

**PHENOL VERSUS FORMALDEHYDE AS AN EXPOSURE HAZARD
IN EMBALMING: MYTH AND REALITY**

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Abstract: Phenol and formaldehyde are critically evaluated and compared as exposure hazards in embalming operations. The mythology that formaldehyde is somehow safer than phenol is exposed and debunked. Misinformation about phenol and formaldehyde in the embalming industry is catalogued and discussed. A critical comparison of both chemicals demonstrates that phenol is no more hazardous than formaldehyde and in many criteria appears to be less of a total exposure concern in embalming. The reluctance of the industry to face these facts and instead condemn all alternatives to formaldehyde is reviewed. A summary and conclusion that phenol is a reasonable and often times preferred alternative to formaldehyde completes the article.

*PAY NO ATTENTION TO THE TOXIC FUMES COMING FROM
BEHIND THE CURTAIN.*

*– Professor Form “Al” D. Hyde,
The Wizard of Embalming*

INTRODUCTION: In this article we will exhaustively compare phenol to formaldehyde in all parameters and modes of use in embalming rooms as an exposure hazard and health concern for embalmers. There exists in the embalming industry a massive mythology concerning phenol as an exposure hazard for embalmers in general. The classic shock mantra is — that phenol is extremely dangerous to use in embalming, a deadly poison that will eat the skin off your arms if you splash any on yourself, and doesn't really do anything important anyway, and consequently should be banned from embalming use. On

the other hand, of course, formaldehyde is a proven safe and effective embalming chemical that has been used for a century with no problems, whatsoever, so go ahead and use lots of it. I never did believe this embalming industry mythology that condemned phenol and its derivatives to damnation and extolled the virtues of formaldehyde in the same breath.

Most of the misinformation regarding this topic comes from the basic formaldehyde-apology stance that most in the industry take — i.e., there is nothing on the face of the earth that will embalm dead bodies except formaldehyde, therefore, formaldehyde is to be defended and justified under all circumstances, for to do otherwise is to court extinction. That about sums up the state of affairs concerning phenol versus formaldehyde in the embalming profession. As far as the formaldehyde-apology industry is concerned phenol is way too dangerous to use in embalming, however, formaldehyde is just perfectly alright.

There's only one problem — little if any of the above is true! When you critically evaluate phenol and formaldehyde in all physical, chemical, environmental and exposure parameters the conclusion is that phenol, at the typical quantities and concentrations used in modern embalming is overall less of a total exposure hazard in embalming than formaldehyde in its typical modality of use in embalming rooms. This is exactly the opposite of what is professed in various ways to the embalming profession. Formaldehyde has the advantage of a century long friendship with embalmers and is viewed as indispensable under all circumstances, consequently, it has to be better and safer than everything else — right? — WRONG!

Unfortunately, this belief is not based on fact and is blatantly false. When the hard facts are examined, formaldehyde looks worse than phenol on almost all evaluated parameters of embalming use. This is a hard, bitter pill to swallow for an embalming industry that strives for justification of formaldehyde at the expense of any and all alternatives. That's just the way it is, the facts are the facts and no wishing and hoping it were different can change that. After exhaustive analysis, formaldehyde when graded on virtually all parameters of use and exposure in embalming rooms — rates as the highest total overall exposure hazard and health concern to the modern embalmer of virtually all the chemicals used in embalming.

What is phenol and how and why was it even incorporated into embalming in the first place? What is the history and industry uses of this high-volume chemical that appears in many formulations, medical and otherwise? These questions and more will be answered, followed by an exhaustive comparison of phenol to formaldehyde that you will see leads to the inevitable conclusion that formaldehyde is the bigger problem for embalmers.

PHENOL — HISTORY, PROPERTIES AND EMBALMING USE: For a comprehensive discussion of the properties of phenol and its various uses in industry, reagents, additives, chemical commerce, medical and veterinarian applications, I refer you to an earlier Encyclopedia article by me that investigated phenol and its exposure values in embalming rooms (Champion Encyclopedia #621/622). In this report I also delineate the various valuable uses of phenol in embalming operations including sanitizing

potential, cauterizing, bleaching and drying, mold and fungal inhibiting and odor neutralizing in putrefaction, in addition to its lipophilic characteristics. Phenol was early on incorporated into embalming formulations due to these valuable embalming properties. I won't belabor or repeat this information in this article and I encourage you to read my previous article.

It is important to note that virtually all the chemical exposure literature refers to phenol in its concentrated raw form, that is commonly used in chemical industry — i.e. 90%+ phenol. This concentrated form of phenol has no use in modern embalming chemicals and such concentrations would never be found in available embalming fluid formulations. Concentrated formaldehyde solutions such as formalin (37%) and even 55%+ formaldehyde concentrations are, unfortunately, frequently found in available embalming fluids and therein lies the majority of exposure problems with formaldehyde in embalming — the constant and repetitive use of high concentration formaldehyde embalming fluids resulting in very high exposure values, well over recommended limits.

Concentrated phenol and formalins are absolutely very dangerous chemicals in industry and careful precautions must be in place for either to be safely used. Both are deadly and both cause serious injury and death when major exposure accidents occur. The point is that the high concentrations of phenols seen in chemical industry are nowhere to be found in modern embalming fluid formulations and final dilutions of in use embalming solutions.

In the past, this was not necessarily the case and some very concentrated and dangerous phenols were available to embalmers and exposure accidents invariably occurred. This has, no doubt, contributed to the war stories and misconceptions that the embalming industry has regarding phenols. My final point is this: there are myths and there are realities — I intend to debunk the myths and confirm the realities of modern phenol and formaldehyde usage in embalming and their relative exposure hazards in embalming use.

CARCINOGENICITY: Cancer-causing potential is a serious concern for embalmers and workers in general in the chemical field. Carcinogenicity of chemicals should be on the mind of every embalmer and in each and every embalming operation that he conducts — your life literally depends on it. Every effort should be made to limit exposure to cancer causing chemicals and eliminate them from use, if at all possible.

Phenol is not classified as carcinogenic to humans by any agency anywhere. There are limited studies pointing to carcinogenic activity of moderate or low level in some laboratory animals, but the studies are equivocal or contradictory in some instances. IARC, NTP, EPA, OSHA, NIOSH and other agencies all list phenol as non-carcinogenic in humans. Phenol, for all intents and purposes as used in modern embalming operations, is not a cancer concern.

Unfortunately, the same cannot be said for formaldehyde. Formaldehyde is listed by virtually all agencies as carcinogenic, including NTP, IARC, OSHA, NIOSH, NTP, MAK and AIHA, in addition to nu-

merous other country-specific regulatory and health advisory agencies. In fact, IARC, the prestigious International Agency for Research on Cancer has just changed the rating of formaldehyde to a known/confirmed carcinogen and placed formaldehyde in Group 1, the highest danger category. It doesn't get any worse than that for formaldehyde. Formaldehyde is the basis for the OSHA Formaldehyde Act CFR1910.1048 and is the cause for the cancer warning signs posted in embalming rooms. What more do you need to know?

REALITY CHECK: FORMALDEHYDE IS A PROVEN CARCINOGEN IN HUMANS IN CERTAIN CANCERS AND STRONGLY IMPLICATED IN NUMEROUS OTHER CANCERS IN HUMANS, PHENOL IS NOT. THE CARCINOGEN IN THE EMBALMING ROOM IS FORMALDEHYDE.

GENOTOXICITY: Both phenol and formaldehyde exhibit mutagenic activity in a variety of circumstances, both in vitro and in vivo. Numerous studies for both phenol and formaldehyde have shown causation both actual or potential for chromosomal aberrations, DNA strand breaks and micronuclei induction. This is not surprising, as most chemicals capable of exhibiting embalming action and preservation, readily react with chemical moieties that induce these changes. The mutagenic activity of phenol appears no more significant than that of formaldehyde, and in some instances, formaldehyde is more strongly implicated. Bottom line, genotoxic potential is not wanted in any chemical used in embalming and there is no good news for either phenol or formaldehyde.

REALITY CHECK: NEITHER CHEMICAL IS PREFERRED DUE TO GENOTOXIC POTENTIAL. FORMALDEHYDE IS AS STRONGLY IMPLICATED, AND IN SOME INSTANCES MORE SO, THAN PHENOL IN MUTAGENIC ACTIVITY.

ALLERGIC SENSITIZATION: Potential for chemical sensitization reactions are a serious concern for embalmers in their constant and repeated long term use of chemicals in embalming. Sensitization and allergic reactions to some chemicals pose major health hazards and chronic health concerns. Asthma, asthmatic conditions and other serious exposure reactions, such as rashes, inflammations, urticaria and others are persistent and potentially dangerous sequelae of exposure to allergenic chemicals.

Phenol is not classified as an allergen or allergenic sensitizer by any regulatory agency anywhere. Only sporadic and isolated incidences of phenol exposure suggest any type of sensitization reactions with this chemical.

Such is not the case with formaldehyde which is a proven serious asthma-causing chemical and known and proven skin and inhalation allergenic sensitizer. Formaldehyde is high on the list of known allergenic chemicals and is always in the first-line patch testing protocol for sensitization testing. Formaldehyde is a documented causative agent for occupational asthma in several industries and is always strongly implicated in sick-building syndrome. Formaldehyde causes serious and insidious long-term health effects in general and specifically in the nasal passages and lungs. Exposure in the

embalming industry is typically way above ACGIH limits with formaldehyde and the allergenic potential for formaldehyde is exacerbated in embalming operations.

REALITY CHECK: PHENOL IS NOT IMPLICATED IN ALLERGENIC SENSITIZATION OR CLASSIFIED AS A SENSITIZER. FORMALDEHYDE IS A KNOWN AND CONFIRMED SKIN AND INHALATION SENSITIZER WITH CONFIRMED CASES OF FORMALDEHYDE-INDUCED ASTHMA AND ASTHMATIC-LIKE CONDITIONS. FORMALDEHYDE IS THE SENSITIZATION DANGER, NOT PHENOL. WHAT MORE IS THERE TO KNOW?

INHALATION HAZARD: Inhalation exposure in embalming is the primary exposure route for embalmers during embalming operations. Consequently, the potential exposure values for any chemical used in the embalming room takes on a maximum and overriding concern. Even with ventilation, exposures with formaldehyde can and do easily exceed the ACGIH maximum allowable values of airborne exposure. Chemicals and their quantities used in embalming should be chosen based on the comparison of their potential for inhalation exposure and all attempts should be made to eliminate high-exposure chemicals or minimize their use.

Phenol exposure in embalming has been extensively investigated by me in a previous Champion Encyclopedia (#621/622) and I encourage you to consult it for an in-depth study of possible inhalation exposures with phenol in embalming rooms. In reading this earlier Encyclopedia, it is evident that it is virtually impossible to have an overexposure scenario with phenol in embalming rooms when using standard, accepted and readily available formulations of arterial, cavity and specialty chemicals containing phenol in typical quantity and concentration. My earlier study looked at high concentration phenols in highly volatile alcohol solutions used as arterials and cavities in worst case embalming scenarios that could not be duplicated with modern embalming fluids. Even under these bizarre circumstances, exposures were under exposure limits and eminently controllable with ventilation. Utilizing modern formulations of available embalming chemicals in reasonable and accepted quantities, with reasonable and adequate ventilation, it is essentially impossible to document inhalation overexposure to phenol during embalming operations.

Sadly, such is not the case with formaldehyde. It is extremely easy to overexpose yourself to formaldehyde in embalming by just using typical and readily available quantities and concentrations of traditional formaldehyde embalming fluids. The exposure value of .3PPM by ACGIH, as an absolute ceiling is exceeded 60-70% of the time during normal embalming operations and using what is considered adequate ventilation.

What is worse, the odor threshold of formaldehyde is .5PPM-1PPM and higher, with embalmers and formaldehyde workers always registering at 1PPM or higher. This is a dangerous situation, in that an exposed individual cannot detect formaldehyde until hopelessly overexposed. If you can smell formaldehyde — you are overexposed. When was the last time you were in the embalming room and couldn't smell formaldehyde? Probably never — in essence then, virtually all exposure scenarios for formalde-

hyde in embalming are probable overexposure scenarios. The funeral industry is deluding itself about the relative dangers of formaldehyde as compared to the modern chemical alternatives available.

Phenol has a very low odor threshold that is generally listed as .04PPM-.06PPM or slightly higher. The accepted global values for maximum allowable airborne exposures are at least 100 times this value at usually 5PPM for an eight hour exposure. Consequently, the smell detection of phenol will occur long before there is any possibility of exceeding safe values of exposure. This is a desirable situation in an embalming scenario where inhalation exposure is the most likely cause of overexposure to embalming chemicals.

There is no comparison between the relative vapor pressures of phenol versus formaldehyde. Phenol barely has a 1/2mmHg vapor pressure at room temperature and a vapor density of 3.24 (relative to air). This means that what little, if any, phenol vapors that are present in a ventilated embalming room would rapidly sink to the floor and be exhausted. This no doubt, explains the very low exposure values typically recorded for phenol during embalming.

Such is not the case with formaldehyde. Formaldehyde is a gas at room temperature and its vapor pressure (typically 70-90mmHg) is sky high compared to phenol (easily 100 times more) and the vapor density is barely higher than atmosphere at 1.03 (relative to air), which essentially means that formaldehyde vapors float and linger in the breathing zone during embalming and are only exhausted when that zones air is exhausted by the ventilation system. Neither of these factors are conducive to exposure safety during use in embalming. The embalming industry refuses to believe it, but the most serious exposure concern in embalming is formaldehyde, and that's just the way it is.

REALITY CHECK: INHALATION EXPOSURE IN AN ADEQUATELY VENTILATED EMBALMING ROOM IS NOT A CONCERN WITH PHENOL. FORMALDEHYDE IS MARGINALLY OR NOT CONTROLLABLE 2/3 OF THE TIME EVEN IN A WELL-VENTILATED EMBALMING ROOM AND YOU ARE OVEREXPOSED IF YOU CAN SMELL FORMALDEHYDE. FORMALDEHYDE PRESENTS AN EXPOSURE HAZARD THAT FAR EXCEEDS ALL OTHER CHEMICALS USED IN EMBALMING. WHAT MORE IS THERE TO KNOW?

ADDITIONAL HAZARDS IN EMBALMING: Skin splash contact, eye splash injury and accidental ingestion are all potentially deadly scenarios for exposures to hazardous chemicals in embalming operations. Consequently, adequate impervious gear and protective equipment and careful choice of chemicals used in embalming moderate and minimize this exposure concern during modern embalming operations.

As would be expected, both phenol and formaldehyde are serious exposure hazards in the above embalming exposure scenarios, in fact, virtually all chemicals used in the embalming room are potentially dangerous when you consider accidental exposure or other splash contact. Phenol and

formaldehyde both exhibit chemical burn and serious skin injury when accidentally spilled onto skin surfaces and eye splash injuries can be very serious.

The point to be made is, that phenol in the concentrations/quantities used in embalming formulations is no more serious a contact/ingestion hazard than is formaldehyde. The industry has denied this underlying fact for a long time and denigrated phenol, while minimizing or overlooking the evidence against formaldehyde. In fact, due to the dilutions typically found for phenol versus the classic full-strength formalin-style formaldehydes, phenol is possibly overall less of a total hazard in this exposure mode than is formaldehyde. Formaldehyde is typically used at 6 - 8 times the average concentration/quantity of phenol in embalming and consequently drives the exposure hazard quotient towards formaldehyde, not phenol.

Adequate glove protection is available for use in embalming rooms for both chemicals. Embalmer/autopsy style gloves in butyl rubber, neoprene or nitrile will provide several hours of protection for both formaldehyde or phenol in concentrations typically found in embalming chemicals. Concentrated industrial phenol will permeate thin to medium thickness nitrile gloves in less than an hour of exposure. This exposure of concentrated phenol would not occur in any reasonable modern embalming scenario and even thinner double-gloved nitrile would adequately protect against the lowered concentrations of phenols in embalming formulations during the time frame of a typical embalming. Butyl rubber, neoprene and nitrile are all effective for formaldehyde protection during embalming. Nitrile is still my overall preferred choice of embalming glove due to excellent overall protection and durability for the typical quantity/concentration chemical mix found in modern embalming operations and their typical time frames of exposure.

A note about latex gloves — hopefully, nobody is using them. They protect against virtually no chemical in embalming, typically trap chemical in the latex matrix, tear and break easily and expose the embalmer to the potential for latex sensitization and allergy. Latex gloves in embalming are absolutely worthless for chemical protection from formaldehyde, phenol and all the rest of the chemicals in the embalming room. Shockingly, despite all the above information, there is still a massive amount of latex gloves being used in embalming operations. Latex gloves are truly an absurdity in modern embalming — abandon their use.

One final myth, perpetuated throughout the embalming industry, mostly by the embalming machine makers, is that somehow phenol is destructive to embalming machines and should not be used, but massive quantities of formaldehyde and all other injection chemicals is just OK. This has no validity in fact. Phenol, in the concentration/quantities found in injection chemicals is no more injurious to embalming machines than all the formaldehyde, alcohol solvents and additional chemicals found in typical embalming products and dumped into embalming machines with impunity. Concentrated industrial phenols would be a problem, but they don't exist in embalming injection products that are designed to be put into an embalming machine.

Embalming machines are archaic, at best, employing simplistic 1940's technology and are fraught with problems such as; leaking fittings, constant rubber gasket disintegration, valve leaks, corrosive action on gauges and general deterioration due to continual harsh chemical usage and lack of cleaning. Virtually all the maintenance and repair problems of embalming machines can be traced to repeated use of harsh formaldehyde/alcohol-based chemicals and failure to adequately flush and clean the machine after use. Phenol, in the concentration/quantities found in modern injection chemicals, is no more of a problem than formaldehyde for embalming machines. In fact, formaldehyde is typically used at 6-8 times the quantity/concentrations that phenol is, and therefore, presents the greatest overall corrosive impact on embalming machines. The myth that phenol is bad for embalming machines, is just that, a myth. Constant injection of formaldehyde chemicals is the primary cause of embalming machine failure.

There are a couple of chemicals found in embalming rooms that will destroy embalming machines when used repeatedly. San-Veino and the old-fashioned drywash/cleaning solvents, both of which contain chlorinated hydrocarbon solvents (i.e., TCE and PERC), will quickly soften and dissolve the seals and rubber fittings in an embalming machine. Hexane chemicals would basically do the same. Nobody needs to be using these hydrocarbon/chlorinated solvents anyway, as they have massive exposure and disposal problems in embalming rooms. The fact that they very quickly destroy your embalming machine is just another reason to eliminate them from the embalming room.

The lethal oral dose of concentrated industrial phenol is usually considered to be 1/2 ounce to 1- 2 ounces depending on report and circumstances. Of the diluted phenol product found in embalming, 2-3 ounces would be considered as an acceptable guideline. Formaldehyde is no better with the classic formalin-type embalming chemicals documenting a typical lethal dose at 1-2 ounces. How is phenol any worse in this consideration — it is not?!? The industry documentation for serious and lethal skin and body exposures is little different for formaldehyde versus phenol — both are serious and deadly. Numerous deaths are attributed to both chemicals from accidental submersion or major body skin contact with serious chemical burns accompanying the usually lethal exposure.

REALITY CHECK: PHENOL AT THE CONCENTRATIONS/QUANTITIES USED IN EMBALMING IS NO MORE SERIOUS AND POSSIBLY LESS OF AN EXPOSURE HAZARD THAN FORMALDEHYDE DURING ACCIDENTAL SKIN SPLASH/EYE SPLASH INJURY AND ACCIDENTAL INGESTION OF THE CHEMICAL DURING EMBALMING OPERATIONS. FORMALDEHYDE IS NOT SAFER THAN PHENOL IN THESE CIRCUMSTANCES.

BIOFATE AND ENVIRONMENTAL CONCERNS: Biodegradability, atmospheric persistence and environmental impact in general are all important concerns for chemicals that will be used in embalming and end up going down the drain one way or another during and after embalming operations. Chemicals that minimize the exposure/disposal concerns and have the least total environmental impact should be the preferred chemicals of choice in embalming, if at all possible. Both phenol and formaldehyde are on eight Federal Regulatory Lists, which does not speak well for either chemical. Fortunately, under most circumstances atmospheric and terrestrial biofates are reasonable for both chemicals when used in the

typical quantity/concentrations seen in modern embalming fluids.

Phenol and related cresols are not persistent in the atmosphere, with typical half-lives of 9 hours during the day and only minutes (usually 4) at night. Complete removal from air in daytime is typically 13 hours. The chief mechanisms of degradation is photooxidative reactions with hydroxyl radicals by day and nitrate radicals by night. In lakes and ponds, phenols have a short half-life but can persist by accumulation with half-lives in an oligotrophic lake, marine waters and water/sediment cores of 6 days, less than 4 days, and less than 2 days, at the extremes. Other studies have shown river half-lives of 1/2 hour and 12 hours in lakes and ponds. Phenols are poorly absorbed in soils and leach in water, where they relatively rapidly biodegrade in a matter of hours or a few days at worst. The EPA lifetime HA (health advisory) for phenol in drinking water is 2PPM.

Formaldehyde released into the atmosphere rapidly degrades by hydroxyl radical action in a matter of a few hours to less than one day. There is some persistence in smog and smoke. When released on soil, formaldehyde will leach into water and biodegrade both aerobically and anaerobically. Typical values for near complete elimination from water range for 1-2 days to several days (2-5) in certain aqueous compartments. There is sometimes noted an accumulation period before biodegradation commences, for example in nutrient rich seawater the lag time is 40 hours or more. A major downside of atmospheric elimination is that the initial reaction product is formic acid, a primary component of acid rain. Formaldehyde in the atmosphere is one of the problematic chemicals responsible for this environmental hazard. The EPA lifetime HA (health advisory) for formaldehyde in drinking water is 1PPM, which is significantly lower than the limits for phenol.

It appears that neither phenol nor formaldehyde when used in the typical quantities of modern embalming have serious environmental consequences of use/disposal in embalming operations. After transit times in the waste stream and contact with sewage sludge and massive system wide dilution, environmental impact should be minimal for both phenol and formaldehyde. More total formaldehyde would be released than phenol, which is not good, but the difference should not seriously impact the neutralization potential or final result.

REALITY CHECK: FORMALDEHYDE IS NOT SAFER TO USE OR DISPOSE OF IN EMBALMING ROOMS THAN PHENOL. THE ENVIRONMENTAL IMPACT FROM BOTH PHENOL AND FORMALDEHYDE ARE ESSENTIALLY THE SAME AND SHOULD NOT BE SIGNIFICANT WHEN TYPICAL QUANTITIES/CONCENTRATIONS ARE USED IN MODERN EMBALMING OPERATIONS.

SUMMARY/CONCLUSION: The inescapable conclusion to be reached is that the mythology about phenol in embalming is just that — mythology. There is not one significant shred of evidence to indicate that phenol in modern embalming quantities and concentrations of use is somehow more dangerous than formaldehyde. In fact, the myths have basically been turned on their heads, in that when viewed critically and methodically formaldehyde by virtually all accounts appears the greater overall

exposure hazard in modern embalming operations. This is not surprising, as the indictment of formaldehyde as a serious exposure hazard and concern is massive indeed.

Phenol is a valuable and useful embalming chemical when used in typically reasonable and moderate quantities and concentrations in embalming formulations. To profess the dangers of phenol and to preach against it while extolling the virtues of formaldehyde in embalming and continuing to encourage the use of high index arterial and cavity fluid is intellectually dishonest. Formaldehyde is not safer than phenol when used in modern quantities/concentrations of embalming chemicals. The brutal truth is that phenol appears to be the preferred choice for reduced exposure hazard in embalming. That's just the way it is and no amount of myth or rumor can change that reality. Formaldehyde is the real exposure problem in embalming — always has been, always will be. What more do you need to know?

FINAL REALITY CHECK: THE GOAL OF CHEMICAL SELECTION IN EMBALMING SHOULD BE A COMPARATIVE BALANCING OF A DESIRABLE AND EFFECTIVE EMBALMING ACTION VERSUS THE TOTAL OVERALL EXPOSURE RISK OF THE CHEMICAL MIX CHOSEN. THAT GOAL IS ABSOLUTE AND SHOULD NEVER BE COMPROMISED. PHENOL, IN REASONABLE AMOUNTS, APPEARS TO ADEQUATELY MEET THIS CRITERIA, WHILE FORMALDEHYDE FAILS MISERABLY IN ACHIEVING THIS GOAL.

BIBLIOGRAPHY: As expected, the literature on phenol and it's derivatives is substantial. Following is a selected array of informative articles. The research literature on formaldehyde is overwhelming and the indictment of formaldehyde is ponderous. A massive listing of research literature cites has been published by me in a previous article (Champion Encyclopedia #650) and I refer you to it, to avoid needlessly reprinting that voluminous list of articles pertaining to formaldehyde as an exposure hazard.

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