitted where more than 25 people are employed, and no privy should be permitted within 100 feet of any room in which foodstuffs are stored or handled. No privy should be used unless it can be located, constructed, and maintained without danger of contaminating any sources of drinking water.

Construction, installation and ventilation of toilet rooms and facilities shall conform to the requirements of the local public health authority having jurisdiction.

Waste receptacles with covers should be kept in all toilet rooms. They should be emptied at regular, frequent intervals.

An adequate supply of toilet paper in proper holders should be provided in each toilet room. All toilets should have solid partitions separating them from workrooms. They should be effectively separated and designated as to sex, and should be lighted and ventilated adequately. Windows may be translucent, but not transparent.

3. **Washrooms.**—Every place of employment shall be provided with adequate washing facilities in the ratio of 1 lavatory (or equivalent wash place) for each 10 employees up to 100 persons, and 1 lavatory (wash place) for each additional 15 persons. Each lavatory (wash place) shall be provided with soap and hot and cold running water.

Individual clean towels of cloth or paper shall be provided. Other apparatus for drying the hands shall be substituted only after approval by the local health authority having jurisdiction.

[T.D. 72-153]

PART 10—ARTICLES CONDITIONALLY FREE, SUBJECT TO A REDUCED RATE, ETC.

Free Withdrawal of Supplies and Equipment for Aircraft

In accordance with section 309(d), Tariff Act of 1930, as amended (19 U.S.C. 1309(d)), the Department of Commerce has found and under date of April 25, 1972, has advised the Treasury Department that Poland allows privileges to aircraft registered in the United States and engaged in foreign trade substantially reciprocal to those provided for in sections 309 and 317 of the Tariff Act of 1930, as amended (19 U.S.C. 1309, 1317). The same privileges are therefore hereby extended to aircraft registered in Poland and engaged in foreign trade effective as of the date of such notification.

Accordingly, paragraph (f) of § 10.59, customs regulations, is amended by the insertion of Poland in appropriate alphabetical order and the number of this Treasury decision in the opposite column headed "Treasury Decision(s)" in the list of nations in that paragraph.

(Secs. 309, 317, 624, 46 Stat. 690, as amended, 696, as amended, 759; 19 U.S.C. 1309, 1317, 1624)

[SEAL] EDWIN F. RAINS,
Acting Commissioner of Customs.

Approved: May 25, 1972.

EUGENE T. ROSSIDES,
Assistant Secretary of the Treasury.

[FR Doc.72-8578 Filed 6-6-72;8:50 am]

Title 29—LABOR

Chapter XVII—Occupational Safety and Health Administration, Department of Labor

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Standard for Exposure to Asbestos Dust

On December 7, 1971, an emergency temporary standard concerning exposure to asbestos fibers was published in the FEDERAL REGISTER (36 F.R. 23207). In accordance with section 6(c)(3) of the Williams-Steiger Occupational Safety and Health Act of 1970, a notice of proposed rulemaking regarding a permanent standard for exposure to asbestos fibers was published in the FEDERAL REGISTER on January 12, 1972 (37 F.R. 466). The notice invited interested persons to submit both orally and in writing, data, views, and arguments concerning the proposal.

On or about January 24, 1972, the Advisory Committee on Asbestos Dust was established and requested to make written recommendations with regard to the proposed standard on asbestos. On or about February 1, 1972, the Department of Health, Education, and Welfare transmitted to the Secretary of Labor a criteria document containing Recommendations for an Occupational Exposure Standard for Asbestos by the National Institute for Occupational Safety and Health (NIOSH). Public notice was given of the receipt of the recommendations and their availability for inspection and copying. On or about February 25, 1972, the Advisory Committee on Asbestos Dust submitted its written recommendations to the Assistant Secretary of Labor for Occupational Safety and Health.

Pursuant to the notice of rule making, a hearing was held on March 14 through 17, 1972, for the purpose of receiving oral data, views, and arguments concerning the proposed standard. On or about March 31, 1972, the presiding hearing examiner certified to the Assistant Secretary of Labor for Occupational Safety and Health the record of the proceeding. The record includes prehearing written comments, a transcript of the oral presentations made at the hearing, and numerous exhibits received during the course of the hearing or within the period allowed after the close of the hearing.

The proposed standard dealt with (1) permissible concentrations of asbestos fibers; (2) methods of compliance; (3) warning signs; (4) monitoring; (5) medical examinations; and (6) recordkeeping. Each of these major proposals elicited comments, arguments, objections, and counterproposals. They all have been examined and considered.

1. *Acceptable concentrations of asbestos dust.* The proposed standard would limit occupational exposure to 8-hour time-weighted average (TWA) airborne concentrations of asbestos dust not exceeding five fibers longer than five micrometers per milliliter. Concentrations above five fibers but not to exceed 10 fibers (ceiling concentration) would be permitted up to 15 minutes in an hour, but for not more than 5 hours in any one 8-hour day.

NIOSH in effect has recommended that the five-fiber TWA and 10-fiber peak concentrations be permitted only for 2 years; thereafter, TWA concentrations should be not more than 2 fibers per cubic centimeter (cm.^{3}) of air, and peak concentrations should not exceed 10 fibers/cm.^{3}, with no time restriction. Numerous objections and counterproposals have been made, with regard to both the limits of asbestos fiber concentrations and the time periods to comply with them. Some, for example, have recommended return to a 12-fiber standard of an earlier day; i.e., a level adopted under the Walsh-Healey Public Contracts Act in 1969. Others have recommended a two-fiber standard to become effective in 6 months, then a one-fiber standard for 2 years, and finally a zero-fiber standard after 3 years. These recommendations give a fair indication of the wide spread of the counterproposals.

No one has disputed that exposure to asbestos of high enough intensity and long enough duration is causally related to asbestosis and cancers. The dispute is as to the determination of a specific level below which exposure is safe. Various studies attempting to establish quantitative relations between specific levels of exposure to asbestos fibers and the appearance of adverse biological manifestations, such as asbestosis, lung cancers, and mesothelioma, have given rise to controversy as to the validity of the measuring techniques used and the reliability of the relations attempted to be established. Because of the long lapse of time between onset of exposure and biological manifestations, we have now evidence of the consequences of exposure, but we do not have, in general, accurate measures of the levels of exposure occurring 20 or 30 years ago, which have given rise to these consequences. There are also controversies concerning the relative toxicity of the various kinds of asbestos, and varying hazards in different workplaces.

It is fair to say that the controversy has centered in the area between a two-fiber TWA concentration and five-fiber TWA concentration, with variations on the time needed for compliance. Many employers support a five-fiber TWA. Most medical opinion is divided between a two-fiber standard and a five-fiber standard.

In view of the undisputed grave consequences from exposure to asbestos fibers, it is essential that the exposure be regulated now, on the basis of the best evidence available now, even though it may not be as good as scientifically desirable. An asbestos standard can be re-evaluated in the light of the results of ongoing studies, and future studies, but cannot wait for them. Lives of employees are at stake.

It is concluded that there should be one minimum standard of exposure to asbestos applicable to all workplaces exposed to any kind, or mixture of kinds, of asbestos. Reasons of practical administration preclude a variety of standards for different kinds of asbestos and of workplaces. Also, while the evidence tends to show that crocidolite, for instance, is more harmful than chrysotile, the evidence is not sufficient to establish separate standards for varieties of asbestos.

Because there must be one standard governing exposure to all varieties of asbestos, and in workplaces apparently more hazardous than others; because some present employees with regular exposure to asbestos have probably already accumulated great doses of asbestos fibers, due to higher levels of exposure in the past; because it appears that levels of exposure which may be safe with regard to asbestosis are not safe with regard to mesothelioma; because the statute requires the protection of every employee, even of one who may have regular exposure to asbestos during a working life which may reach, or even exceed, 40 years; and because of several other considerations which have been urged and are reflected in the record of the proceeding, the conflict in the medical evidence is resolved in favor of the health of employees. As of July 1, 1976, TWA concentrations of asbestos fibers longer than 5 micrometers will not be allowed to exceed two fibers/cc., with a ceiling value of 10 fibers/cc. The current TWA concentrations of five fibers, and ceiling concentrations of 10 fibers/cc, will be permitted until July 1, 1976, during what will be a transitional period deemed necessary to allow employers to make the needed changes for coming into compliance with the more stringent standard.

The record shows that the many work operations subject to the single asbestos standard (textile, manufacturing, industrial, and marine installation, etc.) will meet varying degrees of difficulty in complying with the standard. In some plants, extensive redesign and relocation of equipment may be needed. It appears, however, the delay in the effective date of the two-fiber standard will provide all employers a reasonable time to comply. At the same time, so long as the ceiling limit is complied with, no harm is reasonably expected to result from exposures during the transitional period.

2. *Methods of compliance.* It has been pointed out by many persons, that protection against asbestos fibers is best obtained by controlling the generation of fibers first, and secondly, by controlling the dispersion of released fibers into the ambient air of the workplaces. Therefore, the standard requires feasible technological controls and appropriate work practices as the primary means of compliance. Rotation of employees as a way of meeting the TWA concentration requirement is allowed only in stated exceptional circumstances, because, as a general rule, it would be difficult to implement. Personal protective equipment, such as respirators, cannot be relied upon because, among other reasons, they may be so uncomfortable as to be burdensome, except for short periods of time. Therefore, it is expected that respirators and shift rotation will be used during the period necessary to install engineering controls and to train employees in sound work practices, but, after technological compliance has been achieved, their use must be limited to special work situations and emergencies. Where both are practicable, shift rotation is required.

3. *Labeling.* The proposed standard stopped short of requiring labeling asbestos and asbestos-containing products. The proposed standard would have required only warning signs at locations where asbestos hazards are present. However, labeling, rather than warning signs, has proved to be a point of controversy. Both NIOSH and the Advisory Committee on Asbestos Dust recommended labels for asbestos products and containers, and these recommendations became very controversial in the course of the proceeding. Many counterproposals have been made as to the language of the warning as well as to the products to be subject to the labeling requirements. Employers, in general, strongly contend that (1) finished products which effectively entrap asbestos fibers, so that these would not be released in the normal use of the products, should not be required to be labeled; and (2) words such as "danger" and "cancer" are unwarrantedly alarming.

Both contentions have merit, and the standard has been changed accordingly.

4. *Monitoring.* The proposed standard would have required personal monitoring and environmental monitoring. Many issues have been raised concerning the availability and reliability of measuring instruments, frequency of monitoring, and conditions in which monitoring should be required. The adopted standard takes the objections into consideration. It requires periodic monitoring at intervals no longer than 6 months, thus allowing considerable time and discretion, and prescribes the use of the membrane filter method, which is an acceptable method for determination of asbestos fibers.

It has also been recommended that employees or their representatives should have an opportunity to observe the monitoring. The recommendation has been accepted.

5. *Medical examinations.* The proposed standard would only require an appropriate medical examination on a periodic basis. The generality of the proposal has attracted many objections and also many helpful comments. The recommendations of NIOSH and of the Advisory Committee on Asbestos Dust were much more specific with respect to both frequency and type of medical examinations to be required. The comments vary as to the class of employees to be examined and as to the frequency of the examinations.

The adopted standard requires medical examinations both at the beginning and the termination of employments exposed to concentrations of asbestos fibers, and also requires annual medical examinations of every employee exposed to airborne concentrations of asbestos. It has been pointed out that in certain industries, such as construction, an employee may work for several employers during the same year. Accordingly, the standard does not require either preemployment, or termination, or periodic examinaton of any employee who has been examined in accordance with the standard within the past year.

One question which has been raised goes to whether the employer or the employee should be allowed to choose the examining physician. The standard gives the option to the employer. Since some employers already have a medical examination program in operation, and also, have medical departments with some expertise in the diagnosis of asbestos-related diseases, it seems more reasonable to permit them to utilize the present programs and expertise, than to permit an employee to choose a private general practitioner.

6. *Records.* The standard, as proposed and as adopted, requires maintenance of records of monitoring and of medical examinations. Most of the controversy in this area has revolved around the question whether an employer should be allowed to have access to the results of the required medical examinations. The apprehension of those who have argued against employer access is based on the expectation that some employers will use the medical examinations as a means of screening employment applicants, and worse, as grounds for discharging current employees, who show signs of being affected by exposure to asbestos. Since the purpose of the medical examinations is to monitor the health of employees exposed to the hazards of abestos, employees cannot in reason be granted the privilege of refusing to disclose to their employers results of occupational exposure. It does not make sense to require employers to provide medical examinations if they cannot know and use the results of the examinations. For these reasons the standard provides that employers may have a restricted access to some medical information.

On the other hand, there is no intention to allow employers to abuse medical information obtained pursuant to the Act, to the detriment of employees. Therefore, the administration of the medical records requirement will be closely watched, and, in cases of abuse, appropriate action will be considered.

The issues discussed above are believed to be the major ones. Numerous other issues have been raised in the rulemaking proceedings. Some have been referred to incidentally. Many recommendations, for instance, about work practices, are so obviously meritorious that their adoption needs no exposition here. Other recommendations and many objections have not been adopted for a variety of reasons which should be manifest. Several, for instance, have recommended the use of respirators only pursuant to a variance, or in cases of emergency and occasional short-term exposures. The recommendation with respect to variances undoubtedly has many merits, but is considered administratively impractical.

Accordingly, after consideration of the whole record of the proceeding, and pursuant to sections 6 (b) and (c) and 8(c) of the Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1596, 1599; 29 U.S.C. 655, 657), 29 CFR 1910.4, and to Secretary of Labor's Order No. 12-71 (36 F.R. 8754), Part 1910 of Title 29 of the Code of Federal Regulations is amended as set forth below.

(1) Section 1910.93 is amended by revising Table G-3 to read as follows:

§ 1910.93 Air contaminants.

* * * * *

TABLE G-3—MINERAL DUSTS

Substance	Mppcf	Mg/M³
Silica:		
Crystalline:		
Quartz (respirable)	250[1] / $\%SiO_2+5$	10mg/M³[2] / $\%SiO_2+2$
Quartz (total dust)		30mg/M³ / $\%SiO_2+2$
Cristobalite: Use ½ the value calculated from the count or mass formulae for quartz.		
Tridymite: Use ½ the value calculated from the formulae for quartz.		
Amorphous, including natural diatomaceous earth	20	80mg/M³ / $\%SiO_2$
Silicates (less than 1% crystalline silica):		
Mica	20	
Soapstone	20	
Talc	20	
Portland cement	50	
Graphite (natural)	15	
Coal dust (respirable fraction less than 5% SiO_2)		2.4mg/M³ or
For more than 5% SiO_2		10mg/M³ / $\%SiO_2+2$
Inert or Nuisance Dust:		
Respirable fraction	15	5mg/M³
Total dust	50	15mg/M³

NOTE: Conversion factors—
mppcf × 35.3 = million particles per cubic meter
= particles per c.c.

[1] Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics.

[2] The percentage of crystalline silica in the formula is the amount determined from air-borne samples, except in those instances in which other methods have been shown to be applicable.

[3] As determined by the membrane filter method at 430 X phase contrast magnification.

[4] Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics:

Aerodynamic diameter (unit density sphere)	Percent passing selector
2	90
2.5	75
3.5	50
5.0	25
10	0

The measurements under this note refer to the use of an AEC instrument. If the respirable fraction of coal dust is determined with a MRE the figure corresponding to that of 2.4 Mg/M³ in the table for coal dust is 4.5 Mg/M³.

2. A new § 1910.93a is added to Part 1910, reading as follows:

§ 1910.93a Asbestos.

(a) *Definitions.* For the purpose of this section. (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) *Permissible exposure to airborne concentrations of asbestos fibers*—(1) *Standard effective July 7, 1972.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) *Standard effective July 1, 1976.* The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) *Ceiling concentration.* No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(c) *Methods of compliance*—(1) *Engineering methods.* (i) *Engineering controls.* Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) *Local exhaust ventilation.* (*a*) Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(*b*) See § 1910.6 concerning the availability of ANSI Z9.2-1971, and the maintenance of a historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(iii) *Particular tools.* All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) *Work practices*—(i) *Wet methods.* Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) *Particular products and operations.* No asbestos cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated so as to prevent effectively the release of airborne asbestos fibers in excess of the limits prescribed in paragraph (b) of this section.

(iii) *Spraying, demolition, or removal.* Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d)(2)(iii) of this section and with special clothing in accordance with paragraph (d)(3) of this section.

(d) *Personal protective equipment*—(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (c) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivisions (i), (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 F.R. 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii), and (iv) of this subparagraph.

(i) *Air purifying respirators.* A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) *Powered air purifying respirators.* A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) *Type "C" supplied-air respirators, continuous flow or pressure-demand class.* A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) *Establishment of a respirator program.* (*a*) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2–1969, which is incorporated by reference herein.

b. See § 1910.6 concerning the availability of ANSI Z88.2–1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in § 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of a respirator. Such employee shall be rotated to another job or given the opportunity to transfer to a different position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms: (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering: (*a*) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(*b*) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (*a*) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(*c*) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) *Method of measurement.* All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400–450 × (magnification) (4 millimeter objective) with phase contrast illumination.

(f) *Monitoring*—(1) *Initial determinations.* Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

(2) *Personal monitoring*—(i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) *Environmental monitoring*—(i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which may reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) *Sampling frequency and patterns.* After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) *Employee observation of monitoring.* Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) *Caution signs and labels.* (1) *Caution signs.* (i) *Posting.* Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee may read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) *Sign specifications.* The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" x 14" vertical format signs specified in § 1910.145(d)(4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this subdivision.

Legend	*Notation*
Asbestos	1" Sans Serif, Gothic or Block.
Dust Hazard	¾" Sans Serif, Gothic or Block.
Avoid Breathing Dust	¼" Gothic.
Wear Assigned Protective Equipment.	¼" Gothic.
Do Not Remain In Area Unless Your Work Requires It.	¼" Gothic.
Breathing Asbestos Dust May Be Hazardous To Your Health.	14 point Gothic.

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) *Caution labels*—(i) *Labeling.* Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) *Label specifications.* The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION

Contains Asbestos Fibers

Avoid Creating Dust

Breathing Asbestos Dust May Cause Serious Bodily Harm

(h) *Housekeeping*—(1) *Cleaning.* All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) *Waste disposal.* Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other closed, impermeable containers.

(i) *Recordkeeping*—(1) *Exposure records.* Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least 3 years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National

Institute for Occupational Safety and Health, and to authorized representatives of either.

(2) *Employee access.* Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) *Employee notification.* Any employee found to have been exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) *Medical examinations*—(1) *General.* The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) *Preplacement.* The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(3) *Annual examinations.* On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examination shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(4) *Termination of employment.* The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second ($FEV_{1.0}$).

(5) *Recent examinations.* No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1-year period.

(6) *Medical records*—(i) *Maintenance.* Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be retained by employers for at least 20 years.

(ii) *Access.* The contents of the records of the medical examinations required by this paragraph shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of NIOSH, to authorized physicians and medical consultants of either of them, and, upon the request of an employee or former employee, to his physician. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

3. A new § 1910.19 is added to Subpart B of Part 1910, reading as follows:

§ 1910.19 Asbestos dust.

Section 1910.93a shall apply to the exposure of every employee to asbestos dust in every employment and place of employment covered by § 1910.12, § 1910.13, § 1910.14, § 1910.15, or § 1910.16, in lieu of any different standard on exposure to asbestos dust which would otherwise be applicable by virtue of any of those sections.

Effective date. Paragraph (b)(2) of § 1910.93a shall become effective July 1, 1976. All other provisions of §§ 1910.93a, 1910.93, and 1910.19 shall become effective July 7, 1972. The current emergency temporary standard remains in effect until July 7, 1972.

(Secs. 6, 8, 84 Stat. 1593, 1598; 29 U.S.C. 655, 657; 29 CFR 1910.4; Secretary of Labor's Order No. 12-71, 36 F.R. 8754)

Signed at Washington, D.C., this 2d day of June 1972.

G. C. GUENTHER,
Assistant Secretary of Labor.

[FR Doc.72-8574 Filed 6-6-72;8:48 am]

Title 41—PUBLIC CONTRACTS AND PROPERTY MANAGEMENT

Chapter 9—Atomic Energy Commission

PART 9-1—GENERAL

Subpart 9-1.1—Procurement Regulations

MISCELLANEOUS AMENDMENTS

The changes made in AECPR Subpart 9-1.1, Procurement Regulations, have been made in order to establish the AECPR Temporary Regulations, which are a part of the AEC Procurement Regulations and the Federal Procurement Regulations System. The AECPR Temporary Regulations implement and supplement the FPR Temporary Regulations. They also contain policies and procedures initiated by the AEC which are to be effective for a period of 6 months or less. The AEC Procurement Instruction section has been revised accordingly. Minor editorial changes have also been made.

1. Section 9-1.101 *Scope of subpart,* is revised to read as follows:

§ 9-1.101 Scope of subpart.

This subpart describes the Atomic Energy Commission Procurement Regulations and the AECPR Temporary Regulations. It also describes exclusions from the AECPR as contained in the AEC Procurement Instructions.

2. Section 9-1.102 *Establishment of AEC Procurement Regulations,* is revised to read as follows:

§ 9-1.102 Establishment of the AEC Procurement Regulations and the AECPR Temporary Regulations.

§ 9-1.102-1 AEC Procurement Regulations.

(a) The AEC Procurement Regulations (AECPR) are hereby established.

(b) These regulations implement and supplement the Federal Procurement Regulations (FPR) and are a part of the Federal Procurement Regulations System.

(c) The effective date of FPR issuances throughout AEC will be the date indicated in the respective issuances unless otherwise provided in the AEC Procurement Regulations.

(d) The effective date of AECPR issuances throughout AEC will be the date indicated in the respective issuances.

§ 9-1.102-2 AECPR Temporary Regulations.

(a) The AECPR Temporary Regulations are hereby established.

(b) These regulations implement and supplement the Federal Procurement Regulations Temporary Regulations. They also contain policies and procedures initiated by the AEC which are expected to be effective for a period of 6 months or less.

(c) The effective date of the FPR Temporary Regulations issuances throughout AEC will be the date indicated in the respective issuances unless otherwise provided in the AECPR Temporary Regulations.

(d) The effective date of the AECPR Temporary Regulations issuances throughout AEC will be the date indicated in the respective issuances.

(e) The AECPR Temporary Regulations are a part of the AEC Procurement Regulations and the Federal Procurement Regulations System. All references to the AEC Procurement Regulations or AECPR in §§ 9-1.103 through 9-1.109 of this subpart shall be deemed to include the AECPR temporary regulations.

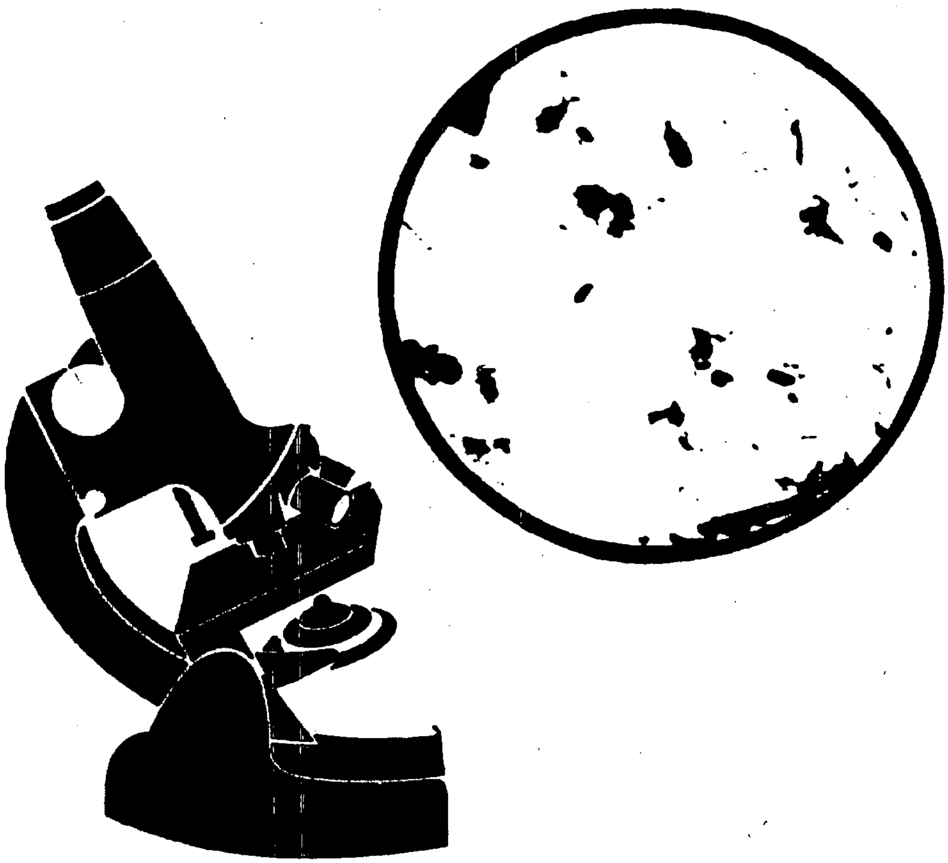
3. Section 9-1.103 *Authority,* is revised to read as follows:

§ 9-1.103 Authority.

The AEC Procurement Regulations are prescribed by the General Manager, Assistant General Manager for Administration, or the Director, Division of Contracts of the AEC, pursuant to the authority of the Atomic Energy Act of 1954, and the Federal Property and Administrative Services Act of 1949.

NIOSH

REVISED RECOMMENDED ASBESTOS STANDARD



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

REVISED RECOMMENDED

ASBESTOS STANDARD

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Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

DECEMBER 1976

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The Division of Surveillance, Hazard Evaluations, and Field Studies, National Institute for Occupational Safety and Health (NIOSH), having primary responsibility for development of a NIOSH position paper on health effects of occupational asbestos exposure, has critiqued all available data and prepared the following document for publication and transmittal to the Occupational Safety and Health Administration (OSHA), as requested by the Assistant Secretary of Labor. Primary responsibility for development of this document was shared by Richard A. Lemen and John M. Dement, with technical consultation provided by Dr. Joseph K. Wagoner. Individuals who served as the NIOSH review committee were:

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DHEW (NIOSH) Publication No. 77-169

REVISED RECOMMENDED
ASBESTOS STANDARD

Table of Contents

I. INTRODUCTION

When the asbestos criteria document was first published in 1972, the National Institute for Occupational Safety and Health (NIOSH) recommended a standard of 2.0 asbestos fibers/cubic centimeter (cc) of air based on a count of fibers greater than 5 micrometers (μm) in length. This standard was recommended with the stated belief that it would "prevent" asbestosis and with the open recognition that it would not "prevent" asbestos-induced neoplasms. Furthermore, data were presented which supported the fact that technology was available to achieve that standard and that the criteria would be subject to review and revision as necessary. Since the time that the asbestos criteria were published in 1972, sufficient additional data regarding asbestos-related disease have been developed to warrant reevaluation.

On June 7, 1972, the Occupational Safety and Health Administration (OSHA) promulgated a standard for occupational exposure to asbestos containing an 8-hour time-weighted average (TWA) concentration exposure limit of 5 fibers longer than 5 μm/cc of air, with a ceiling limitation against any exposure in excess of 10 such fibers/cc. The standard further provided that the 8-hour TWA was to be reduced to 2 fibers/cc on July 1, 1976.

As the result of a court case, OSHA decided that to achieve the most feasible occupational health protection, a reexamination of the standard's general premises and general structure was necessary. To this end, on October 9, 1975, OSHA announced a proposed rule-making to lower the exposure limit to an 8-hour TWA concentration of 0.5 asbestos fibers longer than 5 μm/cc of air with a ceiling concentration of 5 fibers/cc of air determined by a sampling period of up to 15 minutes. On December 2, 1975, OSHA requested NIOSH to reevaluate the information available on the health effects of occupational exposure to asbestos fibers and to advise OSHA on the results of this study.

This document contains an updated review of the available information on the health effects of exposure to asbestos. In addition, NIOSH's proposal for a new numerical exposure limit is included.

Edward J. Fairchild

for John F. Finklea, M.D.
Director, National Institute for
Occupational Safety and Health

II. BIOLOGIC EFFECTS OF EXPOSURE ON ANIMALS

Carcinogenicity

The carcinogenicity of asbestos was studied through various routes of exposure

(a) Instillation

(1) Intratracheal Injection

This technique has been used to study co-carcinogenesis of chrysotile asbestos with benzo(a)pyrene in hamsters (Miller et al, 1965) and rats (Vosamae, 1972; Pylev, 1972; Pylev and Shabad, 1973; Shabad et al, 1974). In both species, it was demonstrated that the effect of chrysotile was additive to that of benzo(a)pyrene for tumors of the respiratory tract.

Shabad et al (1974) showed that intratracheal injection of 2 mg of Russian chrysotile on which 0.144 mg benzo(a)pyrene was absorbed (3 times at monthly intervals), or 2 mg of Russian chrysotile together with 5 mg benzo(a)pyrene (single injection) produced lung papillomas, epidermoid carcinomas, reticulosarcomas, or pleural mesotheliomas in 6/21 and 6/11 rats, respectively, within 9-28 months. No lung tumors or mesotheliomas occurred in 49 rats given 3 doses of 2 mg chrysotile alone or in 19 rats given a single dose of 5 mg benzo(a)pyrene alone during or up to 28 months of observation.

(2) Intraperitoneal (ip) Administration

Reeves et al (1971) gave ip injections of 0.3, 0.5, or 1.0 ml of a solution of 20 mg/ml amosite, crocidolite or chrysotile to groups of 11, 13, and 13 Charles River CD rats, respectively. Three peritoneal mesotheliomas were observed with chrysotile, three with crocidolite, and none with amosite after 7-17 months. No data on control animals were reported.

Maltoni and Annoscia (1973) injected 25 mg of crocidolite into 50 male and 50 female Sprague-Dawley rats, 18 weeks old, and later observed 65 mesotheliomas-31 in males and 34 in females.

Pott and Friedrichs (1972) and Pott et al (1974) injected fibrous and granular dusts into the peritoneal cavities of Wistar rats. The dosage, number of inoculations, and results are shown in Tables II-1 and II-2.

After injection of powdered chrysotile, the latent period for the induction of tumors was found to be longer than that after injection of standard chrysotile. The rate of tumor occurrence was about 40% in both groups and was not distinctly influenced by the addition of benzo(a)pyrene. In another group, benzo(a)pyrene without asbestos induced tumors in 10% of the animals. Histologically, the types of tumors observed were connected with structures of the abdominal wall, including the serosa, and in isolated cases with those of the intestinal wall (Pott et al, 1972).

(3) Intrapleural Administration

All commercial types of asbestos have produced mesotheliomas in CD Wistar rats. A dose of 20 mg of the 5 UICC standard reference samples produced mesotheliomas in varying numbers - crocidolite, (61%); amosite, (36%); anthophyllite, (34%); Canadian chrysotile, (30%); Rhodesian chrysotile, (19%) (Wagner et al, 1974). The lowest dose used (0.5 mg chrysotile or crocidolite) produced mesotheliomas (Wagner et al, 1973). Stanton and Wrench (1972), using a dose of 40 mg asbestos dust on gelatin-coated fiber glass pledgets, found that three of the UICC samples, crocidolite, amosite and Rhodesian chrysotile, all produced mesotheliomas in about 60% of the Osborne-Mendel rats. Pylev and Shabad (1973) induced mesotheliomas with 60 mg of Russian chrysotile. In all these studies there was a long latent period between inoculation and appearance of the tumors. Evidence that the response was dose-related was provided by Wagner et al (1973) and by Stanton (1973). Mesotheliomas have also been produced by other workers: in rats (Donna, 1970; Reeves et al, 1971), in hamsters (Smith et al, 1965) and in rabbits (Reeves et al, 1971). Groth et al (1975) reported no mesotheliomas or other neoplasms from chrysotile in 45 female discard-breeder albino rats, approximately 10 months old. However, all surviving tumor-free animals were killed at 90 or 150 days after injection--a time period insufficient for the development of mesotheliomas as demonstrated by the experiments of Wagner and Berry (1969).

The suggestion has been made that natural oils and waxes (Harrington, 1962) and contaminant oils from milling of the asbestos fiber (Harrington and Roe, 1965; Roe et al, 1966) or from plastic storage bags (Commins and Gibbs, 1969) contributed to the incidence of pleural tumors. However, samples from which the oils had been removed gave very similar results to untreated fiber (Wagner and Berry, 1969; Wagner et al, 1973).

Morgan and Holmes (1970) and Morgan et al (1971) showed that when asbestos was injected intrapleurally, the majority of the fibers were cleared from the lungs during the first 10 days; subsequently there was also a very slow elimination through the gut. In feeding experiments almost all of the fibers were eliminated. After intrapleural or subcutaneous inoculation, only a minute fraction of the finer fibers were translocated through the tissues. This finding was supported by the studies of Kanazawa et al (1970).

The fiber diameter, length, and shape may be important in disease production. All of the eight separate sub-samples which were pooled in the UICC Canadian chrysotile reference sample (Timbrell and Rendall, 1972), when ground separately to a finer powder, produced a higher incidence of mesothelioma than the pooled sample. The highest incidence (66%) was produced by a separate superfine chrysotile sample (20 mg dose) fractionated from fine grade asbestos by water sedimentation (Wagner et al, 1973). Using UICC crocidolite, Stanton and Wrench (1972) found that partially pulverized material gave fewer mesotheliomas than did the standard unpulverized fiber. Prolonged fine grinding is known to destroy fiber and crystalline structure (Occella and Maddalon, 1963). Stanton (1973) showed that fibers of other materials, including glass, could induce mesotheliomas, but only when the diameter was of the same order as that of asbestos when measured by light microscopy.

In addition to the UICC standard reference samples, other fibers were injected intrapleurally into rats by Wagner et al (1973). Out of a group of 32 rats, mestheliomas occurred in 18 animals injected with a sample of brucite, 3 injected with a ceramic fiber, 1 each with barium sulphate, glass powder, and aluminum oxide. None occurred with a coarse glass fiber.

Wagner et al (1976) conducted a series of experiments comparing the biologic effects of a pure asbestos-free cosmetic talc with the superfine chrysotile asbestos used in previous experiments. In an intrapleural inoculation experiment, 48 rats were inoculated with each dust. Eighteen rats of the chrysotile group developed mesotheliomas, but no tumors were seen in those given talc.

Further evidence on the importance of fiber diameter was provided by Wagner et al (1976), who reported on rats injected intrapleurally with glass fiber (Table II-3). Two samples of glass fiber were used, one with a median fiber diameter of 0.12 μm and the other with a median diameter of 1.8 μm. Four mesotheliomas were observed in 32 rats injected with the finer fiber and none with the coarser fiber. Also, the degree of mesothelial cell hyperplasia was more pronounced in the rats injected with the finer fiber. These results were comparable with those of the previous experiment.

Shabad et al (1974) reported that when 20 mg of Russian chrysotile was injected intrapleurally 3 times into 67 rats, 31 developed mesotheliomas within 2 years.

(b) Ingestion

Gross et al (1974) reported the results of a series of feeding experiments with chrysotile and crocidolite fed to rats of various origins. In groups of rats varying in number from 10 through 35, no significant differences in tumor incidence were observed in comparison with controls. Survival rates were not reported, sample sizes were small (from 10 through 35) and no pathologic details were given.

In another experiment, Wagner et al (1976) fed 100 mg/day of talc (5 days/week) or chrysotile in malted milk powder for 100 days over a 6-month period to groups of 32 Wistar SPF rats; 16 controls were fed only malted milk. The mean survival from the start of feeding was 614 days for talc, 618 for chrysotile, and 641 days for the controls. The only tumors which may have been associated with ingestion were two gastric leiomyosarcomas;

one in an animal fed talc and the other in one fed chrysotile. None occurred in the controls.

(c) Inhalation

Lynch et al (1957) exposed AC/F1 hybrid mice by inhalation to a commercial preparation of chrysotile asbestos and observed a higher incidence of multiple pulmonary adenomas in the exposed group of animals, 45.7% (58/127), as compared with the 36.0% (80/222) in controls. These results were reported as not statistically significant.

Reeves et al (1974) exposed groups of 30 Swiss mice to dusts of crocidolite, amosite, and chrysotile for 4 hours/day, 4 days/week, for 2 years at a mean concentration of about 50 mg/m^3. Two of the animals exposed to crocidolite developed papillary carcinomas of the bronchus, as did one of the nonexposed controls.

Gross et al (1967) observed carcinomas of the lung in rats repeatedly exposed to chrysotile dust with a mean concentration of 86 mg/m^3 for 30 hours/week. Twenty of 72 rats surviving for 16 months or longer developed adenocarcinomas and 4 developed squamous-cell carcinomas, whereas no tumors occurred in 39 controls. The authors suggested that the presence of trace metals from the hammers of the mill used to prepare the fiber was a factor in causing these tumors. However, this suggestion was not confirmed by subsequent experiments (Reeves et al, 1974; Wagner et al, 1974), thus leading Gross et al (1974) to retract the trace metal hypothesis for asbestos-induced neoplasia.

Reeves et al (1971) found squamous carcinomas of the bronchus in 2 of 31 rats which survived exposure to crocidolite for 2 years at a concentration of 49 mg/m^3 for 16 hours/week. Five rats in a group of 40 exposed to chrysotile developed pulmonary adenomatosis, but no malignant tumors were observed in rats exposed to either chrysotile or amosite.

In a subsequent experiment, Reeves et al (1974) exposed groups of 69 Charles River CD rats to crocidolite, amosite, and chrysotile for 4 hours/day, 4 days/week, for 2 years, at mean concentrations of about 50 mg/m^3 (Table II-4). In addition, groups of 20 rabbits, 32 guinea pigs, and 68 gerbils were exposed for 18 months to the same three asbestos dusts as the rats mentioned above. No tumors were observed, but mean survival times were not stated.

Wagner et al (1974) exposed groups of C/D Wistar rats to the five UICC asbestos samples at concentrations of about 12 mg/m^3 of dust for 7 hours/day, 5 days/week, for several lengths of exposure: 1 day, 3 months, 12 months, and 24 months. At the end of the periods of exposure, the amount of dust in the lungs of animals exposed to the two chrysotile samples was much less than in the animals exposed to the three amphibole samples. However, all types of fiber produced asbestosis which was progressive after removal from the dust. Furthermore, whereas no tumors were found in the control group, carcinogenicity was demonstrated in the groups exposed to chrysotile (Canadian or Rhodesian) and the amphiboles (Table II-5). An increasing incidence of neoplasms was observed with increasing exposures to each form of asbestos. Even as little as 1 day of exposure - when the animals were allowed to survive and were observed - produced neoplasia (Table II-6). One-day exposures to Canadian chrysotile produced lung tumors. Mesotheliomas were observed in 11 rats, 2 of which were exposed for only 1 day, one to amosite, and one to crocidolite.

Wagner et al (1976) compared rats exposed for a 2-year period to a pure nonfibrous cosmetic talc, with another group of rats exposed to superfine chrysotile. Similar degrees of fibrosis were found in each group while one adenocarcinoma was found in an animal exposed to the chrysotile.

(d) Fiber Analysis in Tissue

Following inhalation, asbestos fibers found in sections of lung tissue were usually <3 μm in diameter and <100 μm in length. Thicker or longer fibers were either not inhaled or were rapidly cleared from the respiratory tract. On a weight basis, only a very small proportion of inhaled fiber was retained. An account of the inhalation of fibers is given by Timbrell (1965, 1972). Electron-microscopy is essential for studies of asbestos in tissue as many of the fibers of chrysotile and amphiboles are too small in diameter to be seen with the light microscope (Langer and Pooley, 1973).

The retention of different types of asbestos in animals following exposure to the same concentrations of respirable dust was described by Wagner et al (1974). For the amphiboles, there was a similar pattern with an almost proportional increase of lung dust with the dose. Much less dust was found for the chrysotiles and no increase of dust content in the lungs was shown. Dust in the lungs of animals exposed for 6 months had been partially cleared 18 months after the inhalation period. About 74% of the amosite and crocidolite and 41% of the anthophyllite were eliminated. The elimination rate of chrysotiles could not be exactly determined because of their low content in the lung (Figure II-1) (Wagner et al, 1974).

The penetration and clearance of radioactive UICC crocidolite has been studied in rats. After 30 days, the lung content of crocidolite was reduced to 75% of the initial value (Evans et al, 1973).

In early experiments, guinea pigs and monkeys exposed to the four commercial types of asbestos developed fibrotic lesions of the lung and pleura similar to those seen in human cases of asbestosis (Vorwald et al, 1951; Wagner, 1963; Holt et al, 1965). In more recent experiments, this finding has been confirmed in rats (Wagner et al, 1973).

The question whether asbestos fibers can move from their site of primary deposition in the body and induce cancer in other sites is still a vexing one. Volkheimer (1973) and Schreiber (1974) have reported that particles and plant fibers ingested by experimental animals and man can penetrate the wall of the gastrointestinal tract and be transported throughout the body, possibly appearing in the urine. Westlake et al (1965) fed a diet containing 6% of chrysotile to rats and reported that the animals had fibers in the wall of the colon. Cunningham and Pontefract (1973) performed a similar experiment and reported that asbestos fibers appeared in the blood and various tissues. A more recent report by Gross et al (1974) concluded, however, that there was no satisfactory evidence from their study of transmigration of fibers outside the gastrointestinal tract.

In studies in which chrysotile labelled intrinsically with radioactive trace metals by neutron irradiation was injected intrapleurally into rats, Holmes and Morgan (1967) found evidence of where a small amount of the fiber passed from the pleural cavity and lungs into such other organs as the liver. In a later, similar experiment, Morgan et al (1971) reported that a population of radionuclides, consistent with that expected on the basis of the labelled chrysotile, was found in the heart, the lungs, the diaphragm, and the chest muscles.

Karacharova et al (1969) and Friedrichs et al (1970) found some evidence of movement of asbestos fibers from an ip site of injection into various tissues in rats. The latter group of investigators reported that movement was inversely related to the length of the fiber, becoming essentially zero for fibers 20 or more μm long.

Roe et al (1967) and Kanazawa et al (1970) found evidence of transport of asbestos fibers from subcutaneous sites of deposition to such organs as the spleen, the liver, kidneys, and the brain of mice. Cunningham and Pontefract (1973, 1974) reported that iv-injected asbestos localized mostly in the liver and the lungs. The later paper found further that chrysotile injected iv into pregnant rats crossed the placenta and appeared in the livers and lungs of the fetuses.

Mutagenicity

Sincock and Seabright (1975) found that chrysotile and crocidolite asbestos dust in a concentration of 0.01 mg/ml in culture medium induced chromosomal aberrations in Chinese hamster cells. However, these changes were not observed with glass fiber or glass powder.

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SUMMARY TABLE OF ASBESTOS-INDUCED CARCINOGENICITY IN ANIMALS

Author	Date	Finding	Type of Animal	Dosage	Type of Fiber
INTRATRACHEAL INSTILLATION					
Miller	1965	Tumors of respiratory tract	Hamster	Unknown	Chrysotile with benzo (a) pyrene
Vosamae	1972	"	Rats	"	"
Pylev	1972	"	"	"	"
Pylev & Shabad	1973	"	"	"	"
Shabad et al	1974	Lung papillomas, epidermoid carcinomas reticulosarcomas, pleural mesotheliomas 6/21 and 6/11 rats within 9-28 mon	"	2 mg Russian chrysotile 5 mg benzo (a) pyrene	Russian chrysotile
INTRAPERITONEAL ADMINISTRATION					
Reeves et al	1971	3/13 peritoneal mesotheliomas with chrysotile 3/13 peritoneal mesotheliomas with crociodolite 0/11 peritoneal mesotheliomas with amosite After 7-17 mon	"	0.3, 0.5 or 1.0 ml of solution of 20 mg/ml.	Amosite Crocidolite Chrysotile
Maltoni	1973	31/50 mesothelioma in males 34/50 mesothelioma in females	Sprague-Dawley rats (18 wk old)	25 mg crocidolite	Crocidolite
Potts and Friedrichs	1972	40% tumor occurrence	Wistar rats	2, 6.25, 25, 75, 100 mg	Chrysotile A
Pott	1974	"	"	2, 10, 50 mg	"

SUMMARY TABLE OF ASBESTOS-INDUCED CARCINOGENICITY IN ANIMALS (CONTINUED)

Author	Date	Finding	Type of Animal	Dosage	Type of Fiber
INTRAPLEURAL ADMINISTRATION					
Wagner	1973	61% tumors with crocidolite 36% tumors with amosite 34% tumors with anthophyllite 30% tumors with Canadian chrysotile 19% tumors with Rhodesian chrysotile	Rats	20 mg	Crocidolite Amosite Anthophyllite Canadian chrysotile Rhodesian chrysotile
Stanton and Wrench	1972	Mesotheliomas in 60% rats	"	40 mg	Crocidolite Amosite and Rhodesian chrysotile
Pylev and Shabad	1973	Mesotheliomas	"	60 mg	Russian chrysotile
Groth et al	1975	No mesotheliomas-but animals killed 90-150 d after injection-insufficient latent period	Albino rats	Unknown	
Wagner	1976	18/48 mesotheliomas- 0/48 mesotheliomas-talc	Rats		Chrysotile Talc
Reeves et al	1971	1/15 mesothelioma with crocidolite 2/12 mesothelioma with chrysotile	"	.5 ml	Amosite Crocidolite Chrysotile
Reeves et al	1971	2/13 mesothelioma with chrysotile	Rabbit	.8 ml	Chrysotile
Shabad et al	1974	31/67 mesotheliomas within 2 yr	Rats	20 mg	Russian chrysotile

SUMMARY TABLE OF ASBESTOS-INDUCED CARCINOGENICITY IN ANIMALS (CONTINUED)

Author	Date	Finding	Type of Animal	Dosage	Type of Fiber
INGESTION					
Gross et al	1974	No significant difference in tumor incidence observed; survival rates not reported sample sizes were small	Rats	5% fiber by weight in food	Chrysotile and Crocidolite
Wagner et al	1976	2 gastric leiomyosarcomas, 1 in animal fed talc and 1 fed chrysotile	32 Wistar SPF rats	100 mg/d/ 5 d/wk 100 d over a 6-mon period	Chrysotile or Talc
INHALATION					
Lynch et al	1957	45.7 (58/127) pulmonary adenomas in exposed group 36.0% (80/222) pulmonary adenomas in controls	AC/F hybrid mice	Dust concentrations ranged from 150,000,000 to 300,000,000 particles per cc.	Chrysotile
Reeves et al	1974	2/30 bronchiogenic carcinoma with chrysotile	Swiss mice	50 mg/m^3 4 hr/d, 4 d/wk for 2 yr	Crocidolite Amosite Chrysotile
Gross et al	1967	20/72 rats surviving 16 mon or longer developed adeno-carcinomas 4/72 rats developed squamous-cell carcinomas 0/39 tumors in controls	Rats	86 mg/m^3 for 30 hr/wk	Chrysotile dust
Reeves et al	1971	2/31 rats developed carcinoma of the bronchus with crocidolite exposure 5/40 rats developed adenomatosis with chrysotile exposure	"	49 mg/m^3 for 16 hr/wk for 2 yr	Crocidolite Chrysotile Amosite

SUMMARY TABLE OF ASBESTOS-INDUCED CARCINOGENICITY IN ANIMALS (CONTINUED)

Author	Date	Finding	Type of Animal	Dosage	Type of Fiber
INHALATION					
Wagner et al	1974	Asbestosis produced with all types of fibers	C/D Wistar rats	12 mg dust hr/d -- d/wk for several lengths of exposure (1 d, 3 mon, 12 mon, 24 mon)	Chrysotile Amosite
Sincock and Seabright	1975	Chromosal abberation in Chinese hamster cells	Hamster	0.01 mg/ml	Chrysotile Crocidolite

Wagner et al (1974):

Lung Cancer	Mesothelioma	Fiber
11/146	1/146	amosite
16/145	2/145	anthophyllite
16/141	4/141	crocidolite
17/137	4/137	chrysotile (Canadian)
30/144	0/144	chrysotile (Rhodesian)

TABLE II-1

TUMORS IN ABDOMEN AND/OR THORAX AFTER INTRAPERITONEAL INJECTION OF DIFFERENT FIBROUS AND GRANULAR DUSTS

Dust	Form*	Dose i.p. (mg)	Effective Number of Dissected Rats	First Tumor After ... Days	Average Survival Time of Rats with Tumors (days after inj.)	Rats with Tumor (%)
Chrysotile A UICC	f	2	37	431	651	16.2
"	f	6.25	35	343	501	77.1
"	f	25	31	276	419	80.6
"	f	4 x 25	33	323	361	54.5
"	f	3 x 25	33	449	449	3.0
" milled	f	4 x 25	37	400	509	32.4
Palygorscite	f	3 x 25	34	257	348	76.5
Glass fibers S + S 106	f	2	34	692	692	2.9
"	f	10	36	350	530	11.1
"	f	4 x 25	32	197	325	71.9
Gypsum	f	4 x 25	35	579	583	5.7
Nemalite	f	4 x 25	34	249	315	73.5
Actinolite	g	4 x 25	39	-	-	-
Biotite	g	4 x 25	37	-	-	-
Haematite (precipit.)	g	4 x 25	34	-	-	-
Haematite (mineral)	g	4 x 25	38	-	-	-
Pectolite	g	4 x 25	40	569	569	2.5
Sanidine	g	4 x 25	39	579	579	2.6
Talc	g	4 x 25	36	587	587	2.8
NaCl-Control	-	4 x 2m	72	-	-	-

*f = fibrous
g = granular
From Potts and Friedrichs (1972)

TABLE II-2

TUMORS IN ABDOMEN AND/OR THORAX AFTER INTRAPERITONEAL INJECTION OF GLASS FIBERS, CROCIDOLITE AND CORUNDUM

Dust	Form*	Dose i.p. (mg)	Effective Number of Dissected Rats	First Tumor After ... Days	Average Survival Time of Rats with Tumors (days after inj.)	Rats with Tumor (%)
Glass fibers						
MN 104	f	2	73	421	703	27.4
"	f	10	77	210	632	53.2
"	f	2 x 25	77	194	367	71.4
Glass fibers						
MN 112	f	20	37	390	615	37.8
Crocidolite	f	2	39	452	761	38.5
Corundum	g	2 x 25	37	545	799	8.1

*f = fibrous
g = granular
From Pott et al (1974)

TABLE II-3

PERCENTAGE OF RATS DEVELOPING MESOTHELIOMAS AFTER INTRAPLEURAL INOCULATION OF VARIOUS MATERIALS

Material	Percentage of rats with mesotheliomas
SFA Chrysotile	66
UICC crocidolite	61
UICC amosite	36
UICC anthopyllite	34
UICC chrysotile (Canadian)	30
UICC chrysotile (Rhodesian)	19
Fine Glass Fibre (code 100)	12
Ceramic fibre	10
Glass powder	3
Coarse glass fiber (code 110)	0

From Wagner et al (1976)

TABLE II-4

INHALATION CARCINOGENESIS FROM VARIOUS FORMS OF ASBESTOS

Form of Asbestos	Number of Tumors
Controls	no tumors
Amosite	2 pleural mesotheliomas
Crocidolite	3 squamous-cell carcinoma, 1 papillary carcinoma and 1 adenocarcinoma, all of lungs.
Crysotile	1 papillary carcinoma, 1 squamous-cell carcinoma of lungs, and 1 pleural mesothelioma.

From Reeves et al (1974)

TABLE II-5

NUMBER OF ANIMALS WITH LUNG TUMORS OR MESOTHELIOMA ACCORDING TO TYPE OF ASBESTOS

Dust	No. of Animals	Tumor Type		
		Adenocarcinoma	Sq. Carcinoma	Mesotheliomas
Controls	126	0	0	0
Amosite	146	5	6	1
Anthopyllite	145	8	8	2
Crocidolite	141	7	9	4
Chrysotile (Canadian)	137	11	6	4
Chrysotile (Rhodesian)	144	19	11	0

From Wagner et al (1974)

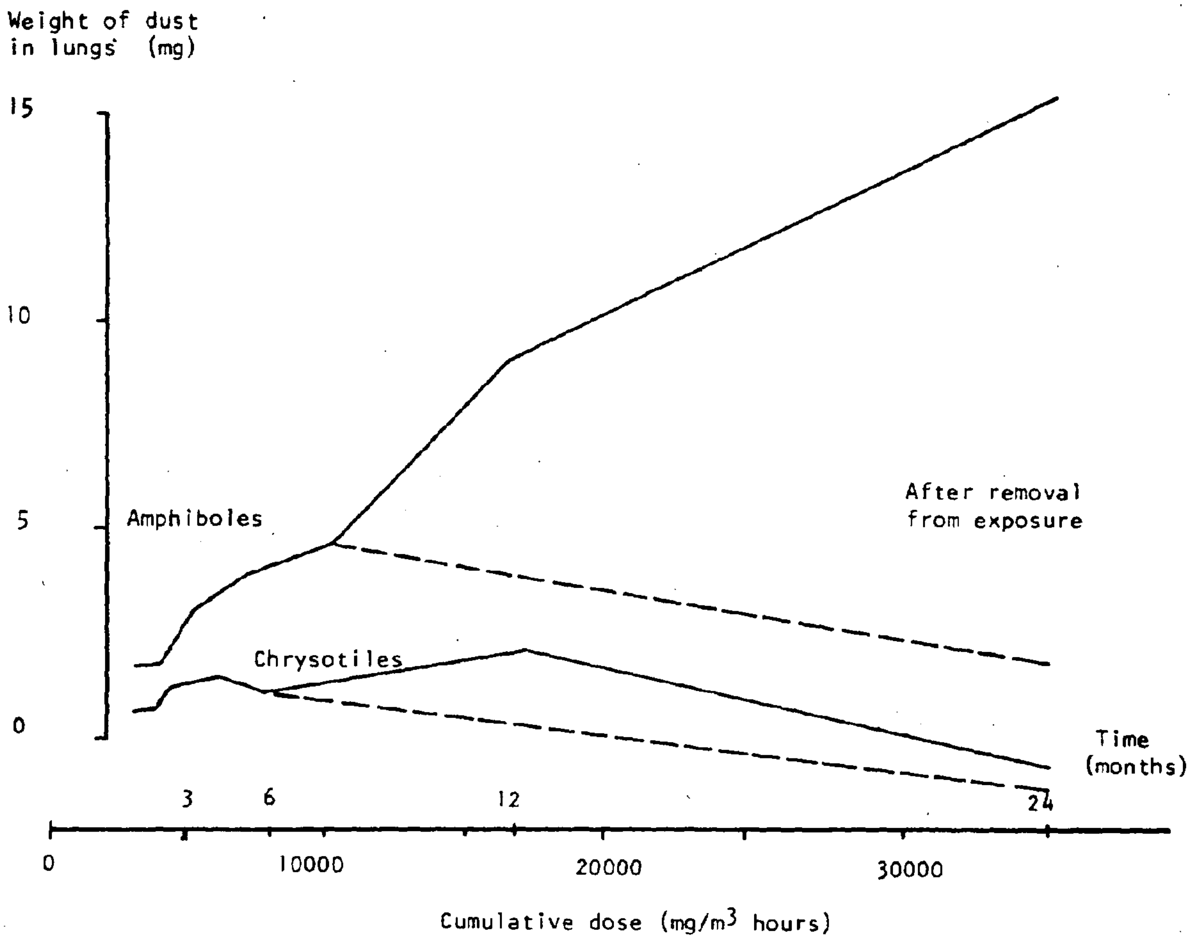
TABLE II-6

NUMBER OF ANIMALS WITH LUNG TUMORS OR MESOTHELIOMA ACCORDING TO LENGTH OF EXPOSURE

Length of Exposure	No. of Animals	No. with Lung CA	No. with Pleural Mesotheliomas	% of Animals with Tumors
Controls	126	0	0	0.0
1 d	219	3	2	2.3
3 mon	180	8	1	5.0
6 mon	90	7	0	7.8
12 mon	129	35	6	31.8
24 mon	95	37	2	41.0

From Wagner et al (1974)

Effects of Inhalation of Asbestos in Rats



Mean weight of dust in lungs of rats in relation to dose and time.
from Wagner et al (1974)

FIGURE II-1

III. EFFECTS ON HUMANS

Nonmalignant Respiratory Diseases

(a) Historical Studies

The use of asbestos dates back thousands of years; however, the modern industry dates from about 1880, when it was used to make heat and acid resistant fabrics, (Hendry, 1965; Hueper, 1966). With the increasing use of asbestos materials, reports of asbestos-related disease emerged.

The first record of a case of asbestosis was reported in England by Montague Murray in 1906. Hoffman (1918) reported that it was the practice of American and Canadian insurance companies not to insure asbestos workers due to unhealthful conditions in that industry. Pancoast et al (1917) commented on x-ray changes resembling pneumoconiosis in 15 individuals exposed to asbestos. The first complete description of asbestosis and of the "curious bodies" seen in lung tissue appeared when Cooke (1927) reported on a case of asbestosis, and McDonald (1927) reported on the same and another case. Each author gave reasons for believing that these "curious bodies" originated from asbestos fibers that had reached the lungs. Mills (1930) reported the first case of asbestosis in the United States, and in the same year, Lynch and Smith (1930) reported on "asbestosis bodies"* found in the sputum of asbestos workers. Early studies led many investigators to conclude that people exposed to asbestos

*"Ferruginous bodies" is a more descriptive term, as other inhaled fibers, eg, fibrous glass, may also become iron coated.

dust developed the disease "asbestosis" if the dust concentration was high or their exposure was long (Merewether and Price, 1930; Merewether, 1934; Fulton et al 1935; Dreessen et al, 1938).

(b) Epidemiologic Studies

Harries (1968) reported that although first impressions would lead one to believe that only workers continuously exposed to asbestos are at risk of developing asbestosis, further consideration of the industry and processes should have suggested that many other workers were also at risk. For example, some trades worked in confined spaces where asbestos was used. Work in shipboard trades was accepted by the Pneumoconiosis Panel of the United Kingdom as associated with asbestosis.

Murphy et al (1971a) found that asbestosis was 11 times more common among pipe insulators involved in new ship construction than among a control group. Asbestosis first appeared 13 years after exposure or at about 60 mppcf-years. The prevalence was 38% after 20 years. They also reported a case of extensive pleural calcification in a worker whose only known asbestos exposure was during sanding asphalt and vinyl tile floors (Murphy et al, 1971b).

Lorimer et al (1976), in a study of brake repair and maintenance workers exposed to asbestos, found that 25% of the workers showed evidence of x-ray abnormalities consistent with asbestosis. One quarter also had restrictive pulmonary function test findings.

Meurman et al (1973) found a three-fold risk of dyspnea and a two-fold risk of cough for asbestos workers as compared with controls, after adjusting for smoking.

Weill et al (1975) reported a decreased lung function in relation to increasing cumulative dust exposure in a group of asbestos cement manufacturing workers. Ayer and Burg (1976) reported a decrease in pulmonary function in asbestos textile workers with less than ten years of exposure.

In a study of 232 former insulation plant employees, Selikoff (1976a) reported positive x-ray findings among individuals having exposures to asbestos known to be as short as 1 day. More recently, Anderson et al (1976) reported x-ray findings consistent with asbestosis in household and family members having no known exposure to asbestos other than residing with a known asbestos worker. These two studies demonstrate the presence of asbestos disease in the absence of continuing new known exposures.

Wagoner et al (1973) demonstrated a significantly increased risk of death from nonmalignant respiratory disease and for diseases of the heart, which in part were secondary to pulmonary disease, among a cohort of workers in a major manufacturing complex using predominately chrysotile. Among those workers observed 20 or more years after onset of employment, a four-fold increased risk of death due to nonmalignant respiratory disease was observed. Further evaluation of these deaths revealed that the majority occurred within 1 year after termination of employment and at an average age of 53.8 years.

Newhouse (1969) reported an increased risk of death from nonmalignant respiratory disease in male asbestos textile and insulation workers with low to moderate exposure.

Enterline and Henderson (1973) reported that for all ages, only 18 deaths from asbestosis occurred in several asbestos plants studied from 1941 to 1969. It is significant to note, however, that the state of New

Jersey alone, in the years 1969-1970, had awarded workman's compensation for asbestosis to 455 workers from one of the plants in the study. (Heymann, 1971; Serraino, 1970)

Selikoff (1976a) reported a significant excess of deaths due to asbestosis among a group of workers in the US and Canada. Out of 17,800 asbestos insulation workers, there were 119 observed deaths attributed to asbestosis. Although it was not reported, the expected death rates from asbestosis in the general population would be virtually zero.

(c) Description of Asbestosis

Asbestosis is a chronic lung disease due to the inhalation of asbestos fibers and is characterized by diffuse interstitial fibrosis, frequently associated with pleural fibrosis (thickening) or pleural calcification.

The characteristic x-ray changes of asbestosis are small irregular opacities in the lower and middle lung fields, often accompanied by pleural thickening and pleural calcifications.

The pulmonary fibrotic changes develop slowly over the years--often progressively even without further exposure--and their radiographic detection is a direct correlate of their extent and profusion. In some cases, minor fibrosis with considerable respiratory impairment and disability can be present without equivalent x-ray changes. Conversely, extensive radiographic findings may be present with little functional impairment.

Commonly found in asbestosis are pulmonary rales, dyspnea, finger clubbing and cyanosis, but any or all can be absent in any one case.

Pulmonary hypertension is frequently associated with advanced asbestosis and the resultant cor pulmonale (right-sided heart failure) may be the cause of death.

Carcinogenicity

(a) Occupational Exposure

(1) Historical Studies

In 1935, 55 years after the start of large-scale usage of asbestos in industry, suspicion of an association between asbestosis and lung cancer was reported by Lynch and Smith (1935) in the USA and by Gloyne (1935) in the UK. About 10 years later, case reports of pleural and peritoneal tumors associated with asbestos appeared (Wedler, 1943, a,b; Wyers, 1946). Epidemiologic evidence from Doll (1955) showed a ten-fold excess risk of lung cancers in those UK asbestos textile workers who had been employed before 1930, before regulations produced improved dust conditions in factories. Similar findings were reported in the USA in 1961. Mesotheliomas were also detected but this fact was not published until later (Mancuso and Coulter, 1963; Selikoff et al, 1964). Possible variations in risk with different types of fiber were rarely considered in the early reports. Since 1964, following the recommendations of the UICC Working Group on Asbestos Cancers (UICC 1965) for new studies, there has been an expansion of epidemiologic studies in many parts of the world.

(2) Epidemiologic Studies

(A) Lung Cancer, Pleural and Peritoneal Mesotheliomas

(i) Mixed Types of Fiber

In most industrial processes different types of fiber are mixed, so that pure exposures to a single asbestos type are rare. Mortality studies of defined populations of asbestos-manufacturing, insulating, and shipyard workers have provided the most concrete evidence concerning the association between bronchial cancer, pleural, and peritoneal mesotheliomas and exposure to asbestos. Reports have come from several countries: (UK) Newhouse, 1969; (FRG) Bohlig et al, 1970; (USA) Selikoff et al, 1970; (UK) Elmes and Simpson 1971; (The Netherlands) Stumphius, 1971; (Italy) Rubino et al, 1972.

A seven-fold excess of lung cancer was found in a group of insulation workers whose exposures had been to chrysotile and amosite but not crocidolite (Selikoff et al, 1971). Enterline and Henderson (1973) reported a 4.4 times increased risk of respiratory cancer mortality among retired men who had worked as production or maintenance employees in the asbestos industry and who had been exposed to mixed fibers. Among men with mixed exposure to crocidolite and chrysotile in the asbestos cement industry, the rate was 6.1 times the expected rate. In a British naval dockyard population, Harries (1976) showed that there had been a steep rise in mesotheliomas since 1964. However, the full biologic effects of asbestos in shipyard workers would not have been expected to be detected until the 1970's and thereafter (Selikoff, 1976a).

Edge (1976) reported that shipyard workers with mixed asbestos exposure and pleural plaques (without evidence of pulmonary fibrosis) had a 2.5 times increased risk of developing carcinoma of the bronchus, when compared with matched controls without plaques. In a study of sheet metal workers (Cooper et al, 1975) with measurable and mixed asbestos exposure, an excess of deaths from malignant neoplasms (24.7% of deaths for two cohorts selected for 5 or more years worked in the trade, 19.1% of deaths for a group with death claims where 14.5% was expected) was largely attributed to an excess of malignant tumors of the respiratory tract. Of the 307 deaths in the first cohort, 32 lung cancer deaths were significantly in excess (1.7 times the expected). One pleural mesothelioma was observed.

Additional confirmatory evidence of the association between mesotheliomas and past exposure to asbestos comes from many institutes and departments of pathology and cancer registers, eg, (France) DeLarjarte et al, 1973; (Italy) Gobbato and Ferri, 1973; (South Africa) Webster, 1973; (UK) Greenberg and Lloyd Davies 1974; (FRG) Hain et al, 1974; (Finland) Nurminen and Markku), (German Democratic Republic) Sturm, 1975; (The Netherlands) Zielhuis et al, 1975). These studies have shown an association between asbestos and mesothelioma even with exposures as brief as 1 day; however, approximately 15% of the mesotheliomas are not known to be related to exposure to asbestos. Three studies (McDonald et al, 1973; Greenberg and Lloyd Davies, 1974; Newhouse et al, 1972) showed a poor correlation between certified cause of death and histologic diagnosis of mesothelioma. There is still a need to reduce the inter-observer variation in the diagnosis of these rare and pleomorphic tumors (McCaughey and Oldham, 1973).

The ratio of pleural to peritoneal tumors appear to be associated with heavier exposures (Newhouse et al, 1973). Among a number of occupationally exposed groups studied, approximately 5 - 7% of deaths have been from mesotheliomas (Gilson, 1973; Hammond and Selikoff, 1973; Selikoff, 1976b). More recently however, an estimate has projected that 11% of asbestos workers' deaths in England will be from mesotheliomas

(Newhouse and Berry, 1975).

(ii) Individual Types of Fibers

Crocidolite - In 1956, Wagner started investigating the occurrence of pleural and peritoneal mesotheliomas in the crocidolite mining areas of the Northwest Cape Province in South Africa. It was shown that these tumors occurred in the nonmining population living in the vicinity as well as among men working in the mines and mills and in the transportation and handling of the fiber (Wagner, 1960). Asbestosis was not invariably present. The latent period between first exposure and clinical recognition of the tumor was long - a mean of 40 years. Subsequent surveillance of the mining population in all the asbestos-producing areas in South Africa has added support for a major difference in the incidence of mesotheliomas within the crocidolite mining areas of that country. (Harrington et al, 1971; Webster, 1973). The mining of crocidolite in northwest Australia has been associated with mesotheliomas (McNulty 1962). Jones et al (1976) have reported a high incidence of mesotheliomas among women who worked with crocidolite in a factory producing gas mask canisters during World War II.

Chrysotile - McDonald et al (1973, 1974) reported that the overall death rate among 11,500 workers born between 1891 and 1920 and employed in the chrysotile mines and mills of Quebec was lower than for Quebec Province as a whole. An increased lung cancer risk was found and considered to be dose-related, and those who had been most heavily exposed to the dust showed about a five-fold risk compared with the least exposed. Of the 3,270 deaths, 134 were from respiratory cancer, with 129 being lung cancer and 5 mesotheliomas. Recently, the authors (McDonald and McDonald, 1976) have observed 3,938 total deaths among males through 1973, of which 224 were from lung cancer and 7 from mesothelioma. The authors suggested that the respiratory cancer mortality in the Quebec chrysotile industry as a whole was greater than that expected on the basis of regional mortality data.

Kogan et al (1972) investigated the cancer mortality among workers in asbestos mining and milling industries between 1948 and 1967. The total cancer mortality rate among workers was 1.6 times higher than that found in the general male population; for female workers the rates were 0.8 for those in mines and 1.3 for those in mills. The lung cancer risk for male miners and millers was twice that of the general male population. For females in mines and mills, the risks were 2.1 and 1.4 times that of the general female population, respectively. For those workers over 50 years of age, the risk of lung cancer was greater: for men in mining, 4.9; those in milling, 5.9; for women in mining, 9.5; and for those women in milling, 39.8 times that found in the general population. No mesotheliomas were found, but Kogan et al (1972) indicate that this might be explained by the insufficient experience of pathologists with this rare type of cancer in that geographical area. Also, the number of people in the study populations were not reported.

Wagoner et al (1973) reported on the cancer risk among a cohort of workers in a major manufacturing complex utilizing predominately chrysotile asbestos in textile, friction, and packaging products. An excess of respiratory cancer occurred among asbestos workers in each duration-of-employment category down to and including 1-9 years. They observed statistically significant standard mortality ratios of 122 for all malignant neoplasms and 244 for malignant neoplasms of the respiratory system. The asbestos workers in this study were located in an area of predominately Amish Dutch population with known low frequencies of smoking. The authors, nevertheless, used the general white male US population as a control group, which would tend to underestimate the degree of risk.

Enterline and Henderson (1973) found that for retired men who had worked as production or maintenance employees in the asbestos industry and who had reached 65 years of age, those who had been exposed only to chrysotile had a respiratory cancer risk two - four times than that expected. Among men within the asbestos cement industry exposed only to chrysotile, a one- to four-fold excess of respiratory cancer was found. Of 802 deaths, only one mesothelioma had been recorded in the several plants investigated. In contrast, a subsequent investigation by Borow et al (1973) found 70 cases of mesothelioma from only one of these plants. The discrepancy was due to methodologic variations, for example, Enterline and Henderson (1973) had limited their investigation to men age 65 or over, while many of the mesothelioma cases reported by Borow et al (1973) had died before that age.

Amosite - In a study of a group of miners exposed to amphibole fibers in the cummingtonite-grunerite ore series, Gillman et al (1976) demonstrated mortality from malignant respiratory disease to be three times than that found in the general population.

Exposures to amosite alone in a factory making insulation material were reported by Selikoff (1976 a & b). Ten mesotheliomas were found in addition to an increased risk of lung cancer in workers who were observed 20 years or longer. The excess lung cancer risk in the amosite workers was shown to increase with duration of employment. There was a three-fold increase in lung cancer among those with less than 3 months employment and among those with less than 1 month employment there was a 2.25-fold increase.

In a retrospective study of 914 men who had worked periodically during World War II in a plant manufacturing insulating materials from amosite for the US Navy, Seidman et al (1976) concluded that the group of 65 men who had worked for less than 1 month had experienced excess mortality, on the age-specific basis, from lung cancer during the 30 years since the beginning of their exposure, but not from all cancers or all causes of death. Men who had worked for a full month or longer had excess mortalities from all three causations examined, the risk of death from lung cancer increasing with duration of exposure.

Anthophyllite - In Finland, anthophyllite mining has been associated with an excess bronchial cancer risk of 1 - 4 times the expectation overall, and about double this figure for those with more than 10 years' exposure (Meurman et al, 1974).

There was also a higher prevalence of dyspnea and cough in the miners. However, no mesotheliomas were found despite the presence in Finland of an unusually high incidence of pleural thickening and calcification as detected by radiographic and pathologic surveys (Kiviluoto, 1960; Meurman, 1966).

(B) Other Types of Cancer

Epidemiologic studies of the already defined populations have consistently shown an excess risk of other cancers, especially of the gastrointestinal tract (Mancuso and El Attar, 1967; Elmes and Simpson, 1971; Kogan et al, 1972; Newhouse, 1973; Wagoner et al, 1973; McDonald et al, 1974; Selikoff et al, 1974); however, it has been less than that of lung cancers.

Schneiderman (1974), in a literature review with an emphasis on dose-response, concluded that "good dose-response data, with quantitative estimates of dose are uncommon; however, in all the literature reviewed, only one paper did not support the conclusion that increased exposure to inhaled asbestos particles leads to increased digestive system cancer."

Stell and McGill (1973) found that out of 100 men with squamous carcinoma of the larynx, 31 had known exposure to asbestos compared with only three in matched controls. Similar associations have been reported by Morgan and Shettigara (1976). Newhouse and Berry (1973) found two cases of cancer of the larynx (ICD 161) in their cohort of over 4,000 workers compared with an expected 0.4.

(b) Nonoccupational Exposure

Household contact with asbestos is associated with an increased mesothelioma risk. Anderson et al (1976) have recently reviewed 34 such cases of mesothelioma from nine countries and reported four new cases among the traced family members of 1,664 asbestos workers. Cases of mesotheliomas have also occurred in nonoccupationally exposed individuals living in the neighborhood of industrial sources of asbestos (Wagner et al, 1960; Newhouse and Thompson, 1966; Bohlig and Hain, 1973). Studies of the geographical distribution of cases of mesothelioma in the UK over a 10-year period indicate that the new cases are nearly all from areas in which there has been a recognized industrial source of asbestos (Gilson, 1970; Greenberg and Lloyd Davies, 1974).

Lesions among nonoccupationally exposed persons in Finland have been reported where anthophyllite asbestos is mined. In this study, 118 cases of the total 126 cases of roentgenologically-diagnosed pleural calcification studied, excluding those individuals with hemothorax, emphysema, and tuberculosis, lived or have lived in areas immediately adjacent to asbestos mines (Kiviluoto 1960). The results of this study suggest a health hazard from community exposure to ambient asbestos.

SYNERGISM

There is marked enhancement of the risk of lung carcinoma in those workers exposed to asbestos who also smoke cigarettes (Selikoff et al, 1968; Doll, 1971; Berry et al, 1972; Hammond and Selikoff, 1973); Hammond and Selikoff (1973) interpret the excess lung carcinoma risk from asbestos in nonsmokers to be small. No link between cigarette smoking and mesotheliomas has been observed in a prospective study by Hammond and Selikoff (1973). A preliminary study (Lemen, 1976) on female workers employed between January 1940 and December 1967, in a predominately chrysotile asbestos textile plant, revealed 7 lung cancer deaths among 580 women when only 0.63 deaths were expected ($p<0.01$). One lung cancer death was observed in a smoker, two in women of undetermined smoking history, and four in "never" smokers as determined from hospital admission charts.

It is important to note that the historic documentation of cigarette consumption patterns is lacking for most retrospective cohort studies of asbestos workers. It is further important to note that a sizable portion of the general population, the group usually selected for comparison in these studies, are cigarette smokers. Therefore, the risk of lung cancer demonstrated for these industrial groups exposed to asbestos is of such magnitude as to preclude the identification of an independent etiologic role for cigarette smoking.

FIBER ANALYSIS IN TISSUE

The physical characteristics of asbestos fibers which penetrate to the lung parenchyma have been studied by Timbrell (1965 and 1972) who demonstrated fiber respirability to be largely a function of fiber diameter.

Two kinds of data are relevant. Timbrell et al (1971) and Timbrell (1972) have shown that the crocidolite mined in Northern Cape Province, South Africa, and in Western Australia is associated with a high incidence of pleural mesothelioma among the local populations and has finer and shorter fibers than the crocidolite or amosite mined in the Transvaal Province, which is associated with a relatively lower incidence of pleural mesothelioma among the exposed population. As crocidolite and amosite are similar in chemical composition, there is reason to assume that the risk difference may be attributable to the differing physical characteristics of fibers.

Preliminary studies (Fondimare et al, 1974) concerning diameter and length of 5,000 asbestos fibers from the lungs of 10 deceased persons who had been occupationally exposed, showed that these fibers were all less than 0.5 μm micrometer in diameter. When separated according to type of asbestos, 90% of chrysotile fibers and 70% of amphibole fibers were less than 5 μm in length.

Asbestos bodies have been found in large numbers by light microscopy in occupationally exposed individuals (Ashcroft and Heppleston, 1973). Numerous asbestos fibers, either of chrysotile or amphibole or both types, have been found by electron microscopy in lungs of industrially exposed men (Pooley, 1972, 1973; Fondimare et al, 1974). A quantitative topographic study of asbestos fibers in the lung has been carried out in 12 industrially exposed men which showed that heavily exposed cases with lung fibrosis and carcinomas had fewer fibers in the fibrotic lower lobes than in the less fibrotic type. In less exposed cases with lung cancer but without lung fibrosis, a higher concentration of asbestos fibers, mostly of the chrysotile type, was clearly demonstrated in peripheral areas of the lung.

Optical and electron microscopic study of pleural plaques revealed the presence of some coated fibers and large numbers of uncoated fibers, mostly short, ultimate fibrils of chrysotile (Fondimare et al, 1974).

Pooley (1973) found that 93% of 120 mesothelioma cases studied had asbestos fibers in their lungs visible by electron microscopy versus less than 50% of 135 nonmesothelioma cases. Higher concentrations of fibers were observed in mesothelioma than in nonmesothelioma cases. In mesothelioma cases, the fiber types were either amphibole or chrysotile, or both, but amphibole was predominant; in nonmesothelioma cases, chrysotile fibers were predominant. In the three cases included in the study by Fondimare et al (1974), the percentage of chrysotile fibers was from 44 to 97% in the peripheral areas of the lung. The ratio of amphibole to chrysotile has been found to decrease from the central toward the peripheral areas of the lung (Fondimare et al, 1974; LeBouffant et al, 1976).

Coated fibers ("asbestos" or "ferruginous bodies") have been found in the lungs of most adults who have lived in urban areas (Gross et al, 1969; Bignon and Goni, 1969; Selikoff et al, 1972; Thompson et al, 1966; Davis and Gross, 1973; Oldham, 1973). The number of coated fibers in the lung has been compared in cases with and without lung carcinoma. Meurman (1966), who took cigarette consumption into account, could find no significant difference.

Doniach et al (1975) found an increased incidence of asbestos bodies in men with stomach cancer and in women with breast cancer, but not in lung cancer cases. Warnock and Churg (1975) found that lung cancer cases had more coated fibers in their lungs, even though only one case had known occupational exposure. The variations in percentage are probably from methodologic differences. In general, methods involving the counting of fibers/unit of weight or volume of lung tissue have greater associations with health outcomes in epidemiologic studies. However, coated fibers are not specific to asbestos (Gross et al, 1968) and cannot be related to asbestos unless the core has been identified as such by electron diffraction and/or x-ray analytical techniques (Pooley, 1970, 1975; Langer and Pooley, 1973, 1974; Fondimare et al, 1975).

Transmission electron microscopy has demonstrated the presence of chrysotile fibers or fibrils in the lungs of most consecutive autopsy cases in London (Pooley et al, 1970), New York (Langer et al, 1971) and Pittsburgh (Gross et al, 1973).

Although some differences in both the fibrotic and the carcinogenic responses to asbestos fibers may depend on the type of fiber administered, all types have definitely shown both these kinds of action (eg, Karacharova et al (1979), Shin and Firminger (1973), Wagner et al (1976). Godwin and Jagatic (1970), Gross et al (1973), and Taskinen et al (1973) reported finding fibers in lymph nodes and in the spleen, abdomen, and intestinal mucosa of occupationally exposed patients with mesotheliomas and pleural nodules. These findings emphasize the practical importance of penetration and transport of the small fibers of asbestos from their initial sites of impaction. They also stress the importance of guarding against the entrance of asbestos fibers into the body by any route.

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TABLE III-1

STUDIES OF HUMAN POPULATIONS-NONMALIGNANT RESPIRATORY DISEASE

Author	Date	Finding	Group and Exposure
<u>Historical Studies</u>			
Murray	1906	First reported case of asbestosis	Asbestos workers
Cooke	1927	Case of asbestosis reported	"
McDonald	1927	Two cases of asbestosis reported	"
Mills	1930	First case of asbestosis reported in U.S.	"
Lynch and Smith	1930	Ferruginous or "asbestosis bodies" found in sputum	"
<u>Epidemiological Studies</u>			
Murphy	1971	Asbestosis	Pipe insulators
Lorimer et al	1976	X-ray abnormalities consistent with with asbestosis and restrictive pulmonary function testing	Brake repair maintenance workers
Meurman et al	1973	Dyspnea and cough	Asbestos workers
Weill et al	1975	Decreased lung function	Asbestos cement manufacturing workers
Ayer and Burg	1976	Decrease in pulmonary function	Asbestos textile workers with less than 10 yr exposure
Selikoff	1976a	Asbestosis	Former insulation plant employees with as little as one day exposure
Anderson et al	1976	X-rays consistent with asbestosis	Household and family members of asbestos worker
Wagner et al	1973	Death due to nonmalignant respiratory disease and diseases of heart, in part secondary to pulmonary disease	Chrysotile workers
Newhouse	1969	Death due to nonmalignant respiratory disease	Male asbestos textile and insulation workers
Enterline and Henderson	1973	Death due to asbestosis	Asbestos plant workers
Selikoff	1976a	"	Insulation workers and factory workers exposed to asbestos
Bohs	1968	X-ray evidence of asbestos	Workers in asbestos industry in Britain after 1933 with perponderance of less than 20 yr exposure
Lewinsohn	1972	X-ray abnormalities	Asbestos workers in Britian
Gillam et al	1976	Nonmalignant respiratory disease	Amosite miners

TABLE III-2

STUDIES OF HUMAN POPULATION CARCINOGENICITY

Author	Date	Finding	Group and Exposure
Occupational Exposure			
Historical Studies			
Lynch and Smith	1935	Suspicion of association	Asbestos workers
Gloyne	1935	Between asbestos and lung cancer	"
Wedler	1943a,b	Case reports of pleural and peritoneal tumors associated to asbestos	"
Doll	1955	Lung cancer	Asbestos textile workers employed before 1930
Mancusco and Coulter	1963	Lung cancer and mesotheliomas	Asbestos workers
Selikoff	1964	"	"
Epidemiological Studies			
Lung, Pleural and Peritoneum			
Mixed Types of Fibers			
Newhouse (UK)	1969	Bronchial cancer, pleural and peritoneal mesotheliomas	Asbestos manufacturing, insulation and shipyard workers
Bohlig et al (FRG)	1970	"	"
Selikoff et al (USA)	1970	"	"
Elmes and Simpson (UK)	1971	"	"
Stumphius (Netherlands)	1971	"	"
Rubino et al (Italy)	1972	"	"
Selikoff et al	1973	Lung cancer	Insulation workers, chrysotile and amosite asbestos exposure
Enterline and Henderson	1973	Respiratory cancer	Retired production and maintenance workers in asbestos industry
Harries	1976	Mesotheliomas	Naval dockyard workers
Edge	1976	Carcinoma of bronchus	Shipyard workers

TABLE III-2 (CONTINUED)

STUDIES OF HUMAN POPULATION CARCINOGENICITY

Author	Date	Finding	Group and Exposure
Mixed Types of Fibers			
DeLajarte et al (France)	1973	Evidence of association between mesotheliomas and past exposure to asbestos	Occupational exposures in some cases as brief as one day
Gobbato and Ferri (Italy)	1973	"	"
Webster (South Africa)	1973	"	"
Greenberg and Lloyd	1974	"	"
Davies (UK)		"	"
Hain et al (Fed. Rep. Germany)	1974	"	"
Nurminen (Finland)	1975	"	"
Stunn (Ger. Dem. Rep.)	1975	"	"
Zielhuis (The Netherlands)	1975	"	"
Newhouse et al	1973	Peritoneal tumors associated to heavy exposures	"
Gilson	1973	5% to 7% asbestos workers' deaths due to mesotheliomas	"
Hammond and Selikoff	1973		"
Selikoff	1976	"	"
Newhouse and Berry	1975	11% asbestos workers deaths due to mesotheliomas	"
Single Types of Fibers			
Crocidolite			
Wagner	1960	Pleural and peritoneal cancer	Workers in mines, mills and in transportation and handling of crocidolite and population in vicinity of mines
Harrington et al	1971	Mesotheliomas	Mining population of crocidolite mines
Webster	1973		
McNulty	1962	"	Miners of crocidolite
Jones et al	1976	"	Women working with crocidolite in WWII gas mask canister factories

TABLE III-2 (CONTINUED)

STUDIES OF HUMAN POPULATION CARCINOGENICITY

Author	Date	Finding	Group and Exposure
Chrysotile			
McDonald et al	1973,1974	Lung cancer	Chrysotile mine and mill workers
Kogan et al	1972	Total cancer Lung cancer	Workers in asbestos mining and milling, men and women
Wagoner et al	1973	Respiratory cancer	Workers in manufacturing of textile, friction and packaging products using chrysotile
Enterline and Henderson	1973	"	Men 65 yr and older, retired production or maintenance employees in asbestos industry exposed only to chrysotile
Borow et al	1973	Mesotheliomas	Workers at plant using chrysotile, all ages
Amosite			
Gilliam et al	1976	Malignant respiratory disease	Miners exposed to amphibole fibers in cummingtonite-grunerite ore series
Selikoff et al	1976a,b	Mesotheliomas, lung cancer	Insulation workers in factory using amosite
Anthophyllite			
Neurman et al	1974	Bronchial cancer, dyspnea and cough	Anthophyllite mining employees
Other Cancer			
Mancuso and El Attar	1967	Cancer of gastrointestinal tract	Asbestos workers
Elmes and Simpson	1971	"	"
Kogan et al	1972	"	"
Newhouse	1973	"	"
Wagoner et al	1973	"	"
McDonald et al	1974	"	"
Selikoff et al	1974	"	"
Stell and McGill Morgan et al	1973 1976	Squamous carcinoma of larynx	Workers with exposure to asbestos
Newhouse and Perry	1973	Cancer of larynx	Asbestos workers

TABLE III-2 (CONTINUED)

STUDIES OF HUMAN POPULATION CARCINOGENICITY

Author	Date	Finding	Group and Exposure
Nonoccupational Exposure			
Anderson et al	1975	Mesotheliomas	Family members of asbestos workers
Wagner et al Newhouse and Thompson Bohlig and Hain	1960 1965 1973	"	Individuals in neighborhood of industrial sources of asbestos
Gilson Greenburg and Lloyd Davies	1970 1974	"	New cases from areas with recognized industrial source of asbestos
Kiviluoto	1960	Pleural plaques	Persons in farming region of Bulgaria where minute quantities of anthophyllite, tremolite and sepiolite in soil and non-occupationally exposed persons in anthophyllite mining area of Finland
Other Studies			
Newhouse Newhouse et al	1969- 1972	Cancer, mesothelioma "	Women factory workers exposed to chrysotile, amosite and crocidolite
Howard et al	1976	Lung cancer	Workers in asbestos industry from 1933 to 1950 and after 1950
Cooper et al	1975	"	Sheet metal workers with 5 or more years exposure

IV. SAMPLING METHODS AND ENVIRONMENTAL DATA

Review of Sampling and Analysis Techniques for Asbestos

A variety of sampling and analysis techniques have been used to identify asbestos fibers and determine their concentrations in air, water, mineral samples, and biologic tissue. These include optical and electron microscopy, x-ray diffraction, and differential thermal analysis. Asbestos fiber identification and quantitation in occupational and environmental air samples is difficult for a variety of reasons:

1) Asbestos fibers are generally present in low mass quantities even though fiber number concentrations may be high.

2) Many instrumental analytical techniques cannot differentiate asbestos fibers from their nonfibrous mineralogic polymorphs.

3) Many airborne asbestos fibers are generally below resolution limits of the optical microscope. These fibers may only be detected by using electron microscopic methods.

4) For identification of the various asbestos fiber types by electron microscopy, electron diffraction and microchemical analyses must be performed which require expensive instrumentation and analysis time.

(a) Electron Microscopy and Microchemical Analysis

Both transmission and scanning electron microscopy have been used for asbestos fiber identification and quantitation. In addition to morphologic observation, selected area electron diffraction and microchemical analytical techniques may be used for fiber identification.

In addition to superior resolution capabilities, most modern transmission electron microscopes are equipped with electron diffraction facilities. Crystalline materials scatter electrons in regular patterns related to their crystal structure. The image of the scattered electrons is mainly predicted by Bragg geometry. In the transmission electron microscope, the diffraction image is formed in the back focal plane of the objective lens and is focused in the viewing screen by defocusing the intermediate lens. Visual observation of single fiber (single crystal) electron diffraction patterns may be used to differentiate chrysotile fibers from amphibole fibers (Langer et al, 1974; Timbrell 1970). Chrysotile fibers produce streaked diffraction patterns (lattice defects), with the streaks or layer lines nearly perpendicular to the fiber length. The spacing between the layer lines denotes the fiber "a" axis of approximately 5.3 Å. Reflections along the layer lines are usually very streaked and Debye-Scherrer rings are common. With progressive electron beam bombardment, the diffraction pattern may change because of fiber damage. The "central core" of chrysotile fibers may also aid in fiber identification with the precaution that the central core is not always discernable and may disappear with the beam damage (Langer et al, 1974). Also, other fibrous minerals may have hollow cores.

The amphibole minerals are generally straighter in appearance than chrysotile fibers. Moreover, light and dark banding (diffraction images) may cross the fiber at right angles (Langer et al, 1974). Diffraction contrast figures have been observed on all amphibole fiber types. Selected area diffraction patterns for the amphibole asbestos minerals are all similar in appearance; therefore, visual observation of these patterns is sufficient only to classify the fiber as being a fibrous amphibole (Langer et al, 1974; Cook et al, 1974). Amphibole electron diffraction patterns show layers and sometimes streaks perpendicular to the fiber length with the spacing between the layer lines or streaks representing the fiber "c" axis (Langer et al, 1974) of approximately 5.3 Å. In contrast to chrysotile, less streaking along the layer lines is observed with the spot repeat along the lines representing one of the two remaining lattice spacings ("b" or "a") depending on fiber orientation relative to the electron beam. Typically, approximately 30 seconds is needed to perform a selected area electron diffraction analysis on a single fiber.

In addition to visual observation of electron diffraction patterns for fiber identification, photographs can be made of the diffraction patterns and crystal "d" spacings measured from the plate and calculated using the instrument camera constant (Timbrell, 1970). Both "spot" and polycrystalline patterns may be measured. It must be borne in mind that intensities may not be the same as those observed for x-ray powder patterns and additional reflections may be present.

Electron beam microchemical analytical techniques may sometimes be used to identify asbestos fibers from other fibrous particles (Rubin and Maggiore, 1974; Ferrell et al, 1975; Langer et al, 1975; Maggiore and Rubin, 1973). The most common system presently in use is the energy dispersive x-ray detector in combination with a scanning or transmission electron microscope. Wavelength x-ray analyzers and the conventional electron microprobe have been used; however, their routine application is limited because of data acquisition times (Langer et al, 1975). On the other hand, data acquisition times with energy dispersive analyzers are far less, ranging from 20 to 80 seconds/analysis.

Semiquantitative microchemical analysis in the electron microscope is based on the fact that a beam of high energy electrons incident on an asbestos fiber generates x-rays characteristic of the elements present in that fiber. The generated x-rays are observed by means of a detector (lithium-drifted silicon crystal) placed in the electron microscope column close to the specimen. The energy of the x-ray photon is converted to a voltage pulse which is amplified, digitized and stored in a multichannel analyzer or a minicomputer. The content of the memory is usually displayed on a CRT (Maggiore and Rubin, 1973). With the energy dispersive detector, all elements with atomic numbers of sodium or higher may be analyzed. Continuous background or brehmsstrahlung radiation is always present with the x-ray spectrum.

Each of the asbestos minerals has an x-ray spectrum which is usually characteristic enough, when combined with fiber morphology, to allow its identification (Rubin and Maggiore, 1974; Ferrell et al, 1975; Dement et al, 1975). Visual observation of the semiquantitative fiber x-ray spectra is usually sufficient for fiber identification; however, three component diagrams have been used after subtracting the continuous background from the semiquantitative x-ray spectrum (Ferrell et al, 1975). For asbestos fiber analysis, matrix corrections are rarely used. Typically, iron, magnesium, and silicon are plotted on the three component diagram and compositional boundaries for the asbestos minerals established. This technique suffers from inability to use all compositional data obtained, such as presence or absence of sodium, calcium, aluminum and manganese, which aid in identification.

technique suffers from inability to use all compositional data obtained

With energy dispersive x-ray techniques, possession of proper elemental intensities may not be sufficient for positive identification as many fibrous minerals show similar elemental intensities. For example, chrysotile, anthophyllite, and fibrous talc, which have similar elemental compositions, may be difficult to differentiate. However, these materials may easily be distinguished by using selected area electron diffraction. In addition, unique identification of the various fibrous amphiboles usually requires both selected area diffraction and microchemical analysis. Transmission electron microscopes equipped with an energy dispersive x-ray detector are now available which allow simultaneous observation of morphology, crystal structure, and elemental composition. These microscopy systems have been used to study asbestos fibers in environmental and material samples. (Cook et al, 1974; Dement et al, 1975)

Quantitative analysis of asbestos fiber concentrations in environmental and tissue samples has been accomplished by electron microscopy. Environmental samples (water and air) are generally collected by first concentrating the sample by filtration, centrifuging, etc (Cook et al, 1974; Nicholson, 1974). The filters (Millipore) and polycarbonate filters (Nuclepore) are prepared for electron microscopic analysis by various methods. For scanning electron microscopy, Nuclepore filters, because of their smooth surface, may be directly coated with an appropriate metal (gold, etc) and analyzed (Porter and Berggren, 1974). Millipore filters have a rough surface texture and are not generally suitable for direct coating for scanning electron microscopy as small fibers may escape detection due to impaction below the filter surface (Nicolson, 1974).

For transmission electron microscopy, the filter substrate must be removed and the particles mounted on suitable electron microscopy grids. A wide variety of mounting techniques have been used. The two most commonly used methods are the Jaffe Wick and condensation washing techniques. The techniques offer simplicity in addition to maintaining the original particle size distribution of the sample. Different investigators have reported particle losses up to 60% with Millipore filters while using the condensation washing method with rapid filter dissolution, whereas losses with the Jaffe Wick method have been reported to be considerably less (>10%) (Beaman and File, 1975). Lesser particle loss has been observed with the condensation washing method when longer times for dissolution of the filter are used. Ortiz and Loom (1974) reported that a modification of the Jaffe Wick method, whereby the filter is first coated with silicon monoxide and carbon by vacuum evaporation prior to dissolving the Millipore filter, minimized particle loss. Several investigators have reported minimal particle loss with Nuclepore filters when the filter is first carbon-coated prior to dissolving the filter substrate (Cook et al, 1974; Maggiore and Rubin, 1973).

In addition to the so-called direct clearing/mounting techniques mentioned above, many other techniques have also been used for preparing environmental samples. Seikoff et al (1972) have used a so-called "rub-out" technique whereby the Millipore filter is ashed in a low temperature asher to remove organic or carbonaceous material. The residue is then dispersed on a microscope slide using a solution of 1% Nitrocellulose in amyl acetate. After grinding with a watch glass to liberate individual fibers, the sample is dispersed evenly between two microscope slides to

amyl acetate. After grinding with a watch glass to liberate individual

form a thin film which is transferred to standard electron microscope grids. Particle losses averaging 50% have been reported with this technique. This technique also increases the apparent number of fibers present due to breaking up of fiber bundles. Asbestos fiber levels in environmental samples and biologic tissue are usually expressed as asbestos fibers/unit volume of sample (fibers/m^3, fibers/liter, fibers/g dry lung, etc). These concentrations are determined by counting fibers within calibrated areas on the electron microscope viewing screen or counting fibers from photographs. Asbestos fiber concentrations in water samples determined by laboratories using the same mounting techniques have been reported to vary by a factor of 2-3 (Cook et al, 1974). Much larger variations have been reported between laboratories using different techniques.

Asbestos mass (chrysotile) concentrations in environmental samples have also been determined using electron microscopy. This is accomplished by measuring the length and diameter (volume) of each fiber and calculating the mass using the appropriate density (Selikoff et al, 1972). The accuracy of this technique has not been studied in detail.

Electron microscopic techniques represent the "best available" methods for asbestos fiber analysis. However, application of these techniques to routine samples is not practical because of extremely high analysis costs ($200-$400/sample), long analysis times, and limited equipment availability.

(b) X-Ray Diffraction

X-ray powder diffractometry is one of the standard mineralogic techniques used in the analysis of solid crystalline phases. X-ray diffraction has been widely used for identification and quantitation of asbestos fibers in bulk materials such as talc (Stanley and Norwood, 1974; Rohl and Langer, 1974) and other industrial materials (Crable and Knott, 1968; Keenan and Lynch 1970).

X-ray diffraction has also been used to study amphibole asbestos contamination of water samples (Cook et al, 1974). X-ray diffraction is generally considered more sensitive for asbestos than light microscopy, although less sensitive than electron microscopy (Rohl and Langer, 1974).

Diffraction lines and relative intensities for each of the asbestos minerals have been published and may be found in the ASTM Powder Diffraction File. Variations in asbestos fiber chemical composition, especially for the amphiboles, may result in slight peak shifts from reported x-ray diffraction data.

Quantitative determinations of asbestos fiber levels in material samples (talc, etc) require that particle size first be reduced to an average of 0.1 - 10 μm. Preferred orientation and surface roughness must also be eliminated.

A number of techniques have been used to minimize preferred orientation effects including binder and slurry mounting methods, sifting and backloading of dry powders, and several others. To minimize preferred orientation, Rohl and Langer (1974) have developed a method for filtering an aqueous slurry through Millipore filters using a filtration adapter attached to a hypodermic syringe. Other investigators have used the backloading technique with multiple x-ray diffraction scans.

Using conventional scan rates (0.5 - 1 degree 2 theta/minute), lower limits of detection of asbestos by x-ray diffraction of 5% in bulk samples have been reported (Crable and Knot, 1966). Automated step scanning procedures by which diagnostic reflections are slowly scanned and integrated counts recorded have been reported to significantly reduce detectable limits. Rohl and Langer (1974) have detected anthophyllite at 2.0%, chrysotile at 0.25%, and tremolite at 0.10% by wieght in a talc matrix using external dilution standards for calibration. Similar lower detectable levels have been reported by Stanley and Norwood (1974).

Application of x-ray diffraction for routine asbestos fiber analysis of environmental samples has been limited. Birks et al (1975) have reported a feasible study concerning quantitative analysis of airborne asbestos. Their technique involved alignment of the asbestos fibers in an electrostatic field to enhance diffraction intensity followed by x-ray counting in a specially designed diffraction apparatus with two x-ray detectors. A lower limit of detection of 0.4 - 0.5 μg was reported. This technique has not been applied to actual environmental samples.

Amphibole and cummingtonite-grunerite mass concentrations in water samples have been semiquantitatively determined using x-ray diffraction with step scanning (Cook et al, 1974). This technique involves filtering the water through 0.45-μm Millipore filters followed by step scanning a major amphibole diffraction peak (110) and a peak specific to cummingtonitegrunerite (310). The integrated peak count above background is recorded and mass concentrations are determined using external dilution standards.

Proper selection of diagnostic reflections to maximize detection sensitivity and minimize interference due to other mineral phases is necessary for proper use of x-ray diffraction. It must also be recognized that x-ray diffraction methods are not capable of differentiating between asbestos fibers and their nonfibrous mineralogic polymorphs. This fact, combined with relatively poor detection levels, suggests that alternate techniques such as electron microscopy should be combined with x-ray analysis.

(c) Differential Thermal Analysis

Differential thermal analysis has been used to determine asbestos fiber levels in talc samples (Schlez, 1974) Chrysotile (serpentine minerals) shows a dehydroxylation endotherm at approximately 650 degrees C and an exotherm at approximately 820 degrees C, associated with the formation of forsterite. These peaks may be used for quantitative analysis. Using a 140-mg sample holder with an exposed loop differential thermcouple and a 10 degree C/minute heating rate, Schlez (1974) reported that a 1% concentration of chrysotile could be detected in pharmaceutical grade talc. A dynamic helium atmosphere was maintained to sweep out gaseous mineral decomposition products and to prevent oxidative reactions.

Differential thermal analysis has not been used for environmental samples as lower limits of mass detection are extremely poor. Differential thermal analysis, like x-ray diffraction, is not capable of differentiating between asbestos fibers and their nonfibrous mineralogic polymorphs.

(d) Optical Microscopy

A number of optical microscopic techniques have been used to identify and/or quantitate asbestos fibers in environmental samples. These include petrographic and phase contrast microscopy. Petrographic microscopic techniques may be used to identify asbestos fibers greater than approximately 0.2 - 0.3 μm in diameter. Using the polarizing microscope, various optical crystallographic measurements such as refractive index, extinction angles, and sign of elongation may be measured and compared with data reported for standard asbestos reference samples. Typical optical data for selected asbestos minerals are shown in Table IV-1 (Julian and McCrone, 1970).

Dispersion staining with polarized light has been used to identify asbestos fibers, as reported by Julian and McCrone (1974). With this technique, the fibers are immersed in a mounting medium with a steeper dispersion curve than the fibers. A central or annular stop is used in the objective lens back focal plant to allow either the wavelength of light at which the index of the particle matches that of the mounting media, or complements to that color to reach the observer's eye. Using plane polarized light, asbestos fibers show two characteristic dispersion staining colors; one for the light vibration parallel to and the other for that perpendicular to the fiber length. The dispersion colors depend on the refractive index media in which the fibers are mounted, as shown in Table IV-2. Dispersion staining colors may change slightly depending on the geographic area from which the asbestos was mined and subsequent treatment. Fibers less than 0.5 μm in diameter may not be identified by this technique because of difficulties in distinguishing colors.

Phase contrast optical microscopy is the technique specified for determining the Occupational Safety and Health Administration asbestos standard (US Department of Labor 1975). The method consists of collecting breathing zone samples during 15-minute to 8-hour periods on membrane filters (millipore AA). Samples are analyzed by first clearing the membrane filter to make it optically transparent, then by fiber counts at

400-500X magnification by phase contrast optical microscopy. Asbestos fibers are defined as those particles with a length greater than 5 μm and a length-to-diameter ratio of 3:1, or greater. This technique, by which only fibers longer than 5 μm are counted, is recognized as only an <u>index</u> of total fiber exposure and does not imply that shorter fibers do not pose a health hazard. The relative proportion of airborne fibers longer than 5 μm has been shown by Dement et al (1975) to vary from 1 to approximately 50% depending on the industrial operation and asbestos fiber type. In addition to problems of detecting short fibers, phase contrast microscopy may not be specific for asbestos fibers in industrial operation where mixed fiber types are encountered.

Despite its limitations, phase contrast microscopy represents the only technique available that can reasonably be used for routine asbestos fiber sampling and analysis. It is adaptable to personal sampling where low air volumes are sampled and analysis equipment is readily available.

Minimum detectable fiber concentrations by phase contrast microscopy depend on a number of factors such as air volume sampled, microscope field counting area, number of microscopic fields counted, and presence or absence of nonfibrous particles. Theoretical minimum detectable concentrations may be calculated assuming one fiber longer than 5 μm is observed per 100 microscopic fields (after filter background subtraction). Table IV-3 shows theoretical minimum detectable fiber concentrations as a function of sample period for a typical microscope arrangement. For a 15-minute sampling period, 0.04 fibers >5 μm/cc may be detected; however, with an 8-hour sample, 0.001 fibers/cc can be detected. These minimum concentrations are similar to those reported by Corn and Sansone (1974).

These authors reported that 0.01 fibers/cc could be detected with a 2-hour sample period (40 microscopic fields counted).

The above calculations represent theoretical minimum detectable concentrations, not considering the many factors affecting precision and accuracy of the technique. There are many sources of variability in the laboratory analysis technique. The major sources of variability are as follows:

1) Variability of fiber distribution across the filter surface.
2) Variability of fiber distribution on a given filter wedge being analyzed.
3) Variability due to differences between microscopes.
4) Variability due to differences between individual counters.
5) Variability in laboratories.

Leidel and Busch (1974) found that the fiber distribution on a given filter section could best be described by the Poisson-distribution. However, Conway and Holland (1973) found that the distribution of fibers on filters was not uniform and were more disperse than predicted by the Poisson distribution, so that concentrations between sections could vary by as much as 50-60%. Similar results were found by Rajhans and Bragg (1975) in Series I of their study.

If the Poisson distribution is taken to adequately describe fiber distributions on filter sections, the standard deviation of the fiber count may be estimated from the square root of the count. In order to maintain an acceptable Coefficient of Variation (CV) (below 20%), a minimum of 25 fibers must be counted. For a typical industrial asbestos sample of 2 hours (2 lpm flow), this would correspond to a concentration of 0.13 fibers/cc.

The precision of the entire sampling and analysis procedure (all sources of variability) has been estimated by Leidel et al (1975). These authors estimated the total CV to be 22%.

Comparisons of Asbestos Mass Concentrations (ng/m^3) and Fiber Number Concentrations (fibers/cc)

In order to relate ambient asbestos levels, which are generally expressed as ng/m^3, to occupational exposures, which are expressed as fibers >5 μm in length/cc, a conversion factor is needed. Attempts to formulate such a conversion have generally been unsuccessful because of exceptionally large variability. This is to be expected as ambient levels are generally determined using electron microscopy whereas phase contrast microscopy is used to measure occupational exposures. In addition, techniques used to prepare samples for electron microscope observation may cause alterations in fiber size (diameter and length) distributions.

Lynch and Ayer (1966) presented results of environmental studies in the asbestos textile industry where fiber concentrations were determined using phase contrast optical microscopy and fiber size distributions were determined using electron microscopy. The mass of chrysotile on the filter was estimated by using atomic absorption spectroscopy to determine the magnesium content of the sample and asbestos content was calculated, assuming a 25% magnesium content for chrysotile. These data are summarized in Table IV-4. Based on the magnesium analysis, the authors concluded that one nanogram of asbestos was roughly equivalent to five fibers greater than 5 μm in length by optical microscopy, although much variability about this value was observed. By using fiber size data determined by electron microscopy to calculate the mass of a typical fiber, the authors concluded that one nanogram of asbestos corresponded to 8 fibers (all lengths) by optical microscopy.

In a subsequent paper, Lynch et al (1970) published results of count to weight comparisons for other industrial operations using the sample techniques previously described. These data are summarized in Table IV-5. Again, large variations in the relationships were observed, as evidenced by large geometric standard deviations. Table IV-5 shows that one nanogram of asbestos may be roughly equivalent to 6.7 - 46.5 fibers >5 μm, depending on the operation.

In their study of asbestos contamination in commercial building, Nicholson et al (1975a) compared the results of asbestos concentrations (ng/m^3) determined by electron microscopy to fiber concentrations determined by phase contrast microscopy for the same samples. These data were highly variant showing no consistent relationship. One nanogram of asbestos was shown to range from none detected to 6,570 asbestos fibers >5 μm by phase contrast microscopy. By averaging data, it was calculated that one nanogram was equivalent to 52 asbestos fibers >5 μm in length.

Air samples collected in communities surrounding the Reserve Mining Company, Silver Bay, Minnesota, have been analyzed by electron microscopy and concentrations expressed in ng/m^3 by mass calculation and $fibers/m^3$ by direct counts (Nicholson, 1973). These results showed one nanogram of amphibole fibers to be equivalent to 640-108,000 total amphibole fibers by electron microscopy, with an average value of 30,600 fibers/ng.

A study recently published by Dement et al (1975) provides additional data for the conversion of mass concentration to fiber number for amphiboles. In this study, 22 air samples collected in an underground gold mine were analyzed by phase contrast optical microscopy and electron microscopy to determine fiber concentrations. A direct clearing technique which preserved the original fiber size distribution was used to prepare samples for electron microscopy. In addition to fiber counts by electron microscopy, each fiber was sized (length and diameter) so that the mass could be calculated (assuming a density of 2.5 g/cc). These data are summarized in Table IV-6. From these data, approximate relationships between mass concentrations and fiber count concentrations were calculated. One nanogram was calculated to be equivalent to approximately 1,200 total fibers by electron microscopy or 400 fibers >5 µm in length by phase contrast microscopy.

The above studies have not shown a consistent conversion factor for fiber mass to fiber count. Bruchman and Rubino (1975) have suggested a conversion ratio of 20 asbestos fibers >5 µm in length, as determined by optical microscopy, per nanogram of asbestos. Based on the above review, the validity of such a general conversion may be seriously questioned.

Nonoccupational Exposures - Ambient Levels

Asbestos air pollution in urban areas has been studied. Levels of chrysotile asbestos at various locations in New York City, Philadelphia, Ridgewood, NJ, and Port Allegany, Pa, have been studied by electron microscopy (Selikoff et al, 1972). Sample sites were chosen which were distant from any known significant source of asbestos. Study results summarized in Table IV-7 show concentrations ranging from 11 to 100 nanograms/cubic meter of air (ng/m^3). These authors point out that one nanogram of asbestos could represent a million chrysotile fibrils.

Ambient samples have been collected in the cities of Reading and Rochdale, England, Bochum and Dusseldorf, Germany, Prague and Pilsen, Czechoslovakia, Johannesburg, South Africa, and Reykjavik, Iceland (Holt and Young, 1973). Although no effort was made to quantitate levels, electron microscopy studies revealed the presence of chrysotile asbestos in most samples.

Results of electron microscopy studies of ambient samples in the United Kingdom are summarized in Table IV-8. Chrysotile concentrations of 1/10 ng/m3 were observed (Richards, 1973).

Asbestos levels in major US cities during 1969-1970 have been determined under contract with the US Environmental Protection Agency (Nicholson, 1971).Samples were collected on three or four different occasions for each city and analyzed by electron microscopy. Results are summarized in Table IV-9 and show that mean concentrations for the samples range from 0.7 to 24.3 ng/m^3;however, 48% of the cities had average concentrations less than 2.0 ng/m^3. The highest mean, 24.3 ng/m^3, was observed in Dayton, Ohio, where numerous plants processing asbestos are located. The highest concentration of 95 ng/m^3 was also observed in Dayton.

Results of chrysotile measurements within buildings insulated with asbestos and ambient levels in the vicinity of these buildings have been presented (Nicholson et al, 1975). Crysotile concentrations were determined using electron microscopy techniques as in previous studies (Selikoff et al, 1972). Ambient levels were found to range from 0 to 46 ng/m^3. Using phase contrast optical microscopy, fiber levels (ambient and indoor) were found to range from 0.000 to 0.027 fibers >5 μm/cc, with an average of 0.006 fibers/cc. Average concentrations within the building sampled ranged from 2.5 to 200 ng/m^3, indicating the possibility of fiber erosion from insulated air plenums. The same report indicates that asbestos concentrations in excess of 100 ng/m^3 may often be found in the homes of asbestos workers, with the highest measured concentration being 5,000 ng/m^3. These authors suggest that exposure in excess of 100 ng/m3 may be associated with an observable risk of asbestos disease.

Nicholson et al (1975a) published data indicating that 35 rooms in 17 office buildings in Boston, New York, Chicago, and San Francisco-Berkeley had a mean concentration of asbestos fibers in their airs of $11{,}600/m^3$ whereas the intake airs for 15 of these buildings (all for which such data was given) contained a mean of 6,000 $fibers/m^3$. One room had a concentration of 102,800 $fibers/m^3$, all the others having fiber counts below $60{,}000/m^3$. Samples of air from plenums in 11 of these buildings contained a mean concentration of 5,100 $fibers/m^3$. In an earlier report (1975b), the same investigators stated that two buildings in New York in which no asbestos was known to have been used as a fireproofing or anechoic material had a mean concentration of asbestos within their circulating airs considerably above that of the intake airs for these buildings. These findings indicate that, although pick-up of asbestos from linings applied to air-ducts and plenums may be a factor in the distribution of these fibers within buildings, these linings are not a major source of the asbestos fibers found in the air circulating within buildings.

A survey carried out in the United Kingdom (Wagg, quoted by Meyer, 1976) has shown that 82% of 73 buildings examined had airborne concentrations of asbestos fibers of up to $20{,}000/m^3$. Only 4% had concentrations of asbestos in the range 50,000-80,000 fibers/m^3. No higher concentrations were reported. The higher concentrations were found in office buildings, residences, and miscellaneous types of buildings. Really high concentrations of asbestos in air (of the order of 1-100 ng/m^3) have been found only within a few hundred meters downwind of asbestos processing plants (Richards and Badami, 1971, 1973;Simecek, 1967; Meyer, 1976).

Asbestos fiber levels in communities surrounding the Reserve Mining Company's milling operations in Silver Bay, Minnesota, have been reported by numerous investigators. Recent preliminary air sampling results have been reported for ten stations located between the Reserve Mining Company pollution source and several population centers (Fairless, 1974). Samples were collected each 6th day, beginning on November 6, 1974, (for a 1-year period). These samples were submitted blind to one or more of three laboratories where asbestos fibers concentrations were determined by electron microscopy. Results of these preliminary analyses are summarized in Table IV-10. Mean concentrations of amphibole fibers ranged from 2.6 to 8.9×10^3 fibers/m^3. In addition to amphibole fibers, chrysotile concentrations for individual samples ranged from none detected to 10.4×10^4 fibers/m^3. Analyses of all samples collected have not been completed.

Concentrations of amphibole fibers have also been reported near specific point emission sources of the Reserve Mining Company (Nicholson et al, 1974). Concentrations as high as 11 x 10^6 fibers/m^3 of air were reported.

NIOSH has performed two studies of fiber concentrations in the air of public buildings using the phase contrast microscopy counting technique (Wallingford et al, 1973; Zumwalde, 1973). Samples were collected over 6-8 hours at 7 - 10.5 liters/minute. These data are summarized in Table IV-11. Mean concentrations of 0.004 and 0.001 fibers >5 μm were observed, with the highest single concentration observed being 0.008 fiber >5 μm/cc.

In summary, ambient asbestos levels as determined by electron microscopy techniques are generally less than 10 ng/m^3 with occasional peaks as high as 100 ng/m^3. Only a few studies of ambient levels have been performed using phase contrast optical microscopy. These studies indicate ambient levels to be generally less than 0.01 fibers >5 μm/cc, with some peak values as high as 0.03 fibers >5 μm/cc.

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TABLE IV-1

TYPICAL OPTICAL DATA FOR ASBESTOS MINERALS

Asbestos Type	Crystal System	Refractive Indices	Extinction Angles	Sign of Elongation
Chrysotile	monoclinic	1.49-1.57	yAL* = 0°	+
Anthophyllite	orthorhombic	1.60-1.66	yAL = 0°	+
Amosite	monoclinic	1.66-1.70	yAL = $14-21^{\circ}$	+
Crocidolite	"	1.69-1.71	yAL = $3-15^{\circ}$	-
Tremolite**	"	1.60-1.65	yAL = $10-21^{\circ}$	+
Actinolite **	"	1.62-1.68	yAL = $10-15^{\circ}$	+

*L = long direction of fibers
** Tremolite and actinolite form a continuous mineralogical series.
Values shown are for end members.

TABLE IV-2

DISPERSION STAINING COLORS FOR ASBESTOS MINERALS
USING PLANE POLARIZED LIGHT

Asbestos Type	Refractive Index Liquid	Dispersion Staining Colors	
Chrysotile	1.560	light blue	magenta
Anthophyllite	1.610	blue-green	golden yellow
Amosite	1.670	red magenta	"
Crocidolite	1.700	magenta	blue magenta

TABLE IV-3

THEORETICAL MINIMUM DETECTABLE FIBER CONCENTRATIONS BY PHASE CONTRAST OPTICAL MICROSCOPY

Sampling Period (Minutes)	Minimum Detectable Conc. fibers >5 μm/cc
15	0.04
30	0.02
60	0.01
90	0.007
120	0.005
240	0.003
480	0.001

*Based on a sample flow rate of 2.01 lpm and a microscope counting field area of 0.0071 mm^2.

TABLE IV-4

ASBESTOS COUNT/WEIGHT RELATIONSHIPS FOR ASBESTOS TEXTILE PLANTS

Type Count By Phase Contrast Microscopy	Fibers per Nanogram of Asbestos
Total Fibers	11
>5 μm Fibers	5

From Lynch and Ayer (1966)

TABLE IV-5

ASBESTOS COUNT/WEIGHT RELATIONSHIPS FOR VARIOUS INDUSTRIAL OPERATIONS

Product	Type Fiber Count	Geometric Mean Fibers/ng	Geometric Standard Deviation
Textile	Total	14.5	2.5
	>5 µm	6.7	3.3
Friction	Total	26.3	3.4
	>5 µm	13.9	3.6
Pipe	Total	46.5	2.8
	>5 µm	22.5	2.9

From Lynch and Ayer (1966)

TABLE IV-6

SUMMARY OF FIBER COUNT/MASS RELATIONSHIPS

Analysis Method	Average Conc. (range)	Units of Measure
Total Fibers by Electron Microscopy	4.82 (0.66 - 11.79)	fibers/cc
Asbestos Mass by Electron Microscopy	3,900 (540 - 9600)	ng/m^3
Fibers >5 µm by Optical Microscopy	1.51 (0.16 - 2.8)	fibers/cc

Approximate Relationships:
1 ng ≅ 1,200 total fibers by electron microscopy
1 mg ≅ 400 fibers >5 µm in length by phase contrast microscopy
From Dement et al (1975)

TABLE IV-7

SUMMARY OF AMBIENT ASBESTOS LEVELS IN VARIOUS CITIES

Sample Site	Asbestos Conc. 10^{-9} gm/m^3
New York City	25-60
Manhattan	25-28
Bronx	19-22
Queens	18-29
Staten Island	11-21
Philadelphia, Pa.	45-100
Ridgewood, N.J.	20
Port Allegany, Pa.	10-30

From Selikoff et al (1972)

TABLE IV-8

SUMMARY OF AMBIENT CHRYSOTILE LEVELS IN THE UNITED KINGDOM

Sample Site	Chrysotile Conc. 10^{-9} gm/m^3
Rochdale (Factory Grounds)	1-10
Rochdale (Town Center)	10
Lancashire/Yorkshire	1-10
Industrial Site (Oldbury)	10

From Richards (1973)

TABLE IV-9

SUMMARY OF AMBIENT ASBESTOS LEVELS
IN 49 CITIES FOR 1969-1970

Conc. 10^{-9} gm/m^3	Cumulative % of City Mean Conc. ≤ Given Conc.
0.1-1.9	12
1.0-1.9	48
2.0-2.9	64
3.0-3.9	72
94.0-4.9	86
5.0-5.9	94
>6.0*	6%

*Highest Mean - 24.3 ng/m^3 observed
in Dayton, Ohio
From Nicholson et al (1971)

TABLE IV-10

SUMMARY OF AMPHIBOLE FIBER CONCENTRATIONS
FOR TEN SAMPLE SITES IN THE VICINITY OF RESERVE MINING

Sample Site	Amphibole Conc. 10^{-9}fibers/m^3	
	Mean	Range
Duluth	7.5	0-17
Duluth (Residence)	2.6	0- 8
Silver Day (Residence)	11	0-30
Babbit (Residence)	13	0-82
Hoyt Lake	8.5	0-31
Hibbing	5.6	0.19
Cloquet	6.8	0-30
Pengilly	6.6	0-17
Virginia	4.2	0-12
Mt. Iron	8.9	0-45

Overall Mean = 7.6 X 10^{-9}fibers/m^3
From Fairless (1974)

TABLE IV-11

SUMMARY OF FIBER CONCENTRATION DETERMINATIONS IN THE AIR OF PUBLIC BUILDINGS USING PHASE CONTRAST OPTICAL MICROSCOPY

Building Location	Fibers >5 μm in Length/cc Mean and Range
Baltimore, Maryland and Washington, D.C.	0.004 (0.001-0.008)
Towson, Maryland	0.001 (0.000-0.003)

From Wallingford et al (1973) and Zumwalde (1973)

V. BASIS FOR THE RECOMMENDED STANDARD

The first modern approach to the setting of an asbestos standard was proposed by the British Occupational Hygiene Society (BOHS 1968) in terms of fiber concentration. In 1968, a subcommittee of the Society evaluated data on 290 men at work in an asbestos factory. These data were provided by company sources. All the men had been employed after January 1933, following implementation of dust control measures mandated by the Factory Inspectorate in 1931. Estimates of the fiber exposure of these workmen were also provided by the company. Of the 290 individuals, 8 were stated to have x-ray evidence of asbestos disease and 16 had rales. Noteworthy in the 1968 data was the preponderance of individuals who had been employed less than 20 years. Only 118 of the 290 persons had worked for longer than 20 years and a scant 13 has been employed for 30 or more years.

After a review of these data, the BOHS proposed a standard which was adopted with minor modifications by the British government in 1969, and implemented in May 1970. All fibers between 5 and 100 microns in length were counted by light microscopy. The standard required no action to be taken below 2 fibers/cc. Between 2 fibers/cc and 12 fibers/cc, control measures commensurate with the exposure circumstances (time and frequency of worker exposure) were prescribed; above 12 fibers/cc, full application of control measures, including respiratory protection, was mandatory. The BOHS predicted that the risk of being affected, to the extent of having the earliest clinical signs of asbestos exposure (rales), would be less than 1% for an accumulated exposure of 100 fiber-years/cc (2 fibers/cc for 50 years, 4 fibers/cc for 25, etc). Data (Lewinsohn, 1972) from the same factory which formed the basis for the BOHS standard demonstrate that a greater prevalence of abnormalities now exist (Table V-1). These data, in addition to demonstrating a dose-response relationship for radiographically detected abnormalities consistent with asbestosis, further showed a 17% prevalence of abnormal radiographic findings (6% consistent with asbestosis) in individuals employed since 1950.

Weill et al (1975), when considering lung function and irregular small opacities, reported that there was little evidence of a dose-response relationship below 100 mppcf-years. They further concluded that a concentration of 5 fibers/cc could be cautiously considered as "safe". Ayer and Berg (1976), however, reported data which suggest that the BOHS standard, of an average cumulative exposure of 100 fiber-years/cc, for chrysotile asbestos may prevent significant decreases in pulmonary function only when combined with periodic spirometry and further reduction of exposure for affected workers. Holmes (1973) has since stated that the data upon which the BOHS standard was based were inadequate to set a standard to prevent asbestosis. The BOHS-recommended standard of 2 fibers/cc was based on data related only to asbestosis and the Society clearly cautioned that, since a quantitative relationship between asbestos exposure and cancer risk was not known, it was not possible at that time to specify an air concentration which was known to be free of increased cancer risk. (BOHS 1968)

Howard et al (1976), in a follow-up examination of the textile workers previously studied by Doll (1955) and Knox et al (1965, 1968) for cancer, and by Lewinsohn (1972) for asbestosis, reported a statistically significant increase in the risk of developing lung cancer (1.8 times the expected) among those first entering scheduled areas from 1933 to 1950. In the same study, they also reported an excess of deaths due to lung cancer (1.9 times the expected) after 15 or more years from initial exposure among those who started work subsequent to 1950, a period of improved industrial engineering control technology and regulation.

In a study of miners exposed to amphibole fibers (amosite) in the cummingtonite-grunerite ore series, with airborne concentrations of less than 2.0 fibers/cc (average concentration, 0.25 fibers/cc) and 94% of the fibers shorter than 5 μm in length, Gillam et al (1976) have demonstrated threefold increases in the risks of mortality from both malignant and nonmalignant respiratory diseases.

Newhouse (1969, 1973) and Newhouse et al (1972) have shown that the cancer risk to factory workers following mixed exposure to chrysotile, amosite, and crocidolite is dose-related. The women reported to have heavier exposures (as judged by their occupations) showed a sixfold excess of cancer following only 15 years' latency, whereas those with moderate or low exposures required 25 years' latency to demonstrate an excess. The rate of mesothelioma increased with both the severity and the length of exposure. However, even with as little as two years of asbestos exposure, six mesotheliomas occurred among female employees.

McDonald (1973) stated that the risk of developing lung cancer was essentially confined to persons with a dust index above 200 mppcf-years, and Enterline et al (1973) showed no direct dose-response for respiratory cancer below 125 mppcf-years. In a review of these two papers, Schneiderman (1974) concluded that, instead of being consistent with a threshold level at which no cancer risk exists, these data did not provide evidence for a threshold or for a "safe" level of exposure. He pointed out that in the paper by Enterline et al (1973) there is no dose group for which the Standardized Mortality Ratio (SMR) is below 100 (100 = normal), but that the 95% confidence limits on the SMR's included 100 for two of the three dose groups below 125 mppcf-years. One of the dose groups (25-62.4) had a statistically significant excess mortality from lung cancer, whereas for the other two this mortality rate was insignificantly elevated above the expected values. Regarding McDonald's paper, Schneiderman stated that it is hard to determine what is excess since no expected numbers for each group were given upon which to base this comparison.

Among amosite workers with employment of 3 months or less, Selikoff (1976) reported excess cancer risks of 3.87, 1.68, and 1.65 times those expected for cancer of the lung, colon and rectum, and all sites, respectively.

Anderson et al (1976) have reported a significant excess of radiographic abnormalities of the chest characteristic of asbestos exposure (pleural and/or parenchymal) 25 - 30 years after the onset of household contamination. These abnormalities were observed in 35% of 326 otherwise healthy workers who had household contacts with amosite asbestos. In addition, four pleural mesotheliomas were found in this group.

VI. THE RECOMMENDED STANDARD

Available studies provide conclusive evidence that exposure to asbestos fibers causes cancer and asbestosis in man. Lung cancers and asbestosis have occurred following exposure to chrysotile, crocidolite, amosite, and anthophyllite. Mesotheliomas, lung and gastrointestinal cancers have been shown to be excessive in occupationally exposed persons, while mesotheliomas have developed also in individuals living in the neighborhood of asbestos factories and near crocidolite deposits, and in persons living with asbestos workers. Asbestosis has been identified among persons living near anthophyllite deposits.

Likewise, all commercial forms of asbestos are carcinogenic in rats, producing lung carcinomas and mesotheliomas following their inhalation, and mesotheliomas after intrapleural or ip injection. Mesotheliomas and lung cancers were induced following even 1 day's exposure by inhalation.

The size and shape of the fibers are important factors; fibers less than 0.5 µm in diameter are most active in producing tumors. Other fibers of a similar size, including glass fibers, can also produce mesotheliomas following intrapleural or ip injection.

There are data that show that the lower the exposure, the lower the risk of developing cancer. Excessive cancer risks have been demonstrated at all fiber concentrations studied to date. Evaluation of all available human data provides no evidence for a threshold or for a "safe" level of asbestos exposure.

In view of the above, the standard should be set at the lowest level detectable by available analytical techniques, an approach consistent with NIOSH's most recent recommendations for other carcinogens (ie, arsenic and vinyl chloride). Such a standard should also prevent the development of asbestosis.

Since phase contrast microscopy is the only generally available and practical analytical technique at the present time, this level is defined as 100,000 fibers >5 μm in length/m^3 (0.1 fibers/cc), on an 8-hour-TWA basis with peak concentrations not exceeding 500,000 fibers >5 μm in length/m^3 (0.5 fibers/cc) based on a 15-minute sample period. Sampling and analytical techniques should be performed as specified by NIOSH publication USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers - T.R. 84 (1976).

This recommended standard of 100,000 fibers >5 μm in length/m^3 is intended to (1) protect against the noncarcinogenic effects of asbestos, (2) materially reduce the risk of asbestos-induced cancer (only a ban can assure protection against carcinogenic effects of asbestos) and (3) be measured by techniques that are valid, reproducible, and available to industry and official agencies.

However, some difficulties arise in that specific work practices and innovative engineering control or process changes are needed. But because of the well-documented human carcinogenicity from all forms of asbestos, these difficulties should not be cited as cause for permitting continued exposure to asbestos at concentrations above 100,000 fibers >5 μm in length/m^3.

This standard was not designed for the population-at-large, and any extrapolation beyond general occupational exposures is not warranted. The standard was designed only for the processing, manufacturing, and use of asbestos and asbestos-containing products as applicable under the Occupational Safety and Health Act of 1970.

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TABLE VI-1

B.O.H.S. ASBESTOS STANDARD
X-RAY FINDINGS IN AN ASBESTOS TEXTILE FACTORY
DECEMBER 1970 (MALES)

Years of Exposure	No.	X-ray Findings			
		Normal	Pleural Fibrosis*	Pulmonary Fibrosis	Total Abnormal**
0 - 9	613	548	10	0	65(11%)
10 - 19	189	122	18	20	67(36%)
20 - 29	114	51	30	21	63(55%)
30 - 39	42	9	17	17	33(78%)
40 - 49	12	2	6	3	10(83%)

* Consistent with asbestos exposure
**Including changes not considered due to asbestos exposure
Adapted from reference 2

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1978-1993	Head, Pulmonary Pathology Group, Laboratory of Pulmonary Pathobiology, National Institute of Environmental Health Sciences
1978-1993	Adjunct Professor, Department of Pathology, and member of Graduate School Faculty, Duke University, Durham, NC
1985-1993	Faculty: Curriculum in Toxicology, University of North Carolina College of Medicine, Chapel Hill, NC
1991-1993	GS-15 (Full Professor with Tenure)-NIEHS
1993 -2006	Full Professor, Department of Pathology and Department of Environmental Health Sciences, Tulane University Medical Center, New Orleans, LA
1993 -2006	Director, Lung Biology Program, Center for Bioenvironmental Research, Tulane University Medical Center, New Orleans, LA
1993 -2006	Graduate Faculty, Molecular and Cellular Biology Program, Tulane University Medical Center, New Orleans, LA
1999 –2006	Vice Chairman, Department of Pathology, Tulane University Medical Center, New Orleans, LA
2006- 2011	Professor, Department of Molecular Biomedical Sciences, North Carolina State University, Raleigh, NC
2012-Date	**Professor Emeritus**, Department of Pathology, Tulane Univ. School of Medicine, New Orleans, LA

Military Service:

1961-1963 Army ROTC

Honors and Invited Participation:

1967 Outstanding teaching assistant, Department of Zoology, University of Illinois.

1969 Sigma Xi, Biological Honorary.

1974 Visiting Scientist: Pneumoconiosis Research Center, Cardiff, Wales.

1977 Research Fellowship: Institut National de la Sante et de la Recherché Medicale, Paris, France.

1978 Invited Participant and Oral Presentation: Aspen Lung Conference on Immunology of the Lung.

1979 Chairman: Use of SEM and associated techniques (DES) in studies of pulmonary pathobiology at Annual Electron Microscopy Society Mtgs.
Invited participant: IARC Mtg. on Biological Effects of Mineral Fibers, Lyon.

1980 Invited Presentation: Aspen Lung Conference on Environment and the Lung.

1981 Chairman: Use of electron microscopy and associated techniques in studies of pulmonary structure, function and disease at Annual Electron Microscopy Society Meetings.

1982 Invited Participant: Aspen Lung Conference on Pulmonary Secretions an Fluids.
Invited Presentation: International Conference on Occupational Lung Disease, Chicago, IL.
Invited Presentation: 4th Annual Occupational and Environmental Health Conference, Salt Lake City, UT.
Invited Presentation: Conference on The In Vitro Effects of Mineral Dusts, Little Rock, AR.
Invited Participant: NIH Workshop on the Fibroblast in Interstitial Lung Disease.

1983 Invited Participant and Elected Member of Committee on Basic Science: EPA Task Force on Environmental Lung Disease, Washington, DC, March.
Invited Tutorial on Pathogenesis of Asbestos-Induced Lung Disease: Annual Electron Microscopy Soc., Detroit, April.
Invited presentation: Aspen Lung Conference on Pathobiology of Pulmonary Emphysema, June.
Invited Paper: Theodore F. Hatch Symposium on Occupational Health, U. of Pittsburgh, September.

1984 Chairman: Symposium on Mechanisms of Acute Lung Injury. FASEB, St. Louis, MO.
Member NIH Study Section: Isolation and Characterization of Human Lung Cells.

Invited Speaker: Rochester International Conference on Environmental Toxicity, Rochester, NY, June.
Faculty: Pulmonary Pathology Course, University of Vermont, Department of Pathology, August.
Scientific Advisory Committee and Invited Presentation: In Vitro Effects of Mineral Dusts, Schluchsee, FRG, October.

1985 Visiting Professor: Department of Pathology, Instituto Nacional DeCardiologia, Mexico City, January.
Visiting Professor: Department of Biology, University of California, Santa Barbara, April.
Chairman: Symposium on Pulmonary Response Following Particulate Exposure in Experimental Animals, Annual Meeting American Thoracic Society, Anaheim, CA, May.
Visiting Professor: Department of Pathology, State University of New York at Stony Brook, June.
State-of-the-Art Presentation: Cellular Pathobiology of Asbestosis at 28th Annual Aspen Lung Conference, June.
Awarded: John P. Wyatt Traveling Fellowship In Environmental Pathology.
Invited Speaker: Depts. of Pathology and Medicine Pulmonary Seminar Program, Washington University, St. Louis, September.
Standing Member of Merit Review Board: Respiratory Disease Section, Veterans Administration, Washington, DC, September 1985-88.

1986 Invited Speaker: Pathology Grand Rounds, Harvard Medical School, Boston, January.
Invited Speaker: Conference on Silicosis and Mixed-Dust Pneumoconiosis Chantilly, France, April.
Visiting Scientist: Institut Nationale de Sante et Recherché Medicale, Paris, France, May - June.
Invited Speaker: Gordon Conference on Pulmonary Biology, New London, New Hampshire, July.
Invited Speaker: Electron Microscopy Society of America, Albuquerque, August.
Invited Speaker: Third International Conference on Environmental Lung Disease, Montreal, October.

1987 Appointed: National Academy of Sciences Panel on Pulmonary Toxicology.
Outstanding Performance Cash Award from NIH, March.
Chairman: Symposium on Cellular Mechanisms of Occupational Lung Injury. Annual Meeting American Thoracic Society, New Orleans, May.
NIH Study Section: Ad Hoc Panel to review RFA on subpopulations of pulmonary interstitial cells.
Invited Speaker: IARC Conference on Mineral Fibres in the Non-Occupational Environment, Lyon, France, September.
Keynote Address: "Mechanisms of Particle-Induced Lung Injury" American College of Chest Physicians, Atlanta, October.
Invited Speaker: Lung Dosimetry: Extrapolation Modeling of Inhaled Particles and Gases, Duke University, October.

1988 Appointed: Visiting Committee: Harvard School of Public Health, Respiratory Biology Program, March.

Outstanding Performance Cash Award from NIH, March.
Visiting Scientist: University of Rochester School of Medicine, Environmental Health Sciences Center, March.
Organizer and Faculty: Course on Environmental Lung Disease, Mexico City, March.
Invited Speaker: Biological Interactions of Inhaled Mineral Fibers and Cigarette Smoke, Seattle, April.
Chairman: Symposium on "Pulmonary Macrophage Biology and Interstitial Lung Disease" Annual FASEB Conference, May.
Chairman and Invited Speaker: Symposium on "Biochemical and Molecular Mechanisms of Alveolar Fibrosis," Annual Meeting American Thoracic Society, May.
Invited Speaker: VIIth International Pneumoconioses Conference, Pittsburgh, August.
Scientific Advisor: Workshop on In Vitro Effects of Mineral Dusts, Sherbrooke, Canada, September.
Chairman: "Mechanisms of Cellular Response to Inhale Substances," IIIrd Chicago Conference on Occupational Lung Disease, October.
Science Advisory Board: Health Effects Institute, Boston.

1989 Invited Speaker: Congressional Subcommittee on Environment and Technology. Washington, DC, January.
Invited Speaker: Dept. of Environmental Hygiene, University of Gothenburg, Sweden, March.
Invited Speaker: 3rd Alexis Carrell Conference on Accelerated Atherosclerosis, Washington, DC, March.
Invited Speaker: 2nd GERP Conference on Occupational Lung Disease, Paris, France, March.
Invited Speaker: Dept. of Pathology, Baylor College of Medicine. Houston, TX, May.
Conference Organizer and Speaker: Fiber Toxicology, Research Triangle Park, NC, June.
International Advisory Committee: Appointed as standing member for The Annual Aspen Lung Conference.
Invited Participant: XIVth Annual European Symposium on Hormones and Cell Regulation, Mont St-Odile, France, September.

1990 Invited Speaker: Symposium on Molecular Biomarkers of Disease, NIEHS, February.
Invited Participant: Banbury Center Conference on Molecular Mechanisms of Fiber Cytotoxicity and Carcinogenesis, Cold Spring Harbor, NY, March.
Program Committee and Session Chair: Mechanisms of Particle-Overload Induced Lung Disease, Rochester, May.
Session Chair: Symposium on Cell-Cell Interactions in the Lung, World Conference on Lung Health, Boston, May.
State-of-the-Art Speaker: Aspen Lung Conference on Mechanisms of Lung Repair, Aspen, CO, June.
Program Committee and Invited Speaker: The Third Wave of Asbestos Disease, Exposure to Asbestos in Place, NY, June.
Invited Participant: International Congress on Inflammation, Barcelona, June.

Invited Participant: Alveolar Macrophages in the Clearance of Inhaled Particles, Oxford, September.
Program Committee and Speaker: Biannual Symposium on Pulmonary Fibrosis, Stowe, VT, October.

1991 NIH Study Section: Specialized Centers of Research in Pulmonary Disease. Bethesda, January.
Visiting Scientist: Environmental Science Center, Univ. of Calif., Davis, February.
Visiting Pulmonary Scholar: Univ. of Wisconsin School of Medicine, March.
Keynote Speaker: American Association of Respiratory Therapy, Providence, March.
Session Chair and Speaker: Mechanisms of Pulmonary Fibrosis Amer. Assoc. of Pathologists Minisymposium, Atlanta, April.
Invited Speaker and Member of the Environmental Lung Disease Working Group of the Pulmonary Diseases Advisory Council, NHLBI Workshop, Washington, DC, May.
Christie Memorial Lecturer: Australian Society for Experimental Pathology, Adelaide, Australia, September.
Chairman: Basic Science Symposium, Fourth International Conference on Environmental Lung Disease, Montreal, September.
Chairman: Biological Reaction to Dust, Seventh International Symposium on Inhaled Particles, Edinburgh, September.
Invited Speaker: Woods Hole Conference on Pulmonary Biology, October.

1992 Invited Speaker and Organizer: Environmental Pulmonary Disease, Cuernavaca, Mexico, January.
Invited Faculty: Scientific Frontiers of Occupational Pulmonary Medicine, Miami, May.
Scientific Committee: Workshop on Durability of Inhalable Minerals, Lyon, France, September.
Invited Speaker: International Conference on Pulmonary Vascular Remodeling in Health and Disease, London, September.
Scientific Committee and Speaker: Seventh International Pulmonary Fibrosis Colloquium, Cambridge, U.K., October.
Visiting Professor: University of Michigan School of Medicine, October.
Invited Speaker: Cochin Hospital, Paris, November.

1993 Member: American Thoracic Society Task Force Developing a Strategic Plan for Lung Research into the 21St Century.
Invited Speaker: FASEB Conference on Pulmonary Pathobiology, New Orleans, April.
Invited Participant: Workshop on Interactions of Particles with the Lung, ATS Meeting, San Francisco, May.
Invited Speaker: 4th European Meeting of Environmental Hygiene, Wagenigen, The Netherlands, June.
Invited Speaker and Organizing Committee: Cytokines and Lung Inflammation, Institut Pasteur, Paris, June.
Invited Speaker: 24th International Conference in Occupational Health, Nice, September.
Invited Speaker: Effects of Mineral Dusts on Cells, Paris, October.
Member: Scientific Site Visit Committee to the Institut Pasteur, Paris,

October.
Invited Speaker: World Congress on Inflammation, Vienna, October.

1994 Invited Participant: Colloquium on Particulate Air Pollution and Human Mortality and Morbidity, National Academy of Sciences Conference, Irvine, CA, January.
Invited Speaker: European Society for Clinical Investigation, Toledo, Spain, April.
Invited Speaker: American Lung Association, Science Day for the Media, New York, September.
Scientific Co-Chairman and Member of Organizing Committee: Eighth International Conference on Pulmonary Fibrosis, Dijon, France, October.
Ad Hoc Participant: Lung Biology Study Section, Bethesda, October.
Invited Speaker: Institute of Preventive and Clinical Medicine, Bratislava, Slovakia, November.

1995 Invited Speaker: 5th International Inhalation Symposium, Hannover, Germany, February.
Invited Speaker: American College of Chest Physicians, 5Th International Conference on Environmental and Occupational Lung Disease, Orlando, March.
Invited Speaker: NIEHS-Sponsored Public Health Symposium, Mexico City, March.
Chairman and Invited Speaker: Environmental Biology '95, Minisymposium on Environmental Pathology and Toxicology, Atlanta, April.
Invited Speaker: American Thoracic Society Annual International Conference, Symposium on Interstitial Pulmonary Fibrosis, Seattle, May.
Co-Chair and State-of-the-Art Speaker: 38th Annual Aspen Lung Conference, Environmental Lung Disease, Aspen, June.
Chairman: Session on Fiber Dissolution, British Association for Lung Research, Edinburgh, September.
Selected: Wellcome Visiting Professor in the Basic Medical Sciences, sponsored by the Burroughs Wellcome Fund, November.

1996 NIH SCOR (Fibrotic Lung Diseases) Study Section, Washington, DC, January.
NIH Lung Biology Pathology Study Section, Washington, DC, February.
Featured Speaker: American Thoracic Society Annual Conference, Symposium on Cell Activation in Lung Injury, New Orleans, May.
Invited Speaker: NATO Advanced Study Institute, Vascular Endothelium, Crete, Greece, June.
Invited Speaker and Scientific Organizing Committee: International Conference on Toxicology of Natural and Man-Made Particles, Lake Placid, NY, September.
Invited Participant and Workgroup Member: Association of Occupational and Environmental Clinics, Workshop on Particulates and Chronic Airways Disease, Pittsburgh, October.
Invited Speaker: Annual Woods Hole Conference on Lung Biology, Woods Hole, MA, October.
Invited Speaker and Organizer: Ninth International Colloquium on Pulmonary Fibrosis, Oaxaca, Mexico, November.

1997 Invited Speaker: Dean's Distinguished Faculty Forum, Tulane University Medical Center, New Orleans, February.

Participant: NIH Lung Biology and Pathology Study Section, Bethesda, MD, February.

Invited Speaker and Co-Chair: Mediator and Signal Transduction in Lung Injury Models, Annual Meeting of the American Society for Investigative Pathology, New Orleans, April, 1997.

Invited Speaker and Co-Chair: Cellular Mechanisms of Pulmonary Fibrosis, Annual Meeting of the ATS, San Francisco, May.

Invited Speaker: World Health Organization Conference on Lung Injury, Corfu, June.

Participant: NIH Special Study Section--Oxidative Lung Injury, Research Triangle Park, NC, August.

Scientific Advisor and Participant: Second International Meeting on Oxygen/Nitrogen Radicals and Cellular Injury, Chapel Hill, NC, September.

Invited Speaker: International Conference on Occupational Health, Kyoto, Japan, October.

Visiting Professor: Tainan Medical College, Taiwan, October.

Visiting Professor: Beijing Medical College, Beijing, China, October.

Invited Speaker: University of California, Davis, College of Medicine, November.

1998 Study Section: Member of MIT Site Visit Team for the Environmental Science Center, Boston, March.

Special Study Section: Children and Environmental Health, NIEHS, Research Triangle Park, NC, March.

Invited Speaker: EurΩConference on Therapeutic Approaches for Diseases of the Respiratory Tract, Institut Pasteur, Paris, April.

Invited Speaker: Respiratory Biology at the American Society for Investigative Pathology, San Francisco, April.

Session Chairman: Mechanisms of Lung Injury, American Thoracic Society, Annual Conference, Chicago, April.

Invited Speaker and Organizer: Tenth International Colloquium on Pulmonary Fibrosis, Siena, Italy, October.

Session Chairman: Symposium on Systemic Sarcoidosis, National Heart, Lung, and Blood Institute Conference, New Haven, October.

Member: National Institute of Environmental Health Sciences, Environmental Health Sciences Review Committee, 1998-2002.

1999 Member: ATS Committee on Research Advocacy, American Thoracic Society, 1999-2000.

Faculty and Invited Speaker: 6th International Conference on Environmental and Occupational Lung Diseases, American College of Chest Physicians, Vancouver, February.

Member: ATS Government Relations Committee, American Thoracic Society, 1999-2000.

Invited Speaker: Signal Transduction and Growth Factors in Molecular Toxicology, National Institute of Environmental Health Sciences, Research Triangle Park, NC, March.

Member: Research Grants Review Committee, American Lung Association, 1999-2000.

Invited Speaker: Cytokines: Biology, Gene Regulation and Role in the Pathogenesis of Lung Disease, Society of Toxicology, New Orleans, March.
Invited Speaker: Experimental Biology, Recent Advances in Molecular Mechanisms and Pharmacological Interventions of Lung Fibrosis, Washington, D.C., April.
Invited Speaker: Tissue Repair and Fibrosis, 4th World Congress on Inflammation, Paris, June.
Keynote Speaker: Seventh Symposium on Particle Toxicology, Maastricht, The Netherlands, October.

2000 Invited Panelist and Speaker: Advanced Research Cooperation in Environmental Health, 7th Biennial Symposium on Minorities and Cancer, Washington, D.C., February.
Invited "Special Lecturer": 4th Conference on Acute Lung Injury, Tokyo, Japan, February.
Invited Speaker: Update in Occupational Lung Disease, Johns Hopkins University, Baltimore, March.
Invited Speaker: Andrews' 15th Annual Asbestos Conference, Andrews Publications, New Orleans, April.
Chairman and Speaker: ATS-NIEHS Workshop, Toronto, Canada, May.
Study Section: Cancer and Smoking Disease Program, Nebraska Department of Health and Human Services, Omaha, May.
Scientific Committee and Conference Summarizer: 11th International Colloquium on Lung Fibrosis, Stockholm, Sweden, September.

2001 Member: ATS Committee on Research Advocacy, American Thoracic Society, 2000-2001.
Sabbatical Leave, Duke University, Division of Pulmonary Medicine, January–April; Institut Pasteur, Paris, May-June.
Study Section: University of California, Tobacco-Related Disease Research Program – PulmonaryDisease Review Committee, San Francisco, March.
Invited Speaker: ATS 2001 Meet-the-Professor Seminar 97th International Conference, San Francisco, May.
Organizer and Speaker: EurΩconference on Chronic Lung Diseases, Paris, June.
Study Section: NIEHS Environmental Health Sciences Review Committee Meeting, Research Triangle Park, NC , November.

2002 Special Study Section: National Heart, Lung, and Blood Institute Conference, Chevy Chase, MD, February.
Site Visit: NIEHS – National Jewish Medical and Research Center, February.
Study Section: University of California, Tobacco-Related Diseases Research Program – PulmonaryDisease Review Committee, San Francisco, April.
Site Visit: NIEHS Special Emphasis Panel - Harvard School of Public Health, Boston, May-June.
Study Section: American Heart Association, Lung, Resuscitation, and Respiration Study Group, Chicago, October.
Invited Speaker: International Conference on Lung Fibrosis, Geneva, October
Invited Speaker: 7th Congress of Asian Pacific Society of Respirology, Taipei, November.
Invited Speaker: Liaocheng Peoples Hospital, Peoples Republic of China, November.

2003 Chairman – Study Section:National Heart, Lung, and Blood Institute Special Emphasis Panel, Molecular Targets and Interventions in Pulmonary Fibrosis, Columbia, MD, March.

Study Section: University of California, Tobacco-Related Diseases Research Program – Pulmonary Disease Review Committee, San Francisco, March.

Invited Lecture: Mechanism of TGF-β Activation by Reactive Oxygen Species Harvard School of Public Health, Boston, April.

Invited Speaker: Andrews' 18th Annual Asbestos Litigation Conference, Andrews Publications, New Orleans, May.

Site Visit: NIEHS - Harvard School of Public Health, Boston, June

Invited Lecture: EPA Workshop on Mechanisms of Asbestos Fiber Toxicity and Carcinogenicity, Chicago, June.

Study Section: NIH (LPBA) Lung Biology and Pathology, Washington, DC, June.

Invited Speaker: XVII World Asthma Congress, St. Petersburg, Russia. July.

2004 Study Section: NIH (NHLBI) National Heart, Lung, Blood Institute, Special Review Committee for Program Project Grant/PO1, Lung Fibrogenesis and the Biology of Fibroblast, Rockville, MD, February.

Study Section: NIH (NHLBI) National Heart, Lung, Blood Institute, Special Review Committee for Program Project Grant/PO1, Regulation of Respiratory Epithelial Cell Homeostasis, Rockville, MD, February.

Chairman -Study Section: NIH NHLBI National Heart, Lung, Blood Institute, Special Emphasis Panel Granulomatous Lung Inflammation in Sarcoidosis, Rockville, MD., March.

Study Section: University of California, Tobacco-Related Diseases Research Program – Pulmonary Disease Review Committee, San Francisco, April.

Invited Speaker: St. Luke's Medical Center, Grand Rounds, "Asbestos-induced fibrogenesis: how unraveling of the molecular mechanisms will direct potential therapeutic approaches,"Milwaukee, WI, September.

Invited Speaker and Session Chair: 13th International Colloquium on Lung Fibrosis. Banff, Alberta, Canada, October.

2005 Invited Speaker: Shanghai International Respiratory Symposium. Shanghai, China, October.

Invited Speaker: 8th International Meeting on Effects of Mineral Dusts and Nanoparticles. NIH Research Triangle Park, NC, October.

Scientific Advisory Board: BioMarck Pharmaceuticals

2006 Invited Speaker: University of Rochester College of Medicine, Department of Pulmonary Medicine, March

Invited Speaker: 14th International Colloquium on Pulmonary Fibrosis, Frankfurt, Germany, September.

Invited Speaker: International Mesothelioma Conference; Chicago, October

Invited Chair: Amer Physiol Soc Conf; Physiological Genomics and Proteomics Of Lung Disease; Ft. Lauderdale, November

2007 Invited Speaker: Univ. of Pennsylvania, Dept. of Pulmonary and Critical Care Medicine; Philadelphia, March
Study Section: NIH-National Heart Lung and Blood Institute; RFA for Adult Stem Cell Biology; Bethesda, April
Invited Speaker: University of California, Los Angeles, Dept. of Pulmonary and Critical Care Medicine; Los Angeles, May
Invited Speaker: NIH Conference on Lung Cell Biology; Bethesda, July
ATS Program Committee for 2007 Annual Meeting
Invited Speaker: Duke University, Dept. of Pulm. and Crit. Care Med., October
Study Section: Asthma and Allergy Cooperative Research Centers; NHLBI Bethesda, October.

2008 Invited Speaker: University of Southern California, Dept. of Pulmonary and Critical Care Medicine, Los Angeles, January.
Study Section: National Institute of Allergy and Infectious Diseases, Bethesda, February
Study Section: National Institute of Environmental Health Sciences, RTP, NC, April
ATS Program Committee for 2008 Annual Meeting
Invited Speaker: Hopital Bichat, Dept. of Lung Biology, Paris, June
Study Section: National Heart Lung and Blood Inst, Bethesda, August
Invited Speaker and Scientific Organizing Committee, International Conference on Lung and Airway Fibrosis, North Carolina, September
Visiting Scientist: UC Davis College of Medicine, Davis, CA, October

2009 ATS Program Committee for 2009 Annual Meeting, May
Co-Chair: Symposium on Stem Cells in Interstitial Disease and Lung Cancer, at the Annual Meeting of the American Thoracic Society
Invited Speaker: Francoise and Guy Basset Memorial Conference, Paris, June
Co-Chair of Conference and Named Lecturer: Annual Aspen Lung Conference, The Environment and the Lung, June
Invited participant: NIEHS workshop- "A Science-Based Examination of the Mode of Action of Asbestos and Related Mineral Fibers", October.

2010 ATS Program Committee for 2010 Annual Meeting, May
Invited Speaker and scientific organizing committee: International Conference on Lung and Airway Fibrosis. Perth, Australia, October

2011 Invited Speaker: Perrin Asbestos Conference, Los Angeles, March
Invited Reviewer: National Heart Lung and Blood Institute Study Section

2012 Invited Speaker: Perrin Asbestos Conference, Los Angeles, March
Invited Speaker: "Lung Stem Cell Biology", American Society for Investigative Pathology, Annual International Conference, San Diego, April
Invited Reviewer, National Heart Lung and Blood Institute, July
Invited Speaker: Perrin Asbestos Conference, San Francisco, September
Scientific Advisory Committee: International Conference on Lung and Airway Fibrosis, Modena, Italy, October
Invited Speaker: LexisNexis Conference on Asbestos Disease. London, October

2013 Invited reviewer: National Institute of Allergy and Infectious Disease, March
Session Chairman: Annual Aspen Lung Conf., Pulmonary Microbiome, June

2014 Invited participant: ATS Foundation Research Program planning, September
Invited Speaker: Perrin Conference on Asbestos, September

2015 Invited participant: Aspen Lung Conference on Mechanisms of Asthma
Invited Speaker: Perrin Conference on Asbestos, March and September

2016 Invited Speaker: American Conference Institute, Philadelphia, January
Invited Speaker: Perrin Conference on Asbestos Medicine, March

2017 Invited Speaker: Grand Rounds -Case Western Reserve University School of Medicine-Dept of Pulmonary and Critical Care Medicine, March

Co-Chair: Aspen Lung Conference on Environmental Lung Disease, June

Committees:

NIEHS
Chairman: GS-9/11 Promotions Committee (1988-91)
Standing Member: Animal Care Committee (1984-90)
Standing Member: Tenure Review and Promotions Committee (1991-93)

Tulane
Department of Pathology - Tenure and Promotions (1993 - 2006)
- Delegate to the Basic Science Faculty
President's Search Committee for Senior Vice President for the Health Sciences
President's Search Committee for Director of the Center for Bioenvironmental Research
Chairman: Subcommittee on Training Grants
Chairman: Dean's Pharmacology Department Review
Standing Member: Cancer Center Steering Committee
Dean's Pharmacology Chair Search Committee
Chairman: Dean's Forum for Advances in Research Committee
Member: Dean's Personnel and Honors Committee (1999-2006)
Elected Member: Faculty Advisory Committee
Appointed: Center for Bioenvironmental Research Faculty Council

Editorial Boards
American Journal of Pathology
American Journal of Physiology: Lung, Cellular, and Molecular Physiology
American Journal of Respiratory, Cell, and Molecular Biology
Current Respiratory Medicine Reviews
Journal of Environmental Pathology, Toxicology, and Oncology
Journal of Inflammopharmacology

Section Editor (Pathology)
Journal of Lipid Mediators and Cell Signalling

Review Manuscripts for:
American Journal of Respiratory and Critical Care Medicine
Environmental Health Perspectives
Environmental Research
FASEB Journal

Journal of Cellular Physiology
Journal of Clinical Investigation
Journal of Immunology
Journal of the American Physiological Society
Laboratory Investigation
Science
Toxicology and Applied Pharmacology
American Journal of Pathology

Active Memberships:
AAAS - American Association for the Advancement of Science
American Thoracic Society - Assembly Nominating Committee
FASEB – American Society for Investigative Pathology
Sigma Xi (Biological Honorary)

Peer-Reviewed Publications

1. Brody, A. R. Comparative fine structure of acarine integument. J.N.Y. Entomol. Soc. 77(2):105, 1969.

2. Brody, A. R., and Wharton, G. W. Dermatophagoides farinae: Ultrastructure of lateral opisthosomal dermal glands. Trans. Amer. Micros. Soc. 89(4):499, 1970.

3. Brody, A. R. Observations on the fine structure of the developing cuticle of a soil mite, Oppia coloradensis (Acarina: Cryptostigmata). Acarologia 12(2):421, 1970.

4. Brody, A. R., and Wharton, G. W. The use of glycerol-KCL in the scanning microscopy of Acari. Ann. Entomol. Soc. Amer. 64(2):528, 1971.

5. Brody, A. R. (Ed.) Colloquium: The entomology of house-dust allergy. Proc. N. Central Branch, Entomol. Soc. Amer. 26:57, 1971.

6. Brody, A. R., and Wharton, G. W. The peritrophic membrane of the house-dust mite, Dermatophagoides farinae. Parasitology 58:801, 1972.

7. Brody, A. R., and Wharton, G. W. Dermatophagoides farinae: The digestive system. J.N.Y. Entomol. Soc. 80:152, 1972.

8. Brody, A. R., and Craighead, J. E. A simple perfusion apparatus for lung fixation. Proc. Soc. Biol. Med. 143:388, 1973.

9. Brody, A. R., and Craighead, J. E. Pathogenesis of pulmonary cytomegalovirus infection in immunosuppressed mice. J. Infect. Dis. 129:677, 1974.

10. Brody, A. R., Graham, W. G., Kanich, R. E., and Craighead, J. E. Cyst wall formation in pulmonary eosinophilic granuloma. Chest 66:576, 1974.

11. Murphy, G. M., Brody, A. R., and Craighead, J. E. Monocyte migration across pulmonary membranes in mice infected with cytomegalovirus. J. Exp. Mol. Pathol. 22:35, 1975.

12. Brody, A. R., and Craighead, J. E. Cytoplasmic inclusions in pulmonary macrophages of cigarette smokers. Lab. Invest. 32:125, 1975.

13. Brody, A. R., and Craighead, J. E. Preparation of human lung biopsy specimens by perfusion-fixation. Am. Rev. Respir. Dis. 112:645, 1975.

14. Harrow, E. M., Brody, A. R., Jakab, G. J., and Green, G. M. The pulmonary response to a bacteremic challenge. Am. Rev. Respir. Dis. 112:7, 1975.

15. Brody, A. R., Wharton, G. W., and McGrath, J. C. Dermatophagoides farinae: The supracoxal glands. J.N.Y. Entomol. Soc. 84:34, 1976.

16. Brody, A. R., and Craighead, J. E. Interstitial associations of cells lining air spaces in human pulmonary fibrosis. Virchows Arch. A. of Pathol., Anat. and Histol. 372:39, 1976.

17. Brody, A. R., Vallyathan, N. V., and Craighead, J. E. Distribution and elemental analysis of inorganic particulates in pulmonary tissue. Scanning Elect. Microsc. 1:477, 1976.

18. Davis, G. S., Brody, A. R., Landis, J. N., Graham, W. G., Craighead, J. E., and Green, G. M. Quantitation of inflammatory activity in interstitial pneumonitis by bronchofiberscopic pulmonary lavage. Chest 69:265, 1976.

19. Suratt, P. M., Winn, W. C., Brody, A. R., et al. Acute silicosis in tombstone sandblasters. Am. Rev. Respir. Dis. 115:521, 1977.

20. Brody, A. R., et al. The elemental content of granulomata in pulmonary sarcoidosis and hypersensitivity pneumonitis. Scan. Elect. Microsc. 2:129, 1977.

21. Davis, G. S., Brody, A. R., and Craighead, J. E. Analysis of airspace and interstitial mononuclear cell populations in human diffuse interstitial lung disease. Am. Rev. Respir. Dis. 118:7-15, 1978.

22. Brody, A. R., Vallyathan, N. V., and Craighead, J. E. Use of scanning electron microscopy and X-ray energy spectrometry to determine the elemental content of inclusions in human tissue lesions. Scan. Elect. Microsc. 3:252, 1978.

23. Brody, A. R., Kelleher, P. C., and Craighead, J. E. A mechanism of exudation through intact alveolar epithelial cells in the lungs of cytomegalovirus-infected mice. Lab. Invest. 39:281-288, 1978.

24. Davis, G. S., Moehring, J. M., Absher, M. P., and Brody, A. R. Isolation and characterization of fibroblasts obtained by pulmonary lavage of human subjects. In Vitro 15:612-623, 1979.

25. Davis, G. S., and Brody, A. R. Changes in human alveolar macrophage cell shape and surface morphology. Chest 75:280-282, 1979.

26. Newman, R. A., Brody, A. R., and Krakoff, I. H. Gallium nitrate induced toxicity in the rat. A pharmacologic, histopathologic, and microanalytical investigation. Cancer 44:1728, 1979.

27. Davis, G. S., and Brody, A. R. Changes in the surface morphology of human alveolar macrophages induced by tobacco and marijuana smoking. Exp. Lung Res. 1:281, 1980.

28. Brody, A. R., Roe, M. W., and Davis, G. S. Use of backscattered electron imaging to quantify the distribution of inhaled crystalline silica. Scanning Elect. Microsc. 3:301, 1980.

29. Perl, D. P., and Brody, A. R. Alzheimer's disease: X-ray spectrometric evidence of aluminum concentration in neurofibrillary tangle-bearing neurons. Science 208:297, 1980.

30. Adler, K. B., Brody, A. R., and Craighead, J. E. Studies on the mechanism of mucin secretion by cells of the porcine tracheal epithelium. Proc. Soc. Exp. Biol. Med. 166:37, 1981.

31. Brody, A. R., and Hill, L. H. Deposition pattern and clearance pathways of inhaled chrysotile asbestos. Chest 80:64-67, 1981.

32. Brody, A. R., Hill, L. H., Adkins, B., and O'Connor, R. W. Chrysotile asbestos inhalation in rats: deposition pattern and reaction of alveolar epithelium and pulmonary macrophages. Am. Rev. Respir. Dis. 123:670-679, 1981.

33. Brody, A. R., Soler, P., Basset, F., Haschek, W., Witschi, H. Epithelial-mesenchymal association of cells in human pulmonary fibrosis and in BHT-oxygen induced fibrosis in mice. Exp. Lung. Res. 2:207-220, 1981.

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154. Morris, G.F., Danchuk, S., Wang, Y., Xu, B., Rando, R., Brody, A. R., Shan, B., Sullivan, D.E. Cigarette Smoke Represses the Innate Immune Response to Asbestos. Physiological Reports, 3 (Dec.): 1-14, 2015.

Chapters and Proceedings

1. Crapo, J. D., Brody, A. R., et al. Morphologic, morphometric, and X-ray microanalytical studies on lung tissue of rats exposed to chrysotile asbestos in inhalation chambers. In: Biological Effects of Mineral Fibers (Wagner, J. C., Ed.), IARC Publications, Lyon, France, Vol. I, pp. 273-283, 1980.

2. Brody, A. R., and DeNee, P. B. Biological activity of inorganic particles in the lung. In: Critical Reviews in Environmental Control (Straub, C. P., Ed.), CRC Press, Boca Raton, FL, pp. 277-299, 1981.

3. Brody, A. R., and Davis, G. S. Alveolar macrophage toxicology. In: Mechanisms in Respiratory Toxicology (Witschi, H. and Nettesheim, P., Eds.), CRC Press, Boca Raton, FL, Vol. II, pp. 3-28, 1982.

4. Brody, A. R., and Hill, L. H. Interactions of chrysotile asbestos with erythrocyte membranes. In: The In Vitro Effects of Mineral Dusts (Brown, R.C. et al., Eds.), Environ. Health Perspect. 51:85-89,1983.

5. Brody, A. R. and Hill, L. H. Initial epithelial and interstitial events following asbestos inhalation. In: Health Issues Related to Metal and Nonmetallic Mining (Wagner, W. L., Rom, W. N., and Merchant, J. A., Eds.), Butterworth Publ., Boston, pp. 162-172, 1983.

6. Brody, A. R. Inhaled particles in human disease and animal models: Use of Electron Beam Instrumentation. Environ. Health Perspect. 56:149-162, 1984.

7. Brody, A. R., Roe, M. W., Evans, J. H., and Davis, G. S. Deposition and translocation of inhaled silica. In: Occupational Lung Disease (Gee, J. B. and Morgan, W. K., Brooks, S. M., Eds.), Raven Press, NY, pp. 168-170, 1984.

8. Brody, A. R. and Hill, L. H. The target cells for inhaled mineral dusts. In: In Vitro Effects of Mineral Dusts (Beck, E. G. and Bignon, J., Eds.), NATO ASI Series, Springer-Verlag, Berlin, Vol. G3, pp. 53-58, 1985.

9. Kouzan, S., Nettesheim, P., Eling, T., and Brody, A. R. Production of arachidonic acid metabolites by alveolar macrophages treated with asbestos. In: In Vitro Effects of Mineral Dusts (Beck, E. G. and Bignon, J., Eds.), NATO ASI Series, Springer-Verlag, Vol. G3, Berlin, pp. 291-295, 1985.

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11. Brody, A. R., Hill, L. H., Hesterberg, T. W., Barrett, J. C., and Adler, K. B. Intracellular translocation of inorganic particles. In: The Cytoskeleton (Clarkson, T. W., Sager, P. R., and Syversen, T. L. M., Eds.), Plenum Publishing Corp., pp. 221-227, 1986.

12. Brody, A. R. Initial fiber interactions with bronchiolar-alveolar epithelium, macrophages and fibroblasts. In: Silicosis and Mixed Dust Pneumoconiosis (Le Bouffant, L., Ed.), INSERM, Paris, France, pp. 81-92, 1987.

13. Roggli, V. L. and Brody, A. R. Imaging techniques for application to lung toxicology. In: Toxicology of the Lung (Gardner, D.E., Crapo, J.D., Massaro, E.J., Eds.), Raven Press, New York, pp. 117-146, 1988.

14. Brody, A. R., McGavran, P. D., and Overby, L. H. Brief inhalation of chrysotile asbestos induces rapid proliferation of bronchiolar-alveolar epithelial and interstitial cells. In: Non-Occupational Exposure to Man-Made Mineral Fibers. IARC Publications, Lyon, Fra., (Cheney, J. Editorial Services), pp. 102-108, 1988.

15. Brody, A. R. The lung matrix and inflammation: Part II. In: Annual Meeting Highlights. Am. Rev. Respir. Dis. 138:1056-57, 1988.

16. Kumar, R. K., Bennett, R. A., and Brody, A. R. An enzyme immunoassay for platelet-derived growth factor: application to the measurement of macrophage-derived PDGF. Monokines and Other Non-Lymphocytic Cytokines. Alan R. Liss, Inc. pp. 393-396, 1988.

17. Brody, A. R. and Overby, L. H. An animal model of asbestos-induced lung disease. In: Handbook of Animal Models of Pulmonary Disease, CRC Press, Boca Raton, FL, pp. 183-196, 1989.

18. Brody, A. R. and Yu, C. P. Particle deposition at the alveolar duct bifurcations. In: Lung Dosimetry: Extrapolation Modeling of Particles and Gases (Crapo, J.D. and Smolke, E., Eds.), Academic Press, Chapter 9, pp. 91-99, 1989.

19. Brody, A. R. and McGavran, P. D. Incorporation of tritiated thymidine by vascular, epithelial and interstitial cells in asbestos-exposed animals. In: Biological Interaction of Inhaled Mineral Fibers and Cigarette Smoke (A.P. Wehner, Ed.), Battelle Press, Columbus, OH, pp. 269-277, 1989.

20. Schapira, R., Osornio, A. R., Bonner, J. C., and Brody, A. R. Platelet-derived growth factor secretion by alveolar macrophages is stimulated by carbonyl iron and chrysotile asbestos in vitro. In: The Physiological and Pathological Effects of Cytokines. (P. Oppenheim, Kluger, Dinarello, Eds.), Wiley-Liss, Inc., pp. 189-194, 1989.

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22. Brody, A. R. Production of Cytokines by particle-exposed lung macrophages. In: Cellular and Molecular Fiber Carcinogenesis (Brinkley, W., Lechner, J., Harris, C., Eds.), Cold Spring Harbor Laboratory Press, CSH, New York, pp. 83-102, 1991.

23. Brody, A. R. Asbestos-induced proliferation of bronchial and pulmonary parenchymal cells. In: Asbestos Related Cancer (Sluyser, M., Ed.), Ellis Horwood Ltd., Amsterdam, pp. 191-206, 1991.

24. Lasky, J. A., Bonner, J. C., and Brody, A. R. The pathobiology of asbestos-induced lung disease: A proposed role for macrophage-derived growth factors. In: Toxicology and Environmental Health, Proceedings of the Conference "Exposure to Asbestos in Place", (Selikoff, I., Ed.), pp. 239-244, 1991.

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26. Brody, A. R. Asbestos exposure as a model of inflammation inducing interstitial pulmonary fibrosis. In: Inflammation: Basic Principles and Clinical Correlates (Gallin, J. I., Goldstein, I. M., Snyderman, R., Eds.), Raven Press, N.Y., 2nd Edition, pp. 1033-1049, 1992.

27. Roggli, V. L., Pratt, P. C., and Brody, A. R. Analysis of tissue mineral fiber content, Chap. 11. In: Pathology of Asbestos-Associated Diseases. (Roggli, V. L., Greenberg, S. D., Pratt, P. C., Eds.), Little, Brown, Boston pp. 229-345, 1992.

28. Brody, A. R. Asbestos Induced Lung Disease. Environ. Health Perspect. 100: 21-30, 1993.

29. Bonner, J. C. and Brody, A. R. Macrophage Signal Transduction Mechanisms. In: Lung Biology in Health and Disease. (Brody J., et. al., Eds.), Marcel Dekker, N.Y., 65: 483-520, 1993.

30. Brody, A. R. Asbestos Induced Lung Injury and Fibrosis: A Month in the Life of an Inhaled Asbestos Fiber. In: The Identification and Control of Environmental and Occupational Diseases. (Mehlman, M. and Upton, A., Eds.), Princeton Scientific Publishing, pp. 213-232, 1994.

31. Brody, A. R. Control of lung fibroblast proliferation by macrophage-derived PDGF. Proceedings of the Symposium on Cells and Cytokines in Lung Inflammation. Ann. NY, Acad. Sci. 725:193-199, 1994.

32. Roggli, V., Hammer, S. P., Pratt, P. C., Maddox, J. C., Legier, J., Mark, E. J., and Brody, A. R. Commentary: Does asbestos or asbestosis cause carcinoma of the lung? Am. J. Ind. Med. 26:835-838, 1994.

33. Bonner, J. C. and Brody, A. R. Cytokine-Binding Proteins in the Lung. Am. J. Physiol. Lung Cell. Mol. Physiol. 268:L869-L878, 1995.

34. Morris, G. F., Liu, J-Y., Lei, W-H., and Brody, A. R. Expression of genes coding for growth factors in experimental pneumoconiosis. Chest. 109:45-49, 1996.

35. Hoyle, G. W. and Brody, A. R. Gene Expression in Rodent Models of Environmental Lung Disease. Ann. N. Y. Acad. Sci. 796:162-172, 1996.

36. Kagan, E. and Brody. A.R. Immunopathology of Asbestos-Related Lung Disease. In: Immunopathology of Lung Disease. (Kradin, R. L., Robinson, B. W. S., Eds.) Butterworth-Heinemann, Boston, Chapter 20. pp 421-443, 1996.

37. Brody, A. R. Toxicology. Peptide Growth Factors in Fibroproliferative Lung Disease: In Vivo Models and In Vitro Correlates. In: Correlations Between In Vitro and In Vivo Investigations in Inhalation Toxicology, (Mohr, U., Ed.), ILSI Press, Washington, D. C. pp. 19-28, 1997.

38. Brody, A. R. **Asbestos.** In: Comprehensive Toxicology. (Roth, R. A., Ed.), Elsevier Science, New York, Vol. 8(25), pp. 393-413, 1997.

39. Brody, A. R., Liu, J.-Y., Brass, D., and Corti, M. Analyzing the genes and peptide growth factors expressed in lung cells *in vivo* consequent to asbestos exposure *in vitro*. In: Proceedings of the International Conference on Toxicology of Natural and Man Made Particles. Environ. Health Perspect. 105:1165-1171, 1997.

40. Brody, A. R. Occupational lung disease and the role of peptide growth factors. Curr. Opin. Pulm. Med. 3:203-208, 1997.

41. Lasky, J. A. and Brody, A. R. Interleukins involved in the pathogenesis of chronic airway inflammation. Research in Immunology. 148: 39-47, 1997.

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43. Brody, A. R., Brass, D. M., Liu, J.-Y, Morris, G. F., and Hoyle, G. W. Asbestos-induced peptide growth factors that mediate interstitial pulmonary fibrosis. In: Advances in the Prevention of Occupational Respiratory Diseases. (Chiyotani, K., Hosoda, Y., Aizawa, Y., Eds.), Elsevier Science, The Netherlands, pp. 878-883, 1998.

44. Morris, G. F. and Brody, A. R. Molecular mechanisms of particle-induced lung disease. In: Environmental and Occupational Medicine. (Rom, W. R., Ed.) Lippincott-Raven Publishers, Philadelphia, PA, 3rd Edition, pp. 305-333, 1998.

45. Brody, A. R., Brass, D., Liu, J.-Y., Hoyle, G. W., and Warshamana, G. S. Remodelling of lung tissue consequent to chronic injury. Res. Immunol. 149:249-251, 1998.

46. Lasky, J. A. and Brody, A. R. Interstitial fibrosis and growth factors. Environ. Health Perspect. 108(suppl. 4):751-762, 2000.

47. Brody, Arnold R. Inhalation of asbestos fibers and consequent expression of peptide growth factors. Inhal. Toxicol. 12(suppl. 3):245-250, 2000.

48. Crapo, J.D., Courtney-Broaddus, V., Brody, A.R., Malindzak, G., Samet, J., Wright, J.R.. American Thoracic Society Documents. Workshop on lung disease and the environment. Where do we go from here? Am. J. Respir. Crit. Care Med., Vol. 168, pp 250-254, 2003.

49. Mutsaers, S.E., Prele, C.M., Brody, A. R., and Idell, S. Pathogenesis of Pleural Fibrosis. Respirology. 9:428-440, 2004.

50. Lasky, J. A., Ortiz, L. A., and Brody, A. R. Mediators and Mechanisms in Chronic Lung Injury and Fibrosis. In: Lung Injury: Mechanisms, Pathophysiology, and Therapy. (Notter, R. H., Holm, B. A., Finkelstein, J. N., Eds.) Marcel Dekker, N.Y., 2005.

51. Sullivan DE and Brody AR. The asbestos model of interstitial fibrosis: TNF-a and TGF-b1 as mediators of asbestos-induced lung fibrogenesis. Donaldson and Borm P, ed. Particle Toxicology. Boca Raton, Taylor & Francis: 227-244, 2006.

52. Franks TJ, Colby TV, Travis WD, Tuder RM, Reynolds HY, Brody AR, Cardoso WV, Crystal RG, Drake CJ, Engelhardt J, Frid M, Herzog E, Mason R, Phan SH, Randell SH, Rose MC, Stevens T, Serge J, Sunday ME, Voynow JA, Weinstein BM, Whitsett J, Williams MC. Resident cellular components of the human lung: current knowledge and goals for research on cell phenotyping and function. Proc Am Thorac Soc. 2008 Sep 15;5(7):763-6.

53. Brody, A.R. Asbestosis and Silicosis. In: Interstitial Pulmonary and Bronchiolar Disorders, (J. Lynch, Ed.), **Vol 227:** pp. 317-328; New York, Informa Healthcare, 2008.

54. Brody, A. R. **Asbestos and Lung Disease**. Editorial Review. Am. J. of Resp. Cell and Mol. Biol. **42**:131-132, 2010

55. Brody, A. R., Salazar, K.D, Lankford, S. M. Mesenchymal Stem Cells Modulate Lung Injury. Proc. Am. Thorac. Soc. 7: 1-4, 2010.

Book Published

Brody, D. E. and Brody, A. R. The Science Class You Wish You Had . . . **The Seven Greatest Scientific Discoveries in History and the People Who Made Them.** With the Foreword by Martin Rodbell, Ph.D., Nobel Prize Recipient. A Perigee Book Published by the Penguin Group, New York, NY, 392 pp, (Revised and Updated) 2013.

CURRICULUM VITAE

ARTHUR L. FRANK, MD, PHD

PERSONAL INFORMATION

Place of Birth:	United States of America
Citizenship:	United States of America
Marital Status:	Married with three children
Office Address:	Drexel University Dornsife School of Public Health Nesbitt Hall, 7th Floor 3215 Market Street, Philadelphia, PA 19104
Home Address:	1216 Yarmouth Road Wynnewood, PA 19096
Telephone:	267-359-6048 (O) 267-359-6006 (F) 267-246-4185 (M) 610-642-1785 (H)
E-mail:	alf13@drexel.edu

EDUCATION

College:	State University of New York at Buffalo Buffalo, NY 14214 1964 – 1968, BA, May 31, 1968 Major: Anthropology
Medical School:	Mount Sinai School of Medicine of the City of NY New York, NY 10029 1968 – 1972, MD, June 4, 1972
Graduate School:	The City University of New York Biomedical Sciences Doctoral Program Mount Sinai Medical Center New York, NY 10029 1971 – 1977, PhD, June 2, 1977 Thesis Title: *Quantitation of Asbestos-Induced Hyperplasia in Hamster Trachea Epithelium Maintained in Organ Culture*
Internship and Residency:	Straight Medical Internship, Internal Medicine Residency Mount Sinai Hospital, New York, NY 1972 – 1973, 1975 – 1977 Occupational Medicine Residency, Mount Sinai Hospital, New York, NY 1975 – 1977

Plaintiff's exhibit 936.1

MILITARY SERVICE

Commissioned Officer (Active), United States Public Health Service
Rank: SA Surgeon (03) 1973 – 1975
Lung Cancer Branch, DCCP, National Cancer Institute, National Institutes of Health, Bethesda, MD
Member, Inactive Reserve, 1975 – 2010. Permanent Rank: Surgeon (04)
Active Duty (variable), 1992 – 1994. Temporary Rank: Medical Director (06)

HONORS AND AWARDS

College: BA, Cum Laude, with High Honors in Anthropology, 1968
Medical School: National March of Dimes Award, 1971
Residency: Chairman's Award – Department of Medicine, Mount Sinai Hospital, 1977
Graduate School: Sigma XI, 1977
Horowitz Memorial Award of the Mount Sinai School of Medicine, 1983
Educator of the Year Award, Association of Teachers of Preventive Medicine (First Annual Award), 1987
University of Kentucky Faculty Grant Award, 1988-91 (Awarded to top 20% of University-wide faculty)
Honorable Order of Kentucky Colonels (3)
Senior Associateship, National Academy of Science, 1990-91 (NIOSH)
Honorary Ambassador of Labor, Labor Secretary, Commonwealth of Kentucky, 1992
BRASH 1994 Chaos and Strange Attractor Award
Topperman Professorship – The University of Texas Health Center at Tyler, 1994-2002
Arthur L. Frank, MD, Keynote Lectureship, UTHCT, 2002
Marcus Key Lecture, TOMA, 2003
American College of Preventive Medicine Distinguished Service Award, February 2004
Sappington Lectureship, American College of Occupational and Environmental Medicine, May 2005
Canadian Board of Occupational Medicine Lectureship, June 2006
Hygeia Society, Drexel University School of Public Health, 2009
Presidential Volunteer Service Gold Award, 2010
Honorary "Duke of Hazard", 2011
Irving J. Selikoff Lifetime Achievement Award, ADAO, March 2012
Outstanding Academic Partner Award, District 1199C, May 2013
Ramazzini Award, Collegium Ramazzini, 10/2016 – Ramazzini lecturer

CERTIFICATION AND LICENSURE

National Board of Medical Examiners, 1973 [Certification No. 123394, July 2, 1973]
Kentucky State License, MD, #22985 [September 29, 1983]
New York State License, MD, #116288 [July 2, 1973]
Maryland State License, MD, Certificate D16595 [May 17, 1974]
Diplomate, American Board of Internal Medicine [#58896, September 13, 1978]
Diplomate, American Board of Preventive Medicine (Occupational Medicine) [#21574, November 26, 1979]
Texas State License [Distinguished Professor's License issued December 28, 1994]
(Converted on March 2, 1996 to unrestricted Texas License J9855)
Pennsylvania State License, MD, #418954 [March 20, 2002]

ACADEMIC APPOINTMENTS

Professor of Public Health, Department of Environmental and Occupational Health, Drexel University, Dornsife School of Public Health, 2002 to present (tenured)
Professor of Medicine, Drexel University School of Medicine (secondary), 2002 to present

Professor of Civil, Architectural and Environmental Engineering, Drexel University College of Engineering (secondary), 2011 to present
Member, Obama-Singh Grant Team (Drexel and IIT-Delhi), 2012-2015
Sam Topperman Professor of Medical Education, Professor of Occupational and Environmental Medicine, Professor of Cell Biology and Environmental Science, University of Texas Health Center at Tyler, 1994-2002
Adjunct Professor, Department of Preventive Medicine and Community Health, The University of Texas Medical Branch at Galveston, 1995-present
Clinical Professor, Department of Medicine, The University of North Texas Health Science Center at Fort Worth, 1997-2002
Clinical Professor, Department of Occupational Medicine, University of Texas Health Science Center at Tyler, March, 2004-present
Adjunct Graduate Faculty, Stephen F. Austin State University, Nacogdoches, Texas, 1997-2002
Visiting Faculty, US Air Force School of Aerospace Medicine, Brooks AFB, Texas; Wright Patterson AFB, Ohio, 2001-present
Adjunct Professor, Mongolian National University of Medical Sciences, School of Public Health, Ulaanbaatar, Mongolia, 2015-present
Professor, Department of Preventive Medicine and Environmental Health, University of Kentucky, 1983-1994
Member, Graduate Center for Toxicology, University of Kentucky, 1988-1994
Associate Member, Appalachian Center, University of Kentucky, 1989-1992
Instructor, Assistant Professor, Associate Professor, Department of Community Medicine (Environmental Medicine), Mount Sinai School of Medicine, 1977-78, 1978-82, 1982-83
Instructor, Department of Medicine, Mount Sinai School of Medicine, 1978-1983
Member, Graduate Faculty, City University of New York, Biomedical Sciences Program, 1980-1983

ADMINISTRATIVE APPOINTMENTS

Chair Emeritus, Department of Environmental and Occupational Health, Drexel University, Dornsife School of Public Health, 2014 –
Chairman, Department of Environmental and Occupational Health, Drexel University, Dornsife School of Public Health, 2002-2014
Vice President for Medical Education, (title change as of 2/99), Associate Director for Medical Education (1994-1999), University of Texas Health Center at Tyler, 1999-2002
Ethics Officer, University of Texas Health Center at Tyler, 1998-2002
Center Director, Southwest Center for Agricultural Health, Injury Prevention and Education, 1995-2001, Renewed, 2001
Medical Director, Lake County Area Health Education Center, University of Texas Medical Branch at Galveston, 1995-2002
Chairman, Department of Preventive Medicine and Environmental Health, University of Kentucky College of Medicine, 1983-1994
Director, Occupational Medicine Residency Program, 1984-1994; General Preventive Medicine Residency Program, 1984-1989; Department of Preventive Medicine and Environmental Health University of Kentucky College of Medicine
Principal, Behavioral Research Aspects of Safety and Health Working Group (BRASH), 1984-1994
Director of Graduate Studies, Master of Science in Public Health Degree Program, 1987-1994, University of Kentucky Graduate School
Deputy Director, Southeast Center for Agricultural Health and Injury Prevention, 1992-1994
Scientific Administrator, Environmental Sciences Laboratory, The Mount Sinai School of Medicine,. 1981-1983
Director, Residency Programs in Community Medicine, Mount Sinai School of Medicine, 1977-1981

CLINICAL APPOINTMENTS

Clinical Appointment, Drexel University College of Medicine, 2002-present
Attending Staff and Chief of Service, University Hospital, University of Kentucky Medical Center, 1983-1994
Consultant Appointment, Veterans' Administration Hospital, Lexington, Kentucky
Courtesy Staff Appointments, Middlesboro ARH 1985-1994; Hazard ARH 1985-1994
Assistant Attending, Mount Sinai Hospital, New York, NY, 1982-83; Senior Clinical Assistant, 1978-1982; Clinical Assistant, 1977-1978

FELLOWSHIPS AND MEMBERSHIPS IN PROFESSIONAL ORGANIZATIONS

American Association for the Advancement of Science, 1972; Elected to Fellowship, 1996
American College of Physicians, Fellow
American College of Preventive Medicine, Fellow, Occupational Medicine Regent, 1997-1999
Chair, CME Committee, 1997-2015, Board of Directors, American Journal of Preventive Medicine, 1999-2003, Secretary - Treasurer, 2000 – 2004, Member, Finance Committee, 2000-2015, Environmental Health Committee
American Public Health Association
American Thoracic Society
Association of Teachers of Preventive Medicine; Secretary, 1981-84; Board of Directors, 1987-90, Education Committee, 1992-1994
Association of Teachers of Preventive Medicine Foundation, Inc.; Board of Directors, 1981-84
New York Academy of Sciences, Life Member
Society for Occupational and Environmental Health, Founding Member; Governing Council, 1992-1994, Vice-President 1998-2000
American College of Occupational and Environmental Medicine
Collegium Ramazzini, Executive Board 2002-2006
International Society for Preventive Oncology
Kentucky Occupational Safety and Health Network, Founding Member; Board of Directors, 1986-94; Executive Board, 1991-94; Secretary, 1992-93; President-Elect, 1993-94
National Occupational Safety and Health Education Association, Founding Member, 1989; Chair, 1990-91
Farm Safety for Just Kids
British Occupational Hygiene Society
Sigma Xi, Life Member
Texas Council on Agricultural Safety and Health, President 1999-2001
College of Physicians of Philadelphia 2002, elected to Fellowship, 2005

TEACHING ACTIVITIES

Course Coordinator, Occupational and Environmental Medicine, Georgetown University School of Medicine, 1975
Division of Industrial Safety, District of Columbia Industrial Safety Board, Washington, DC 1974, 1976
Page and William Black Post-Graduate School of Medicine, Mount Sinai Medical Center, 1977-82
Continuing Education, Mount Sinai Hospital Department of Nursing, 1976-78
Hahnemann Medical School, 1978-82
Hahnemann Hospital, 1980
University of Pennsylvania School of Medicine, 1979
University of Medicine & Dentistry of New Jersey, 1979-1981
Senior Medical Consultants, 1979-83
Practicing Law Institute, 1980-85

State University of New York at Buffalo, 1980-81
State University of New York at Stony Brook, 1981-82
IBM/University of Kentucky EXCEL Program, 1985-89
University of Kentucky Annual Family Medicine Review (Continuing Medical Education), 1985-86, 1993
University of Kentucky Annual Physician Assistant Review, 1987
University of Kentucky College of Engineering, Continuing Education 1984-89, 1994
University of Louisville College of Medicine, 1986-87, 1991
Bay State Medical Center, Springfield, Massachusetts, 1988
Preceptor, William Osler Program, UK Medical Center, 1988-1994
American College of Preventive Medicine, Board Review Course, 1989, 1990
EPOCH Awardee, NIOSH, 1989-91
St. Elizabeth's Hospital, Edgewood, KY, 1991, 1992, 1993, 1994
University of Texas Health Center at Tyler, Tyler, TX, 1993
Beijing Medical University, Beijing, People's Republic of China, 1993, 1995
Methodist Hospital, Indianapolis, IN, 1993
American Occupational Health Conference, Chicago, IL, 1994
Forum Program, Donovan Scholars Program, University of Kentucky, 1994
Kentucky Thoracic Society, 1994 (L. E. Smith Lectureship)
Southern Agromedicine Consortium, Keynote Luncheon Address, 1994
Kentucky School Board Insurance Trust, 1994
Qingdao Sanitation and Anti-Epidemic Station, 1995
School of Public Health, University of Texas, Houston, 1995
School of Public Health, University of Texas, San Antonio, 1997
Qingdao University School of Medicine, Qingdao, PRC, 1997
Ain Shams University Institute of Postgraduate Studies, Cairo, Egypt, 1998
UTMB, Course on Occupational Medicine, Galveston, Texas 1999, 2000, 2001
Qingdao Centers for Disease Control and Prevention, Qingdao, PRC, 2000
UTMB, Department of Family Practice, Galveston, Texas, 2000, 2001,2002
University of Texas Southwestern Public Health Program, Dallas, Texas 2000
UNTHSC, Fort Worth, Texas, 7/2001
Air Force School of Aerospace Medicine, Brooks AFB, Texas 2/02, 2/03, 6/06
GI Conference, Drexel 2/03
Pulmonary Conference, Drexel 2/03, 5/03, 5/15

CONSULTANCIES AND RELATED ACTIVITIES

Consultant, George Washington University School of Medicine, Science Communication Division, 1976-78
Consultant, Environmental Protection Agency; Ad Hoc Committee for the in-vitro study of fibrous amphiboles, 1977
Consultant, DHEW Committee to Coordinate Toxicology, Subcommittee on Asbestos, 1978
Consultant, State University of New York at Stony Brook, School of Medicine, Department of Community Medicine, 1980
Consultant, National Academy of Sciences Committee on Indoor Air Pollution, 1981
Invited Participant, Conference on Vision Effects of VDT Use, National Academy of Sciences, 1983
Ad Hoc Grant Reviewer, Health Resources Administration, Division of Medicine, Study Section on Environmental Medicine Curriculum Development Grants, 1979; Preventive Medicine Residencies, 1980, 1983, 1988, 1991
Site Visitor, National Institute for Occupational Safety and Health, 1983-91
Editorial Board, *American Journal of Industrial Medicine, Environmental Research, Journal of Community Health, Toxicology and Industrial Health, Cancer Detection and Prevention, International*

Journal of Occupational Medicine and Toxicology, International Journal of Hygiene and Environmental Health, etc.

Article Reviewer, *Journal of the National Cancer Institute, Journal of the American Medical Association, Journal of Environmental Pathology and Toxicology, Science, American Journal of Public Health, The American Statistician, Journal of Occupational and Environmental Medicine, Archives of Environmental Health, Southern Medical Journal, Law and Social Inquiry, Occupational and Environmental Medicine, American Journal of Preventive Medicine, Archives of Internal Medicine, etc.*

Associate Editor, Environmental Health Section, *Maxcy-Rosenau-Last Public Health and Preventive Medicine*, 12th Edition, 13th Edition

Advisor, New York City Health Systems Agency Task Force on Environmental Health, 1979

Member, Environmental Health Committee, New York City Health Systems Agency, 1979-80

Member, New York Lung Association Committee on Occupational Hazards to the Lung, 1977-78

Consultant, University of Arizona College of Medicine, Department of Family and Community Medicine, Project on Incorporation of Preventive Medicine into Family Practice, 1985-86

Consultant, Occupational Cancer Project, Workers Occupational Health Clinic, Cincinnati, Ohio, 1985-87

Member, NIOSH Study Section for Occupational Safety and Health, 1985-89; Chairman, 1988-89

Consultant, Labor Cabinet, Commonwealth of Kentucky, 1987-1994

Member, National Board of Medical Examiners, FLEX Examination Committee, 1985-91; NBME Pulmonary Medicine Subcommittee, 1989-91; USMLE Content Reviewer, 1994

Consultant, Toyota Motor Manufacturing, USA, Inc., 1986-1994; Acting Medical Director, 1988

Member, Steering Committee, National Conference on Residencies in Occupational Medicine, 1988

Chair, Association of Occupational Medicine Residency Directors, 1988-1989

Grant Reviewer, Arizona Disease Control Research Commission, 1988-2016

Consultant, Ashland Oil, Ashland, Kentucky, 1988-1994

Member, Advisory Board Center for Applied Energy Research, University of Kentucky, 1990-1995

Member, Board of Directors, Occupational Physicians Scholarship Fund, 1988- 2010

Consultant, Urgent Treatment Center, Lexington, Kentucky, 1989-1994

Consultant, NIOSH Review of Document on Workplace Screening, 1990

Consultant, Natural Resource and Environmental Protection Cabinet, Commonwealth of Kentucky, 1990-1994

Consultant, Island Creek Corporation, 1990-1993

Member, NIOSH Board of Scientific Counselors, 1992-1996

Presenter, International Conference on Exposure to Carcinogens and Mutagens in the Industrial and Ambient Environment, "Issues of Asbestos Carcinogenicity". Jerusalem, Israel, January 30, 1992.

Member, Environmental Board, Commonwealth of Kentucky (Appointed by the Governor), 1991-95

Presenter, Ohio AFL/CIO Worker's Compensation Institute, "The Role of the Primary Care Physician in Occupational Disease". Akron, Ohio, March 1992.

Presenter, (20th Anniversary Class Representative) Alumni Day Program, Mt. Sinai School of Medicine, "The Mt. Sinai-Kentucky Connection". New York, NY April 11, 1992.

Presenter, NIOSH Grand Rounds, ALOSH, Morgantown, WV, 1992.

Associate Editor, *Mosby Year Book of Occupational and Environmental Medicine*, 1992-94, Co-Editor-in-Chief, 1995-98

Guest Editor, Memorial Volume of *Environmental Research* honoring Dr. Irving J. Selikoff, 1992

Consultant, Qingdao Hygiene and Anti-Epidemic Station, Qingdao, Shandong Province, (now Qingdao Municipal Center for Disease Control and Prevention), 1993-Present

Guest Professor, Beijing Medical University, Peoples Republic of China, 1993-1996

Presenter, From Rio to the Capitals: State Strategies for Sustainable Development, May 25-28, 1993, Louisville, Kentucky

Presenter, State of Ohio Workers Compensation Program, 1993

Presenter, Kentucky Laborer's Union Asbestos Training Program, 1993

Presenter, Collegium Ramazzini Scientific Session, 1993, Session Co-Chair

Kentucky Nominee, Technical Oversight Committee, Southern Appalachian Mountain Initiative, 1993
Consultant, EPA Panel on the Use of Genetic Monitoring for Risk Assessment in Communities Exposed to Hazardous Waste, University of Texas Medical Branch at Galveston, 1994
Member, Residency Advisory Committee, U.S. Air Force Residency Program in Preventive Medicine, Brooks Air Force Base, San Antonio, Texas, Wright-Patterson AFB, Dayton, Ohio 1994-Present
Advisory Board Member, "Cost-effective Medicine Reports", Mosby Publishing Co. 1994-1996
Presenter, Collegium Ramazzini Scientific Session, Carpi, Italy, October 29, 1994
Advisory Board Member, BRASH (Behavioral Research Aspects of Safety and Health) Working Group, University of Kentucky, 1994
Presenter and Session Chair, SOEH Conference on Tuberculosis in the Workplace. December 1-2, 1994, Washington, DC
Presenter, Andrews Publications Seminar on Asbestos-Related Diseases, Houston, Texas, March 1995
Presenter, Bar Ilan University, Israel, March 1995
Presenter, Hadassah Medical School, Israel, March 1995
Presenter, 1st International Congress of the Minia School of Medicine, Minia, Egypt April, 1995
Program Participant, Kentucky Governor's Safety and Health Conference, Louisville, Kentucky, April 1995.
Member, Advisory Board, Southwest Center for Occupational and Environmental Health, Houston, Texas, 1995-1998.
Consultant, Texas Medical Association, Council on Medical Education, 1994-2002; Subcommittee on Accreditation, 1995-2001; Chair 1997-2001; CME Committee, 1997-2001.
Presenter, Occupational and Environmental Respiratory Disease Course, The University of Texas School of Public Health, Houston, Texas 1995.
Presenter, Departmental Seminar, The Department of Preventive Medicine and Community Health, The University of Texas Medical Branch, Galveston, Texas 1996.
Presenter, Second International Conference of Environmental Mutagenesis in Human Populations at Risk, Prague, Czech Republic, 1995.
Session Chair, Annual Meeting of the Society of Occupational and Environmental Health, Bethesda, Maryland, Dec-6-8, 1995.
Member, Advisory Board, Lake Country AHEC, 1995-2002; Board chair, 1996-1997.
Member, Advisory Board, NIEHS, Toxicology Center, UTMB, 1996-2002
Session Chair and Rapporteur, Third Annual NIOSH Agricultural Health and Safety Conference, Iowa City, Iowa, March 1996.
Seminar Program Chair, AOHC, San Antonio, Texas, ACOEM, 1995-96.
Alumni Day Centennial Program, Mount Sinai Medical Center, New York, NY, April 13, 1996.
Speaker and Session Co-chair, The 6th International Conference on "Preservation of our World in the Wake of Change", Jerusalem, Israel, June 1996.
Speaker, VIII Inhaled Particles Meeting, Cambridge, England, August 1996.
Presenter, Collegium Ramazzini Scientific Session, Carpi, Italy, October 27, 1996.
Member and Chair, Residency Advisory Committee, Occupational Medicine, University of Texas Medical Branch, Galveston, Texas 1997
Member, University of Texas System Master Planning Organization and Task Force for Distance Learning and the Virtual University, 1997.
Member, Advisory Board, Texas A&M University Rural School of Public Health, College Station, Texas, 1997-2002
Presenter, TOMA meeting, Houston, Texas, March 14, 1997
Presenter, Environmental Information Association, New Orleans, Louisiana, March 25, 1997
Presenter, The University of Texas Medical Branch, Galveston, Texas, April 18, 1997
Member, University of Texas Telehealth Committee, 1997-2002
Presenter, ACOEM, AOHC Session, Orlando, Florida, May 12, 1997
Presenter, Qingdao Municipal Hospital, Department of Radiology, June 1997
Presenter, Research in China, Directors Associates. Tyler, June 1997

Presenter and Session Co-Chair, Collegium Ramazzini meeting, Carpi, Italy October, 1997
Presenter, Medical Education Grand Rounds, Mount Sinai School of Medicine, New York, NY, November 1997
Member, Shared Student Information Systems Committee, U.T. System, Austin, Texas, 1997-98
Member, Shared Administrative Support Systems Committee, U.T. System, Austin, Texas, 1997-98
Member, Texas Council for Agricultural Safety & Health 1997; Chair-Elect, 1997-99
Presenter, "Children in the Workplace", presented at the Annual Ain Shams University Institute of Child Studies Conference, Cairo, Egypt, March, 1998
Presenter, Texas Academy of Mathematics and Science, University of North Texas, Denton, "Medical Sleuthing: Environmental Toxins", April 13, 1998
Grand Rounds Presenter, Presbyterian Hospital of Dallas, Environmental Toxins, April 29, 1998
Member, International Scientific Advisory Committee Third International Conference on Environmental Mutagens in Human Populations, 1998
Member, Telehealth Steering Committee Working Group on Education/Community Networks/Libraries, Telecommunications Infrastructure Fund Board, Austin, Texas 1998-1999
Presenter, AHEC-SW, Texarkana, Arkansas, Conference on Respiratory Therapy. "Occupational Lung Cancer" and "Occupational and Environmental Lung Disease Case Studies", Texarkana, Arkansas 8/28/98
Presenter, First Annual TCASH Scientific Conference, Fort Worth, Texas, October 16, 1998
Presenter, Childhood Agricultural Hazards at Collegium Ramazzini meeting, Carpi, Italy, October 25, 1998
Consultant, Medical Communities Project, Environmental Protection Agency, Washington, D.C., 1998-99
Presenter, two presentations for the Third International Conference on Environmental Mutagens in Human Populations, November-December, 1998, Thailand
Presenter, TAMS Senior Seminar, February 1, 1999
Presenter, East Texas Council on World Affairs, Tyler, Texas, February 8, 1999
Presenter, Prevention '99, ACPM Session on Preventive Medicine, March 20, 1999
Presenter, Texas Occupational Medicine Association Meeting, Dallas, Texas, May 7, 1999
Panelist, East Texas Minority Health Network Conference, Tyler, Texas, June 3, 1999
Presenter, 7th International Conference of the Israel Ecology Society, Jerusalem, Israel, June, 1999
Presenter, University of Texas Houston School of Public Health Course on Occupational Medicine for the Primary Care Practitioner, Houston, Texas, September 25, 1999
Invited Presenter, Committee on Work and Industry, Chamber of Deputies, Brasilia, Brazil, September 29, 1999
Presenter and Session Chair, Collegium Ramazzini, October 1999, Carpi, Italy
Chair, International Scientific Advisory Committee of the Selikoff Center, Ra´anana, Israel, 1999
Presenter, Texas Academy of Mathematics and Science, Denton, Texas, January 31, 2000
Presenter, Pediatrics Grand Rounds, UTHCT, Tyler, Texas, 2/17/00
Consultant, Qingdao Centers for Disease Control and Prevention, Qingdao, PRC, 2000-present
Session Chair, NYCASH Meeting on Agricultural Safety and Health, Cooperstown, New York, 2000
Site Visitor, NIEHS, 2000
Guest Consultant, Annual Review of Public Health, Palo Alto, California, 2000
Award Recipient, Guest Speaker, ACCME, Chicago, Illinois, 2000
Presenter, TMA CME Conference, June 2000
Presenter and Conference Planning Committee, International Cancer Conference, Grand Rapids, Michigan, September 2000
Presenter, Pulmonary Program, UTHCT, September 2000
Presenter, Collegium Ramazzini, Carpi, Italy October 2000
Presenter, Session Chair and Conference Planning Committee, ISPO Conference, Geneva, November 2000

Presenter and Session Chair, Indian Association of Occupational Health Conference, New Delhi, February 2001
Presenter, Industrial Toxicology Research Center, Lucknow, India, February 2001
Member, Editorial Board, Annual Review of Public Health, 2001 – 2005
Presenter, Allen Cohen Memorial Lecture, Tyler, Texas, April 5, 2001
Presenter, UTHCT Grand Rounds, April 6, 2001
Presenter, Grand Rounds, Family Practice, UTMB, Galveston, Texas, July 11, 2001
Presenter, UTHSC, Grand Rounds, Internal Medicine, Fort Worth, Texas July 8, 2001
Member, Physicians Panel Member, State Claims Assistance Program, Department of Energy, October 1, 2004
Co-Moderator, Institute of Water Quality, ACPM Meeting, San Antonio, Texas, February 2002
Presenter, East Texas Council on World Affairs, March 2002
Presenter, Scientific Program, Alumni Day (30th class year representative), Mount Sinai Medical Center, New York, NY, April 6, 2002
Presenter, TAMS Program UNT, Denton, Texas April 8, 2002
Presenter, University of Texas at Tyler School of Nursing, April 15, 2002
Presenter and Chair, New York Academy of Sciences, Mesothelioma Program, April 25, 2002
Presenter, Occupational Medicine Program, UTHCT, June 2002
Presenter, UTMB, Occupational Medicine Residency Program, July 2002
Session Chair, Collegium Ramazzini Meeting, Bologna, Italy, October 2002
Member, State Advisory Committee on Environmental Health Tracking, Pennsylvania, November 2002
Presenter, Drexel University SESEPS Seminar, December 2002
Presenter, Drexel University SPH Grand Rounds, December 2002
Presenter, Air Force School of Aerospace Medicine, February 2003
Presenter, GI Conference, Drexel, February 2003
Presenter, Pulmonary Conference, Drexel 02/03, 05/03
Presenter, University of Pennsylvania Residency Program in Occupational Medicine, March 2003, March 2005, April 2006, 2011, 2012, 2013, 2015
Presenter, George Washington University Seminar, April 2003
Marcus Key Lecturer, TOMA Meeting, April 2003
Consultant, Waste Management Corporation, April 2003
Presenter, ACPM Water Conference, Washington, DC, June 2003
Presenter, UTMB, Galveston, Texas, July 2003
Presenter, Fox Chase Cancer Center, September 16, 2003
Presenter, APHA, San Francisco, California, November 2003
Moderator, ACPM National Teleconference on Pediatric Environmental Health, May 2004
Member, Environmental Justice Advisory Board, DEP, Harrisburg, Pennsylvania, 2004; Chair 2006
Presenter, Harris Martin Conference, Manganese, San Francisco, California, June 15, 2004
Presenter, UTHCT – Occupational Lung Disease, June 26, 2004
Presenter, UTMB – Occupational Cancers, Occupational Lung Disease, The History of Occupational Medicine, July 7, 2004, July 5, 2006
Presenter, Graduate School of Public Health, Pittsburgh, Asthma Seminar, August 10, 2004
Presenter, Drexel School of Public Health, Agriculture and Public Health, Faculty Seminar, August 13, 2004
Presenter, PCIEP Program, September 2004
Session Chair and Discussant, Olin Seminar on Environmental Justice, Drexel University, October 2004
Presenter, Collegium Ramazzini Annual meeting, Carpi, Italy, October 2004
Presenter, UCLA MD/PhD Program, November 2004
Presenter, Qingdao Centers for Disease Control and Prevention, Qingdao, China
Presenter, Asbestos Conference, Tokyo, Japan, November 2004
Presenter, Pulmonary Conference, Hahnemann Hospital, January 2005
Member, Institute of Medicine Committee, Gulf War and Health, 2005-2006

Presenter, Post Graduate Occupational Medicine Programs, New Delhi, India, March-April 2005, May 2006
Presenter, Department of Labor Conference, Washington, DC, April 2005
Presenter, Sappington Lecture, ACOEM, Washington, DC, May 2005
Presenter, US School of Aerospace Medicine, San Antonio, Texas, May 2005; June 2006
Presenter, Nahariya Hospital, Israel, Lecture on asbestos, May 2005
Presenter, University of Paris France, Lectures on occupational cancers and asbestos, June 1, 2005
Presenter, AAMC Meeting on MD/MPH Programs, Chicago, Illinois, June 27, 2005
Presenter, UTMB, Grand Rounds Residency Program, Galveston, Texas, July 5-6, 2005
Session Chair, Collegium Ramazzini Conference, Living in a Chemical World, Bentivolgio, Italy September 19, 2005
Presenter, Institute of Public Health, Iasi, Romania, Keynote Address September 22, 2005, Address September 23, 2005
Presenter, 14th Brazilian Congress of Toxicology, Recife, Brazil, October 10, 2005
Presenter, Beijing Forum (2005) Beijing, People's Republic of China, November 19, 2005
Member, ACGME Appeals Panel for Preventive Medicine, 2006-2018
Presenter, EPA Public Hearing on Air Pollution Criteria, Representing ATS, March 8, 2006
Presenter, UMDNJ, March 2006
Session Chair, Asbestos Program, ADAO, April 1, 2006
Member, Delaware River Basin Commission, Toxics Advisory Committee, 2006-2009.
Presenter, Maulana Azad Medical College, New Delhi, India, May 2006
Presenter, Occupational and Environmental Medical Association of Canada, Toronto, CBOM Memorial Lecture, June 2006
Presenter, Summer Public Health Institute, Iasi, Romania, July 2006
Session Chair and Presenter, Asian Asbestos Conference, Bangkok, Thailand, July 2006
Presenter, Business Exchange Breakfast, Philadelphia, October 17, 2006
Session Chair and Presenter, Collegium Ramazzini Meeting, Capri, Italy, October 29, 2006
Presenter, PCOEM, November 2006
Presenter, Asbestos Conference and Continuing Education Conference, New Delhi, India, December 2006
Presenter, State University of New York at Stony Brook, Occupational Lung Diseases, December 2006
Presenter, PCOM, Internal Medicine Group, January 2007
Participant, AAD Program, Drexel University School of Public Health, March 31 – April 1, 2007
Lecturer, Physician Assistant Course, Drexel University, April 2007
Lecturer, ACOEM Program, New Jersey, Asbestos, May 1, 2007
Presenter, Environmental Mutagenesis Conference, Turkey, May 22, 2007
Presenter, Drexel School of Public Health Program, Asbestos, June 1, 2007
Presenter, Occupational Medicine Course, Maulana Azad Medical College, New Delhi, India, June 2007
Presenter, UTMB, Galveston, Texas, July 2007
Member and Chair, Ad hoc Committee to Assess Liver Cancer in Bexar County Texas, San Antonio, August 2007, December 2007
Presenter, SUNY Stony Brook, October 2007
Presenter, Collegium Ramazzini Meeting, Princess Chulaborn Institute, Bangkok, Thailand, December 2007
Presenter, Integral University, Lucknow, India, December 2007
Presenter, Sanjay Gandhi Institute, Lucknow, India, December 2007
Presenter, Joint Labor-Management Safety and Health Meeting, Vishakhaptnam, India, December 2007
Presenter, Centre for Occupational and Environmental Health, Maulana Azad Medical College, Delhi, India, December 2007
Presenter, Department of Medicine CME Program, Maulana Azad Medical College, Delhi, India, December 2007

Session Chair,41st Annual Meeting of the Indian College of Allergy, Asthma and Applied Immunology, Delhi, India, December 2007
Presenter, Toxic Links Meeting, Delhi, India, December 2007
Presenter, Philadelphia Zoning Code Commission, January 2008
Member and Chair, Advisory Committee, Mountain and Plains ERC, Denver, Colorado, January 2008-present
Speaker, George Washington University School of Public Health, Washington, DC, February 2008
Lecturer, U.S. Air Force School of Aerospace Medicine, San Antonio, Texas, Mach 2008
Grant Reviewer, NIOSH Agricultural Center Program, March 2008
Session Chair, ADAO 4th Annual Conference, Detroit, Michigan, March 2008
Lecturer, Physician Assistants Program, Drexel University, April 2008
Lecturer, Maulana Azad Medical College, Delhi, India, May 2008
Presenter, National Conference on Climate Change, Delhi, India May 2008
Presenter, 1st International Conference on Mesothelioma, Sao Paulo, Brazil June 2008
Member, City of Philadelphia Air Pollution Control Board, June 2008-present
Lecturer, UTMB, Galveston, Texas, July 2008
Lecturer, Qingdao Centers for Disease Control and Prevention, Qingdao, China, August 2008
Member, Board of Scientific Counselors, CDC Center for Environmental Health/ATSDR, July 2008-June 2012
Member, Scientific Review Board, Peking Medical University, August 2008
Presenter, ACPM Program on Indoor Air Pollution, August 2008
Presenter, Inhaled Particles X Meeting, Sheffield, England, September 2008
Presenter, FASLI Occupational Medicine Program, Mumbai, India, September 2008
Presenter, ESIC Occupational Medicine Program, Mumbai, India, September 2008
Invited Lecturer, University of Brescia, Italy, October 2008
Lecturer, Drexel University College of Medicine, November 2008
Consultant and Speaker, Sri Lankan NIOSH, Colombo, March 2009
Speaker, ESI Program, Chennai, India, March 2009
Session Chair, ADAO Annual Scientific Meeting, Los Angeles, California, March 2009
Speaker, Occupational Medicine Program, UMDNJ, March 2009
Speaker, ESI Program, Goa, India, May 2009
Speaker, Occupational Medicine Program, Maulana Azad Medical College, Delhi, India, May 2009
Participant, Harris Martin Asbestos Program, Chicago, Illinois, June 2009
Speaker, University of Occupational and Environmental Health, Kitakyushu City, Japan, August 2009
Speaker, Hangzhou Preventive Medicine Program, Hangzhou, China, August 2009
Speaker, Qingdao CDC, China, August 2009
Speaker, Uniformed Services, University of the Health Sciences, Bethesda, Maryland, November 2009
Organizer, Session Chair, Speaker, Collegium Ramazzini/Drexel/MAMC Meeting, New Delhi, India, December 2009
Speaker, Clinical Case Conference, MAMC, New Delhi, India, December 2009
Speaker, MAMC Center for Liver and Biliary Disease, New Delhi, India, December 2009
Session Chair/Discussant, Round Table Conference on Issues Related to Asbestos Use in India, New Delhi, India, December 2009
Speaker, Medical-Legal Program, Salisbury, North Carolina, January 2010
Advisory Board, Libby Epidemiology Research Program, Scientific Advisory Group, 2009-2014
Member, NIOSH NORA Mining Sector Council, 2010
Speaker, Medical-Legal Program, Philadelphia, Pennsylvania, February 2010
Session Chair, ADAO Annual Meeting, Chicago, April 2010
Lecturer, Maulana Azad Medical College, New Delhi, June 2010
Lecturer, Sri Lanka NIOSH, Colombo, June 2010
Lecturer, University of Colombo, Sri Lanka, June 2010
Lecturer, University of North Colombo, Sri Lanka, June 2010

Lecturer, Moratuwa University, Sri Lanka, June 2010
Lecturer, University of Peradeniya, Kandy, Sri Lanka, June 2010
Lecturer, Postgraduate Institute of Medicine, Colombo, Sri Lanka, June 2010
Member, Editorial Board, Oxford University Press On-Line, Public Health Encyclopedia, 2010
Keynote Speaker, Environmental Justice in Chester Conference, July 27, 2010
Invited Lecturer, UTMB, Galveston, Texas, August 5, 2010
Keynote Speaker, Shantou Medical College, Shantou, China, September 2010
Invited Lecturer, Fudan University School of Public Health, Shanghai, China, September 2010
Invited Speaker, McGeorge Law School, Sacramento, California, October 2010
Invited Speaker, Asbestos Conference, New York, NY, October 2010
Invited Speaker, Asia Asbestos Initiative Conference III, Fukuoka, Japan, November 2010
Presenter, APHA Meeting, Denver, Colorado, November 2010
Invited Speaker, California EPA, Sacramento, California, November 2010
Invited Lecturer, University of Brunei Darussalam, November 2010
Invited Speaker, Ministry of Health, Occupational Health Unit, Brunei, November 2010
Invited Speaker, Jodhpur National University, Jodhpur, India, November 2010
Lecturer, Emerging Developments in Occupational Medicine Practice Conference, Maulana Azad Medical College, New Delhi, India, November 2010
Invited Speaker, National Institute of Health, Family and Welfare, New Delhi, India, December 2010
Invited Speaker, Basaidharapur Hospital, ESIC, New Delhi, India, December 2010
Grand Rounds Speaker, Crozer Chester Medical Center, January 2011
Invited Speaker, Occupational Health Program, Raleigh, North Carolina, January 2011
Invited Grand Rounds Speaker, UTMB, Galveston, Texas, February 2011
Speaker, International Conference, Maulana Azad Medical College, New Delhi, India, March 2011
Session Chair, ADAO Meeting, Atlanta, Georgia, April 2011
Invited Speaker, Agricultural Safety and Health Conference, Chulalongkorn University, Bangkok, Thailand, July 2011
Invited Lecturer, UTMB, Galveston, Texas, August, 2011
Peer Reviewer, Diacetyl Document-NIOSH, August, 2011
Guest Editor, Safety and Health special issue of "Minerals" 2011-2012
Member, Technical Advisory Council District 1199C, Susan Harwood OSHA Grant, Philadelphia, Pennsylvania, 2011-present
Member, CEPH Accreditation Planning Committee, 2011-2014
Invited Speaker, Occupational and Environmental Medical Association of Canada, 29th Annual Scientific Conference, Niagara-on-the-Lake, Canada, October 2011
Invited Speaker, Asbestos in Vermiculite Program, Libby, Montana, October 2011
Invited Speaker, Public Interest Law Center of Philadelphia Symposium, Philadelphia, October, 2011
Invited Speaker, NIOH, Ahmedabad, India, December 11
Invited Lecturer, Maulana Azad Medical College, New Delhi, India December 2011
Invited Speaker, Asbestos Program, Philadelphia, January 2012
Invited Speaker, U.S. Air Force Occupational Medicine Program, March 2012
Invited Speaker, University of Colorado SPH Research Day Keynote Speaker, March 2012
Session Chair, ADAO Annual Meeting, Manhattan Beach, California, March 2012
Invited Speaker, Johns Hopkins University SPH, Baltimore, Maryland, April 2012
Invited Speaker, USUHS, Department of Preventive Medicine, Bethesda, Maryland, April 12
Invited Speaker: University of Pennsylvania Occupational Medicine Program, April 12
Invited Speaker, Occupational Health Clinics for Ontario Workers, Sarnia, Ontario, April 2012
Invited Speaker, Workers Memorial Day Program, Sarnia, Ontario, April 2012
Invited Speaker, Maulana Azad Medical College, New Delhi, India, July 2012
Invited Presenter, Supreme Court of Brazil, Brasilia, August 2012
Invited Speaker, Qingdao CDC, China, September 2012
Invited Speaker, IIT, New Delhi, India, November 2012

Invited Speaker, Maulana Azad Institute of Dental Sciences, New Delhi, India, November 2012
Invited Speaker, Maulana Azad Medical College, New Delhi, India, December 12
Invited Speaker, International Meeting, Maulana Azad Medical College, New Delhi, India, December 2012
Invited Speaker, UMDNJ, Piscataway, New Jersey, December 2012
Invited Speaker, Asbestos Program, Philadelphia, January 2013
Invited Speaker, American College of Preventive Medicine Annual Meeting, Scottsdale, Arizona, February 2013
Grand Rounds Speaker, Department of Medicine, Drexel University College of Medicine, February 2013
Invited Speaker, ADAO Annual Meeting, Washington, DC, March 2013
Invited Speaker, DOE Former Workers PI Meeting, Washington, DC, May 2013
Invited Speaker, ATS Annual Meeting, Philadelphia, Meet the Professor Session, May 2013
Speaker, Clean Air Council, Philadelphia, June 2013
Speaker, Health Sciences University, Ulaanbaatar, Mongolia, July 2013
Grand Rounds Speaker, Christiana Hospital, August 2013
Speaker, Inhaled Particles XI, Nottingham, England, September 2013
Invited Speaker, Maulana Azad Medical College, New Delhi, India, December 2013
Invited Speaker, Conference for Orland Gas Industry, New Delhi, India, December 2013
Grand Rounds Speaker, Mount Sinai School of Medicine, January 2014
Invited Speaker, Asbestos Program, San Francisco, California, January 2014
Invited Speaker, Agricultural Safety and Health Talk, Drexel Sacramento Campus, March 2014
Invited Lecturer, JH-Perdana University, Malaysia, June 2014
Invited Speaker, AOEMM 8th Annual Conference, Kuala Lumpur, Malaysia, June 2014
Speaker, Occupational Health Workshop, MAMC, New Delhi, India, June 2014
Invited Lecturer, National Institute of Health and Family Welfare, New Delhi, India, July 2014
Invited Speaker, Asbestos Meeting, SPH, Ulaanbaatar, Mongolia, July 14
Invited Speaker, Occupational Health Center, Ulaanbaatar, Mongolia, July 2014
Invited Faculty, ITT-Delhi, India, July14
Invited Grand Rounds Speaker, Christiana Care, September 2014
Invited Speaker, Collegium Ramazzini, Silica Session, Carpi, Italy, October 2014
Invited Lecturer, Maulana Azad Medical College, New Delhi, India, December 2014
Member, University Honorary Degree Committee, 2014
Invited Speaker, UMDNJ EOH Program, New Jersey, February 2015
Invited Speaker, International Conference on Hearing Loss, New Delhi, India, February 2015
Invited Lecturer, Obama-Singh Grant Program on Risk Assessment Hyderabad, India, March 2015
Invited Speaker, ADAO Conference, Washington, DC, April 2015
Invited Lecturer, School of Public Health, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia, June 2015
Invited Speaker, DOE Public Session, Amarillo, Texas, July 2015
Invited Lecturer, UTMB, Galveston, Texas, July 2015
Invited Speaker, Collegium Ramazzini Scientific Meeting, Carpi, Italy, October 2015
Invited Speaker, Health 3000 Meeting, Colombo, Sri Lanka, December 2015
Invited Speaker, MAMC Conference, New Delhi, India, December 2015
Member, University Tenure Appeals Committee, 2015-2016
Member, Dornsife Professor Search Committee, 2016
Member, Boren Fellowship Review Committee, January 2016
Member, Drexel University Travel Committee, 2016
Member, University Grievance Committee, 2016-2019
Member, Dornsife Committee on Global Health, 2016
Speaker, ADAO Conference, Washington, DC, April 16
Speaker, Scientific Conference, UTHSCT, Tyler, Texas, June 2016

Visiting Faculty, Mongolian National University of Medical Science, School of Public Health, June 2016
Invited Lecturer, UTMB, Galveston, Texas, July 2016
Visiting Faculty, Buenos Aires, Argentina, September 2016
Invited Speaker, Brazil, October 2016
Presenter: Collegium Ramazzini Meeting, Carpi, Italy, October 2016
Lecturer: Ramazzini Lecture, Carpi, Italy, October 2016
Member: SPH Global Health Advisory Board, 2016 –
Member: AOEC Board of Directors, 2017 –
Invited Speaker: Asbestos Program, January 2017
Invited Speaker: Indian National Institute of Health and Family Welfare, New Delhi, February 2017
Invited Speaker: Health and Environment Foundation, New Delhi, February 2017
Invited Speaker: ITT-Delhi, New Delhi, February 2017
Invited Speaker: Workshop on Silicosis, Jodhpur, February 2017
Invited Speaker: Indian Public Health Association meeting, Jodhpur, February 2017

PLANNED PRESENTATIONS

Invited Speaker, ADAO Meeting, Washington, DC, April 2017
Visiting Faculty, Mongolian National University of Medical Science, School of Public Health, June 2017
Invited Lecturer, UTMB, Galveston, TX, July 2017
Invited Speaker, Asbestos Program, Bogota, Columbia, August 2017
Advisor, Invited Speaker and Chairperson, Amity University meeting on Women's and Environmental Health, Lucknow, India, November 2017

BOOKS, REVIEWS, AND BOOK CHAPTERS

1. Trump BF, McDowell EM, Barrett LA, Frank A, Harris C. Studies of Ultrastructure. Cytochemistry and Organ Culture of Human Brochial Epithelium. In *Experimental Respiratory Carcinogenesis and Bioassays*. New York: Springer-Verlag, 1974, p. 548-563.

2. Harris C, Autrup H, Van Haaften C, Connor R, Frank A, Barrett L, McDowell E, Trump B. Inhibition of Benzo(a)pyrene Binding to DNA in Cultured Human Bronchi. In *Proc 3rd Int Symposium Cancer Detection and Prevention*, Part I, Vol 2, Nieburgs H. (Ed). Amsterdam: Excerpta Medica, 1977, p. 1359-1364.

3. Frank AL. Occupational Lung Cancer. In *Pathogenesis and Therapy of Lung Cancer*, Harris C. (Ed). New York: M. Dekker, Inc., 1978, p. 25-51.

4. Frank AL. In *Public Health and Preventive Medicine*, 11th Edition, Last J. (Ed). New York: Appleton-Century-Crofts, 1980. a. Arsenic, p. 660-662; b. Antimony, p. 681; c. Thorium, p. 681-682; d. Benzidine, The Napthylamines, and Miscellaneous Carcinogenic Compounds, p. 751-755; e. Non-Ionizing Radiation, p. 777-787.

5. Frank AL. *Cancer*. New York: Matthew Bender and Co., 1978.

6. Frank AL, Spigelman M. Lung Cancer. In *Cancer*. New York: Matthew Bender and Co., 1980, p. 1-51.

7. Frank AL. *Asbestosis*. New York: Matthew Bender and Co., 1980, p. 1-51.

8. Frank AL. Definition of Preventive Medicine. In *Charting Graduate Education in Preventive Medicine*, Byrd B. (Ed). Washington, DC: American College of Preventive Medicine, 1980, p. 7-8.

9. Frank AL. Asbestos-Induced Changes in Hamster Trachea Organ Culture. In *The In-Vitro Effects of Mineral Dusts*. Brown R, et al. (Eds). London: Academic Press, 1980, p. 235-240.

10. Wade MJ, Lipkin LE, Stanton MF, Frank AL. P388D_1 In-Vitro Cytotoxicity as Applied to Asbestos and Other Minerals: Its Possible Relevance to Carcinogenicity. In *The In-Vitro Effects of Mineral Dusts*, Brown R, et al. (Eds). London: Academic Press, 1980, p. 351-358.

11. Frank AL. Health Effects of Fibers. *National Academy of Sciences Report on Indoor Air Pollutions*, Washington, DC, 1981.

12. Frank AL. Occupational and Environmental Exposure. In *An Introduction to Physical Diagnosis*. Swartz M (Ed). New York: Raven Press, 1981, p. 303-311.

13. Frank AL, Spigelman M. Blood-Related Malignancies. In *Cancer*. New York: Matthew Bender & Co., 1981, p. 1-123.

14. Frank AL. The Hospital as an Environmental Health Resource. In *Principles of Hospital- Based Ambulatory Care*, Pascarelli EF (Ed). New York: Appleton- Century- Crofts, 1982, p. 309-314.

15. Frank AL, Spigelman M. Cancer of the Liver, Gall Bladder, and Bile Ducts. In *Cancer*. New York: Matthew Bender and Co., 1982, p.1-43.

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