SYMPOSIUM
WELCOMING REMARKS
and
OPENING SESSION

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WELCOMING REMARKS

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METALWORKING FLUIDS: COMPOSITION and USE

SYMPOSIUM WELCOMING REMARKS and OPENING PLENARY SESSION

Dr. RICHARD KLIMISCH, AAMA: Good morning ladies and gentleman, and welcome!

My name is Dick Klimisch and I am Vice President of the Engineering Affairs Division for the American Automobile Manufacturers Association.

On behalf of AAMA, it is my pleasure to welcome you to Dearborn, and to this unique Symposium on the broad subject of metalworking fluids. The Symposium is unique in the sense that it represents a cooperative partnership between government, organized labor, academia, and the involved industrial manufacturing base and user base of these fluids.

This Symposium has been slightly over a year in the planning, and we should like to express our appreciation and gratitude to the various government, labor, and industrial organizations and associations who have directly been involved in the ongoing planning process. We should like to acknowledge the following organizations who have all cooperated with us in bringing you this Symposium:

> The National Institute for Occupational Safety & Health; the Occupational Safety & Health Administration; the Environmental Protection Agency; the Ontario Ministry of Labour; the United Auto Workers; the International Association of Machinists and Aerospace Workers; the American Federation of Labor & Congress of Industrial Organizations; the American Industrial Hygiene Association; the American Conference of Governmental Industrial Hygienists; the American Society of Safety Engineers; the Independent Lubricant Manufacturers Association; the Chemical Manufacturers Association; the American Petroleum Institute; the Chemical Industry Institute for Toxicology; the American Association for Aerosol Research; the Society of Manufacturing Engineers; the Association for Manufacturing Technology; and the Association of International Automobile Manufacturers.

Over the next four days, you will be hearing technical presentations from many of the top experts in this field. To be certain, there remain many controversial aspects of this broad subject, particularly in relation to health effects from occupational exposures. Indeed, this Symposium is really the result of petitions to federal regulatory agencies to address occupational exposures and formulation issues. We are heartened that the regulatory agencies involved have not reacted in a sort of knee-jerk fashion, but instead have chosen to patiently review the science and attempt to involve all stakeholders in the ensuing discussion. There was an initial stakeholders meeting sponsored by NIOSH in Cincinnati one year ago, and this Symposium was both an outgrowth, and the logical extension of that meeting.

We think it is important to note that this Symposium presents all of us with a unique opportunity. It is an opportunity in which all the various factions, and even those with divergent interests, can demonstrate a willingness to cooperatively address, and perhaps even resolve those areas of disagreement. In addition to the opportunity to achieve consensus and/or agreement, there remains before us the opportunity to determine an appropriate direction for the future. This Symposium has been the result of Herculean efforts by many dedicated people in an attempt to address a large number of the very complicated and sometimes controversial aspects of this subject; it would be unfortunate to lose momentum upon the conclusion of this Symposium. To that end, we are committed to publishing a written Symposium Proceedings before March 1996. The Proceedings will contain both the extended abstracts of each of the technical presentations, and a transcript of all discussions. If you have registered for the full four days, you will automatically receive a copy of the Proceedings when it becomes available. And now, I would like to introduce David Felinski, who is Program Chairman of this Symposium.

Mr. DAVID FELINSKI, AAMA: Good morning everyone and welcome. My name is Dave Felinski and I'm Manager of Occupational & Environmental Programs for AAMA, and I should also like to personally welcome you here and thank you for coming. The fact that we have over 700 people from around the world here, especially considering this is a four-day long technical symposium, in Detroit, in the Winter, is extraordinary, and I think it speaks very powerfully to the importance of this issue, and we're very pleased to sponsor this Symposium and to have you here.

Just a few quick housekeeping issues before I introduce our keynote speakers. First of all, would everyone please make sure that you wear your badges at all times. That is your ‘passport’ to all the events around the Symposium. The format for the next four days is plenary session, and all plenary session activities will occur in this room, the Hubbard Ballroom. We have some fairly long days ahead of us, and each day is basically structured so that there are about five or six technical presentations back to back, followed by a break and then we'll come back and have a “discussants comments and open discussion” period. If there’s not enough time at the end of the technical presentations to actually have questions and answers, we will allow question and answer periods in the discussion session, so if you could please hold your questions until then, if the Session Arrangers determine that that's necessary. At any time that you wish to address a question to either discussants or technical presenters, please use one of the microphones. There's one microphone in each of the three aisles there, and prior to actually addressing your question, please state your name and your affiliation.

There is a luncheon hosted by AAMA on the third day, on Wednesday afternoon. That luncheon will take place in the Great Lakes Center, which is out the door to your left here and then it's all the way past the hotel registration desk. Also today, Tuesday and on Thursday, a buffet luncheon will be available. The hotel has set up a quick buffet for folks to be able to get in and out, otherwise we can't possibly accommodate this many people for lunch, so that will be available. There are prepared menus of the kinds of items available by the Registration Desk, so please feel free to pick those up.

Lastly, I just want to say it would be a very good idea if you would take one of your business cards and place it inside the portfolio that we have handed out to you. I know many people like to take very copious notes, and then invariably, the portfolios get misplaced or lost, so if we find one laying around or it gets turned into the Registration Desk, we know who it belongs to.

And now I'd like to introduce our first keynote speaker. Linda Rosenstock is the Director of the National Institute for Occupational Safety and Health, and a Professor, in the Departments of Medicine and Environmental Health, at the University of Washington.

Dr. Rosenstock received her Bachelor in Arts in Psychology from Brandeis University and her MD and MPH from The Johns Hopkins University. Her advanced training was at the University of Washington, where she was Chief Resident in Primary Care Internal Medicine and a Robert Wood Johnson Clinical Scholar.

At the University of Washington, Dr. Rosenstock conducted research and published extensively on occupational diseases, including asbestos-related disease and effects of exposure to pesticides and other neurotoxins. She has written two occupational medicine textbooks and founded one of the first hospital and university based occupational medicine clinics in the country.

Before becoming NIOSH director, she chaired the United Auto Workers/General Motors Occupational Health Advisory Board and served as a member of the Brotherhood of Teamsters Medical Advisory Committee. She also served on several Institute of Medicine committees that brought national attention to the shortage of occupational medicine physicians and the inadequacy of occupational health training in medical schools.

Dr. Rosenstock has been active internationally in teaching and research in occupational health. She has served as an advisor to the World Health Organization, taught in many developing countries, and conducted pesticides health effects studies in Latin America. Please welcome Dr. Rosenstock.

Dr. LINDA ROSENSTOCK, NIOSH: Thank you and good morning. It's a pleasure to be here, and I must say it is somewhat surprising although maybe it shouldn't be, to see such a large audience for this topic. I'm pleased that someone had the opportunity ahead of me to read all of the co-sponsors because that was going to be taking up too much time of the talk, but the fact that there were this many co-sponsors for this Symposium I think really speaks to the intention of this meeting and its somewhat historic nature in terms of getting together so many interested parties at this point in our deliberations.

One of the things you may note is that the government is sort of on the brink of shutdown. Some of you may have thought the shutdown occurred earlier, but in fact as far as we know, we're still operating. I can't really fully blame it on this, but I have to acknowledge that we were advised that two sets of slides would be appropriate, given the large audience and I must apologize for the fact that I have brought only one set.

Well, since I am the speaker introducing the session this morning, I think I will start by saying what is obvious and why so many of us are here, which is that the issue of metalworking fluids is a significant problem. NIOSH estimated in its occupational exposure surveys, going back now over 15 years, that over a million workers were exposed. Whatever the actual number, it is certainly a large one, in many varied industries and more importantly we know that we are considering a very broad range of potential health effects associated with these exposures.

NIOSH, as I hope you'll be aware over the next four days, has been very involved in the issue of metalworking fluids. It was already mentioned earlier in the introduction that NIOSH actually convened a stakeholders meeting about one year ago, but that was based on our own work, as well as acknowledgment of the work of many others in this area. One of the ways that NIOSH continues to be involved in assessing the current and not just the historic impact of metalworking fluids is through our health hazard evaluations and for those of you who aren't aware of that program, that is an existing program that can be requested by several workers, by employers, by state and local health departments or equivalent agencies, or through technical assistance. In that way, NIOSH is able to go into the field and assess whether or not there are problems and whether or not those problems are due to work.

The main objective of health hazard evaluations is to make prevention recommendations. After all, that's one of the main goals of NIOSH overall, and in fact right now in Michigan, we do have an ongoing health hazard evaluation assessing whether or not a hypersensitivity type lung disease is, in fact, resulting from problems with exposures to metalworking fluids.

We also do more traditional epidemiologic research, or if we don't do it ourselves, fund that by others, and you'll certainly be hearing about much of that work over the next few days. NIOSH surveillance data are very useful, I think, in guiding us to understanding the extent of the problem and pinpointing where it may be, again, with the ultimate objective of prevention. In fact, one of our major surveillance programs, our sensor program or sentinel event notification program has, for example, in the State of Michigan, identified that the second-most common cause attributed by physicians for asthma, following isocyanates, is metalworking fluids. So again, by that kind of surveillance system, we're able to get a sense of where the problem may be, and we're also involved in both basic and applied laboratory research activity such as sampling methodology, both with existing methods, as well as developing new ones to better understand how to measure these exposures.

It's a pleasure to be on the podium today with Joe Dear and take advantage of that to identify some of the ways that NIOSH and OSHA are, I think, increasingly and very successfully working together, and I think it is no accident that Joe and I have been on many panels in many cities around the country in the last year and a half.

One of the ways we do that is by exchanging liaison staff. Each agency then provides to the other a person committed to being the liaison, but perhaps even more important than those functions where we're able to share information and try to do planning together, is that NIOSH has been working specifically at the request of OSHA providing technical assistance, not just in the general way that we are authorized by law, but more specifically, by actually sitting on teams with OSHA employees trying to work to develop standards and to specifically provide the scientific basis and background for standards development.

We have also been working with OSHA through serving on a number of their Advisory Committees and I would like to take this opportunity to also highlight what I think is one of the most exciting activities that the two agencies have undertaken together, which is that at OSHA's lead, NIOSH has served as an integral partner to a priority planning process to identify major items for action. These are not merely items that are going to call for regulatory action, but items for action that are felt to be based on an actual observed need in the workplace for taking some action, whether it be additional research or regulations or other kinds of activities.

In that priority planning process which will soon be fully unveiled publicly, and I know many of you in this room or your associations have been integrally involved in this broad process that had ongoing stakeholder input from the very beginning, NIOSH has worked with OSHA in a number of ways. We have certainly worked to help identify stakeholders. We have also provided our databases to help identify the extent of exposures to these items, whether they be hazards or medical conditions and the like. We have worked to provide technical review for the initial list, and the final list of about 18 items. We provided technical assistance for reviewing the known health effects for all of these items or conditions. We worked and agreed jointly, Joe and I, in terms of approving the final list of recommendations, and we expect to play an ongoing important role because the concept of the priority planning process, which I'm sure Joe will mention as well, was to move forward from the list and then work with partners to develop action plans about what the next step should be. We are also using these items as part of our own new effort to develop a National Research Agenda in Occupational Safety and Health and I wanted to take a moment to just identify that to the audience.

I think it was clear to NIOSH from a series of partners meetings, that one of the roles that others look to NIOSH most commonly for was for us to take the lead in coordinating not just our own research agenda, but to help identify for the United States as a whole, what investigators should be looking at in our field. In order to do that then, we are now undertaking a very ambitious effort in terms of the time line, again using some of the techniques we learned from the OSHA process, of getting broad stakeholder input very early on and continue that dialogue throughout the process.

As a result of our developing with partners a National Research Agenda, it is our goal that we will not only identify what the existing research gaps are, but also be able to project into the future and into the next decade what the changing work force and economy will mean for us in terms of where we should be directing our research effort as we move into the next century. We intend to unveil the research agenda at the 25th anniversary of NIOSH, which will be at the end of April in 1996. That happens to be OSHA's anniversary as well.

Now I wanted to mention again regarding the concept of the priority planning list which was derived from items that were thought to already have sufficient information to demand some regulatory or other type of action, that we expect that priority planning list to have some overlap, but not complete overlap with the final 15 or 20 or 25 items that will go on NIOSH's National Research Agenda. In fact, we expect our research agenda to help guide ourselves and others to be looking at issues that may or may not prove to be significant, but are ones that we are concerned about. They're not merely the ones that we already understand to have exposures that entail health effects that warrant research.

As I mentioned in terms of the timetable, we are in the process now of working very closely with our partners in going through a process, and the process that we're going to be using might be called the Delphi Process. That merely says that you get groups of people who are experts and in some systematic way go through rounds or iterations of review of what you think should be on the list. One of the ways we started this process was to get a group of experts mostly from within NIOSH and a few from outside, to spend a day deliberating on what we thought the most likely items on the research agenda should be, and we use that in order to help give us guidance as we go out to other groups to get their feedback as well. We didn't expect the list we developed in October to be the final list, but we certainly hoped that as active investigators in the field, that we would at least be getting some of it right.

We will be working then through a number of partners groups going through a similar kind of Delphi Process in the next few months, working with a more ‘grass roots’ response in town meetings and several cities around the country, concluding with an all partners meeting in March before we present the final agenda.

Now I have gone through some detail in presenting this because on November 30th in Washington, D.C., assuming that the Government hasn't shut down, we will be having an all stakeholders meeting and I invite any of you who haven't gotten direct solicitation about this, and who is interested, to either attend or to present comments in writing and the 1-800-NIOSH number is one good way to get access to additional information about that agenda.

We're working with a number of Advisory Committees and I think it's very fitting, particularly given the topic and the sponsor of this Symposium, to identify NIOSH's very strong and ongoing work with General Motors and the United Auto Workers, in that General Motors is serving as the Chair of our Corporate Liaison Committee, and we have invited and hope we will get formal acceptance from the UAW to chair our Worker Liaison Committee. We also have a broader outreach committee that will be chaired by the National Safety Council, and we are using our other standing Advisory Boards for help in this endeavor.

Let me now turn more specifically to the issue at hand during this Symposium, but I did take some additional time talking about our research agenda because I would certainly expect that some of the issues being faced and considered during the next four days would still make it on our top list of items to be investigated in the future. As you know from the discussion at the partners meeting one year ago, NIOSH has been over several years now, working at trying to do a review on the issue of metalworking fluids and their health effects. A hazard review is underway. We are considering coming up with a recommended exposure level or a REL and I think it's important to identify some differences about how NIOSH is now proceeding at considering RELs, which is somewhat different than it has in the past.

In addition to using the health effects and exposure data which have always traditionally been part of our recommended exposure levels, NIOSH in the last year and a half has included issues of technologic feasibility as we consider what, assuming that the health effects warrant coming up with a REL, what that REL should be.

This is not meant to say that we will merely accept the status quo, but we feel that we have the expertise internally and that in order to be very real world based and practical considering that we can be technology-forcing as well, that it is important to be realistic about what conceivably can be done in the community and in the varied workplaces in order to achieve a REL. And the reason that I am raising this particular point is because I know we have sitting in this audience many representatives of the industry, as well as professional associations, as well as unions, to say that we have already put out a call for and I hope we will continue to get a good response. The better the information we have about use data in the workplace and exposure levels, the better informed we will be. If we proceed by using the information we get from this meeting to come up with a REL, we can make one that I think can be most useful for all of us.

Now since I've mentioned RELs, and since I know this is an issue of concern to some, as to what happens when NIOSH does decide to proceed down a pathway like this, I thought it would be useful for the audience to just go through a very brief and I think simplistic overview, but one that I think captures some highlights of the differences between OSHA and NIOSH when we decide to consider standards.

The first important thing, of course, is that NIOSH RELs are voluntary and that probably is the most critical difference, but on the other hand, we do have a statutory responsibility to OSHA to come up with recommended exposure levels and to consider all levels, including the level at which no worker shall suffer. Traditionally, NIOSH often stopped and only came up with a REL that was based on a level at which no worker shall suffer, and I have already described to you how we have moved beyond that somewhat, in terms of looking at other issues including practicality and technological feasibility.

Now OSHA, and it's hard to stand here next to Joe and I hope he will correct me if I truly oversimplified the issues that OSHA faces, because OSHA faces many other issues, but I think a critical difference to point out is that OSHA has to consider economic feasibility. This is not in our statutory mandate and I think that is appropriate considering the fact we are a research institute. We are really concerned with the health effects and trying to assess those, not with the cost of interventions. In addition, we know through precedent, that OSHA needs to consider critical levels of those at risk, usually at the level of one in one-thousand and we would hope to provide technical assistance to OSHA to describe levels embracing that, but perhaps other levels of risk as well, so we do undertake formal risk assessment. We do it qualitatively if the information and data aren't sufficient to do it quantitatively and wherever possible, we do quantitative risk assessment.

We have released as of three days ago, a new REL for coal mine dust exposure, not an exposure of interest to most of you, but this document actually reflects this new policy, and does call for a lowering by half of the current exposure level, by including consideration of technologic feasibility. If we had looked at health effects alone and zero based setting or the level at which no worker should suffer, we would have gone down considerably lower, but it was our feeling based on our technical experience and expertise, that had we gone much lower, the industry would have been incapable, now or in the near future, of being able to respond to that.

In order to make our effort successful as we continue in finalizing our decision-making and our considering options of RELs as well as no RELs based on the data, and this meeting is a critical juncture for us in that decision-making, I hope for you to appreciate that we will do the best in our work if we continue to build on strong partnerships. I think it's very fitting that the NIOSH-GM-UAW partnership is one that I hope, all three agencies or associations are proud of in the sense that now about six months ago we signed a memorandum of understanding to undertake broad research activities with this tripartite arrangement, not just conducting research in the traditional sense, but also looking at new technologies, looking at doing intervention research to see whether interventions in the workplace would have their intended effect, as well as being involved in training and education.

One of the four main priority items that we are working together in this tripartite arrangement on is metalworking fluids. It's obviously been recognized by all of these parties that this is a critical area, given the extent of exposure and the potential extent of the many health outcomes, and my own personal experience on the Occupational Health Advisory Board with GM and UAW certainly helps set the way for this partnership, but it has also sensitized me to the very significant issues of metalworking fluids.

So in closing, I have tried to identify in somewhat of a personal way, but also in terms of where NIOSH stands now, why we think this Symposium is so critical and important. I think it was an extraordinary effort from the sponsors to have worked as hard as they have to bring so many people together here. We will certainly be looking at the usual scientific issues of reviewing existing data and identifying gaps, and I hope it's clear to you from my point of view as the Director of NIOSH and I expect for OSHA as well, that we will find this a very critical meeting, as we need to make decisions at this time about what we do next, given our current state of knowledge. Thank you.

Mr. DAVID FELINSKI, AAMA: Thank you Dr. Rosenstock. Our next keynote speaker is Mr. Joseph A. Dear, who was confirmed as Assistant Secretary of Labor for Occupational Safety and Health by the United States Senate November 8, 1993. He has a reputation as an innovative leader in public safety and health programs. Prior to his nomination to be assistant secretary, Mr. Dear was the Director of the Department of Labor and Industries in the State of Washington, where he was responsible for both workplace safety and health, and workers' compensation programs.

With the help of labor and management, Mr. Dear spearheaded a major reform of the workers' compensation program, converting a $225 million deficit into a $350 million surplus while stabilizing premiums for employers and improving benefits to workers at the same time. He also started health care cost containment and quality assurance programs. In 1992 the department's workers' compensation program received the '*Innovations in State and Local Government'* Award from the Ford Foundation and Harvard University.

In nominating Mr. Dear as assistant secretary, President Clinton said that "with his experience running a major state agency regulating workplace safety and related matters, Joseph Dear is an outstanding choice for this important position. Secretary of Labor Robert B. Reich, in praising the appointment, said "Joseph Dear is well grounded in workplace safety and health concerns and has shown himself to be an innovative administrator. He will bring strong, creative leadership to an agency fundamental in developing safe, healthy, high-performance workplaces."

Mr. Dear served as director of Washington's Department of Labor and Industries from July 1987 until early in 1993. He was appointed to the post by Governor Booth Gardner after having served as deputy director from January 1985 until July 1987. Mr. Dear was president of the National Association of Governmental Labor Officials in 1990-91 and served on the board of directors for the occupational Safety and Health State Plan Association from 1989-1993. As director of the state Department of Labor and Industries, he served as state designee for Washington State's Occupational Safety and Health Program. While serving as director of the Department of Labor and Industries, Mr. Dear also served as chairman of the State of Washington Investment Board which manages public pension portfolios and workers' compensation funds totaling more than $19 billion dollars. Before joining the state government, Mr. Dear was research director of the Washington State Labor Council from 1981-85. He was the founder of People for Fair Taxes, a public interest coalition of labor, church and civic organizations supporting progressive state and local tax policy, and served as the organization's executive director from 1977-81.

Mr. Dear graduated from The Evergreen State college in Olympia in 1976, with a bachelor of arts degree in political economy. He is a 1986 graduate of Harvard University's program for Senior Executives in State and Local Government, offered through the John F. Kennedy School of Government.

Please join me in welcoming Joe Dear.

Mr. JOSEPH DEAR, OSHA: Thank you very much, David. Good morning Ladies and Gentlemen. It's a pleasure to be here the day before we shut down our operations and all of us Government types turn into pumpkins or something. Quite an extraordinary period of time;

"how to operate a Government Agency without a budget." Maybe we'll get it worked out shortly.

In preparing my remarks for this speech today, I had a rather basic decision to make. Should I speak to you as a specialist or should I speak to you as a generalist. As a specialist, I'd be getting up talking about sampling, evaluation control methods, technical feasibility and achievability of reducing exposures to half a milligram per cubic meter of time weighted average for oil mist. Or I could take the generalist approach and discuss how OSHA standards and OSHA programs can benefit workers, employers, manufacturers, suppliers and governmental agencies.

Well, my first inclination was to actually take the specialist approach, until Hank Lick told me that his definition of a specialist is someone who knows more and more about less and less until they know practically everything about nothing. I thought, well OSHA has enough of a perception problem already, maybe I should try the generalist approach. Hank then told me that the definition of a generalist is a person who knows less and less about more and more, until they know almost nothing about everything. So being the cautious bureaucrat I am, I said well maybe I'll take the middle course between those two, so I guess my purpose this morning is to show to you that I know nothing about anything.

Really, it's a pleasure for me to be here today. My one wish is, for those decision makers in Washington, DC who believe that workplace safety and health is an issue that must resolve itself through adversarial confrontation between government, management and labor, that they could see this meeting, where a large group of professionals have voluntarily come together to examine a problem that is presented to millions of workers and decide what is the best course of action for dealing with that problem. This is the real work of occupational safety and health in this country and it's a real pleasure and honor to be here, and I commend the organizers of this Symposium.

The sponsorship is impressively broad and we're all brought together here in a desire to fully explore a safety and health problem in America, the health effects of metalworking fluids on workers in industries that employ these fluids. This is exactly what we and OSHA want to see more of. Partnerships between labor, government and management that are focused on resolving problems by identifying them, defining interventions and cooperatively going about their resolution so that we can reduce the toll of injury, illness and death in America's workplaces.

Let me express my special appreciation for Dr. Linda Rosenstock and her staff at NIOSH. In her presentation she has illustrated how OSHA and NIOSH are working together more than ever before to cooperate, to bring NIOSH's scientific and technical capabilities to bear on problems of health and safety in the workplace and to allow OSHA to develop practical programs to implement based on those insights.

I also know that the United Automobile Workers and the American Automobile Manufacturers Association have been cooperating on metalworking fluids for some time, and we are grateful to Frank Mirer of the UAW and Hank Lick of the Ford Motor Company, also Chairman of the AAMA Occupational Safety & Health Committee, and a member of OSHA's National Advisory Committee on Occupational Safety & Health, for the leadership that they have displayed on this issue in helping bring this Symposium to fruition.

During the past ten years, the union and the auto industry have sponsored a great deal of research with funds supplied from collective bargaining agreements. It's been a fine example of union-management cooperation on an important health and safety issue and the research that will be produced by this Symposium will be very helpful to OSHA and to NIOSH as we decide what course to pursue in the future.

As was mentioned earlier, the UAW petitioned OSHA in 1993 for an emergency temporary standard on metalworking fluids that would include a reduction, a significant reduction, to the permissible exposure limit for oil mist. OSHA denied that request for the emergency standard, but indicated a commitment to continue to consider a permanent standard. Again, this Symposium is going to be very helpful in deciding how to move forward. OSHA's former Director of Policy, Mike Silverstein, who is here, was OSHA's leader in exploring the priority planning process that Linda Rosenstock described to you. How can we devise a set of criteria that will help tell us where we should be working with respect to the development of standards or other interventions to protect worker health and safety. As Linda indicated, we will be announcing the results of this prioritization program, the OSHA Action List, next month and we have had a wide involvement of interested organizations in the development of this approach.

We have used a number of criteria to develop this list and I want to share those criteria with you. First, we want to consider the seriousness of the hazard. Second, we want to consider the number of workers potentially exposed to the hazard. Third, we want to consider the quality of the available risk information, and fourth, we want to consider the potential for risk reduction. These major criteria are supplemented by three others, particularly for the consideration of whether rule-making is appropriate for the hazard in question. These additional three criteria are the administrative efficiency and feasibility of the proposed action, the legal feasibility of that action, and other public policy considerations such as the intensity of public concern about the hazard and the public perception of the hazard.

Metalworking fluids is one of the areas being considered for designation as a priority. If this problem is designated as a priority, we will then decide whether we should make it the subject of a rule-making procedure, or use some other approach to deal with the hazard. Again, this Symposium is especially timely in helping us work towards that decision.

Now I referred earlier to a new OSHA and I want to try to present this partnership that brings us together on metalworking fluids in a larger context. OSHA has an enormous and extremely important mission: To see that the right to a healthy and a safe workplace is preserved for some 93 million working men and women in our country. These men and women work at over six million establishments around the country. To accomplish that mission, OSHA has a rather limited budget. It's about 312 million dollars, probably shrinking as I speak, and about 2,300 people that I work with at OSHA at the federal level, and we have partners in 25 states and territories who operate state plans. If you count up all the people who are responsible for inspecting workplaces for compliance with health and safety regulations, you will find there are about 2,100 workplace inspectors in the United States for six million workplaces. Enforcement is really important. Compliance with standards is really important. But we need to ask the question of OSHA - “are there better ways of accomplishing our mission?” We have come to call that search for a better way at OSHA the reinvention of our program.

Last May President Clinton, Vice President Gore and Secretary of Labor Robert Reich, spelled out a program called “Reinventing Worker Health and Safety, the new OSHA.” We conducted this at a workplace in Washington, DC, I mean a real workplace, a sheet metal shop. We actually found a real workplace 20 minutes from the White House. It took a lot of work, but we found one. I guess it's the only one in northwest Washington. At any rate, the President, the Vice President, and the Secretary of Labor, all got up and talked about the importance of worker health and safety, the contribution that OSHA has made in its 25-year history to protecting worker health and safety, not the least of which is a reduction in the rate of fatal occupational injuries in our country by half in that 25-year period and they talked about the importance of finding a new direction.

There are three strategies to this new OSHA that the President announced. The first is giving employers a choice between a partnership or a traditional enforcement relationship. The second part of the strategy is to bring common sense to the development and enforcement of workplace health and safety standards. And third, let's get OSHA focused on results, not red tape. Let me just take a moment to describe how we are now, and are going to in future carry out these three strategies.

In the area of partnership versus traditional enforcement; in the State of Maine in 1993, we began a program called The Maine 200. The 200 were the companies in Maine that had the largest number of Workers' Compensation claims. We wrote them a letter. We said you're on our list, we're going to arrange for a compliance inspection, however, if you choose to develop a health and safety program, we'll put you on a lower priority list for inspection. Well, not surprisingly, all but two of those 200 companies said they would write a plan, but what did they do as a result of that? Upon analysis, we believe that those employers found 14 times more hazards through self-inspection as a result of the Maine 200 Initiative, than OSHA could have found if we had employed our traditional strategy of physically inspecting workplaces for hazards. We monitored almost all of those participating companies. Most of them have done exactly what they said. If you didn't, and one did nothing, they got a huge penalty as a consequence, but we got far more health and safety protection for the worker by leveraging our program than we could have through our traditional strategies.

The Maine Program was recently recognized by the Ford Foundation and Harvard University as an Innovations in Government Award winner and has received a $100,000 grant to help us replicate this program across the United States. But to have willing partners, there has to be an alternative which is less attractive, and that is enforcement. For some employers who have chosen the ‘low road,’ an OSHA compliance inspection is the one way to assure that their worker’s right to a healthy and safe workplace is preserved.

In 1995, OSHA conducted inspections that resulted in 17 egregious, willful penalty cases. That is our worst category of penalty. It was more than double the number in 1994, and in 1995 we increased the number of high penalty cases, cases in excess of $100,000 by 79 percent. So we're trying to do both. If we can have a partnership, that's great. But if enforcement is what it takes, then we'll do that as well. It's a balanced approach, but we obviously believe that we're going to get a much greater multiplication of resources if we can build more partnerships.

The second area of our work: Common sense in developing regulations and enforcing them. Linda in her presentation talked about partnerships, talked about negotiated rule-making in steel erection, about inviting industry and labor in early as we consider how to develop regulations and we're doing that. The potential of this Symposium is also to help move us further down the road towards a cooperative approach to dealing with the problems imposed by metalworking fluids. I see this as the future for standard development in OSHA.

On the enforcement side, common sense can have some interesting implications. Consider OSHA penalties for poster violations. All employers are required to post a notice informing workers of their right to a safe and healthy workplace and of their right to call the government if they believe that that right is not being met. It's a very fundamental bit of information. It's extremely important. We have, in the past, considered it so important that it required a penalty to be assessed for failing to put the poster up. Now you wonder how OSHA got a reputation as a ‘nit-picky’ enforcer who wasn't always concerned about the serious threats to worker health and safety? Well, consider this: In 1990, we cited employers 5,000 times for not having that poster and penalties were increased sevenfold in 1991, so that meant by 1991 we had an average initially assessed penalty of $400 for each poster violation. In my first year at OSHA, we cited employers 3,400 times at $400 a crack. The old OSHA: No poster, here's your citation. The new common sense OSHA: No poster, here's a poster, please put it up. That's the way we have done it.

In the last quarter of fiscal 1995 which ended in September, there were two citations for failing to have a poster and they were both repeat violations. We will be serious about serious threats to worker health and safety and there will be serious consequences for serious violations, but we're going to talk about the things that really make a difference for worker health and safety.

The last area of OSHA's reinvention is about getting results, not red tape. We're just taking a page from the best managed American businesses here. We're looking at our processes, we're trying to introduce quality management principles, we're asking our front line workers what's in their way, how can we help them get their job done, how can we build partnerships around the country and how can we measure our performance in terms of impact on reduction of injury and illness, not by counting things like inspections and violations and penalty dollars collected, which were measures of activity that we represented as measures of impact. I think there is a great future with this "reinvented OSHA." But there are a few obstacles in the way. One is called the United States Congress. Congress is considering so-called regulatory reform that could tie up regulations forever. We would never see a new health and safety protection standard adopted. So-called 'OSHA Reform,' which purports to be a moderate change in the law, but would gut enforcement by eliminating the ability to enforce the general duty clause, by allowing employers who violate health and safety standards to get by with no penalty, regardless of the consequence, unless there's a death or serious injury associated with it. It would require workers in every case to report to the employer first before OSHA could intervene, to assure that health and safety standards were being adhered to that would decimate OSHA's enforcement program. All in all, it is a bill that would set back the 25 years of progress that we made in this country.

I hope that voices like those of the National Safety Council who have established a set of guiding principles for OSHA reform will be heard before the Congress acts and that if there are to be changes in the law, they are ones that make sense that protect workers and allow us to build on the experience we have gained in 25 years in improving the health and safety program.

The last area that OSHA faces a threat in is where I started, our budget. It's mid-November, and we don't have a budget. We're on a continuing resolution that expires tonight. The President has today, vetoed the continuing resolution that Congress proposed for another two weeks of funding, and it looks like we will be shut down tomorrow and limit our operations only to responding to complaints of imminent danger and the investigation of fatal accidents, and all other operations will stop until Congress continues short term funding and then ultimately, I hope, adopts a budget for the fiscal year.

I want to build partnerships. I want to see workers in this country protected. I want to see them be able to come home at the end of the day to their families the same way they left. I think that's what the American people want. They want government, labor and industry to work together. There's no issue which has as large a potential for common ground as workplace safety and health, but as we build partnerships, we're counting on you to talk to Congress and tell them that if there is no enforcement program, if there is no research budget, there can be no partnerships to improve worker health and safety.

We're here to work with you. I hope you're here to work with us and that together we can make a difference in reducing the terrible human and economic toll of preventable injury / illness in this country. I commend the Symposium sponsor for organizing this opportunity, and we at OSHA look forward to working with you in the days ahead.

Thank you very much.

Mr. DAVID FELINSKI, AAMA: Thank you Mr. Dear.

Our first paper will be presented by Dr. John Howell of Castrol Industrial North America, and who is here representing the Independent Lubricant Manufacturers Association. Dr. Howell will be speaking on the Composition and Use of Metalworking Fluids. Dr. Howell.

Metalworking Fluids: Composition and Use

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ABSTRACT

Metal removal fluids, used to cool and lubricate the tool and workpiece being machined or ground, are complex mixtures. Depending on the fluid type, *straight oil, soluble oil, semi-synthetic,* or *synthetic*, the composition of the fluid will vary depending on the application for which it is intended. Each type has advantages and disadvantages. As new health effects questions about fluid components are raised, manufacturers have reformulated their products to address these concerns about operator health and safety, consistent with then-available toxicological information. Petroleum oils, nitrites, chlorinated paraffins, and alkanolamines are examples of issues that have been raised over the last twenty years. Water-miscible metal removal fluids in particular change during use as specific components increase or decrease, other contaminants increase, and as microbial action occurs. Dermal contact and inhalation are the two primary routes of exposure to metal removal fluids. Inhalation exposures have been recently documented and observed short term health effects suggest lowered exposure standards are appropriate.

INTRODUCTION

Metalworking fluids have been used for almost 100 years to aid the process of metal cutting.[1] Over the years, as demands for higher productivity, quality, and worker health and safety have increased, metalworking fluid technology has changed to meet these changing requirements. In the following paragraphs, we will understand why metalworking fluids are used, what they consist of, how fluid formulations have changed over the years, how fluids themselves change as they are used, and what routes of exposure are most commonly encountered.

WHY USE METALWORKING FLUIDS?

Metalworking fluids include a broad range of products designed for many specific applications. The Independent Lubricant Manufacturers Association (ILMA) recently[2] developed several matrices which show the interrelationships among these several types of fluids and how they are used. As shown in Figure 1, metalworking fluids include the category known as metal *removal* fluids. Other types of metalworking fluids include those used for metal *forming,* metal *protecting,* and metal *treating.* In this discussion, we will focus on that category known as metal *removal* fluids, which include those products designed for machining or grinding. Figure 2 shows the relationship of *machining* to other processes and operations common to producing finished parts such as an automotive engine or transmission. Figure 3 describes the many types of *industrial lubricants* used in and around *machine tools*, the actual machines which do the machining or grinding. It is important to note that the types of industrial lubricants described in Figure 3 often leak into machining or grinding fluids, contaminating them in the process. Figure 4 describes the several types of *in-process cleaners* used. As shown in Figure 2, cleaning and surface preparation is included as a common metalworking process and there are often many intermediate cleaning steps in a component manufacturing process. Each one provides an opportunity to further contaminate the metal removal fluid in the next operation.

Metal removal fluids have two primary functions: to *cool* and to *lubricate*. The metal cutting process - whether it be machining or grinding - develops a tremendous amount of heat which must be dissipated if proper part geometry and desired finish is to be achieved. Additionally, the cooling effect provided by a metal removal fluid extends cutting tool or wheel life and prevents burning and smoking.

Lubrication - at the tool-part interface - is the second primary function of a metal removal fluid. Lubrication may be either *physical, boundary,* or *chemical*. Physical lubrication is provided by a thin film of lubricating component, such as a severely solvent refined or hydrotreated mineral oil or an inverse soluble nonionic surfactant above its cloud point. Boundary lubrication occurs when a specially included component, for example a polar material such as a naturally occurring vegetable fat or ester attaches itself to the surface of the metallic part being machined, such as an aluminum casting. Chemical lubrication occurs when a component of the machining or grinding fluid, such as sulfur, reacts with the metallic component being machined, resulting in improved tool life, better finishes, or both.

Besides the primary functions of cooling and lubricating, metal removal fluids have a number of secondary functions. Among these are to provide corrosion protection for the part and machine, assist in the removal of chips or swarf from the machining or grinding process, lubricating the machine tool itself, rancidity control, and, when the fluid has reached the end of its economic service life, ease of disposal. For example, almost all machine tools include at least some amount of steel or brass which could rust or corrode. For that reason, components are included in water-miscible metal removal fluid formulations which retard or prevent such corrosion. Additionally, every metal removal operation involves formation of at least some swarf or metal chip. Metal removal fluids - and the circulating systems which carry the fluid within the machine tool or from machine tool to a central filter - are designed to carry that swarf or chip to a filtration device that will remove most, if not all, of those contaminants prior to the fluid being recirculated back to the machine tool.

Despite being designed for long life and despite the care normally given to fluids by users to maintain them, metal removal fluids do not always perform as intended. The causes are many but any list would include rust or corrosion of the machine tool or of the part produced, rancidity due to failure to control bacteria in water-miscible formulations, growths of fungus which impede or block fluid flow, failure at the workpiece tool interface (for example, burning of the part due to excessive heat build-up), foam, and dermatitis. Understanding how fluids are formulated, what components tend to increase in concentration with use, what components tend to deplete with use, what contaminants enter into the system and accumulate, and how microbial action can affect the performance and longevity of a fluid are all essential to understanding why fluids fail.

COMPOSITION

ILMA recently compiled a list of components which are commonly used in metal removal fluid compositions.[(3)] Metal removal fluids are commonly identified as one of four types: *straight oils* or *neat oils*; *soluble oils; semisynthetics;* and *synthetics.* Foltz[(4)] defined these four types of fluids in a recent publication. Straight oils are metal removal fluids which typically consist of a severely solvent refined petroleum oil, a severely hydrotreated petroleum oil, or other oil of animal, marine, vegetable or synthetic origin used singly or in combination, or with other additives. These products are not designed to be diluted with water before use. Historically, the oldest class of engineered metal removal products, straight oils provide excellent lubricity, good rust control, and long sump life. Depending on the intended application, straight oils may have:

- "oiliness agents" such as the vegetable oils identified above or polyol esters
- extreme pressure additives such as sulfurized fatty materials or chlorinated paraffins
- antioxidants, such as an alkylated phenol

- a metal passivator, such as a triazole
- other corrosion inhibitors, such as a calcium sulfonate
- an antimist agent, such as a polymethacrylate polymer
- dispersants
- odorants
- a dye.

Some lower viscosity straight oil products, such as those designed for an application such as honing, will use middle distillate petroleum fractions, rather than the more viscous vacuum distilled fractions.

In 1984, the International Agency for Research on Cancer ("IARC") reviewed lubricant base oils and products derived from them.(5) IARC noted in their review that "the processes used to produce lubricant base oils and, correspondingly, product formulation have changed considerably over the years. Until about 1940, processing consisted of acid refining with clay finishing and subsequent dewaxing by chilling. Solvent refining (and solvent dewaxing) was first introduced into the USA and in Europe in the 1930s. Hydrotreating, as a newer, more severe process than 'hydrofinishing' was introduced in the 1960s. The trend has been to more highly refined oils with associated removal of impurities including polynuclear aromatic compounds." In the USA, the advent of implementation of the Hazard Communication Standard in 1985, required chemical producers to label products and amend material safety data sheets (MSDS) if they were determined to be carcinogenic or if they contained more than 0.1% of an identified carcinogen; to the extent that any oil that was not highly refined had been used prior to 1985, such use was discontinued by manufacturers at that time.

Soluble oil (or emulsifiable oil) is a combination of between 30-85% severely refined lubricant base oil and emulsifiers and which may include other performance additives. Such products are supplied as concentrates which are diluted with water at ratios of one part concentrate to five to forty parts water. In addition to the base oil, soluble oils can contain:

- oiliness agents, such as an ester
- extreme pressure additives, such as a chlorinated olefin or ester or sulfurized fatty material
- emulsifiers, very typically including a sodium petroleum sulfonate, salts of fatty acids, and/or nonionic surfactants
- alkanolamines to provide "reserve alkalinity"
- a biocide, such as a triazine or oxazolidene
- a "coupler," such as a fatty alcohol
- a defoamer, such as a long chain organic fatty alcohol or salt
- possibly, corrosion inhibitors, antioxidants, dyes, and/or metal passivators, such as may be found in straight oils as previously described.

"Reserve alkalinity" is a term used to describe alkaline materials present in a composition that are available to react with, for example, short chain organic acids produced by bacteria.

Soluble oils as a class provide good lubrication as well as improved (as compared to straight oils) cooling. On the other hand, soluble oils sometimes have poor corrosion control, are sometimes "dirty" (i.e., machine tool surfaces and adjacent areas become covered with oil or difficult-to-remove product residues), may smoke (because of insufficient ability to cool), and may have poor mix stability or short sump life. Distinction needs to be made between "commodity" soluble oils, containing few if any performance enhancing additives, and "premium" soluble oils, which offer the user higher performance and extended fluid life.

A *semisynthetic* metal removal fluid contains a lower amount of severely refined base oil, for example, 5-30% in the concentrate. These products also contain a higher proportion of emulsifiers as well as 30-50% water, resulting in a transparent concentrate, and are typically transparent or translucent when they are diluted with ten to forty parts water. Perhaps the most complex of metal removal fluid formulations, semisynthetics offer good lubrication, good heat reduction, good rust control, and have longer sump life and are cleaner than soluble oils. Conversely, this class of products have a greater tendency to foam in softer water and can be unstable in hard water. Comprised of many of the same ingredients as soluble oils, semisynthetics will contain a more complex emulsifier package, often including fatty amides, additional corrosion inhibitors such as an amine salt of boric acid, and sometimes a chelator, such as a salt of ethylenediamine tetraacetic acid (EDTA).

Straight oils, soluble oils, and semisynthetics may contain chlorinated paraffins as extreme pressure (EP) lubricants. These are typically made by chlorination of various straight chain hydrocarbon C_{10}-C_{50} feedstocks, most commonly paraffins or olefins. Chlorine contents range from thirty to seventy percent of the molecular weight.

Two chlorinated paraffins (C_{23}, 43% chlorine; C_{12}, 60% chlorine) were evaluated by the National Toxicology Program ("NTP") in two-year gavage studies.[6,7] Under the conditions of the studies, NTP found clear evidence of carcinogenicity for male mice and equivocal evidence of carcinogenicity for female mice and rats for the longer chain material and clear evidence of carcinogenicity of the shorter chain material for both sexes of both species. NTP included the shorter chain material in their *Fifth Annual Report on Carcinogens.*[8]

More recently, EPA made all polychlorinated alkanes with chain lengths of C_{10}-C_{13} and chlorine content of forty to seventy percent subject to the reporting requirements[9] of the Toxic Release Inventory (TRI) because of aquatic toxicity concerns.

Fluid manufacturers have replaced the chlorinated paraffins with other performance additives not subject to labeling or reporting requirements to the extent possible. When this is not possible, the appropriate information is included on the MSDS.

Synthetic metal removal formulations do not contain any petroleum oil. Among the four classes of fluids, they are the cleanest, offer the best heat reduction, have excellent rust control and long sump life, are transparent (allowing the operator to see his or her work), and are largely unaffected by hard water. On the other hand, synthetics offer poor physical lubrication, can be more difficult to waste-treat, and can foam in some applications. Like the other classes of water-miscible fluids, synthetics are designed to be diluted with water, from ten to forty parts per part of fluid concentrate. Besides water, synthetics can contain ethylene oxide - propylene oxide polymers, amides, and/or organic esters as lubricants, amine salts of mono- and dicarboxylic and boric acids as corrosion inhibitors; alkanolamines to provide reserve alkalinity; a plasticizer, such as a glycol ether, and, as in other classes of water-miscible fluids, chelators, defoamers, odorants, biocides, and or dyes can be optionally included.

Virtually all synthetics and semisynthetics, as well as many soluble oils contain alkanolamines. These materials - which typically include both ethanolamines and isopropanolamines - are present to provide reserve alkalinity as well as being present as the alkaline portion of carboxylic acid and boric acid salts included to provide corrosion protection. Each of the three ethanolamines, monoethanoloamine, diethanol-amine (DEA), and triethanolamine (TEA) are or have been used in metal removal fluid formulations, depending on the application and other requirements. Both TEA and DEA have been or are being evaluated by NTP in shorter ninety-day and in longer two-year studies. Prior to 1985, and particularly prior to 1976, water-miscible metal removal formulations often included sodium nitrite as a corrosion inhibitor. Nitrite - even under alkaline conditions - was determined to have the potential to react with secondary amines to form N-nitrosamines, many of which are identified animal carcinogens.[8] Despite the fact that formulators no longer included sodium nitrite in formulations, beginning as early as 1977 and no later than 1985, evidence of contamination of fluid concentrates with N-Nitrosodiethanolamine (NDELA) was reported as late as 1990,[10] with mean NDELA concentrations of 0.07 ppm for soluble oil-, 1.5 ppm for semisynthetic-, and 11.4 ppm for synthetic fluid concentrates reported. Since that time, concern over liver and kidney target organ effects in animals has caused use of diethanolamine in metal removal formulations to decline;[11] since it has been shown that the amount of NDELA formed is related to the amount of DEA present,[12] it is likely that contamination of fluids with NDELA has decreased even further. Nonetheless, it may be that carry-over of nitrite-containing in-process cleaners into a metal removal fluid containing a secondary alkanolamine may be responsible for the small amount of NDELA observed. In May, 1993, the U.S. Environmental Protection Agency issued a *Significant New Use Rule* for alkali metal nitrites intended for use in metal removal fluids.[13]

Most water miscible metal removal fluids contain a biocide to provide protection from microbial degradation. Perhaps the most commonly used biocide is "triazine," hexahydro-1,3,5-tris(2 hydroxyethyl)-*s*-triazine. A member of the so-called class of biocides known as formaldehyde-release-agents, triazine used in metal removal fluid operations was the subject of an industrial hygiene survey in 1993 that sought to quantify release of formaldehyde. The results indicated that background levels at a number of facilities and uncertainty in the measurement process allowed for the possibility that results of both area and personal monitoring for formaldehyde may at times exceed 0.1 ppm as a time-weighted average, but that this exposure could not be attributed to the use of triazine.[14] No workplace values exceeded the 0.5 ppm "action level," set in the Formaldehyde Standard.[15] Formaldehyde, under the Standard, has a Permissible Exposure Level of 0.75 ppm.

HOW METAL REMOVAL FLUIDS CHANGE AS THEY ARE USED

Metal removal fluids, particularly water-miscible metal removal fluids, as used in the shop, are not static systems; indeed, they are very dynamic systems. This is due in large part both to the environment they are in and how they are used. And, because the characteristics of individual central systems vary widely, even the same product may have a different "composition" after one or more years use in one central system versus another. Why is this the case? It is largely due to two reasons: 1) increases of some and decreases of other components of the fluid over time; and, 2) addition of and effect from contaminants that arise from a variety of sources. While much of the information is considered to be proprietary by the manufacturers of metal removal fluids, it is generally understood that alkanolamines will tend to increase in concentration in a system over time, relative to other components. Additionally, because of the constant addition of water to circulating systems, increases in concentrations of metal salts is also likely to occur. Such salts, particularly in hard water areas, tend to destabilize semisynthetic and soluble oil fluids as they are used. On the other hand, some components, most notably corrosion inhibitors (particularly organic acid salts) and biocides decrease over time since they are depleted during use; most times, addition of the product concentrate on a routine basis (based on a regular program of chemical testing and analysis) will keep fluid components in balance. Sometimes, however, supplementary additions of these specific components are required to keep fluid performance at the desired level.

In addition to changes in component concentration, other contaminants can have deleterious effects. As noted above, industrial lubricants find their way into circulating metal removal fluid systems. So-called "tramp oil," whether it be from leaking hydraulic or spindle oils or slideway or gear lubricants, add to the complexity of the situation by contaminating the fluid with components that are emulsifiable or miscible with the metal removal fluid, but yet are not part of the fluid as it was formulated or first used. Poorly maintained machine tools can leak a significant amount of hydraulic oil, for example, adding far more oil than might be otherwise provided through addition of make-up metal removal fluid.

Virtually all water-miscible metal removal fluids become contaminated with bacteria,[16,17] sometimes through disposal of materials such as food waste in the fluid itself. Aside from degrading components of the fluid, most notably fatty acids, contamination of fluids with high levels of bacteria may increase the risk from opportunistic pathogens;[18] more recently, endotoxins have been identified as a potential risk from exposure to metal removal fluids.[19] Fungal contamination appears to occur less frequently than bacterial contamination.

Depending on the machining process and the type of metal or alloy machined, contamination of the metal removal fluid by both particulate and dissolved metals occurs. Several metallic contaminants, for example, nickel and cobalt, can have potentially deleterious health effects.[20] Particulate contaminants, usually the result of poorly functioning or absent filtration systems, increase the risk of dermatitis. A recent study[21] identified build-up of alumina in the fluid as a contaminant in the machining of automotive aluminum alloys. A recently published ASTM document suggests guidelines for safe use of water-miscible metal removal fluids.[22]

Straight oils are less affected by component depletion or by contamination. On the other hand, there has been concern expressed about potential increase in polycyclic aromatic compounds (PAC) as a straight oil is used. Evans, *et al.*[23] studied a 91,000 liter straight oil system and found that PACs increased with time for three years, then stabilized. Despite the increase, there was no evidence of carcinogenic potential demonstrated over the 249 week life of the study. Additionally, Mckee, *et al*.[24] evaluated the epidermal carcinogenic potential of cutting fluids formulated with solvent extracted paraffinic and napthenic base oils and found no evidence for dermal carcinogenicity even after simulated industrial usage.

ROUTES OF EXPOSURE

Dermal contact and inhalation are the two most common routes of exposure to metal removal fluids. Although automated part handling on large transfer lines and machining centers has reduced the opportunity for dermal exposure of a machinist to the fluid, there are still many older machine tools that require parts to be manually loaded and unloaded resulting in a machinist with his or her forearms and hands more or less continuously wet with fluid. Dermatitis is the most commonly reported medical situation involving metal removal fluids.[25,26] It has been estimated[25] at various times that between 0.3 and 1 % of machinists have either contact dermatitis or allergic contact dermatitis. Under normal conditions, exposure to fluids does not in itself cause dermatitis. The underlying route cause of skin problems usually involves one or more of the following:

- rich concentrations
- filter malfunction
- abrasive soaps
- poor personal hygiene
- use of solvents
- dirty shop rags
- off job activities
- seasonal conditions
- contamination of the fluid by dissolved metals, abrasive particulates, or alkaline materials.

In most cases, dermatitis situations are managed through a combination of efforts by the fluid manufacturer, user, and medical personnel.

Exposure through inhalation is the second most common route of exposure and one that can be reduced through engineering controls and practices. Several recent studies have given an indication of exposures. For example, in an automotive transmission facility, Kennedy, *et al.*[27] determined total aerosol exposures to be between 0.16 and 2.03 mg/m^3 for machine operators, determined the fractions above, between, and below 9.8 and 3.5 m and noted that exposure levels were very similar across different machining fluid types. Chan, *et al.*[28] determined area total and respirable particulate concentrations in an automotive transmission facility and found total particulate concentrations of between 0.71 and 2.99 mg/m^3, with differences noted between fluid types. Woskie, *et al.*[29,30] found an average total particulate exposure of 0.7 mg/m^3 and used statistical analysis to investigate the factors which contribute most significantly to the variability in exposures to large and small particles. Kenyon, *et al.*[31] determined ethanolamine exposures in an automotive parts facility and found that air levels of TEA in personal samples were related in an operation-specific manner with TEA in the bulk machining fluid formulations, but found no consistent relationship between TEA and particulate mass. And, Ball[32] in a survey of eight plants determined a median exposure level of approximately 1 mg/m^3. Kennedy's (*et al*) finding that a cross-shift decrease in forced expiratory volume with increasing exposure levels above approximately 0.20 mg/m^3 caused them to suggest that allowable exposure levels to metal removal fluid aerosols were too high.

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Figure 1. Metalworking Fluids

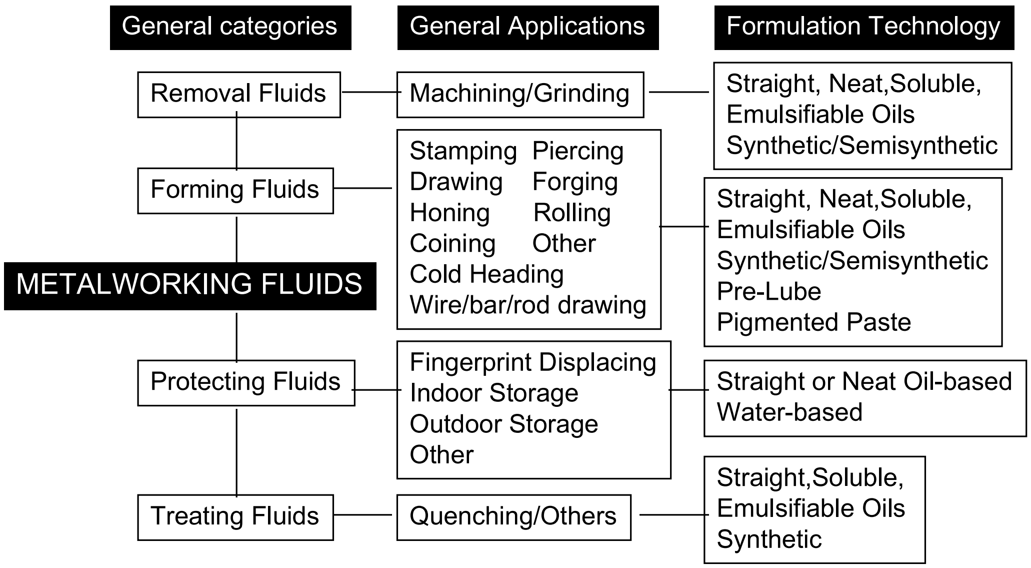

Figure 2. Metalworking Process Flow Chart

Process	Operation	Process Chemicals	Ancillary Lubricants
Forming ↓	Casting, forging, rolling, stamping, piercing, coining, drawing, press forming	Die cast lubes, prelubes, forging compounds, rolling oils, all types of drawing lubricants	Hydraulic fluids, greases,bearing lubes
Machining ↓	Deburring, boring, milling, hobbing, drilling, grooving, turning, tapping, chamfering, broaching, grinding	All types of machining and grinding fluids	Spindle oils, gear lubes, way lubes, hydraulic fluids, greases, chain lubes, bearing lubes
Heat Treating ↓	Quenching Martempering Carbonization	All types of quenching and martempering fluids, carburizer	Hydraulic fluids, greases, bearing lubes
Finishing ↓	Reaming, honing, lapping, grinding, straightening	Honing oil, lapping compounds, machining/grinding fluids	Spindle oils, gear lubes, way lubes, hydraulic fluids, greases, bearing lubes
Cleaning/Surface Prep ↓	Cleaning/drying degreasing, painting, phosphatizing	Cleaners, degreasers, paints, phosphatizing agents	Greases, bearing lubes
Storage ↓	Packaging Palletizing	Indoor and outdoor rust preventives	Hydraulic fluids greases
Assembly	Assembling	Cleaners, degreasers	Hydraulic fluids greases

Figure 3. Industrial Lubricants

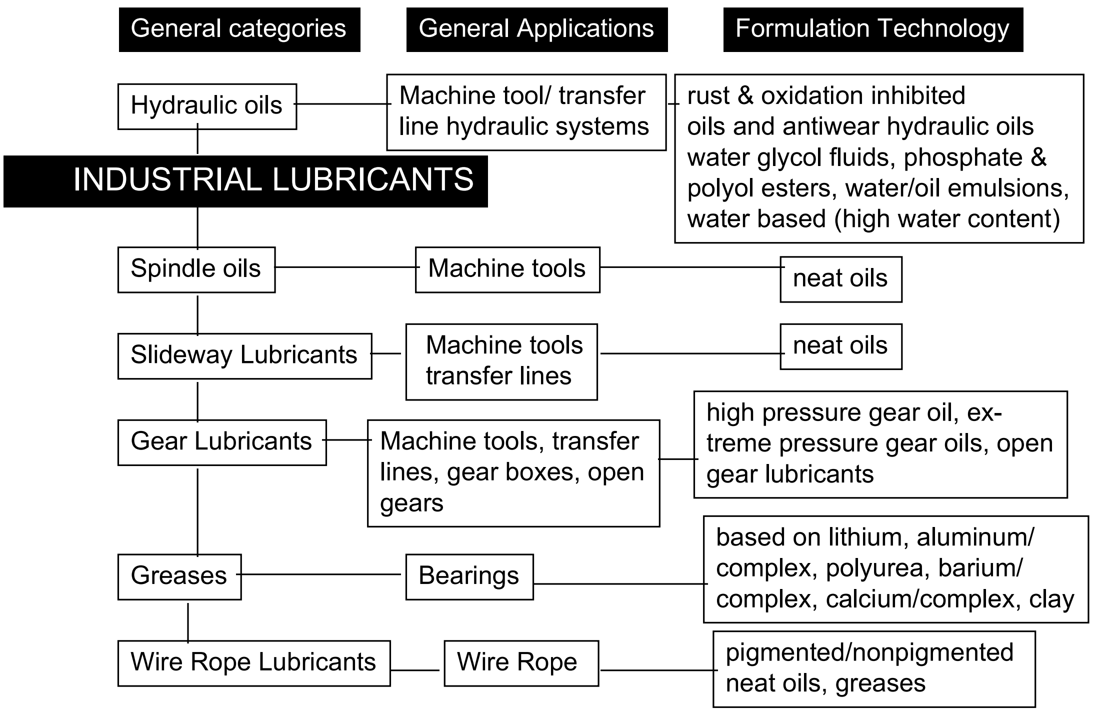

Figure 4. In-Process Cleaners