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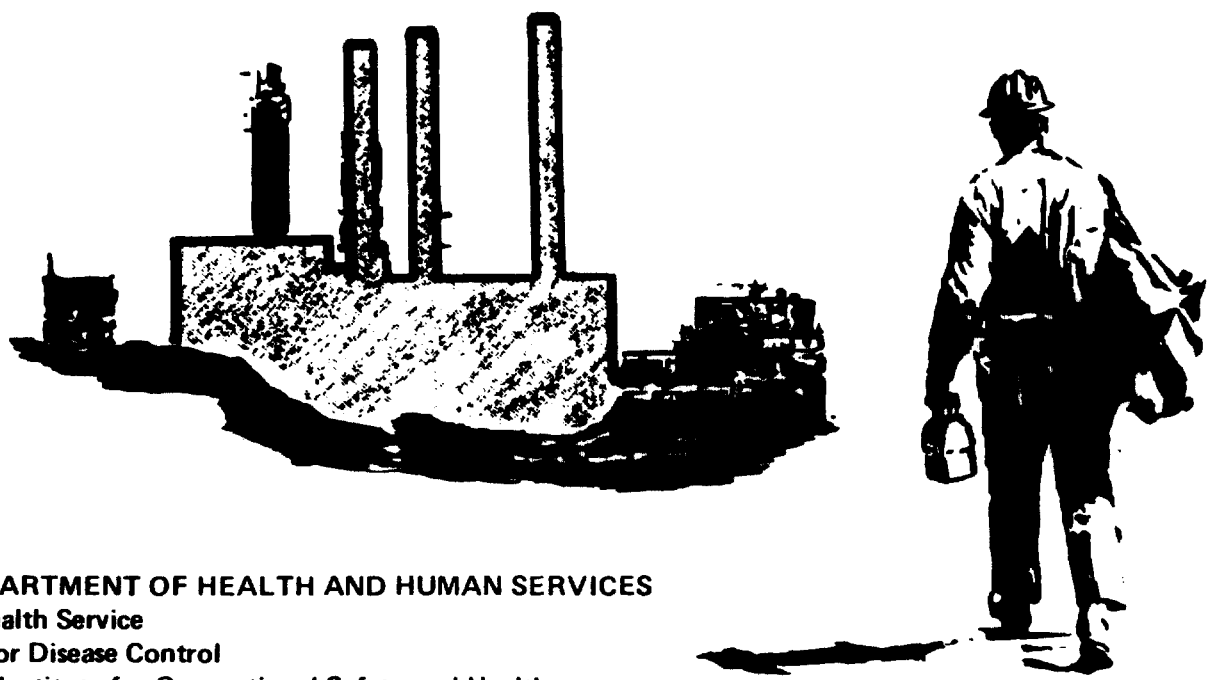
NIOSH

OCCUPATIONAL HAZARD ASSESSMENT

Criteria for Controlling Occupational Exposure to Cobalt



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

CRITERIA FOR CONTROLLING

OCCUPATIONAL EXPOSURE TO COBALT

U.S. Department of Health and Human Services
Public Health Service
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National Institute for Occupational Safety and Health

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PREFACE

The National Institute for Occupational Safety and Health (NIOSH) has evaluated the information available on cobalt and concludes that a potentially serious hazard could exist in the US workforce from exposure to uncontrolled and excessive amounts of cobalt. For cobalt metal fume and dust, toxic effects have been observed in the lungs of workers and experimental animals exposed at or below the current Federal limit. Information on many of the cobalt compounds in commercial use is so limited that permissible exposure limits cannot be derived at this time.

NIOSH will periodically review the available data concerning cobalt and will make successive reports and revised recommendations as new research and epidemiologic studies are completed. If a previously unsuspected hazard becomes known, cobalt will be considered as a subject for recommending new standards.

Contributions to this document on cobalt by NIOSH staff are gratefully acknowledged as are the comments of other Federal agencies or departments, review consultants, and reviewers selected by the American Medical Association, the Society for Occupational and Environmental Health, and the Society of Toxicology, and Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine. Most of these reviewers provided comments on an earlier draft criteria document on cobalt.

The views and conclusions expressed in this document are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. The review consultants and the Federal Agencies that received and commented on an earlier version of this document are listed on pages iv and v.

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The Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, had primary responsibility for development of this document on cobalt. Imogene F. Sevin, Ph.D., of this Division had program responsibility and prepared the document in its final form. Equitable Environmental Health, Inc. developed the basic information for this document under contract CDC 210-79-0148.

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I. SUMMARY AND CONCLUSIONS

More than a million workers in the United States are potentially exposed to cobalt compounds in the course of their employment. By far, most are exposed to cobalt metal or cobalt oxides. Many are potentially exposed to oil-based paint driers containing cobalt, but their exposure is limited because these driers constitute only a small percentage of the ingredients in paint. Production of alloys and hard metal accounts for about 70% of cobalt use, but numerous other industries produce or use lesser amounts of cobalt. The degree of worker exposure in these industries depends on many factors, including the amount of cobalt used in the process, the number of engineering controls available, and the amount of cobalt-containing materials handled manually. Since workers are rarely exposed to only a single substance in the occupational environment, exposure to cobalt can be limited by the availability of engineering controls designed to reduce emission of other respirable and potentially harmful metal fumes and dusts.

The Occupational Safety and Health Administration (OSHA) standard for cobalt is 0.1 milligram of cobalt in a cubic meter of air (mg/cu m). OSHA has interpreted this standard to apply to all cobalt compounds. Of the workplaces inspected by OSHA for cobalt exposure, nearly 20% were not in compliance with this standard. Site visits revealed that plants using large quantities of cobalt have difficulties meeting this standard without extensive engineering controls.

Workers can be exposed to cobalt in many ways. Inhalation is a potential route of exposure occurring most commonly when material containing cobalt is heated, where cobalt powders are handled manually, or where cobalt materials are subjected to grinding. Dermal exposure to cobalt can occur in any operation where these materials are handled manually, but it is a special consideration where solutions containing cobalt are present. Ingestion of cobalt can also occur and is best prevented by good work practices, sanitation, and personal hygiene. The information on the health effects of cobalt is sufficient to conclude that exposure to it by any of these three routes can be a health hazard in the workplace.

Substantial information exists showing that workers who have inhaled cobalt can develop lung disease. Numerous case reports and medical and industry-wide surveys in the cemented carbide industry have demonstrated the persistent occurrence of diffuse interstitial fibrosis of the lung in exposed workers. Mild to fibrotic lung changes have been observed in workers exposed to cobalt at 0.1-0.2 mg/cu m, and airway obstruction has been observed at 0.06 mg/cu m. Although workers received exposures to cobalt mixed with other substances, animals inhaling cobalt metal have similarly developed lesions indicative of developing fibrosis at 0.1 mg/cu m. The adverse lung effects observed at or below the Federal permissible exposure limit (0.1 mg/cu m) pose the serious question of whether that limit is adequate. This is further aggravated by reports of pulmonary hypersensitivity developing in workers

exposed to cobalt. Such persons, once sensitized, could probably not tolerate inhalation of even small amounts of cobalt.

It is well known that cobalt is a skin sensitizer, and is commonly considered as a possible source of allergic dermatitis. In the workforce, persons who become sensitive to cobalt are usually transferred to other jobs, although these cases are rarely reported in the scientific literature. Since solutions of cobalt salts are used for patch testing (which itself can cause sensitization), it is reasonable to believe that these inorganic salts can also cause dermatitis and sensitization in the workplace. However, some workers may also develop skin diseases from the irritant effects of cobalt-containing dusts. These problems are best controlled through prevention of dust accumulation by engineering controls, prompt cleanup of spills, and clothing that prevents or limits excessive dermal contact with cobalt, either as dust or in solution.

Information on the toxic effects resulting from ingestion of cobalt comes from the nonoccupational environment. For example, the effects of cobalt on the heart have been studied because of an outbreak of acute cardiomyopathy in beer drinkers. The amount of cobalt consumed by these beer drinkers was substantially more than that inhaled by workers exposed at the current Federal limit. The effects of cobalt on the heart probably are less of a hazard than pulmonary fibrosis, although studies are needed to determine whether or not adverse effects on the heart become demonstrable following long-term exposures (such as in a stable workforce). Polycythemia and subsequent development of thyroid hyperplasia have also occurred following ingestion of cobalt salts. However, polycythemia does not appear to be a particularly toxic response, especially in workers exposed to cobalt at 0.1 mg/cu m or less. Experiments in animals suggest that some persons might develop changes in the thyroid even at these low concentrations, especially when individual susceptibility is considered. This evidence is sufficient to recommend palpation of the thyroid as part of the medical surveillance for workers exposed to cobalt.

Several other toxic effects can occur following exposure to cobalt. Degenerative changes in organs, including the liver, kidneys, and pancreas, can be demonstrated in animals. While few studies of workers have examined these effects, they do not appear to be severe in humans, even at doses that produce other toxic responses. Information concerning the ability of cobalt to alter blood clot formation indicates that this effect may occur at levels characteristic of the workplace. Cobalt administered orally at 1 mg daily for only 3 days resulted in a prolonged time for blood clot formation in humans. These changes are not easily discounted, having occurred at a low dose, but they need further documentation.

At least qualitatively, systemic effects, such as those on the heart, blood, and thyroid, do not appear to differ greatly between cobalt compounds tested or routes of administration used. Some quantitative differences, however, may be found as more information becomes available. A critical question is whether or not all cobalt compounds should be considered to be potentially capable of producing pulmonary fibrosis. Of the many cobalt

compounds in commercial use, only cobalt metal and cobaltous oxide have been tested by inhalation.

Both substances produced fibrotic or prefibrotic lesions and demonstrated a surprisingly high degree of solubility in lung tissue. This information, coupled with recent studies indicating that workers exposed to cobalt salts have developed adverse effects in the lungs, makes it prudent to conclude that all cobalt compounds may be capable of producing pulmonary fibrosis.

In reviewing the information available, NIOSH found that much research remains to be done before the toxic effects of the many cobalt compounds now in commercial use can be documented. One goal of this publication is to bring the pressing need for information that would permit a better analysis of occupational exposure limits for cobalt compounds to the attention of the research and occupational communities. In the interim, judgments must be made on how to control worker exposure and establish environmental and medical monitoring programs. A summary of these recommendations is presented below.

Engineering Controls

Well-maintained closed systems should be used whenever possible, and diligent attention paid to the prevention of dust accumulation. Properly-designed local ventilation should be utilized for specific operations such as grinding or buffing; particular care is necessary in designing ventilation for handling operations where cobalt-containing powders may be formed. Regular monitoring should be carried out for all ventilation systems by trained personnel.

Work Practices

Employers should institute and ensure the quality of programs that emphasize good personal hygiene. Physical hazards involved in handling cobalt-containing materials should be identified and measures taken to eliminate them. The combustion properties of individual cobalt compounds should be known by all who work with them. Proper methods of cleanup and plant maintenance should be established. Special precautions should be taken whenever a tank or vessel is entered.

Work Clothing and Protective Equipment

The use and proper cleaning of appropriate work clothing is required to prevent skin effects and sensitization. Protective equipment that is appropriate to their potential exposures to cobalt should be provided for all workers. If respirators must be used for specific situations, they should be of proper design, and well fitted and maintained.

Worker Education and Monitoring

Continuing education programs should be established that emphasize to workers proper handling and cleanup procedures for cobalt and its compounds. Instructional material should be available that covers, in written form, good work practices and known health effects, as well as other physical and chemical properties of the substances present.

Industrial hygiene surveys should be carried out to determine locations where workers might be exposed to cobalt. These surveys, carried out at 3-year intervals, should consist of personal monitoring procedures adequate to ensure that an understanding of worker exposure is obtained. All monitoring records should be maintained for 30 years following termination of employment.

Medical Surveillance

Because of the effects of the various forms of cobalt on the body, medical surveillance programs should be established that allow the responsible physician to ensure that workers are adequately surveyed. Primary emphasis should be placed on the occupational history and the surveillance of the lungs and skin. Depending on the specific work being done, the physician may wish to evaluate other organs such as the blood and heart. Medical records must also be kept for 30 years following termination of employment.

The following chapters present more detailed information on the toxic effects of cobalt and the extent and degree of worker exposure to substances containing cobalt. Methods for sampling and analysis of airborne cobalt, including a detailed procedure, are given. Engineering controls and work practices designed to control cobalt emissions into the workplace air are provided, as is a program recommended for medical and environmental surveillance and worker training.