

NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND
SUPPORTING DOCUMENTATION FOR

*** MOLYBDENUM SOLUBLE COMPOUNDS ***

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

THE BASIC TEXT OF THIS DOCUMENT CONTAINS THE DRAFT TECHNICAL STANDARD APPROVED BY THE JOINT REVIEW COMMITTEE OF THE NIOSH/OSHA STANDARDS COMPLETION PROGRAM AND THE SUPPORTING DOCUMENTATION FOR THE SUBSTANCE MOLYBDENUM SOLUBLE COMPOUNDS.

THE SCP DRAFT TECHNICAL STANDARDS ARE RECOMMENDATIONS TO THE DEPARTMENT OF LABOR FOR ITS CONSIDERATION IN RULEMAKING AND HAVE NO LEGAL STATUS UNTIL FINAL RULES HAVE BEEN PROMULGATED BY THAT AGENCY. THIS DRAFT STANDARD IS PROVIDED FOR YOUR INFORMATION ONLY.

THE REFERENCES AND SOURCES, RESPIRATOR TABLE DOCUMENTATION AND USE/EXPOSURE AND CONTROL DOCUMENTATION ARE THE WORKING DOCUMENTS USED BY THE VARIOUS SCP WORKING GROUPS DURING THE DEVELOPMENT OF THE DRAFT TECHNICAL STANDARD AND SERVE AS THE TECHNICAL FOUNDATION FOR THE STANDARD. THE CLASSIFICATION FOR EACH SUBSTANCE AND THE REGULATORY STATEMENTS WERE DERIVED FOLLOWING A DECISION LOGIC ESTABLISHED FOR THE VARIOUS SECTIONS OF THE STANDARD.

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(A) DEFINITIONS. (1) "PERMISSIBLE EXPOSURE" MEANS EXPOSURE OF EMPLOYEES TO AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS NOT IN EXCESS OF 5 MILLIGRAMS PER CUBIC METER (MG/M³), AVERAGED OVER AN EIGHT-HOUR WORK SHIFT (TIME WEIGHTED AVERAGE), AS STATED IN § 1910.1000, TABLE Z-1.

(2) "ACTION LEVEL" MEANS ONE HALF OF THE PERMISSIBLE EXPOSURE FOR SOLUBLE MOLYBDENUM COMPOUNDS.

(B) EXPOSURE DETERMINATION AND MEASUREMENT. (1) EACH EMPLOYER WHO HAS A PLACE OF EMPLOYMENT IN WHICH SOLUBLE MOLYBDENUM COMPOUNDS IS RELEASED INTO THE WORKPLACE AIR SHALL DETERMINE IF ANY EMPLOYEE MAY BE EXPOSED TO AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS AT OR ABOVE THE ACTION LEVEL. THE DETERMINATION SHALL BE MADE EACH TIME THERE IS A CHANGE IN PRODUCTION, PROCESS, OR CONTROL MEASURES WHICH COULD RESULT IN AN INCREASE IN AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS.

(2) A WRITTEN RECORD OF THE DETERMINATION SHALL BE MADE AND SHALL CONTAIN AT LEAST THE FOLLOWING INFORMATION:

(I) ANY INFORMATION, OBSERVATIONS, OR CALCULATIONS WHICH MAY INDICATE EMPLOYEE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS;

(II) ANY MEASUREMENTS OF SOLUBLE MOLYBDENUM COMPOUNDS TAKEN;

(III) ANY EMPLOYEE COMPLAINTS OF SYMPTOMS WHICH MAY BE ATTRIBUTABLE TO EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS; AND

(IV) DATE OF DETERMINATION, WORK BEING PERFORMED AT THE TIME, LOCATION WITHIN WORK SITE, NAME, AND SOCIAL SECURITY NUMBER OF EACH EMPLOYEE CONSIDERED.

(3) IF THE EMPLOYER DETERMINES THAT ANY EMPLOYEE MAY BE EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS AT OR ABOVE THE ACTION LEVEL, THE EXPOSURE OF THE EMPLOYEE IN EACH WORK OPERATION WHO IS BELIEVED TO HAVE THE GREATEST EXPOSURE SHALL BE MEASURED. THE EXPOSURE MEASUREMENT SHALL BE REPRESENTATIVE OF THE MAXIMUM EIGHT-HOUR TIME WEIGHTED AVERAGE EXPOSURE OF THE EMPLOYEE.

(4) IF THE EXPOSURE MEASUREMENT TAKEN PURSUANT TO PARAGRAPH (B) (3) OF THIS SECTION REVEALS EMPLOYEE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS AT OR ABOVE THE ACTION LEVEL, THE EMPLOYER SHALL:

(I) IDENTIFY ALL EMPLOYEES WHO MAY BE EXPOSED AT OR ABOVE THE ACTION LEVEL; AND

(II) MEASURE THE EXPOSURE OF THE EMPLOYEES SO IDENTIFIED.

(5) IF AN EMPLOYEE EXPOSURE MEASUREMENT REVEALS THAT AN EMPLOYEE IS EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS AT OR ABOVE THE ACTION LEVEL, BUT NOT ABOVE THE PERMISSIBLE EXPOSURE, THE EXPOSURE OF THAT EMPLOYEE SHALL BE MEASURED AT LEAST EVERY TWO MONTHS.

(6) IF AN EMPLOYEE EXPOSURE MEASUREMENT REVEALS THAT AN EMPLOYEE IS EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS ABOVE THE PERMISSIBLE EXPOSURE, THE EMPLOYER SHALL:

(I) MEASURE THE EXPOSURE MONTHLY OF THE EMPLOYEE SO EXPOSED; AND

(II) INSTITUTE CONTROL MEASURES AS REQUIRED BY PARAGRAPH (D) OF THIS SECTION; AND

(III) INDIVIDUALLY NOTIFY, IN WRITING, WITHIN FIVE DAYS, EVERY EMPLOYEE WHO IS FOUND TO BE EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS ABOVE THE PERMISSIBLE EXPOSURE. THE EMPLOYEE SHALL ALSO BE NOTIFIED OF THE CORRECTIVE ACTION BEING TAKEN TO REDUCE THE EXPOSURE TO AT OR BELOW THE PERMISSIBLE EXPOSURE.

(7) IF TWO CONSECUTIVE EMPLOYEE EXPOSURE MEASUREMENTS TAKEN AT LEAST ONE WEEK APART REVEAL THAT THE EMPLOYEE IS EXPOSED TO SOLUBLE MOLYBDENUM

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COMPOUNDS BELOW THE ACTION LEVEL, THE EMPLOYER MAY TERMINATE MEASUREMENT FOR THE EMPLOYEE.

(8) FOR PURPOSES OF THIS PARAGRAPH, EMPLOYEE EXPOSURE IS THAT WHICH WOULD OCCUR IF THE EMPLOYEE WERE NOT USING A RESPIRATOR.

(C) METHODS OF MEASUREMENT. (1) AN EMPLOYEE'S EXPOSURE SHALL BE OBTAINED BY ANY COMBINATION OF LONG TERM OR SHORT TERM SAMPLES WHICH REPRESENTS THE EMPLOYEE'S ACTUAL EXPOSURE AVERAGED OVER AN EIGHT-HOUR WORK SHIFT (SEE APPENDIX B (IV) OF THIS SECTION).

(2) THE METHOD OF MEASUREMENT SHALL HAVE AN ACCURACY, TO A CONFIDENCE LEVEL OF 95 PERCENT, OF NOT LESS THAN THAT GIVEN IN TABLE 1.

TABLE 1

CONCENTRATION	REQUIRED ACCURACY
ABOVE PERMISSIBLE EXPOSURE	$\pm 25\%$
AT OR BELOW PERMISSIBLE EXPOSURE AND ABOVE THE ACTION LEVEL	$\pm 35\%$

AT OR BELOW THE ACTION LEVEL $\pm 50\%$

(D) COMPLIANCE. (1) NO EMPLOYEE SHALL BE EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS ABOVE THE PERMISSIBLE EXPOSURE AS DEFINED IN PARAGRAPH (A)(1) OF THIS SECTION.

(2) EMPLOYEE EXPOSURES TO AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS SHALL BE CONTROLLED TO AT OR BELOW THE PERMISSIBLE EXPOSURE BY ENGINEERING AND WORK PRACTICE CONTROLS:

(I) ENGINEERING AND WORK PRACTICE CONTROLS SHALL BE INSTITUTED TO REDUCE EXPOSURES TO AT OR BELOW THE PERMISSIBLE EXPOSURE, EXCEPT TO THE EXTENT THAT SUCH CONTROLS ARE NOT TECHNICALLY FEASIBLE.

(II) WHEREVER ENGINEERING AND WORK PRACTICE CONTROLS ARE NOT SUFFICIENT TO REDUCE EXPOSURES TO AT OR BELOW THE PERMISSIBLE EXPOSURE, THEY SHALL NONETHELESS BE USED TO REDUCE EXPOSURE TO THE LOWEST LEVEL FEASIBLE AND SHALL BE SUPPLEMENTED BY RESPIRATORS IN ACCORDANCE WITH PARAGRAPH (D)(4) OF THIS SECTION.

(3) ENGINEERING CONTROLS. WHEN MECHANICAL VENTILATION IS USED TO CONTROL EXPOSURE, MEASUREMENTS WHICH DEMONSTRATE SYSTEM EFFECTIVENESS, FOR EXAMPLE, AIR VELOCITY, STATIC PRESSURE, OR AIR VOLUME, SHALL BE MADE AT LEAST EVERY THREE MONTHS. MEASUREMENTS OF SYSTEM EFFECTIVENESS SHALL ALSO BE MADE WITHIN FIVE DAYS OF ANY CHANGE IN PRODUCTION, PROCESS, OR CONTROL WHICH MIGHT RESULT IN AN INCREASE IN AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS.

(4) COMPLIANCE WITH THE PERMISSIBLE EXPOSURE SHALL NOT BE ACHIEVED BY THE USE OF RESPIRATORS EXCEPT:

(I) DURING THE TIME PERIOD NECESSARY TO INSTALL OR IMPLEMENT ENGINEERING OR WORK PRACTICE CONTROLS; OR

(II) IN WORK SITUATIONS IN WHICH ENGINEERING AND WORK PRACTICE CONTROLS ARE TECHNICALLY NOT FEASIBLE; OR

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- (III) TO SUPPLEMENT ENGINEERING AND WORK PRACTICE CONTROLS WHEN SUCH CONTROLS FAIL TO REDUCE AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS TO AT OR BELOW THE PERMISSIBLE EXPOSURE; OR
- (IV) FOR OPERATIONS WHICH REQUIRE ENTRY INTO TANKS OR CLOSED VESSELS; OR
- (V) IN EMERGENCIES.
- (5) WHERE RESPIRATORS ARE NEEDED AND PERMITTED UNDER THIS PARAGRAPH TO REDUCE EMPLOYEE EXPOSURE, THE EMPLOYER SHALL SELECT AND PROVIDE THE APPROPRIATE RESPIRATOR FROM TABLE 2 AND SHALL ENSURE THAT THE EMPLOYEE USES THE RESPIRATOR PROVIDED.

TABLE 2 RESPIRATORY PROTECTION FOR SOLUBLE MOLYBDENUM COMPOUNDS

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
PARTICULATE CONCENTRATION	
25 MG/M3 OR LESS	ANY DUST OR MIST RESPIRATOR (*).
50 MG/M3 OR LESS	ANY DUST OR MIST RESPIRATOR EXCEPT QUARTER MASK OR SINGLE USE RESPIRATORS (*).
	ANY HIGH EFFICIENCY PARTICULATE FILTER RESPIRATOR (*).
250 MG/M3 OR LESS	A HIGH EFFICIENCY PARTICULATE FILTER RESPIRATOR WITH A FULL FACEPIECE.
	ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE, HELMET OR HOOD.
	ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
5000 MG/M3 OR LESS	A POWERED AIR-PURIFYING RESPIRATOR WITH A HIGH EFFICIENCY PARTICULATE FILTER AND A FULL FACEPIECE, HELMET OR HOOD.
10,000 MG/M3 OR LESS	A TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINUOUS-FLOW MODE.
GREATER THAN 10,000 MG/M3 OR ENTRY AND ESCAPE FROM UNKNOWN CONCENTRATIONS	SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.
	A COMBINATION RESPIRATOR WHICH INCLUDES A TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE OR CONTINUOUS-FLOW MODE AND AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.
FIRE FIGHTING	SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE

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OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE
MODE.

(*) : IN THOSE CASES WHERE EYE IRRITATION OCCURS, FULL FACEPIECE RESPIRATORS ARE RECOMMENDED. EXAMPLES OF MOLYBDENUM COMPOUNDS WHICH CAUSE EYE IRRITATION ARE: COMPOUNDS CONTAINING NITRATE, ACETATE, CHLORIDE, TRIOX AND MOLYBDATE.

(6) RESPIRATORS SHALL BE APPROVED BY THE MINING ENFORCEMENT AND SAFETY ADMINISTRATION (FORMERLY BUREAU OF MINES) OR BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH UNDER THE PROVISIONS OF 30 CFR PART 11.

(7) THE EMPLOYER SHALL INSTITUTE A RESPIRATORY PROTECTION PROGRAM IN ACCORDANCE WITH § 1910.134(B), (D), (E), AND (F).

(E) FIRE AND SAFETY. (1) THE EMPLOYER SHALL FAMILIARIZE HIMSELF WITH THE INFORMATION CONTAINED IN THE SUBSTANCE TECHNICAL GUIDELINES (APPENDIX B OF THIS SECTION) FOR SOLUBLE MOLYBDENUM COMPOUNDS.

(2) SOLUBLE MOLYBDENUM COMPOUNDS SHALL BE STORED SO AS NOT TO COME IN CONTACT WITH STRONG ALKALI METALS AND MOLTEN MAGNESIUM.

(F) PERSONAL PROTECTIVE EQUIPMENT. (1) EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE IMPERVIOUS CLOTHING, GLOVES, FACE SHIELDS (EIGHT-INCH MINIMUM) AND OTHER APPROPRIATE PROTECTIVE CLOTHING NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS. FACE SHIELDS SHALL COMPLY WITH § 1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).

(2) EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH SOLUBLE MOLYBDENUM COMPOUNDS BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE SOLUBLE MOLYBDENUM COMPOUNDS ARE REMOVED FROM THE CLOTHING.

(3) EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE SAFETY GOGGLES (CUP-COVER TYPE DUST AND SPLASH SAFETY GOGGLES) WHICH COMPLY WITH § 1910.133 (A)(2)-(A)(6) WHERE SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS MAY CONTACT THE EYES.

(G) SPILLS AND DISPOSAL. IN THE EVENT THAT SOLUBLE MOLYBDENUM COMPOUNDS ARE SPILLED, THE EMPLOYER SHALL IMMEDIATELY PROVIDE AVAILABLE VENTILATION AND THEN CLEAN UP THE SPILL.

(H) SANITATION. (1) EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH SOLUBLE MOLYBDENUM COMPOUNDS PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY SOLUBLE MOLYBDENUM COMPOUNDS FROM THE SKIN.

(2) EMPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE SOLUBLE MOLYBDENUM COMPOUNDS ARE HANDLED, PROCESSED OR STORED.

(3) EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING OR USING TOILET FACILITIES.

(I) TRAINING AND INFORMATION. (1) EACH EMPLOYER WHO HAS A WORKPLACE IN WHICH SOLUBLE MOLYBDENUM COMPOUNDS ARE PRESENT SHALL KEEP A COPY OF THIS REGULATION WITH APPENDIXES A, B AND C AT THE WORKPLACE. THIS MATERIAL SHALL BE MADE READILY AVAILABLE TO AFFECTED EMPLOYEES.

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(2) EACH EMPLOYER WHO HAS EMPLOYEES EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS ABOVE THE ACTION LEVEL OR EMPLOYEES WHO MAY HAVE SKIN OR EYE CONTACT WITH SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS, OR EMPLOYEES WHO WORK WHERE A SPILL OF SOLUBLE MOLYBDENUM COMPOUNDS MAY OCCUR, SHALL ANNUALLY:

(I) INFORM AFFECTED EMPLOYEES OF THE INFORMATION CONTAINED IN THE SUBSTANCE SAFETY DATA SHEET FOR SOLUBLE MOLYBDENUM COMPOUNDS (APPENDIX A OF THIS SECTION);

(II) ADVISE AFFECTED EMPLOYEES AS TO THE SIGNS AND SYMPTOMS OF EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS;

(III) INSTRUCT AFFECTED EMPLOYEES TO ADVISE THE EMPLOYER OF THE DEVELOPMENT OF SIGNS AND SYMPTOMS OF EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS WHICH ARE LISTED IN APPENDIX A OF THE SECTION;

(IV) INSTRUCT AFFECTED EMPLOYEES TO INFORM THE EMPLOYER IF THEY DEVELOP ANY OF THE MEDICAL CONDITIONS LISTED IN PARAGRAPH (J)(2) OF THIS SECTION; AND

(V) PROVIDE TRAINING TO ENSURE THAT EMPLOYEES UNDERSTAND THE PRECAUTIONS OF SAFE USE, EMERGENCY PROCEDURES, AND THE CORRECT USE OF PROTECTIVE EQUIPMENT RELATIVE TO SOLUBLE MOLYBDENUM COMPOUNDS.

(J) MEDICAL SURVEILLANCE. (1) THE EMPLOYER SHALL PROVIDE MEDICAL PROCEDURES AS REQUIRED BY THIS PARAGRAPH. ALL MEDICAL PROCEDURES SHALL BE PERFORMED BY OR UNDER THE SUPERVISION OF A PHYSICIAN AT NO COST TO THE EMPLOYEE.

(2) THE EMPLOYER SHALL OBTAIN FROM EACH EMPLOYEE WHO IS EXPOSED, OR WILL BE EXPOSED, TO SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS, OR AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS AT OR ABOVE THE ACTION LEVEL INFORMATION AS TO WHETHER SUCH EMPLOYEE HAS A HISTORY OF ANY OF THE FOLLOWING MEDICAL CONDITIONS:

(I) KIDNEY DISEASE

(II) BLOOD DISEASE

(III) CHRONIC LUNG DISEASE

(IV) GOUT

(3) THE EMPLOYER SHALL PROVIDE A MEDICAL EXAMINATION FOR THE EMPLOYEE IF:

(I) THE EMPLOYEE PROVIDES A HISTORY OF ANY OF THE MEDICAL CONDITIONS LISTED IN PARAGRAPH (J)(2) OF THIS SECTION; OR

(II) THE EMPLOYEE INFORMS THE EMPLOYER OF THE DEVELOPMENT OF ANY OF THE MEDICAL CONDITIONS LISTED IN PARAGRAPH (J)(2) OF THIS SECTION OR ANY OF THE SIGNS OR SYMPTOMS OF EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS WHICH ARE LISTED IN APPENDIX A WHICH THE EMPLOYEE SUSPECTS ARE CAUSED BY EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS.

(4) THE EMPLOYER SHALL PROVIDE TO THE EXAMINING PHYSICIAN THE FOLLOWING INFORMATION:

(I) A COPY OF THIS REGULATION WITH APPENDIXES A, B AND C FOR SOLUBLE MOLYBDENUM COMPOUNDS;

(II) A DESCRIPTION OF THE AFFECTED EMPLOYEE'S DUTIES AS THEY RELATE TO HIS EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS;

(III) A DESCRIPTION OF ANY PERSONAL PROTECTIVE EQUIPMENT AND RESPIRATORS REQUIRED TO BE USED;

(IV) THE RESULTS OF ANY MEASUREMENTS WHICH MAY INDICATE THE AFFECTED EMPLOYEE'S EXPOSURE;

(V) THE AFFECTED EMPLOYEE'S ANTICIPATED EXPOSURE; AND

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(VI) UPON REQUEST OF THE PHYSICIAN, ANY AVAILABLE INFORMATION FROM PREVIOUS MEDICAL EXAMINATIONS OF THE AFFECTED EMPLOYEE.

(5) WHERE A MEDICAL EXAMINATION IS REQUIRED BY PARAGRAPH (J)(3) OF THIS SECTION, FOLLOWING SUCH EXAMINATION THE EMPLOYER SHALL OBTAIN A WRITTEN OPINION FROM THE EXAMINING PHYSICIAN WHICH CONFORMS WITH PARAGRAPH (J)(6) OF THIS SECTION.

(6)(I) THE PHYSICIAN'S WRITTEN OPINION SHALL BE A SIGNED STATEMENT BY THE EXAMINING PHYSICIAN SPECIFICALLY STATING: (A) WHETHER THE EMPLOYEE HAS ANY DETECTED MEDICAL CONDITION WHICH WOULD PLACE THE EMPLOYEE AT INCREASED RISK OF MATERIAL IMPAIRMENT OF THE EMPLOYEE'S HEALTH FROM EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS OR WOULD DIRECTLY OR INDIRECTLY AGGRAVATE ANY DETECTED MEDICAL CONDITION;

(B) ANY RECOMMENDED LIMITATIONS UPON THE EMPLOYEE'S EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS INCLUDING LIMITATIONS UPON THE USE OF PERSONAL PROTECTIVE EQUIPMENT AND RESPIRATORS;

(C) THAT THE EMPLOYEE HAS BEEN INFORMED BY THE PHYSICIAN OF ANY DETECTED MEDICAL CONDITIONS WHICH REQUIRE FURTHER MEDICAL EXAMINATION OR TREATMENT.

(II) THE PHYSICIAN'S WRITTEN OPINION SHALL NOT REVEAL SPECIFIC MEDICAL FINDINGS OR DIAGNOSES UNRELATED TO EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS.

(III) THE EMPLOYER SHALL PROVIDE THE EMPLOYEE WITH A COPY OF THE PHYSICIAN'S WRITTEN OPINION.

(7) NO EMPLOYEE SHALL BE EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS OR AIRBORNE CONCENTRATIONS OF SOLUBLE MOLYBDENUM COMPOUNDS IN SUCH A WAY AS WOULD PUT THE EMPLOYEE AT INCREASED RISK OF MATERIAL IMPAIRMENT OF HIS HEALTH FROM SUCH EXPOSURE. THIS DETERMINATION MAY BE BASED ON THE PHYSICIAN'S WRITTEN OPINION.

(8) THE EMPLOYER SHALL PROVIDE EMERGENCY AND FOLLOW-UP MEDICAL EXAMINATIONS AND TREATMENT FOR ANY EMPLOYEE INJURED THROUGH EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS.

(9) IF AN EMPLOYEE REFUSES ANY REQUIRED MEDICAL EXAMINATION, THE EMPLOYER SHALL INFORM THE EMPLOYEE OF THE POSSIBLE HEALTH CONSEQUENCES OF SUCH REFUSAL AND OBTAIN A SIGNED STATEMENT FROM THE EMPLOYEE INDICATING THAT THE EMPLOYEE UNDERSTANDS THE RISK INVOLVED BY REFUSAL TO BE EXAMINED.

(10) NO MEDICAL PROCEDURE WHICH WOULD BE PERFORMED PURSUANT TO THIS SECTION NEED BE PERFORMED IF RECORDS OF A PREVIOUS SUCH PROCEDURE PERFORMED WITHIN THE PAST SIX MONTHS ARE ACCEPTABLE TO THE EXAMINING PHYSICIAN.

(K) RECORDKEEPING. (1) EXPOSURE DETERMINATION. (I) THE EMPLOYER SHALL KEEP AN ACCURATE RECORD OF ALL DETERMINATIONS REQUIRED TO BE MADE PURSUANT TO PARAGRAPH (B)(1) OF THIS SECTION.

(II) THIS RECORD SHALL INCLUDE THE WRITTEN DETERMINATION REQUIRED IN PARAGRAPH (B)(2) OF THIS SECTION.

(III) THIS RECORD SHALL BE MAINTAINED UNTIL REPLACED BY A MORE RECENT RECORD.

(2) EXPOSURE MEASUREMENTS. (I) THE EMPLOYER SHALL KEEP AN ACCURATE RECORD OF ALL MEASUREMENTS TAKEN TO DETERMINE EMPLOYEE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS.

(II) THIS RECORD SHALL INCLUDE:

(A) THE DATE OF MEASUREMENT;

(B) OPERATIONS INVOLVING EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS WHICH ARE BEING MONITORED;

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(C) SAMPLING AND ANALYTICAL METHODS USED AND EVIDENCE OF THEIR ACCURACY, INCLUDING THE METHOD, RESULTS AND DATE OF CALIBRATION OF SAMPLING EQUIPMENT;

(D) NUMBER, DURATION, AND RESULTS OF SAMPLES TAKEN; AND

(E) NAME, SOCIAL SECURITY NUMBER AND EXPOSURE OF THE EMPLOYEE MONITORED.

(III) THIS RECORD SHALL BE MAINTAINED UNTIL REPLACED BY A MORE RECENT RECORD BUT IN NO EVENT FOR LESS THAN ONE YEAR.

(3) MECHANICAL VENTILATION. (I) WHEN MECHANICAL VENTILATION IS USED AS AN ENGINEERING CONTROL, THE EMPLOYER SHALL MAINTAIN AN ACCURATE RECORD OF THE MEASUREMENTS DEMONSTRATING THE EFFECTIVENESS OF SUCH VENTILATION REQUIRED BY PARAGRAPH (D)(3) OF THIS SECTION.

(II) THIS RECORD SHALL INCLUDE:

(A) DATE OF MEASUREMENT;

(B) TYPE OF MEASUREMENT TAKEN;

(C) RESULT OF MEASUREMENT.

(III) THESE RECORDS SHALL BE MAINTAINED FOR AT LEAST ONE YEAR.

(4) EMPLOYEE TRAINING AND INFORMATION. (I) THE EMPLOYER SHALL KEEP AN ACCURATE RECORD OF ALL EMPLOYEE TRAINING AND INFORMATION REQUIRED BY PARAGRAPH (I) OF THIS SECTION.

(II) THIS RECORD SHALL INCLUDE:

(A) DATE OF TRAINING;

(B) NAME AND SOCIAL SECURITY NUMBER OF EMPLOYEE TRAINED;

(C) CONTENT OR SCOPE OF TRAINING PROVIDED.

(III) THIS RECORD SHALL BE MAINTAINED UNTIL REPLACED BY A MORE RECENT RECORD.

(5) MEDICAL SURVEILLANCE. (I) THE EMPLOYER SHALL KEEP AN ACCURATE RECORD OF EMPLOYEE MEDICAL SURVEILLANCE REQUIRED BY PARAGRAPH (J) OF THIS SECTION.

(II) THIS RECORD SHALL INCLUDE:

(A) INFORMATION CONCERNING MEDICAL CONDITIONS OBTAINED FROM THE EMPLOYEE PURSUANT TO PARAGRAPH (J)(2) OF THIS SECTION;

(B) ANY EMPLOYEE MEDICAL COMPLAINTS RELATIVE TO EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS;

(C) A COPY OF INFORMATION PROVIDED TO THE PHYSICIAN PURSUANT TO PARAGRAPH (J)(4)(II), (III), (IV), (V), AND (VI) OF THIS SECTION.

(D) PHYSICIAN'S WRITTEN OPINION; AND

(E) A SIGNED STATEMENT OF ANY REFUSAL TO BE EXAMINED.

(III) THIS RECORD SHALL BE MAINTAINED FOR THE DURATION OF THE EMPLOYMENT OF THE AFFECTED EMPLOYEE.

(6) ACCESS TO RECORDS. (I) ALL RECORDS REQUIRED TO BE MAINTAINED BY THIS SECTION SHALL BE MADE AVAILABLE UPON REQUEST TO AUTHORIZED REPRESENTATIVES OF THE ASSISTANT SECRETARY OF LABOR FOR OCCUPATIONAL SAFETY AND HEALTH AND THE DIRECTOR OF THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH.

(II) EMPLOYEE EXPOSURE DETERMINATION AND EXPOSURE MEASUREMENT RECORDS REQUIRED TO BE MAINTAINED BY THIS SECTION SHALL BE MADE AVAILABLE TO EMPLOYEES AND FORMER EMPLOYEES AND THEIR DESIGNATED REPRESENTATIVES.

(III) EMPLOYEE MEDICAL RECORDS REQUIRED TO BE MAINTAINED BY THIS SECTION SHALL BE MADE AVAILABLE UPON WRITTEN REQUEST TO A PHYSICIAN DESIGNATED BY THE EMPLOYEE OR FORMER EMPLOYEE.

(L) EMPLOYEE OBSERVATION OF MEASUREMENT. (1) THE EMPLOYER SHALL GIVE AFFECTED EMPLOYEES OR THEIR REPRESENTATIVES AN OPPORTUNITY TO OBSERVE ANY

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MEASUREMENT OF EMPLOYEE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS WHICH IS CONDUCTED PURSUANT TO THIS SECTION.

(2) WHEN OBSERVATION OF MEASUREMENT OF EMPLOYEE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS REQUIRES ENTRY INTO AN AREA WHERE THE USE OF PERSONAL PROTECTIVE DEVICES, INCLUDING RESPIRATORS, IS REQUIRED, THE OBSERVER SHALL BE PROVIDED WITH AND REQUIRED TO USE SUCH EQUIPMENT AND COMPLY WITH ALL OTHER APPLICABLE SAFETY PROCEDURES.

(3) WITHOUT INTERFERING WITH THE MEASUREMENT, OBSERVERS SHALL BE ENTITLED TO:

- (I) RECEIVE AN EXPLANATION OF THE MEASUREMENT PROCEDURE.
- (II) VISUALLY OBSERVE ALL STEPS RELATED TO THE MEASUREMENT OF THE AIRBORNE CONCENTRATION OF SOLUBLE MOLYBDENUM COMPOUNDS THAT ARE BEING PERFORMED AT THE PLACE OF EXPOSURE; AND
- (III) RECORD THE RESULTS OBTAINED.

NOTE: THE INFORMATION CONTAINED IN THE FOLLOWING APPENDIXES IS ADVISORY IN NATURE AND IS NOT INTENDED, BY ITSELF, TO CREATE ANY ADDITIONAL OBLIGATIONS NOT OTHERWISE IMPOSED OR DETRACT FROM ANY EXISTING OBLIGATION.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET
FOR SOLUBLE MOLYBDENUM COMPOUNDS

- I. SUBSTANCE IDENTIFICATION
 - A. SUBSTANCE: SOLUBLE MOLYBDENUM COMPOUNDS
 - B. PERMISSIBLE EXPOSURE: 5 MILLIGRAMS OF SOLUBLE MOLYBDENUM COMPOUNDS PER CUBIC METER OF AIR (MG/M3) AVERAGED OVER AN EIGHT-HOUR WORK SHIFT.
 - C. APPEARANCE AND ODOR: YELLOW TO WHITE ODORLESS SOLIDS
- II. HEALTH HAZARD DATA
 - A. WAYS IN WHICH THE CHEMICAL AFFECTS YOUR BODY: SOLUBLE MOLYBDENUM COMPOUNDS MIGHT AFFECT YOUR BODY IF YOU INHALE THEM OR IF THEY COME IN CONTACT WITH YOUR EYES OR SKIN. THEY MIGHT ALSO AFFECT YOUR BODY IF YOU SWALLOW THEM.
 - B. EFFECTS OF OVEREXPOSURE:
 1. SHORT-TERM EXPOSURE: SOLUBLE MOLYBDENUM COMPOUNDS HAVE CAUSED LOSS OF APPETITE, INCOORDINATION, AND IRRITATION OF EYES, NOSE AND THROAT, DIFFICULTY IN BREATHING, ANEMIA AND COLIC IN ANIMALS.
 2. LONG-TERM EXPOSURE: ANIMAL DATA SUGGESTS THAT REPEATED EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS MIGHT BE ASSOCIATED WITH GOUT.
 3. REPORTING SIGNS AND SYMPTOMS: YOU SHOULD INFORM YOUR EMPLOYER IF YOU DEVELOP ANY SIGNS OR SYMPTOMS AND

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SUSPECT THAT THEY ARE CAUSED BY EXPOSURE TO SOLUBLE
MOLYBDENUM COMPOUNDS.

III. EMERGENCY FIRST AID PROCEDURES

- A. EYE EXPOSURE: IF SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS GET INTO YOUR EYES, WASH YOUR EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, LIFTING THE LOWER AND UPPER LIDS OCCASIONALLY. IF IRRITATION IS PRESENT AFTER WASHING, GET MEDICAL ATTENTION. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.
- B. SKIN EXPOSURE: IF SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS GET ON YOUR SKIN, FLUSH THE CONTAMINATED SKIN WITH WATER. IF SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS PENETRATE THROUGH YOUR CLOTHING, REMOVE THE CLOTHING AND FLUSH THE SKIN WITH WATER. IF IRRITATION IS PRESENT AFTER WASHING, GET MEDICAL ATTENTION.
- C. BREATHING: IF YOU OR ANY OTHER PERSON BREATHES IN LARGE AMOUNTS OF SOLUBLE MOLYBDENUM COMPOUNDS MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.
- D. SWALLOWING: WHEN SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS HAVE BEEN SWALLOWED, GIVE THE PERSON LARGE QUANTITIES OF WATER IMMEDIATELY. AFTER THE WATER HAS BEEN SWALLOWED, TRY TO GET THE PERSON TO VOMIT BY HAVING HIM TOUCH THE BACK OF HIS THROAT WITH HIS FINGER. DO NOT MAKE AN UNCONSCIOUS PERSON VOMIT. GET MEDICAL ATTENTION IMMEDIATELY.
- E. RESCUE: MOVE AFFECTED PERSON FROM THE HAZARDOUS EXPOSURE. IF THE EXPOSED PERSON HAS BEEN OVERCOME, NOTIFY SOMEONE ELSE AND PUT INTO EFFECT THE ESTABLISHED EMERGENCY RESCUE PROCEDURES. DO NOT BECOME A CASUALTY YOURSELF. UNDERSTAND YOUR EMERGENCY RESCUE PROCEDURES AND KNOW THE LOCATIONS OF THE EQUIPMENT BEFORE THE NEED ARISES.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. RESPIRATORS: RESPIRATORS ARE NOT THE BEST WAY TO CONTROL EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS. YOU CAN ONLY BE REQUIRED TO WEAR THEM FOR ROUTINE USE IF YOUR EMPLOYER IS IN THE PROCESS OF INSTALLING CONTROLS OR CONTROL MEASURES PROVE INADEQUATE. YOU MAY BE REQUIRED TO WEAR RESPIRATORS FOR NON-ROUTINE ACTIVITIES OR IN EMERGENCIES. IF RESPIRATORS ARE WORN, THEY MUST HAVE A MINING ENFORCEMENT AND SAFETY ADMINISTRATION (MESA) OR NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOOSH) APPROVAL LABEL. (OLDER RESPIRATORS MAY HAVE A BUREAU OF MINES APPROVAL LABEL.) FOR EFFECTIVE PROTECTION, RESPIRATORS MUST FIT YOUR FACE AND HEAD SNUGLY. RESPIRATORS SHOULD NOT BE LOOSENED OR REMOVED IN WORK SITUATIONS WHERE THEIR USE IS REQUIRED. IF YOU EXPERIENCE DIFFICULTY BREATHING WHILE WEARING A RESPIRATOR, TELL YOUR EMPLOYER.
- B. PROTECTIVE CLOTHING: YOU MUST WEAR IMPERVIOUS CLOTHING, GLOVES, FACE SHIELD OR OTHER APPROPRIATE PROTECTIVE CLOTHING

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TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS. REPLACE OR REPAIR IMPERVIOUS CLOTHING THAT HAS DEVELOPED LEAKS.

- C. EYE PROTECTION: YOU MUST WEAR SPLASH-PROOF SAFETY GOGGLES WHERE LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS MAY CONTACT YOUR EYES. YOU MUST WEAR DUST-RESISTANT SAFETY GOGGLES WHERE THE SOLID FORM OF SOLUBLE MOLYBDENUM COMPOUNDS MAY CONTACT YOUR EYES.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

- A. SOLUBLE MOLYBDENUM COMPOUNDS MUST BE STORED IN TIGHTLY CLOSED CONTAINERS IN A WELL-VENTILATED AREA AWAY FROM STRONG ALKALI METALS (SUCH AS SODIUM OR POTASSIUM) AND MOLTEN MAGNESIUM.
- B. YOU MUST PROMPTLY REMOVE ANY NON-IMPERVIOUS CLOTHING THAT BECOMES CONTAMINATED WITH SOLUBLE MOLYBDENUM COMPOUNDS AND THIS CLOTHING MUST NOT BE REWORN UNTIL THE SOLUBLE MOLYBDENUM COMPOUNDS ARE REMOVED FROM THE CLOTHING.
- C. IF YOUR SKIN BECOMES CONTAMINATED WITH SOLUBLE MOLYBDENUM COMPOUNDS, YOU MUST PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE THE SOLUBLE MOLYBDENUM COMPOUNDS FROM YOUR SKIN.
- D. YOU MUST NOT EAT OR SMOKE IN AREAS WHERE SOLUBLE MOLYBDENUM COMPOUNDS ARE HANDLED, PROCESSED OR STORED.
- E. IF YOU HANDLE SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS, YOU MUST WASH YOUR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING OR USING TOILET FACILITIES.
- F. ASK YOUR SUPERVISOR WHERE SOLUBLE MOLYBDENUM COMPOUNDS ARE USED IN YOUR WORK AREA AND FOR ANY ADDITIONAL SAFETY AND HEALTH RULES.

VI. ACCESS TO INFORMATION

- A. EACH YEAR YOUR EMPLOYER IS REQUIRED TO INFORM YOU OF THE INFORMATION CONTAINED IN THIS SUBSTANCE SAFETY DATA SHEET FOR SOLUBLE MOLYBDENUM COMPOUNDS. IN ADDITION, YOUR EMPLOYER MUST INSTRUCT YOU IN THE SAFE USE OF SOLUBLE MOLYBDENUM COMPOUNDS, EMERGENCY PROCEDURES, AND THE CORRECT USE OF PROTECTIVE EQUIPMENT.
- B. YOUR EMPLOYER IS REQUIRED TO DETERMINE WHETHER YOU ARE BEING EXPOSED TO SOLUBLE MOLYBDENUM COMPOUNDS. YOU OR YOUR REPRESENTATIVE HAVE THE RIGHT TO OBSERVE EMPLOYEE EXPOSURE MEASUREMENTS AND TO RECORD THE RESULTS OBTAINED. IF YOUR EMPLOYER DETERMINES THAT YOU ARE BEING OVEREXPOSED, HE IS REQUIRED TO INFORM YOU OF THE EXPOSURE AND OF THE ACTIONS WHICH ARE BEING TAKEN TO REDUCE YOUR EXPOSURE.
- C. YOUR EMPLOYER IS REQUIRED TO KEEP RECORDS OF EXPOSURE DETERMINATIONS, EXPOSURE MEASUREMENTS, AND MEDICAL SURVEILLANCE. YOUR EMPLOYER IS REQUIRED TO MAKE RECORDS OF EXPOSURE DETERMINATIONS AND YOUR EXPOSURE MEASUREMENTS AVAILABLE TO YOU OR YOUR REPRESENTATIVE UPON YOUR REQUEST. YOUR EMPLOYER IS REQUIRED TO RELEASE YOUR MEDICAL RECORDS TO YOUR PHYSICIAN UPON YOUR WRITTEN REQUEST.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR SOLUBLE MOLYBDENUM COMPOUNDS

(THE STANDARD FOR SOLUBLE MOLYBDENUM COMPOUNDS SHOULD NOT BE INTERPRETED TO A
SUBSTANCES LISTED BELOW FOR WHICH SUBSTANCE SPECIFIC INFORMATION HAS BEEN PR

I. PHYSICAL AND CHEMICAL DATA (MOLYBDIC TRIOXIDE)

A. SUBSTANCE IDENTIFICATION

1. SYNONYMS: MOLYBDENUM ANHYDRIDE; MOLYBDIC OXIDE
2. FORMULA: MoO3
3. MOLECULAR WEIGHT: 144

B. PHYSICAL DATA

1. BOILING POINT (760 MM HG): NOT APPLICABLE
2. SPECIFIC GRAVITY (WATER = 1): 4.7
3. VAPOR DENSITY (AIR = 1 AT BOILING POINT OF SOLUBLE MOLYBDENUM COMPOUNDS): NOT APPLICABLE
4. MELTING POINT: 795 C (1463 F)
5. VAPOR PRESSURE AT 20 C (68 F): ESSENTIALLY ZERO
6. SOLUBILITY IN WATER, % BY WEIGHT AT 20 C (68 F): 0.5
7. EVAPORATION RATE (BUTYL ACETATE = 1): NOT APPLICABLE
8. APPEARANCE AND ODOR: YELLOW TO WHITE ODORLESS SOLID

II. PHYSICAL AND CHEMICAL DATA (AMMONIUM MOLYBDATE)

A. SUBSTANCE IDENTIFICATION

1. SYNONYMS: 85% MOLYBDIC ACID
2. FORMULA: (NH4)2MoO4
3. MOLECULAR WEIGHT: 196

B. PHYSICAL DATA

1. BOILING POINT (760 MM HG): NOT APPLICABLE
2. SPECIFIC GRAVITY (WATER = 1): 2.3
3. VAPOR DENSITY (AIR = 1 AT BOILING POINT OF SOLUBLE MOLYBDENUM COMPOUNDS): NOT APPLICABLE
4. MELTING POINT: DECOMPOSES
5. VAPOR PRESSURE AT 20 C (68 F): ESSENTIALLY ZERO
6. SOLUBILITY IN WATER, % BY WEIGHT AT 20 C (68 F): SOLUBLE, DECOMPOSES
7. EVAPORATION RATE (BUTYL ACETATE = 1): NOT APPLICABLE
8. APPEARANCE AND ODOR: YELLOW TO WHITE ODORLESS SOLIDS

III. PHYSICAL AND CHEMICAL DATA (AMMONIUM PARAMOLYBDATE)

A. SUBSTANCE IDENTIFICATION

1. SYNONYMS: NONE
2. FORMULA: (NH4)6Mo7O24-4H2O
3. MOLECULAR WEIGHT: 1238

B. PHYSICAL DATA

1. BOILING POINT (760 MM HG): NOT APPLICABLE
2. SPECIFIC GRAVITY (WATER = 1): 2.5
3. VAPOR DENSITY (AIR = 1 AT BOILING POINT OF SOLUBLE MOLYBDENUM COMPOUNDS): NOT APPLICABLE
4. MELTING POINT: DECOMPOSES

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5. VAPOR PRESSURE AT 20 C (68 F): ESSENTIALLY ZERO
 6. SOLUBILITY IN WATER, % BY WEIGHT AT 20 C (68 F): 43
 7. EVAPORATION RATE (BUTYL ACETATE = 1): NOT APPLICABLE
 8. APPEARANCE AND ODOR: YELLOW TO WHITE ODORLESS SOLIDS
- IV. PHYSICAL AND CHEMICAL DATA (CALCIUM MOLYBDATE)
- A. SUBSTANCE IDENTIFICATION
 1. SYNONYMS: NONE
 2. FORMULA: CaMoO4
 3. MOLECULAR WEIGHT: 200
 - B. PHYSICAL DATA
 1. BOILING POINT (760 MM HG): NOT APPLICABLE
 2. SPECIFIC GRAVITY (WATER = 1): 4.35
 3. VAPOR DENSITY (AIR = 1 AT BOILING POINT OF SOLUBLE MOLYBDENUM COMPOUNDS): NOT APPLICABLE
 4. MELTING POINT: 695 C (1283 F)
 5. VAPOR PRESSURE AT 20 C (68 F): ESSENTIALLY ZERO
 6. SOLUBILITY IN WATER, % BY WEIGHT AT 20 C (68 F): 0.01
 7. EVAPORATION RATE (BUTYL ACETATE = 1): NOT APPLICABLE
 8. APPEARANCE AND ODOR: YELLOW TO WHITE ODORLESS SOLID
- V. PHYSICAL AND CHEMICAL DATA (SODIUM MOLYBDATE, DIHYDRATE)
- A. SUBSTANCE IDENTIFICATION
 1. SYNONYMS: SODIUM MOLYBDATE
 2. FORMULA: Na2MoO4-2H2O
 3. MOLECULAR WEIGHT: 241.95
 - B. PHYSICAL DATA
 1. BOILING POINT (760 MM HG): NOT APPLICABLE
 2. SPECIFIC GRAVITY (WATER = 1): 3.28
 3. VAPOR DENSITY (AIR = 1 AT THE BOILING POINT OF SOLUBLE MOLYBDENUM COMPOUNDS): NOT APPLICABLE
 4. MELTING POINT: LOSES ITS WATER AT 100 C (212 F)
 5. VAPOR PRESSURE AT 20 C (68 F): DATA NOT AVAILABLE
 6. SOLUBILITY IN WATER, % BY WEIGHT AT 0 C (32 F): 56.2
 7. EVAPORATION RATE (BUTYL ACETATE = 1): NOT APPLICABLE
 8. APPEARANCE: WHITE CRYSTALLINE POWDER
- VI. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA (SOLUBLE MOLYBDENUM COMPOUNDS)
- A. FIRE
 1. NOT COMBUSTIBLE
 - B. REACTIVITY
 1. CONDITIONS CONTRIBUTING TO INSTABILITY: AMMONIUM MOLYBDATE AND AMMONIUM PARAMOLYBDATE DECOMPOSE ABOVE 360 C (680 F). OTHERS ARE STABLE.
 2. INCOMPATIBILITIES: CONTACT WITH ALKALI METALS SUCH AS SODIUM AND POTASSIUM OR WITH MOLTEN MAGNESIUM MAY CAUSE FIRES AND EXPLOSION.
 3. HAZARDOUS DECOMPOSITION PRODUCTS: TOXIC GASES AND VAPORS (SUCH AS AMMONIA AND CARBON MONOXIDE) MAY BE RELEASED WHEN SOME SOLUBLE MOLYBDENUM COMPOUNDS DECOMPOSE.
 4. SPECIAL PRECAUTIONS: NONE.
- VII. SPILL AND DISPOSAL PROCEDURES (SOLUBLE MOLYBDENUM COMPOUNDS)

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- A. IF SOLUBLE MOLYBDENUM COMPOUNDS OR LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS ARE SPILLED, THE FOLLOWING STEPS SHOULD BE TAKEN:
1. VENTILATE AREA OF SPILL.
 2. COLLECT SPILLED MATERIAL IN THE MOST CONVENIENT AND SAFE MANNER AND DEPOSIT IN SEALED CONTAINERS FOR RECLAMATION, OR FOR DISPOSAL IN A SECURED SANITARY LANDFILL. LIQUIDS CONTAINING SOLUBLE MOLYBDENUM COMPOUNDS SHOULD BE ABSORBED IN VERMICULITE, DRY SAND, EARTH OR A SIMILAR MATERIAL.
- B. PERSONS NOT WEARING PROTECTIVE EQUIPMENT SHOULD BE RESTRICTED FROM AREAS OF SPILLS UNTIL CLEANUP HAS BEEN COMPLETED.
- C. WASTE DISPOSAL METHODS: SOLUBLE MOLYBDENUM COMPOUNDS MAY BE DISPOSED OF IN SEALED CONTAINERS IN A SECURED SANITARY LANDFILL.

- VIII. MONITORING AND MEASUREMENT PROCEDURES (SOLUBLE MOLYBDENUM COMPOUNDS)
- A. EXPOSURE ABOVE THE ACTION LEVEL: MEASUREMENTS TAKEN FOR THE PURPOSE OF DETERMINING EMPLOYEE EXPOSURE UNDER THIS SECTION ARE BEST TAKEN SUCH THAT THE AVERAGE 8-HOUR EXPOSURE MAY BE DETERMINED FROM A SINGLE EIGHT-HOUR SAMPLE OR TWO (2) 4-HOUR SAMPLES. SEVERAL SHORT TIME INTERVAL SAMPLES (UP TO 30 MINUTES) MAY ALSO BE USED TO DETERMINE THE AVERAGE EXPOSURE LEVEL. AIR SAMPLES SHOULD BE TAKEN IN THE EMPLOYEE'S BREATHING ZONE (AIR THAT WOULD MOST NEARLY REPRESENT THAT INHALED BY THE EMPLOYEE). SAMPLING AND ANALYSES MAY BE PERFORMED BY INSTRUMENTS SUCH AS DETECTOR TUBES CERTIFIED BY NIOSH UNDER 42 CFR PART 84, PORTABLE DIRECT-READING INSTRUMENTS, DOSIMETERS, OR BY COLLECTION OF THE PARTICULATES USING A HIGH EFFICIENCY MEMBRANE FILTER WITH SUBSEQUENT CHEMICAL ANALYSES. THE METHOD OF MEASUREMENT MUST DETERMINE THE CONCENTRATION OF SOLUBLE MOLYBDENUM COMPOUNDS TO PLUS OR MINUS 35%.
- B. EXPOSURE ABOVE THE PERMISSIBLE EXPOSURE: THE MONITORING AND MEASUREMENTS UNDER THIS SECTION SHOULD BE ESSENTIALLY THE SAME AS DESCRIBED UNDER PARAGRAPH IV. A. LABORATORIES PERFORMING CHEMICAL ANALYSES SHOULD BE ACCREDITED IN INDUSTRIAL HYGIENE CHEMISTRY BY THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION. THE METHOD OF MEASUREMENT MUST DETERMINE THE CONCENTRATION OF SOLUBLE MOLYBDENUM COMPOUNDS TO PLUS OR MINUS 25%.
- C. METHODS: METHODS MEETING THESE ACCURACY REQUIREMENTS ARE AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, U. S. DEPARTMENT OF COMMERCE, SPRINGFIELD, VIRGINIA 22161 UNDER THE TITLE "NIOSH ANALYTICAL METHODS FOR SET M" (ORDER NUMBER XXXXXXXXXX).
- D. QUALIFIED PERSONS: SINCE MANY OF THE DUTIES RELATING TO EMPLOYEE PROTECTION ARE DEPENDENT ON THE RESULTS OF MONITORING AND MEASURING PROCEDURES, EMPLOYERS SHOULD ASSURE THAT THE EVALUATION OF EMPLOYEE EXPOSURES IS PERFORMED BY A COMPETENT INDUSTRIAL HYGIENIST OR OTHER TECHNICALLY QUALIFIED PERSON.

IX. MISCELLANEOUS PRECAUTIONS (SOLUBLE MOLYBDENUM COMPOUNDS)

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- A. STORE SOLUBLE MOLYBDENUM COMPOUNDS IN TIGHTLY CLOSED CONTAINERS IN A WELL VENTILATED AREA.
- B. EMPLOYERS SHOULD ADVISE EMPLOYEES OF ALL AREAS AND OPERATIONS WHERE EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS COULD OCCUR.
- X. COMMON OPERATIONS (SOLUBLE MOLYBDENUM COMPOUNDS)
COMMON OPERATIONS IN WHICH EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS ARE LIKELY TO OCCUR ARE: DURING THEIR PRESENCE AS A FUME DURING THE PROCESSING OF MOLYBDENUM STEELS (OXIDE); DURING THEIR USE AS A CATALYST IN PETROLEUM REFINING; AS A GLAZE FOR CERAMICS; AS AN ANALYTICAL REAGENT FOR PHOSPHORUS AND LEAD; AS AN INGREDIENT IN CORROSION-RESISTANT PIGMENTS (CALCIUM SALTS); AS A COMPONENT OF ELECTRODES AND IN LEATHER AND SKIN TANNING (SULFATE); USE IN PIGMENTS, PAINTS, LACQUERS AND INKS; AND AS A CATALYST IN GASOLINE DESULFURIZATION.

APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

INHALATION.

II. TOXICOLOGY

SOLUBLE MOLYBDENUM COMPOUNDS HAVE A LOW TOXICITY, BUT MAY CAUSE ANEMIA AND DEFORMITIES OF THE FORELEGS WHEN FED TO RABBITS IN HIGH DOSES. THE APPROXIMATE ORAL LD50 IN RATS OF DAILY REPEATED DOSES OF AMMONIUM MOLYBDATE WAS 333 MG MOLYBDENUM/G/DAY; SODIUM MOLYBDATE WAS FATAL TO RABBITS WITHIN A FEW WEEKS AT A DIETARY LEVEL OF 0.1 PER CENT. IN RATS AND GUINEA PIGS, ORAL DOSES OF 1.2 G/KG AMMONIUM MOLYBDATE CAUSED ANOREXIA, COLIC, TREMBLING, INCOORDINATION, AND DYSPNEA; ANEMIA AND DEFORMITY OF THE FORELEGS OCCURRED IN RABBITS. EXPOSURE OF MICE FOR 1 HOUR TO A HIGH CONCENTRATION OF THE DUST OF AMMONIUM MOLYBDATE CAUSED A TRANSITORY IRRITATION OF MUCOUS MEMBRANES. WHILE MOLYBDENUM IS ESSENTIAL TO THE ACTION OF CERTAIN ENZYMES, HIGHER MOLYBDENUM LEVELS MAY INHIBIT THE ACTION OF OTHER ENZYMES. HIGH INTAKE OF MOLYBDENUM IN RATS RESULTED IN A SUBSTANTIAL REDUCTION IN ACTIVITY OF SULFIDE OXIDASE IN THE LIVER. THE REDUCED ACTIVITY OF THIS ENZYME LEADS TO ACCUMULATION OF SULFIDE IN THE TISSUES AND SUBSEQUENT FORMATION OF HIGHLY UNDISSOCIATED COPPER SULFIDE, THUS REMOVING COPPER FROM METABOLIC ACTIVITY. THIS IS A PROBABLE EXPLANATION FOR THE INDUCTION OF COPPER DEFICIENCY BY MOLYBDATE. THERE HAVE BEEN NO REPORTS OF SYSTEMIC EFFECTS FROM INDUSTRIAL EXPOSURE. A STUDY FROM THE ANKAVAN PROVINCE OF RUSSIA WHERE DIETARY MOLYBDENUM INTAKE RANGES FROM 10-15 MG PER DAY DUE TO HIGH NATURAL LEVELS HAS SHOWN ELEVATED BLOOD XANTHINE OXIDASE ACTIVITY AND INCREASED URIC ACID CONCENTRATIONS IN BLOOD OF RESIDENTS COMPARED TO CONTROLS LIVING IN AN AREA WITH LOWER MOLYBDENUM EXPOSURE. A HIGH PERCENTAGE (31%) OF THE POPULATION EXAMINED FROM THE ANKAVAN PROVINCE WERE DIAGNOSED AS HAVING A GOUT-LIKE DISEASE.

III. SIGNS AND SYMPTOMS

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BY ANALOGY TO EFFECTS CAUSED IN ANIMALS IT MAY CAUSE ANOREXIA, INCOORDINATION, DYSPNEA, ANEMIA, AND IRRITATION OF MUCOUS MEMBRANES.

IV. SPECIAL TESTS

NONE IN COMMON USAGE. INCREASED EXCRETION OF URIC ACID MAY BE OBSERVED.

V. TREATMENT

REMOVE FROM EXPOSURE. FLUSH EYES AND SKIN WITH WATER. IF SWALLOWED AND THE PERSON IS CONSCIOUS, INDUCE VOMITING. GIVE ARTIFICIAL RESUSCITATION IF INDICATED. RECOVERY IS USUALLY RAPID AND COMPLETE.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

SOLUBLE MOLYBDENUM COMPOUNDS HAVE A LOW TOXICITY BUT IN ANIMALS AT HIGH DOSES HAVE CAUSED IRRITATION OF MUCOUS MEMBRANES, INCOORDINATION, DYSPNEA, AND ANEMIA. IT IS IMPORTANT THAT THE PHYSICIAN BECOME FAMILIAR WITH PLANT OPERATING CONDITIONS IN WHICH EXPOSURE TO SOLUBLE MOLYBDENUM COMPOUNDS OCCUR. THOSE WITH SKIN DISEASE MAY NOT TOLERATE THE WEARING OF PROTECTIVE CLOTHING AND THOSE WITH CHRONIC RESPIRATORY DISEASE MAY NOT TOLERATE THE WEARING OF NEGATIVE PRESSURE RESPIRATORS.

B. PREPLACEMENT

ROUTINE MEDICAL HISTORIES AND PHYSICAL EXAMINATIONS ARE NOT REQUIRED. HOWEVER, THE EMPLOYER MUST SCREEN EMPLOYEES FOR HISTORY OF CERTAIN MEDICAL CONDITIONS (LISTED BELOW) WHICH MIGHT PLACE THE EMPLOYEE AT INCREASED RISK FROM SOLUBLE MOLYBDENUM COMPOUNDS EXPOSURE. ONLY THOSE GIVING A POSITIVE HISTORY OF THESE CONDITIONS MUST BE REFERRED FOR FURTHER MEDICAL EXAMINATIONS.

1. KIDNEY DISEASE -- ALTHOUGH SOLUBLE MOLYBDENUM COMPOUNDS ARE NOT KNOWN AS KIDNEY TOXINS IN HUMANS, THE IMPORTANCE OF THIS ORGAN IN THE ELIMINATION OF TOXIC SUBSTANCES JUSTIFIES SPECIAL CONSIDERATION IN THOSE WITH IMPAIRED RENAL FUNCTION.
2. CHRONIC RESPIRATORY DISEASE -- IN PERSONS WITH IMPAIRED PULMONARY FUNCTION, ESPECIALLY THOSE WITH OBSTRUCTIVE AIRWAY DISEASES, THE BREATHING OF SOLUBLE MOLYBDENUM COMPOUNDS MIGHT CAUSE EXACERBATION OF SYMPTOMS DUE TO THEIR IRRITANT PROPERTIES.
3. BLOOD DISEASE -- SOLUBLE MOLYBDENUM COMPOUNDS CAUSE ANEMIA IN ANIMALS. PERSONS WITH PREEXISTING BLOOD DISORDERS MAY BE MORE SUSCEPTIBLE TO THE EFFECTS OF THESE AGENTS.

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4. GOUT -- SOLUBLE MOLYBDENUM COMPOUNDS MAY CAUSE GOUT. PERSONS WITH PREEXISTING CONDITIONS MAY BE MORE SUSCEPTIBLE TO THE EFFECTS OF THESE AGENTS.

C. PERIODIC EXAMINATIONS

ROUTINE PERIODIC EXAMINATIONS ARE NOT REQUIRED. HOWEVER, IF THE EMPLOYER BECOMES AWARE OF AN EMPLOYEE WITH THE ABOVE LISTED CONDITIONS, HE MUST REFER SUCH EMPLOYEE FOR FURTHER MEDICAL EXAMINATION.

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1910.93

(F) PERSONAL PROTECTIVE EQUIPMENT, AND, (H) SANITATION
EYE: LARRING AND WERGELAND, "OCULAR TOXICITY OF NEWER INDUSTRIAL METALS," MILITARY MED., VOL. 135, NO. 12, P. 1171 - 4;
STAUDEN, "KIRK-OTTMER ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY;"
"DOCUMENTATION OF THRESHOLD LIMIT VALUES"
SKIN: SAX, "DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS"
INGESTION: BROWNING, "TOXICITY OF INDUSTRIAL METALS;" "DOCUMENTATION OF THRESHOLD LIMIT VALUES;" PATTY, "INDUSTRIAL HYGIENE AND TOXICOLOGY;" SPECTOR, "HANDBOOK OF TOXICOLOGY"
COMMENTS
EYE: CLASSIFICATION: 2 AND 6
OUTPUT STATEMENT NUMBERS: 10 AND 12 COMBINED
EXCEPTIONS: NONE
A SEARCH OF THE LITERATURE FAILED TO REVEAL MUCH INFORMATION ON THE TOXICOLOGICAL PROPERTIES OF MOLYBDENUM AND ITS COMPOUNDS UPON CONTACT WITH THE EYE. THE ABSTRACT OF LARRING AND WERGELAND NOTES THAT THE TOXICITY OF MOLYBDENUM WAS EVALUATED BY THE PLACING OF A SMALL FRAGMENT INTO THE MIDVITREOUS OF A RABBIT'S EYE. IT WAS DETERMINED TO BE "COMPLETELY INERT JUDGED CLINICALLY AND BY PATHOLOGIC EXAMINATION AFTER A YEAR'S DURATION." NO SPECIFIC DATA COULD BE FOUND CONCERNING THE EYE EFFECTS OF COMPOUNDS CONTAINING THE SUBSTANCE. THEY ARE ASSIGNED CLASSIFICATIONS OF 2 AND 6 SIMPLY BY THE FACTS, ACCORDING TO KIRK-OTTMER THAT "SOME HETEROPOLY COMPOUNDS, AND ESPECIALLY HETEROPOLYMOBYDATES, ARE STRONG OXIDIZING AGENTS," AND THAT "THE FREE HETEROPOLYMOBYDIC ACIDS ARE FAIRLY STRONG ACIDS." THIS CONCLUSION IS SOMEWHAT SUPPORTED BY THE STATEMENT IN THE DOCUMENTATION OF TLV'S THAT "THE DUSTS OF MOLYBDENUM METAL AND TRIOXIDE CAUSED ONLY A TRANSITORY IRRITATION OF MUCOSAL SURFACES IN WHITE MICE AFTER AN INTENSIVE 1 HOUR DUSTING."
SKIN - CLASSIFICATION: 2 AND 6
OUTPUT STATEMENT NUMBERS: 2, 176, 171, 20A
EXCEPTIONS: SEE BELOW
SAX CONSIDERS "MOLYBDENUM COMPOUNDS" IN GENERAL AS BEING ACUTE LOCAL IRRITANTS OF SLIGHT TOXIC HAZARD. NO OTHER SPECIFIC DATA COULD BE FOUND IN THE LITERATURE CONCERNING THE LOCAL OR SYSTEMIC EFFECTS OF SKIN CONTACT. BASED ON THE SAME REASONING AS ABOVE, THAT SOME COMPOUNDS ARE FAIRLY STRONG ACIDS AND OTHERS ARE STRONG OXIDIZING AGENTS, IT IS CONCLUDED THAT AT LEAST MINIMUM REQUIREMENTS BASED ON CLASSIFICATIONS OF 2 AND 6 ARE WARRANTED. SPECIFICALLY, STATEMENTS 2 AND 20A ARE UTILIZED TO PREVENT REPEATED OR PROLONGED CONTACT AND STATEMENTS 176 AND 171 TO REQUIRE THAT CONTAMINANTS ARE NOT LEFT IN CONTACT WITH THE BODY FOR EXTENDED PERIODS OF TIME.
INGESTION - CLASSIFICATION: 2 AND 6
OUTPUT STATEMENT NUMBERS: 19, 20A
EXCEPTIONS: NONE

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

BROWNING REPORTS "THE HEXAVALENT WATER-SOLUBLE COMPOUNDS OF MOLYBDENUM ARE READILY ABSORBED FROM THE INTESTINAL TRACT, ALSO SUCH INSOLUBLE COMPOUNDS AS THE TRIOXIDE AND CALCIUM MOLYBDATE IF GIVEN IN LARGE DOSES, BUT APPARENTLY NOT THE SULPHIDE MOLYBDENITE."

SPECTOR LISTS AN ACUTE ORAL LD FOR GUINEA PIGS OF 2200 MG/KG, A CAT LD OF 1600 - 3200 MG/KG, AND A RABBIT LD OF 1870 MG/KG FOR THE COMPOUND AMMONIUM MOLYBDATE. ACCORDING TO BROWNING, IT HAS BEEN FOUND THAT THE SYMPTOMS OF INTOXICATION FROM LARGE DOSES OF AMMONIUM MOLYBDATE BY MOUTH INCLUDED "ANOREXIA, COLIC, TREMBLING, INCOORDINATED MOVEMENTS AND DYSPNOEA. THE SYMPTOMS INCLUDE ANAEMIA IN YOUNG RABBITS AND SOMETIMES A DEFORMITY OF THE FORELEGS . . ."

THE DOCUMENTATION OF TLV'S REPORTS THAT "MOLYBDENUM TRIOXIDE, CALCIUM MOLYBDATE AND AMMONIUM MOLYBDATE, WHEN FED TO RATS AND GUINEA PIGS IN LARGE DOSES FROM 1,200 TO 6,000 MG OF MO/KG INVARIABLY PROVED FATAL. THE FATALITIES WERE FEWER IN ANIMALS FED 120 TO 600 MG OF MO/KG. THERE WERE NO FATALITIES WHEN AMOUNTS AS GREAT AS 6,000 MG OF MO AS MOLYBDENITE PER KG . . . WERE INGESTED." BROWNING ADDS THAT "ONLY IN THE ANIMALS GIVEN MOLYBDENUM TRIOXIDE . . . WERE THERE ANY SIGNIFICANT CHANGES. BY ORAL ADMINISTRATION THESE CONSISTED CHIEFLY OF FATTY CHANGES IN THE LIVER AND KIDNEYS." SHE GIVES ORAL LD50'S FOR RATS OF 125 MG/KG FOR THE TRIOXIDE, 101 MG FOR CALCIUM MOLYBDATE AND 333 MG/KG FOR AMMONIUM MOLYBDATE. PATTY CLARIFIES THIS LATTER STATEMENT BY REPORTING THAT THESE LD50'S ARE FOR DAILY REPEATED DOSES IN MG OF MO/KG/DAY.

PATTY REPORTS THAT "SODIUM MOLYBDATE WAS UNIFORMLY FATAL TO THE RABBIT AT ALL DIETARY LEVELS OF 0.1% AND HIGHER WITHIN A FEW WEEKS," AND THAT MOLYBDENUM DISULFIDE "IS WELL TOLERATED BY RATS IN DAILY REPEATED DOSES OF 10 TO 500 MG/RAT/DAY."

IT IS CONCLUDED THAT CLASSIFICATIONS OF 2 AND 6 ARE SUFFICIENT TO PREVENT EXCESSIVE INGESTION OF THESE COMPOUNDS.

SUBSTANCE TECHNICAL GUIDELINES

THE REFERENCES CITED FOR THIS DOCUMENT INCLUDE:

CLIMAX MOLYBDENUM CO., MATERIAL SAFETY DATA SHEETS (CLIMAX)

KENNECOTT COPPER CORP., INFORMATION BULLETIN ON MOLYBDENUM COMPOUNDS (KEN)

L. T. FAIRHALL, ET AL., U. S. PUBLIC HEALTH SERVICE, PUBLIC HEALTH BULLETIN NO. 293, 1945 (FAIR)

"MERCK INDEX," 8TH EDITION, 1968 (MERCK)

KIRK-OTHMER, "ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY," 2ND EDITION, VOL. 13, P. 645 (K-O)

NATIONAL FIRE PROTECTION ASSOCIATION, "FIRE PROTECTION GUIDE ON HAZARDOUS MATERIALS," 5TH EDITION, 1973 (NFPA)

CHEMICAL RUBBER CO., "HANDBOOK OF CHEMISTRY AND PHYSICS," 54TH EDITION, 1973 - 4 (CRC)

"LANGE'S HANDBOOK OF CHEMISTRY," 11TH EDITION (LANGE)

SOURCES OF DATA ITEMS USED:

1. A. 1. SYNONYMS: CLIMAX; FAIR; K-O
2. FORMULA: CLIMAX; FAIR; MERCK; LANGE; CRC
3. MOLECULAR WEIGHT: MERCK; LANGE; CRC

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

- B.
 - 1. BOILING POINT: NOT APPLICABLE
 - 2. SPECIFIC GRAVITY: CLIMAX; MERCK; LANGE; CRC
 - 3. VAPOR DENSITY: NOT APPLICABLE
 - 4. MELTING POINT: MERCK; K-O; CRC
 - 5. VAPOR PRESSURE: ADL
 - 6. SOLUBILITY IN WATER: CLIMAX; CRC; MERCK
 - 7. EVAPORATION RATE: NOT APPLICABLE
 - 8. APPEARANCE AND ODOR: CLIMAX; CRC; MERCK
- II. A.
 - 1. FLASH POINT: NOT APPLICABLE
 - 2. AUTOIGNITION TEMPERATURE: NOT APPLICABLE
 - 3. FLAMMABLE LIMITS: NOT APPLICABLE
 - 4. EXTINGUISHING MEDIA: NOT APPLICABLE
 - 5. SPECIAL FIRE FIGHTING PROCEDURES:
 - 6. UNUSUAL FIRE AND EXPLOSION HAZARDS: CLIMAX
- B.
 - 1. CONDITIONS CONTRIBUTING TO INSTABILITY: CLIMAX
 - 2. INCOMPATIBILITIES: NFPA-491M
 - 3. HAZARDOUS DECOMPOSITION PRODUCTS: CLIMAX
 - 4. SPECIAL PRECAUTIONS: ADL
- III. A. STEPS IF RELEASED OR SPILLED: CLIMAX
- C. WASTE DISPOSAL METHOD: ADL
- V. MISCELLANEOUS PRECAUTIONS: ADL

USE/EXPOSURE AND CONTROL DOCUMENT

REFERENCES USED IN THE PREPARATION OF THIS DOCUMENT INCLUDE:

- "DOCUMENTATION OF THRESHOLD LIMIT VALUES," AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS, 1971 (ACGIH)
- ELKINS, H. B., "CHEMISTRY OF INDUSTRIAL TOXICOLOGY," JOHN WILEY AND SONS, INC., 2ND EDITION, 1959 (ELKINS)
- FAIRHALL, L. T., "INDUSTRIAL TOXICOLOGY," WILLIAMS AND WILKINS COMPANY, 2ND EDITION, 1957 (FAIRHALL)
- FAIRHALL, L. T., "THE TOXICITY OF MOLYBDENUM," PUBLIC HEALTH BULLETIN NO. 293, U. S. PUBLIC HEALTH SERVICE, 1945 (PUBLIC HEALTH)
- "HANDBOOK OF CHEMISTRY AND PHYSICS," CRC PRESS, CLEVELAND, OHIO, 54TH EDITION, 1973 (CRC HANDBOOK)
- HAWLEY, G. G. - EDITOR, "THE CONDENSED CHEMICAL DICTIONARY," VAN NOSTRAND - REINHOLD COMPANY, 8TH EDITION, 1971 (HAWLEY)
- KIRK, R. AND OTHERS, D., "ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY," INTER-SCIENCE PUBLISHERS, DIVISION OF JOHN WILEY AND SONS, INC., 2ND EDITION, 1968 (K-O)
- "MERCK INDEX OF CHEMICALS AND DRUGS," MERCK AND COMPANY, RAHWAY, NEW JERSEY, 8TH EDITION, 1968 (MERCK)
- "MOLYBDENUM," HYGIENIC GUIDE SERIES, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, FEBRUARY 1960 (AIHA)
- "MOLYBDENUM COMPOUNDS," INFORMATION BULLETIN, KENNECOTT COPPER CORPORATION, UTAH COPPER DIVISION (KENNECOTT)
- PATTY, F. A., "INDUSTRIAL HYGIENE AND TOXICOLOGY," VOL. II, INTERSCIENCE PUBLISHERS, 1962 (PATTY)
- STANFORD RESEARCH INSTITUTE, "CHEMICAL ECONOMICS HANDBOOK," MENLO PARK, CALIFORNIA (CEH)
- STANFORD RESEARCH INSTITUTE, "CHEMICAL ORIGINS AND MARKETS," MENLO PARK, CALIFORNIA, 4TH EDITION, 1967 (ORIGINS)
- "STEEL INDUSTRY METALS - MOLYBDENUM," MINING ANNUAL REVIEW, 1972, U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES (MINING)

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

REFERENCES FOR SPECIFIC USE/EXPOSURES

1. CRC HANDBOOK, FAIRHALL, KENNEDY
2. CRC HANDBOOK, PATTY
3. MERCK, PATTY, K-O, PUBLIC HEALTH, HAWLEY, ORIGINS
4. PATTY, K-O
5. MINING, K-O
6. PATTY, CEH, K-O, FAIRHALL, PUBLIC HEALTH, ORIGINS
7. PATTY, PUBLIC HEALTH
8. PATTY, K-O, ORIGINS
9. HAWLEY
10. HAWLEY
11. HAWLEY
12. PUBLIC HEALTH
13. CRC HANDBOOK
14. ORIGINS

REFERENCES FOR SPECIFIC CONTROL METHODS

AIHA AND KENNEDY WERE THE REFERENCES USED IN ALL THE SPECIFIC CONTROL METHODS.

RESPIRATOR TABLE DOCUMENTATION

SUBSTANCE: SOLUBLE MOLYBDENUM COMPOUNDS

D. C. L. STANDARD: 5 MG/M3

WARNING PROPERTIES:

EYE IRRITATION LEVEL: ACCORDING TO PATTY, "EXPOSURE TO MOLYBDENUM OXIDE IS TO EYES . . ." NO QUANTITATIVE INFORMATION CONCERNING WHAT CONCENTRATIONS PRODUCE EYE IRRITATION IS GIVEN, HOWEVER. A FOOTNOTE IS ADDED TO THE RESPIRATOR TABLE FOR SOLUBLE MOLYBDENUM COMPOUNDS WHICH STATES: "IN THOSE CASES WHERE EYE IRRITATION OCCURS, FULL FACEPIECE RESPIRATORS ARE RECOMMENDED." EXAMPLES OF MOLYBDENUM COMPOUNDS WHICH CAUSE EYE IRRITATION ARE: COMPOUNDS CONTAINING NITRATE, ACETATE, CHLORIDE, TRIOXIDE, AND MOLYBDATE.

IDLH: THERE IS NO INDICATION IN THE AVAILABLE TOXICOLOGICAL INFORMATION THAT AN ACUTE EXPOSURE TO THE SOLUBLE COMPOUNDS OF MOLYBDENUM COULD IMPEDE ESCAPE OR CAUSE IRREVERSIBLE HEALTH EFFECTS IN 30 MINUTES. SINCE THERE IS NO EVIDENCE OF AN IDLH CONCENTRATION, RESPIRATORS HAVE BEEN ASSIGNED ON THE BASIS OF THE PROTECTION FACTOR AFFORDED BY EACH DEVICE.

OTHER TOXICOLOGICAL INFORMATION: THE DOCUMENTATION OF TLV'S STATES THAT "ONLY TWO REPORTS BEARING ON THE INDUSTRIAL TOXICOLOGY OF MOLYBDENUM HAVE APPEARED. THE TWO REPORTS AGREE IN THEIR GENERAL CONCLUSIONS THAT MOLYBDENUM COMPOUNDS EXHIBIT A LOW ORDER OF TOXICITY, BUT THAT SOME DIFFERENCES IN TOXICITY MAY BE ASCRIBED TO DIFFERENT COMPOUNDS; THE TRIOXIDE AND AMMONIUM MOLYBDATE WERE MORE TOXIC THAN THE ORE MOLYBDEnite, THE METAL OR THE DIOXIDE. A POSSIBLE REASON FOR THE LOW DEGREE OF TOXICITY IS THE RECENT FINDING THAT MOLYBDENUM IS A NECESSARY TRACE ELEMENT IN THE BODY FUNCTIONING IN CONJUNCTION WITH THE FLAVOPROTEIN ENZYMES. UNFORTUNATELY, NONE OF THE WORK PROVIDES THE TYPE OF DATA FROM WHICH A THRESHOLD LIMIT MIGHT BE FIRMLY SET OR FROM WHICH ONE MIGHT BE EASILY EXTRAPOLATED; EXPOSURES IN BOTH REPORTS WERE FOR ONE HOUR DAILY AT RELATIVELY HIGH CONCENTRATIONS . . . THE INHALATION OF MOLYBDENUM TRIOXIDE AND CALCIUM MOLYBDATE DUST AND MOLYBDENUM TRIOXIDE FUME AT AN AVERAGE CONCENTRATION OF APPROXIMATELY 175 MG OF MOLYBDENUM PER CUBIC METER OF AIR PROVED INJURIOUS. NO FATALITIES OCCURRED IN ANIMALS SUBJECTED TO MOLYBDIC OXIDE FUME FOR

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

24 ONE-HOUR EXPOSURES AT AN AVERAGE CONCENTRATION OF 53 MG PER CUBIC METER OF AIR, AND ONLY ONE FATALITY IN 24 ONE-HOUR EXPOSURES TO MOLYBDENITE DUST AT AN AVERAGE CONCENTRATION OF 280 MG OF MOLYBDENUM PER CUBIC METER OF AIR."

FATTY SUMMARIZES THE RESULTS OF THE INHALATION TOXICITY STUDY, STATING THAT BY "INHALATION, MOS2 WAS SIMILARLY NONINJURIOUS TO GUINEA PIGS EXPOSED 1 HOUR DAILY TO 287 MG OF MO/CU METER; MOLYBDENUM HIGHLY IRRITATING AND LETHAL (ABOUT 70 PER CENT MORTALITY IN 30 DAYS) UNDER SIMILAR CONDITIONS; CAMO04 AT 160 MG OF MO/CU METER PRODUCED NO OBVIOUS EFFECTS. THESE EXPOSURE LEVELS ARE EXCEEDINGLY HIGH. INHALATION OF MO METAL (OXIDE) FUME WAS REPORTED TO HAVE NO EFFECT IN GUINEA PIGS AT PARTICLE SIZE OF 1.6 U AND CONCENTRATIONS UP TO 190 MG OF MO/CU METER."

ACCORDING TO THE DOCUMENTATION, THE CONCLUSIONS OF ONE INVESTIGATION WERE THAT "DUST OF MOLYBDENUM METAL, THE BROWN MOLYBDENUM DIOXIDE, THE TRIOXIDE AND AMMONIUM PARAMOLYBDATE CAUSED ONLY A TRANSITORY IRRITATION OF MUCOSAL SURFACES IN WHITE MICE AFTER AN INTENSIVE ONE-HOUR DUSTING. REPETITION OF THE EXPOSURE OVER A PERIOD OF 30 DAYS CAUSED SOME TOXIC SYMPTOMS FROM THE TRIOXIDE AND THE PARAMOLYBDATE, BUT JUST SLIGHT TOXICITY FROM THE METAL AND THE DIOXIDE. AS IN THE FAIRHALL REPORT, SUITABLE PROTECTION SHOULD BE PROVIDED TO INSURE AGAINST THE INHALATION OF ANY CONSIDERABLE AMOUNT OF THE MORE SOLUBLE MOLYBDENUM COMPOUNDS WITH PERIODIC MEDICAL EXAMINATIONS OF THE WORKERS."

"ON THIS VERY TENUOUS BASIS, A LIMIT OF 5 MG MO/M3 IS SUGGESTED FOR THE MORE SOLUBLE AND ACTIVE MOLYBDENUM COMPOUNDS, SUCH AS MOLYBDENUM TRIOXIDE AND THE SOLUBLE MOLYBDATES . . ." THE DOCUMENTATION STATES THAT THIS CONCENTRATION, AS FAR AS IS KNOWN, INCLUDES "A RELATIVELY LARGE FACTOR OF SAFETY AGAINST SYSTEMIC EFFECTS."

NOTE: ACUTE TOXICOLOGICAL INFORMATION IS NEEDED UPON WHICH TO BASE AN IDLH.

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

USE/EXPOSURE AND CONTROL DOCUMENT
SOLUBLE MOLYBDENUM COMPOUNDS
PRINCIPAL ROUTE
OF ENTRY

CURRENTLY USED
CONTROL METHODS

- | USE/EXPOSURE | PRINCIPAL ROUTE OF ENTRY | CURRENTLY USED CONTROL METHODS |
|---|--------------------------|--|
| 1. INHALATION OF MOLYBDENUM TRIOXIDE (MoO_3) FUME DURING THE ROLLING OF RED HOT BILLETS IN THE PROCESSING OF MOLYBDENUM STEEL | A | GENERAL DILUTION VENTILATION; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES) |
| 2. INHALATION OF MOLYBDENUM TRIOXIDE FUME DURING OPERATIONS IN WHICH MOLYBDENUM ALLOYS ARE BROUGHT TO RED HEAT. TYPICAL EXAMPLES ARE DURING USE AS ELECTRODES IN ELECTRICALLY HEATED GLASS FURNACES AND FORE-HEARTHS, AND DURING USE IN SOME WELDING OPERATIONS. | A | GENERAL DILUTION VENTILATION; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES) |
| 3. INHALATION OF MOLYBDENUM TRIOXIDE DUST DURING USE AS A REAGENT FOR CHEMICAL ANALYSES, AS A CATALYST IN PETROLEUM REFINING AND CHEMICAL PROCESSING, AND AS AN INTERMEDIATE IN THE MANUFACTURE OF CORROSION INHIBITORS, COLORING AGENTS FOR ENAMELS, CERAMIC GLAZES AND AGRICULTURAL CHEMICALS | A | GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES) |
| 4. INHALATION OF MOLYBDENUM HYDROXIDE ($\text{Mo}(\text{OH})_3$) DUST DURING USE IN ELECTROPLATING PROCESSES. | A | GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES) |
| 5. INHALATION OF SODIUM MOLYBDATE (Na_2MoO_4) DUST DURING USE IN THE FORMULATION OF CORROSION INHIBITORS FOR AQUEOUS SYSTEMS | A | GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES) |
| 6. INHALATION OF SODIUM | A | GENERAL DILUTION VENTILA- |

NIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

MOLYBDATE DUST AND OTHER SOLUBLE MOLYBDATE DUSTS DURING USE IN THE FORMULATION OF PIGMENTS FOR PAINTS, LACQUERS AND PRINTING INKS, AND DURING USE IN COLORING ANIMAL FIBERS AND HAIR

TION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES)

7. INHALATION OF SOLUBLE MOLYBDATE DUST DURING USE IN ENAMELING PROCESSES. MOLYBDATES ARE USEFUL IN PROMOTING ADHERENCE OF VITREOUS COATINGS TO CERAMICS AND METALS

A

GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES)

8. INHALATION OF MOLYBDENUM SULFATE ($\text{MoS}_3(\text{SO}_4)_3$) DUST DURING USE IN LEATHER AND SKIN TANNING

A

GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES)

9. INHALATION OF MOLYBDENUM HEXAFLUORIDE (MoF_6) VAPOR DURING USE IN THE SEPARATION OF MOLYBDENUM ISOTOPES

A

GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES)

10. INHALATION OF AND SKIN CONTACT WITH MOLYBDENUM PENTACHLORIDE DUST (MoCl_5) DURING USE AS A CHLORINATION CATALYST, IN FIRE RETARDANT RESINS, AS A BRAZING FLUX AND AS AN INTERMEDIATE FOR ORGANO-METALLIC COMPOUNDS

A,B

GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES, GLOVES, GOGGLES)

11. INHALATION OF VAPOR AND SKIN CONTACT WITH LIQUIDS CONTAINING 12-MOLYBDOSILICIC ACID ($\text{H}_4\text{SiMo}_{12}\text{O}_{40}\cdot\text{xH}_2\text{O}$) DURING USE AS A CATALYST AND CHEMICAL REAGENTS; AND DURING USE IN PHOTOGRAPHY, ION EXCHANGE PROCESSES AND FORMULATING PLASTICS ADHESIVES AND CEMENTS

A,B

GENERAL DILUTION VENTILATION; PROCESS ENCLOSURE; LOCAL EXHAUST VENTILATION; PERSONAL PROTECTIVE EQUIPMENT (RESPIRATORY PROTECTIVE DEVICES, GLOVES, GOGGLES)

MIOSH/OSHA DRAFT TECHNICAL STANDARD
AND SUPPORTING DOCUMENTATION FOR MOLYBDENUM SOLUBLE COMPOUNDS

- | | | | |
|-----|--|---|---|
| 12. | INHALATION OF COBALT
MOLYBDATE DUST DURING
USE AS A CATALYST IN THE
DESULFURIZATION OF
GASOLINE | A | GENERAL DILUTION VENTILA-
TION; PERSONAL PROTECTIVE
EQUIPMENT (RESPIRATORY PRO-
TECTIVE DEVICES) |
| 13. | INHALATION OF AMMONIUM
MOLYBDATE ((NH ₄) ₂ MOO ₄) DUST
DURING USE AS AN INTER-
MEDIATE IN THE MANU-
FACTURE OF OTHER
MOLYBDENUM COMPOUNDS | A | GENERAL DILUTION VENTILA-
TION; PROCESS ENCLOSURE;
LOCAL EXHAUST VENTILATION;
PERSONAL PROTECTIVE EQUIP-
MENT (RESPIRATORY PROTEC-
TIVE DEVICES) |
| 14. | INHALATION OF MOLYBDIC
ACID (H ₂ MOO ₄) DUST AND
VAPOR DURING USE AS A
REAGENT IN DETERMINING
PHOSPHOROUS AND LEAD, AND
DURING USE IN PREPARING
GLAZES FOR CERAMICS | A | GENERAL DILUTION VENTILA-
TION; PROCESS ENCLOSURE;
LOCAL EXHAUST VENTILATION;
PERSONAL PROTECTIVE EQUIP-
MENT (RESPIRATORY PROTEC-
TIVE DEVICES) |

- A -- INHALATION
- B -- SKIN AND EYE CONTACT RESULTING
IN LOCALIZED IRRITATION
- C -- INGESTION
- D -- SKIN CONTACT RESULTING IN
ABSORPTION AND SUBSEQUENT
SYSTEMIC POISONING