N91-15939

# Design and Development of a Space Station Hazardous Material System For Assessing Chemical Compatibility

Richard T. Congo

NASA/MSFC

November 15, 1988

## ABSTRACT

As the Space Station nears reality in funding support from Congress, NASA plans to perform over a hundred different missions in the coming decade. Incrementally deployed, the Space Station will evolve into modules linked to an integral structure. Each module will have characteristic functions, such as logistics, habitation, and materials processing. Because the Space Station is to be "user friendly" for experimenters, NASA is anticipating that a variety of different chemicals will be taken on-board. Accidental release of these potentially toxic chemicals and their chemical compatibility is the focus of this discourse.

The Microgravity Manufacturing Processing Facility (MMPF) will contain the various facilities within the US Laboratory (USL). Each "facility" will have a characteristic purpose, such as alloy solidification or vapor crystal growth. By examining the proposed experiments for each facility, identifying the chemical constituents, their physical state and/or changes, byproducts and effluents, I will be able to identify those payloads which may contain toxic, explosive, or reactive compounds that require processing or containment in mission peculiar waste management systems. Synergistic reactions from mixed effluent streams is of major concern.

Each experiment will have its own data file complete with schematic, chemical listing, physical data, etc. Chemical compatibility information from various databases will provide assistance in the analysis of alternate disposal techniques (pretreatment, separate storage, etc.). Along with data from the Risk Analysis of the Proposed USL Waste Management System, accidental release of potentially toxic and catastrophic chemicals would be eliminated or reduced.

| ORGANIZATION: | MARSHALL SPACE FLIGHT CENTER | NAME: |
|---|---|---|
| CHART NO.: | | DATE: |

# DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY

| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH | MARSHALL SPACE FLIGHT CENTER | NAME: R. T. CONGO |
|---|---|---|
| CHART NO.: | DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY | DATE: NOVEMBER 1988 |

## SPACE STATION USL PHILOSOPHY

- 30-YEAR LIFE
- USER-FRIENDLY
- SAFE

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U. S. LABORATORY

- MICROGRAVITY MANUFACTURING PROCESSING FACILITY
- EXPERIMENTS
- CHARACTERIZATION STUDIES
- HAZARDOUS WASTES
- PROCESS MATERIAL MANAGEMENT SYSTEM

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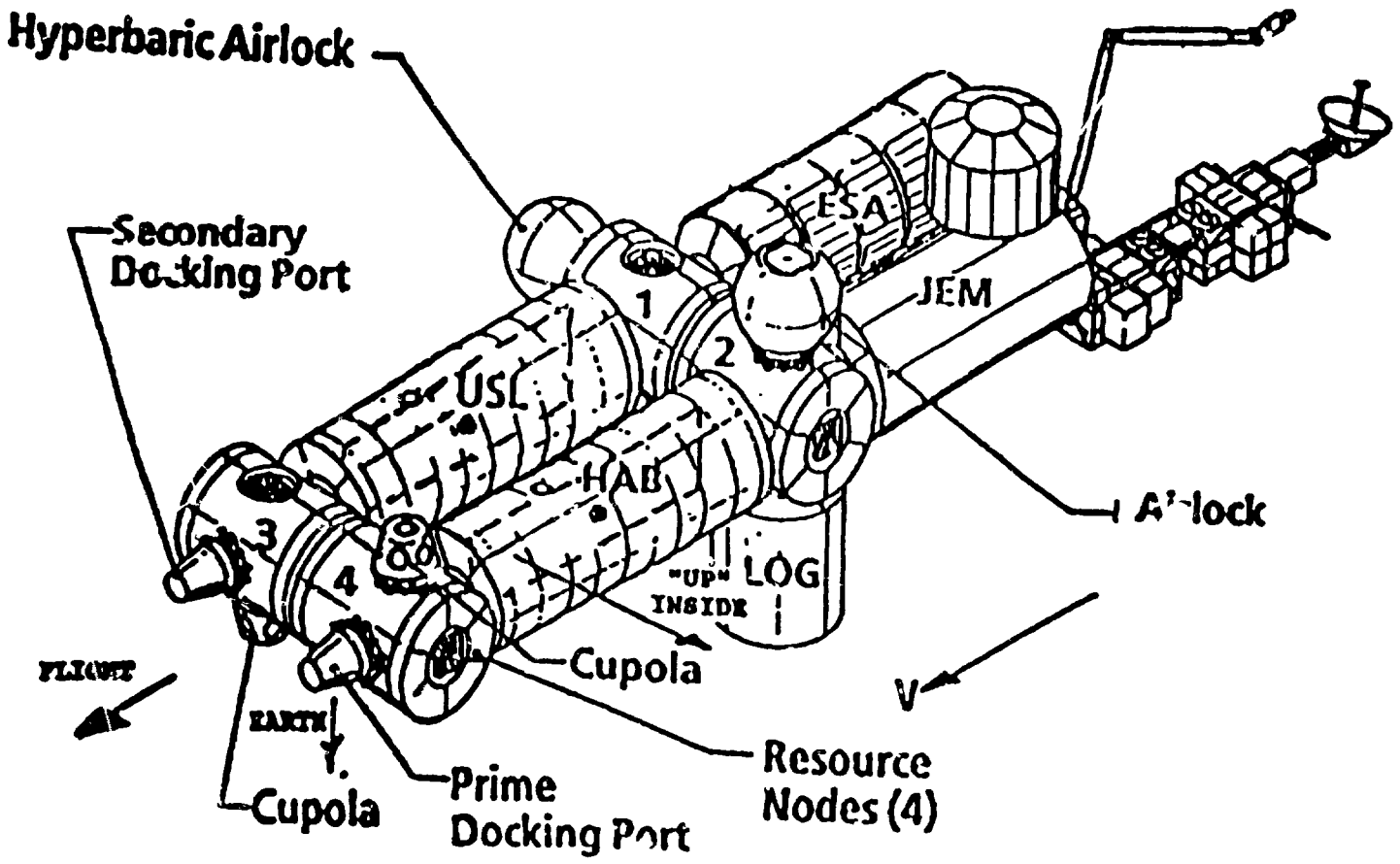


FIGURE 2-1 MODULE CONFIGURATION

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## FACILITY LIST

ACOUSTIC LEVITATOR
ALLOY SOLIDIFICATION
ATMOSPHERIC MICROPHYSICS
AUTO-IGNITION
BIOREACTOR/INCUBATOR
CONTINUOUS FLOW ELECTROPHORESIS
CRITICAL POINT PHENOMENA
DROPLET/SPRAY BURNING
ELECTROMAGNETIC LEVITATOR
ELECTROSTATIC LEVITATOR
FLOAT ZONE
FLUID PHYSICS
FREE FLOAT LEVITATOR
HIGH TEMPERATURE FURNACE
ISOELECTRIC FOCUSING
OPTICAL FIBER PULLING
ORGANIC AND POLYMER CRYSTAL GROWTH
PREMIXED GAS COMBUSTION
PROTEIN CRYSTAL GROWTH
ROTATING SPHERICAL CONVECTION
SMALL BRIDGEMAN
SOLUTION CRYSTAL GROWTH
SOLID SURFACE BURNING FACILITY
VAPOR CRYSTAL GROWTH
VARIABLE FLOW SHELL GENERATOR

FIGURE 2-10 FULL SYSTEMS LABORATORY (LAUNCH)

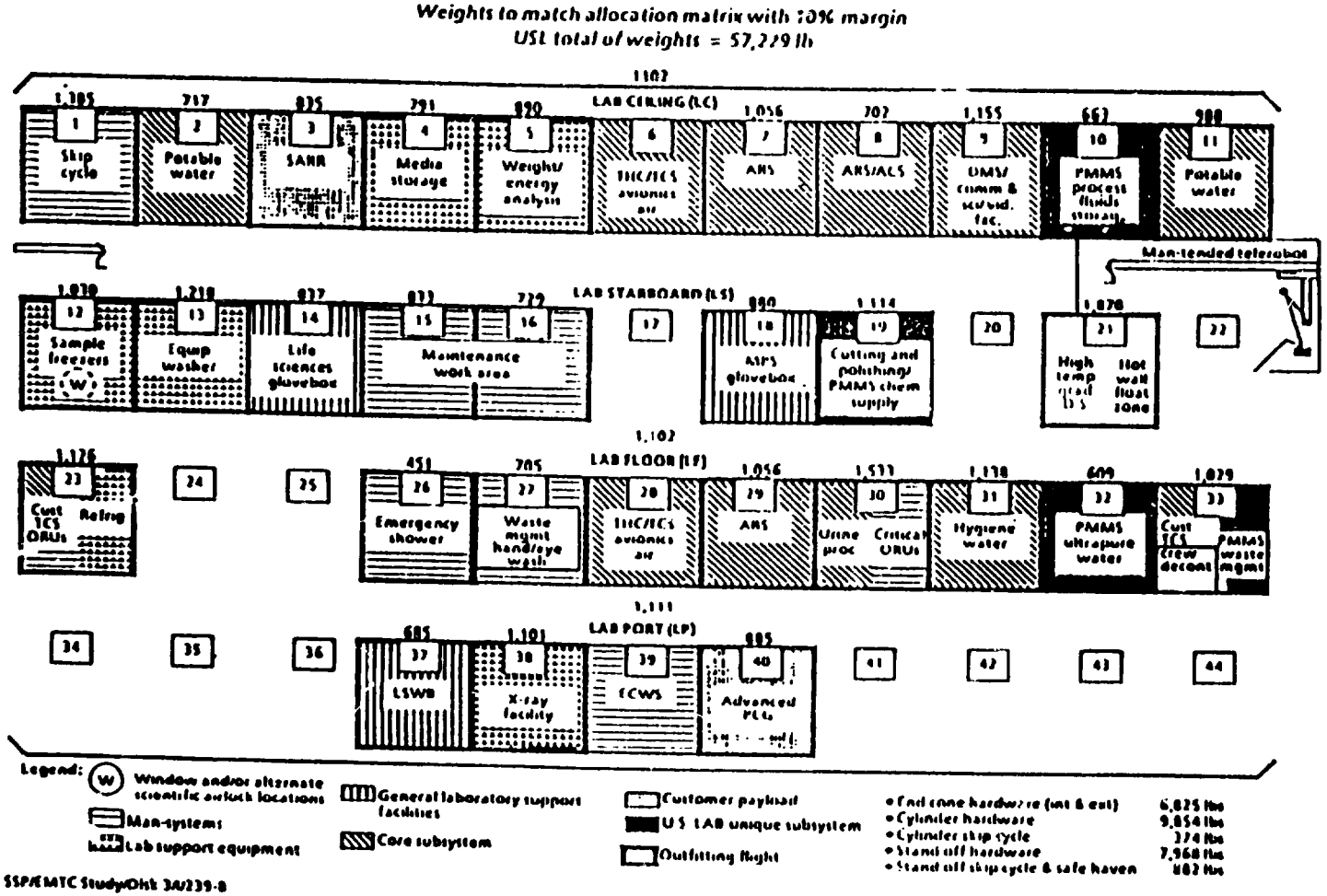



FIGURE 2-11 FULL SYSTEMS LABORATORY (OUTFITTING)

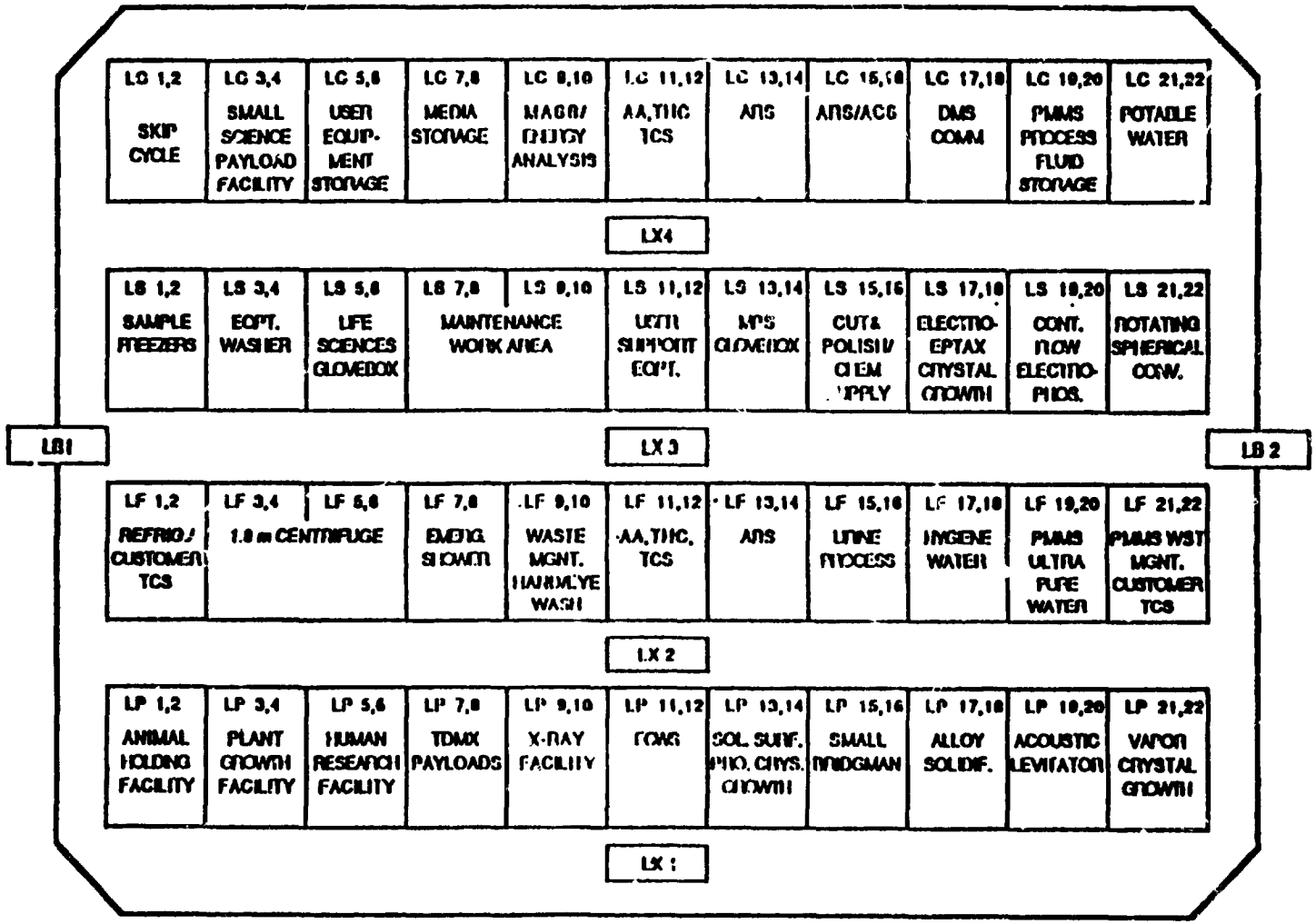



FIGURE 2-2 LAB COMPONENT LOCATIONS

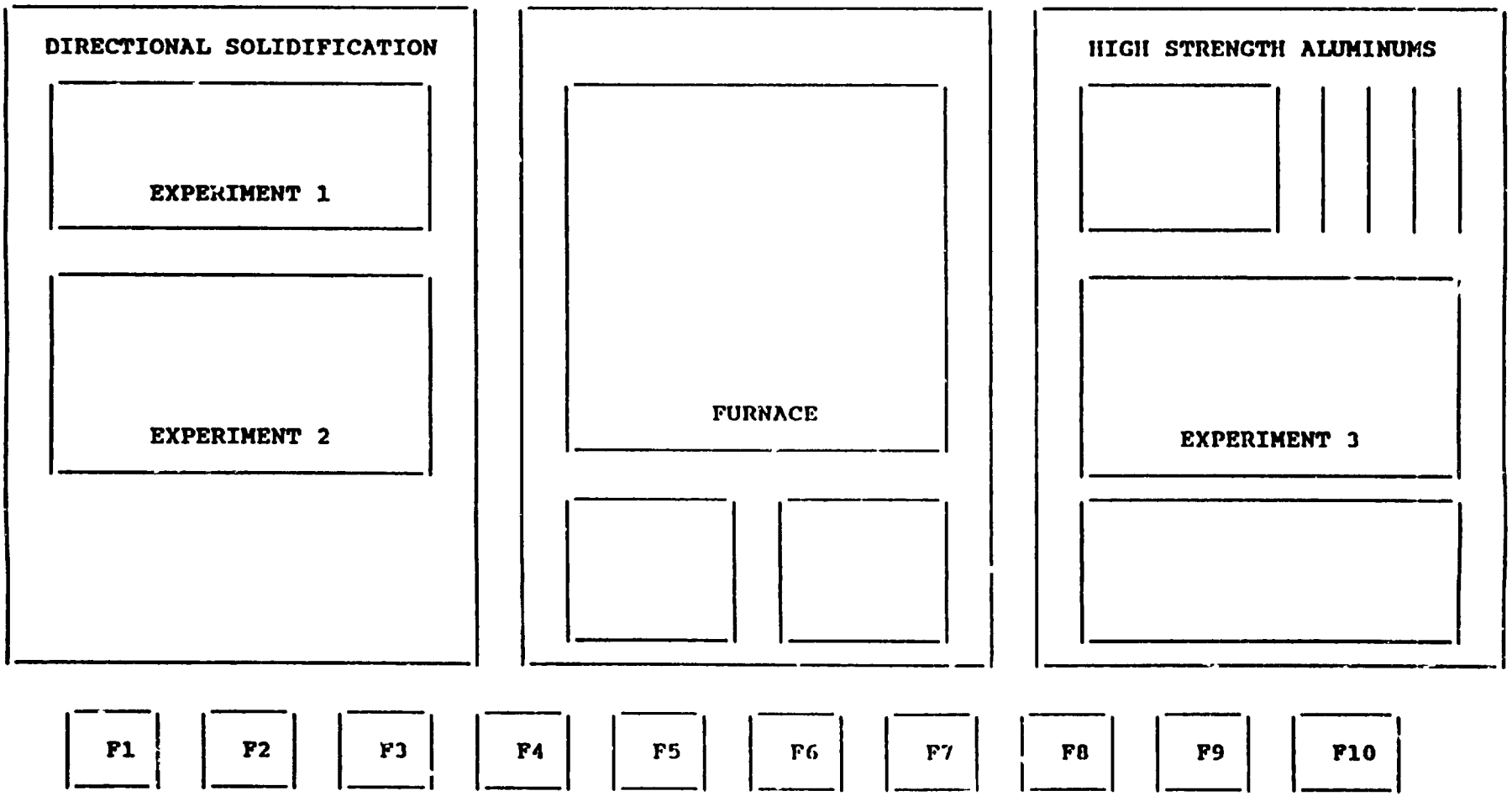
ANALYTICAL AND PHYSICAL
CHEMISTRY BRANCH

R. T. CONGO

DESIGN AND DEVELOPMENT OF A
SPACE STATION HAZARDOUS MATERIAL SYSTEM
FOR ASSESSING CHEMICAL COMPATIBILITY

NOVEMBER 1988

ALLOY SOLIDIFICATION FACILITY



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## ALLOY SOLIDIFICATION

- DIRECTIONAL SOLIDIFICATION
- MODIFIED INCONEL 178
- HIGH TEMPERATURE SUPERALLOYS
- LOW CHROMIUM ALLOYS
- MARAGING STEELS
- HIGH STRENGTH ALUMINUMS

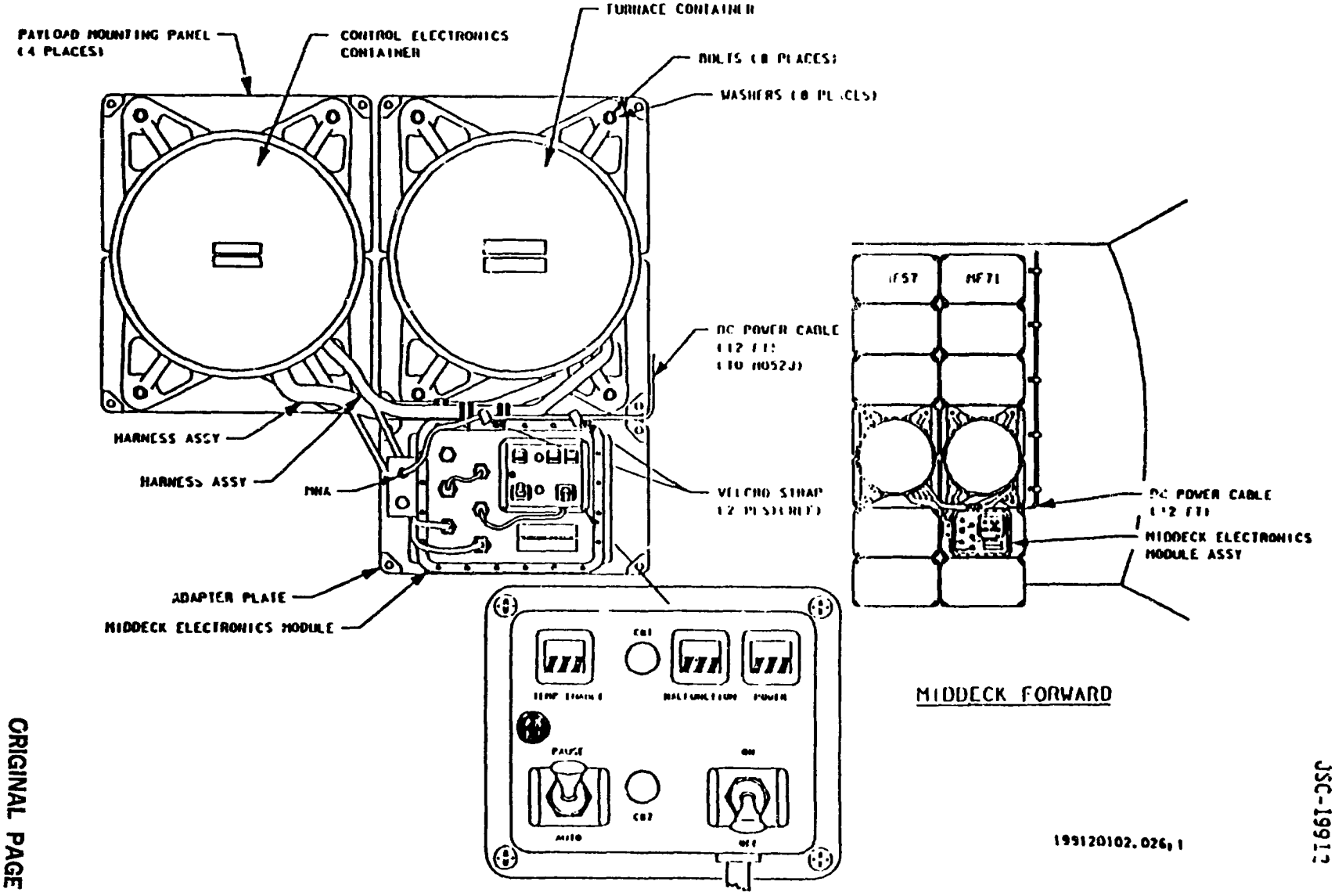


Figure 1-2.- ADSF installation.

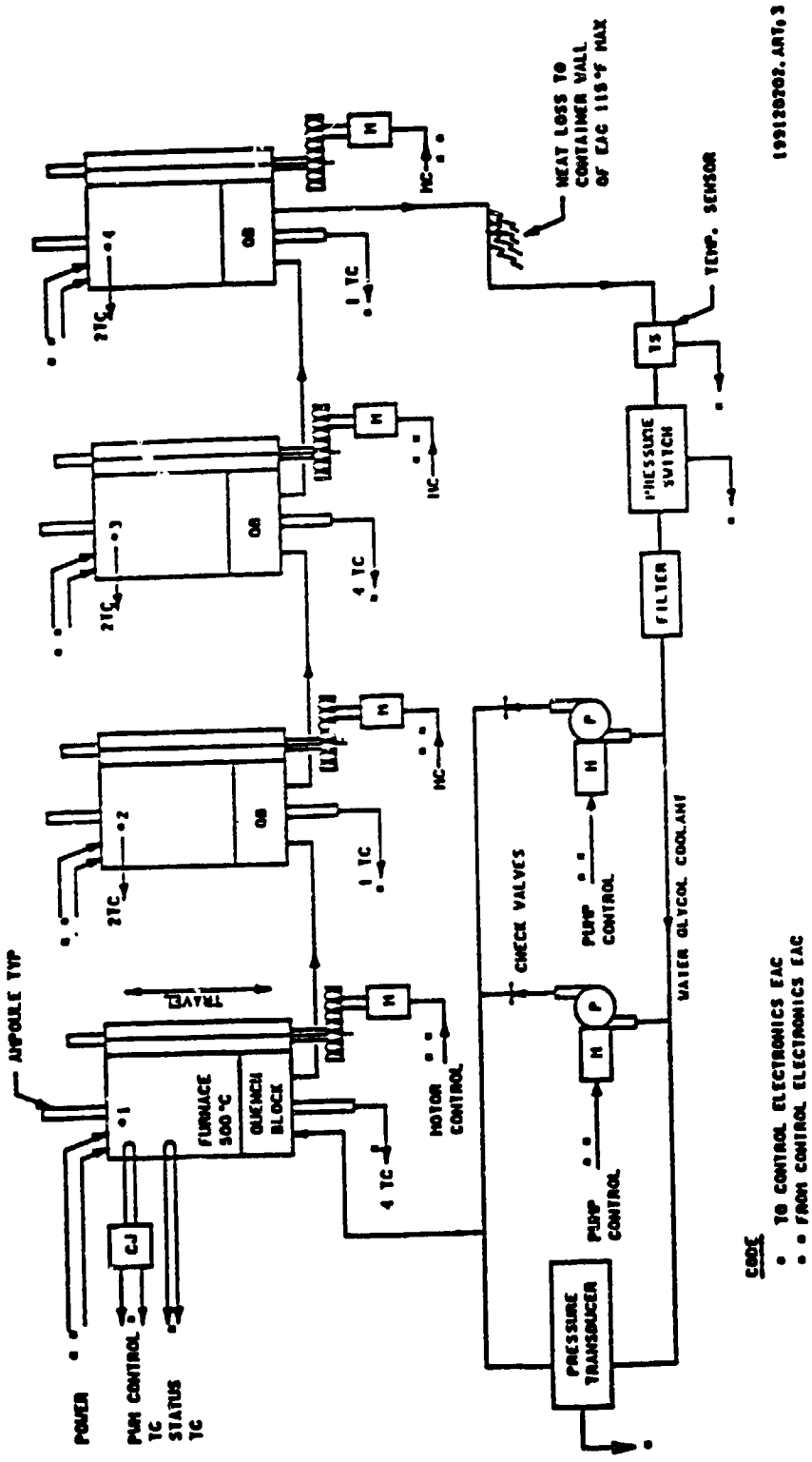


Figure 2-2.- Functional block diagram of furnace system.

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OF POOR QUALITY

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BY INVOKING THE CHEMICAL LISTING, WE WOULD OBTAIN THE DETAILED LISTING OF EVERY CHEMICAL ASSOCIATED WITH THE EXPERIMENT.

COPPER
NICKEL
ALUMINUM
IRON
BERYLLIUM
INDIUM
ACETONE
ETHANOL
HYDROGEN
METHANOL
OXYGEN
TOLUENE
ARGON
NITROGEN
WATER

ALLOY SOLIDIFICATION FACILITY 02/25/88

| HAZARD CLASS | NAME | FORMULA | SMAC mg/m3 | INCOMPATIBILITIES |
|---|---|---|---|---|
| ASPHYXIANTS | ARGON | Ar | 16337.0 | NONE |
| | NITROGEN | N2 | 0.00 | Li,Ti,O3 |
| | WATER | H20 | 0.00 | NONE DOCUMENTED |
| FLAMMABLES | ACETONE (2-PROPANONE) | CH3COCH3 | 712.5 | ACIDS,OX,HNO3,H2SO4,ST.BASE, PLASTIC,NITRATES,RED.AGENTS, ALDEHYDES,AMINES,H2O |
| | ETHANOL | C2H5OH | 94.0* | OX,ALKALI,ACID |
| | HYDROGEN | H2 | 247.3 | OX,HEAT,O2,Br2,AIR+Pt,ACETYC ANHYDRIDE,ALDEHYDES,Cl2,F2, Li,CHLORINE TRIFLUORIDE, KETONES,DIOXANE+Ni,Mg+CaCO3, NITROSANISOLE,NITROGEN FLUORIDE |
| | METHANOL | CH3OH | 52.4 | ST.OX,CHROMIC ANHYDRIDE |
| | OXYGEN | O2 | 0.00 | HEAT, OXIDIZABLE MATERIAL |
| | TOLUENE (METHYL BENZENE) | C6H5CH3 | 75.3 | ST.OX,HNO3,H2SO4,O2, PEROXIDES,HEAT,PLASTICS |
| FLAMMABLE DUSTS | COPPER | Cu | 0.00 | ALKALIES,AIR,CHLORATES, BROMATES |
| | NICKEL | Ni | 0.02 | ST.ACIDS,S,COMBUST,WOOD |
| | ALUMINUM | Al | 0.00 | NONE DOCUMENTED |
| | IRON | Fe | 0.00 | NONE DOCUMENTED |
| TOXINS | BERYLLIUM | Be | 0.0004 | CCl4,Li,ACID,ALKALI,OX,F, CHLORINATED HYDROCARBONS |
| | INDIUM | In | 0.02 | S, MINERAL ACIDS |

WSF PAYLOAD WASTE SOURCE ASSESSMENT 16-Sep

HAB:ASP.DAT

| CYCLE DATA | FACILITY | | | CHARACTERIZATION/SUPPORT EQUIPMENT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN. NO. OF CYCLES | ALLOY SOLIDIFICATION FACILITY | | | FLUIDS GLOVEBOX | | | AUTOMATED CUTTING/POLISHING | | | SCANNING ELECTRON MICROSCOPE | | |
| 2 | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) |
| MAX. NO. OF CYCLES | WATER | L | 2.0000 | NITROGEN | G | 0.3730 | WATER | L | 0.5300 | LIQUID NITROGEN | L | 1.0100 |
| 20 | ARGON | G | 0.3420 | METAL POWDERS | P | | METAL POWDERS | P | | | | |
| | METAL POWDERS | P | 0.3540 | BERYLIUM | | | BERYLIUM | | | | | |
| PROPOSED NO. OF CYCLES | BERYLIUM | | | COPPER | | | COPPER | | | | | |
| | COPPER | | | ALUMINUM | | | ALUMINUM | | | | | |
| | ALUMINUM | | | INDIUM | | | INDIUM | | | | | |
| | INDIUM | | | CARBON STEEL | | | CARBON STEEL | | | | | |
| | CARBON STEEL | | | IRON | | | IRON | | | | | |
| | IRON | | | NICKEL | | | NICKEL | | | | | |
| | NICKEL | | | ETCHANT SOLUTION | L,G | | PLASTIC ENCAPSULATE | L,G,P | | | | |
| | MELT VAPORS | G | 0.0010 | PLASTIC ENCAPSULATE | L,G,P | | CLEANING FLUIDS | L,G | | | | |
| | CLEANING FLUIDS | L,G | 0.0463 | CLEANING FLUIDS | L,G | | ELECTROPOLISHING SOL. | L,G | | | | |

## TABLE 7. FLUIDS/WASTES OF ASF

| MATERIAL | MASS PER RUN (kg) | VOLUME PER RUN (liters) | COMMENT |
|---|---|---|---|
| Air | 0.896 | 700.0 | Used to refill the furnace canisters after each run |
| Cleaning Fluid | 6.00 | 6.00 | Used to clean furnaces |
| Distilled Water | 8.00 | 8.00 | Used for general facility cleanup |
| Gaseous Helium | 0.00071 | 4.00 | Possible coolant for rapid sample quench |
| Gloves | 0.00002 | 0.00002 | Two pair per run |
| Inert Gas | 0.875 | 700.0 | Used to fill furnace canisters during each run. May include either Ar, $N_2$ or He |
| Wipes | $0.41 \times 10^{-5}$ | $0.44 \times 10^{-5}$ | 10 wipes per run |

Eum: 433 min

ETCHING MATERIALS 02/25/88

| HAZARD CLASS | NAME | FORMULA | SNACeq/m3 | INCOMPATIBILITIES |
|---|---|---|---|---|
| IRRITANTS | ACETIC ACID (ETHANOIC ACID) | CH3COOH | 7.40 | ST.OX.,CHR PEROXIDES,CAUSTICS,ST.BASE, PERMANGANATES, ACTIVE METALS, PLASTIC,ACETALDEHYDE,CHLORINE TRIFLUORIDE,CHROMIC ANHYDRIDE ACETIC ANHYDRIDE,Mg, ACETONE |
| | IRON (FERRIC) CHLORIDE | FeCl3 | 0.00 | NONE DOCUMENTED |
| | OXALIC (ETHANEDIOIC) ACID | HOOCCOOH | 0.00 | NONE DOCUMENTED |
| | ORTHOPHOSPHORIC ACID | H3PO4 | 0.00 | NONE DOCUMENTED |
| | SULFURIC ACID | H2SO4 | 0.00 | ORG. MAT,CHLORATES, ACT. METAL |
| ASPHYXIANTS | WATER | H2O | 0.30 | NONE DOCUMENTED |
| FLAMMABLES | ETHANOL | C2H5OH | 94.0 | OX,ALKALI,ACID |
| CORROSIVES | AMMONIUM BIFLUORIDE | NH4HF2 | 0.00 | NONE DOCUMENTED |
| | CHROMIC ACID | H2CrO4 | 0.00 | RED. AGENTS, ORGANIC MATL |
| | HYDROCHLORIC ACID | HCl | 1.5 | ACT.MET,K,Na,Ca,Zn,Mg,Al POR |
| | HYDROFLUORIC ACID | HF | 0.002 | ACTIVE METALS,SAND,GLASS(Si) |
| | NITRIC ACID | HNO3 | 1.0 | ORG.MAT,WOOD,TURPENTINE, ACT.METALS,H2S,STRONG BASES |
| | POTASSIUM HYDROXIDE | KOH | 0.02 | ACID,AIR,NITROMETHANE,H2O, GLASS,Al PWDR,Sn,Zn,ORG.MAL, NITRO COMP,ACTIVE METALS, ACETIC ACID, ACROLEIN,P,CO2, CHLOROFORM+MeOH,STEAM,MOIST, PEROXIDES, COMBUSTIBLES |
| | SODIUM HYDROXIDE | NaOH | 0.4 | H2O,ACID,FLAM.LIQ,ORG.MAL, ACT.MET,Al PWDR,Sn,Zn,NITRO COMP,NITROMETHANE,PLASTICS |
| TOXINS | BENZALKONIUM CHLORIDE | C6H5CH2N(CH3)2RCl | 0.06 | (MIXTURE, R=C8H17-C18H37) |
| | COPPER (CUPRIC) CHLORIDE | CuCl2 | 0.00 | NONE DOCUMENTED |
| | DIHYDROXYDIETHYL ETHER | CH2OHCH2OCH2CH2OH | 0.06 | (DIETHYLENE GLYCOL) NONE |
| | HYDROGEN PEROXIDE | H2O2 | 0.25 | OX,Fe,Cu,Zn,MANGANESE TRIOX |
| | POTASSIUM PERMANGANATE | KMnO4 | 0.00 | ORGANIC MATL, OXIDIZERS |
| | POTASSIUM FERRICYANIDE | K3Fe(CN)6 | 0.00 | ACIDS, HNO3, CHROMIC ACID |
| | SODIUM NITRATE | NaNO3 | 0.00 | ORGANIC MATERIAL,HEAT(537C) |
| | SULFAMIC ACID | HOSO2NH2 | 0.00 | NONE DOCUMENTED |
| | TRINITROPHENOL (PICRIC ACID) | C6H2(NO2)3OH | 0.00 | MET.SALTS,HEAT,SHOCK,METALS |
| UNCLASSIFIED | AMMONIUM SULFATE | (NH4)2SO4 | 0.00 | OX,O2,PEROXIDES,POTASSIUM CHLORATE,SODIUM NITRATE, METAL CHLORATES |
| | LACTIC ACID | CH3CHOHCOOH | 0.00 | NONE DOCUMENTED |
| | POTASSIUM METABISULFITE | K2S2O5 | 0.00 | NONE DOCUMENTED |
| | SODIUM CHLORIDE | NaCl | 0.00 | NONE DOCUMENTED |

MACROETCHING MATERIALS 02/25/88

| HAZARD CLASS | NAME | FORMULA | SMAC(g/m3) | INCOMPATIBILITIES |
|---|---|---|---|---|
| IRRITANTS | ACETIC ACID (ETHANOIC ACID) | CH3COOH | 7.40 | ST.OX.,CHR PEROXIDES,CAUSTICS,ST.BASE, PERMANGANATES, ACTIVE METALS, PLASTIC,ACETALDEHYDE,CHLORINE TRIFLUORIDE,CHROMIC ANHYDRIDE, ACETIC ANHYDRIDE,Hg, ACETONE |
| | AMMONIUM PERSULFATE | (NH4)2S2O8 | 0.00 | ORGANIC MATERIAL |
| | COPPER SULFATE, PENTAHYDRATE | CuSO4*5H2O | 0.00 | NONE DOCUMENTED |
| | IRON (FERRIC) CHLORIDE | FeCl3 | 0.00 | NONE DOCUMENTED |
| | SODIUM DICHROMATE | Na2Cr2O7 | 0.00 | SUSPECTED CARCINOGEN |
| | SULFURIC ACID | H2SO4 | 0.00 | ORG. MAT,CHLORATES, ACT. METAL |
| ASPHYXIANTS | WATER | H2O | 0.00 | NONE DOCUMENTED |
| CORROSIVES | CHROMIC ACID | H2CrO4 | 0.00 | RED. AGENTS, ORGANIC MATL |
| | HYDROCHLORIC ACID | HCl | 1.5 | ACT.MET,K,Na,Ca,Zn,Mg,Al POR |
| | HYDROFLUORIC ACID | HF | 0.002 | ACTIVE METALS,SAND,GLASS(Si) |
| | NITRIC ACID | HNO3 | 1.0 | ORG.MAT,WOOD,TURPENTINE, ACT.METALS,H2S,... & BA... |
| | SODIUM HYDROXIDE | NaOH | 0.4 | H2O,ACID,FLAM.LIQ.,ORG.MAL, ACT.MET,Al PWDR,Zn,In,NITRO COMP,NITROMETHANE,PLASTICS |
| TOXINS | AMMONIUM CHLORIDE | NH4Cl | 0.00 | NONE DOCUMENTED |
| | COPPER (CUPRIC) CHLORIDE | CuCl2 | 0.00 | NONE DOCUMENTED |
| | HYDROGEN PEROXIDE | H2O2 | 0.28 | OX,Fe,Cu,In,MANGANESE TRIOX |
| | MAGNESIUM CHLORIDE | MgCl2 | 0.00 | NONE DOCUMENTED |
| | SODIUM NITRATE | NaNO3 | 0.00 | ORGANIC MATERIAL,HEAT(537C) |
| | TRINITROPHENOL (PICRIC ACID) | C6H3(NO2)3OH | 0.00 | METALLIC SALTS,HEAT,SHOCK,WET |
| UNCLASSIFIED | IRON (FEROUS) CHLORIDE | FeCl2 | 0.00 | NONE DOCUMENTED |
| | LACTIC ACID | CH3CHOHCOOH | 0.00 | NONE DOCUMENTED |

...OR CRYSTAL GROWTH FACILITY

02/25/88

| HAZARD CLASS | NAME | FORMULA | SMACmg/m3 | INCOMPATIBILITIES |
|---|---|---|---|---|
| IRRITANTS | ZINC CHLORIDE | ZnCl2 | 0.00 | POTASSIUM |
| | CHLORINE | Cl2 | 0.87 | COMBUSTIBLES,PLASTIC,AMMONIUM SALTS,ACETALDEHYDE,ACETYLENE, ALCOHOLS,Al PWDR,NH3,C6H6, CESIUM COMP,Cu,DIBORANE |
| ASPHYXIANTS | ARGON | Ar | 16337.0 | NONE |
| | HELIUM | He | 0.00 | NONE |
| | NITROGEN | N2 | 0.00 | Li,Ti,Cl |
| | WATER | H2O | 0.30 | NONE DOCUMENTED |
| FLAMMABLES | ACETONE (2-PROPANONE) | CH3COCH3 | 712.5 | ACIDS,OX,HNO3,H2SO4,ST.BASE, PLASTIC,NITRATES,RED.AGENTS, |
| | ACETYLENE (ETHYNE) | C2H2 | 532.4 | ALDEHYDES,AMINES,H2O OX,Cu,Ag,Hg,CHLORATES,HAL. COMP.,F2,K,NOx |
| | ETHANOL | C2H5OH | 94.0 | OX,ALKALI,ACID |
| | METHANOL | CH3OH | 52.4 | ST.OX,CHROMIC ANHYDRIDE |
| | OXYGEN | O2 | 0.00 | HEAT, OXIDIZABLE MATERIAL |
| FLAMMABLE DUSTS | COBALT | Co | 0.00 | OX, NITRATES |
| | NICKEL | Ni | 0.02 | ST. ACIDS,S,COMB[illegible],WOOD |
| CORROSIVES | HYDROCHLORIC ACID | HCl | 1.5 | ACT.MET,K,Na,Ca,Zn,Mg,Al PDR |
| | HYDROFLUORIC ACID | HF | 0.082 | ACTIVE METALS,SAND,GLASS/SI |
| | NITRIC ACID | HNO3 | 1.0 | ORG.MAT,WOOD,TURPENTINE, ACT.METALS,H2S,STRONG BASE. |
| TOXINS | ARSENIC | As | 0.002 | BROMATES,CHLORATES,CHROMIUM TRIOXIDE,AgNO3,SODIUM PER-OXIDE,NITROGEN TRIFLUORIDE, ACIDS,HALOGENS,Na,K,Li,Zn,H2 ACETYLIDES,Pd,Pt |
| | CADMIUM | Cd | 0.02 | OX,S,Se,Te |
| | CADMIUM IODIDE | CdI2 | 0.00 | NONE DOCUMENTED |
| | CADMIUM SULFIDE | CdS | 0.00 | OX,S,Se,Te |
| | CADMIUM SELENIDE | CdSe | 0.00 | NONE DOCUMENTED |
| | CADMIUM TELLURIDE | CdTe | 0.00 | NONE DOCUMENTED |
| | GALLIUM | Ga | 0.50 | ACT.MET,ALKALI,HAL.COMP,ACID HCl,HNO3 |
| | GALLIUM ARSENIDE | GaAs | 0.178 | NONE |
| | HYDROGEN BROMIDE | HBr | 0.00 | NONE DOCUMENTED (HYD.BROMIC AC |
| | HYDROGEN PEROXIDE | H2O2 | 0.28 | OX,Fe,Cu,Zn,MANGANESE TRIOX |
| | HYDROGEN IODIDE | HI | 0.00 | F2,HClO4,Ox,P,HNO3,Cl,KClO4 |
| | IODINE | I2 | 0.1 | NH3,ACETYLENE,Al PDR,ACT.MET |
| | INDIUM | In | 0.02 | S, MINERAL ACIDS |
| | INDIUM PHOSPHIDE | InP | 0.00 | NONE DOCUMENTED |
| | MERCURY | Hg | 0.006 | ACETYLENE, NH3 |
| | MERCURIC BROMIDE | HgBr2 | 0.00 | NONE DOCUMENTED |
| | MERCURIC CHLORIDE | HgCl2 | 0.00 | NONE DOCUMENTED |
| | MERCURIC IODIDE | HgI2 | 0.006 | NONE DOCUMENTED |
| | MERCUROUS IODIDE | Hg2I2 | 0.006 | NONE DOCUMENTED |
| | MERCURY CADMIUM TELLURIDE | HgCdTe | 0.00 | NONE DOCUMENTED |
| | TELLURIUM | Te | 0.02 | ST.OX,CHLORINE TRIFLUORIDE, F2, K |

25 21

| | | | |
|---|---|---|---|
| ZINC TELLURIDE | ZnTe | 8.68 | NONE DOCUMENTED |

PAYLOAD WASTE SOURCE ASSESSMENT 16-Sep

HAZVC6.DAT

| CYCLE DATA | FACILITY | CHARACTERIZATION/SUPPORT EQUIPMENT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MAX. NO. OF CYCLES 1 | VAPOR CRYSTAL GROWTH FACILITY | | | FLUIDS GLOVEBOX | | | AUTOMATED CUTTING/POLISHING | | | FOURIER TRANSFORM INFRARED SPECTROMETER | | | GAS CHROMATOGRAPHS | | |
| | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) | WASTE TYPE | PHASE | MASS/ CYCLE(KG) |
| MAX. NO. OF CYCLES 90 | NITROGEN | G | 0.3130 | NITROGEN | G | 0.375 | WATER | L | 0.5000 | NITROGEN | G | 0.0620 | NITROGEN | G | 0.0010 |
| | AIR | G | 0.5300 | SAMPLE MATERIAL | G,P | | AMPOULE FRAGMENTS | P | | AIR | G | 0.0600 | METHANE | G | 0.0000 |
| | CLEANING FLUIDS | L,G | | HgCdTe | G,P | | OBOULE FRAGMENTS | P | | LIQUID NITROGEN | L | 0.1500 | ARGON | G | 0.0000 |
| PROPOSED NO. OF CYCLES | WEAK SOLUTIONS OF THE FOLLOWING REAGENTS: | | | GaAs | G,P | | PLASTIC ENCAPSULATE | L,G,P | | CLEANING FLUIDS | L,G | | LIQUID NITROGEN | L | 0.5100 |
| | HYDROGEN PEROXIDE | L,G | | InP | G,P | | CLEANING FLUIDS | L,G | | | | | AIR | G | 0.0020 |
| | HYDROFLUORIC ACID | L,G | | InAs | G,P | | WEAK SOLUTIONS OF THE FOLLOWING REAGENTS: | | | | | | ACETYLENE | G | 0.001 |
| | METHANOL | L,G | | CdTe | G,P | | HYDROGEN PEROXIDE | L,G | | | | | | | |
| | NITRIC ACID | L,G | | CdS | G,P | | HYDROFLUORIC ACID | L,G | | | | | | | |
| | HYDROCHLORIC ACID | L,G | | Cu | G,P | | METHANOL | L,G | | | | | | | |
| | SAMPLE MATERIAL | G,P | | Al | G,P | | NITRIC ACID | L,G | | | | | | | |
| | HgCdTe | G,P | | AMPOULE FRAGMENTS | P | | HYDROCHLORIC ACID | L,G | | | | | | | |
| | GaAs | G,P | | OBOULE FRAGMENTS | P | | SAMPLE MATERIAL | G,P | | | | | | | |
| | InP | G,P | | CLEANING FLUIDS | L,G | | HgCdTe | G,P | | | | | | | |
| | InAs ? | G,P | | WEAK SOLUTIONS OF THE FOLLOWING REAGENTS: | | | GaAs | G,P | | | | | | | |
| | CdTe | G,P | | HYDROGEN PEROXIDE | L,G | | InP | G,P | | | | | | | |
| | CdS ? | G,P | | HYDROFLUORIC ACID | L,G | | InAs | G,P | | | | | | | |
| | Cu | G,P | | METHANOL | L,G | | CdTe | G,P | | | | | | | |
| | Al | G,P | | NITRIC ACID | L,G | | CdS | G,P | | | | | | | |
| | TRANSPORT GASES | G | | HYDROCHLORIC ACID | L,G | | Cu | G,P | | | | | | | |
| | $H_2Br_2$ | G | | ETCHANTS | L,G | | Al | G,P | | | | | | | |
| | $I_2$ | G | | HYDROGEN PEROXIDE | L,G | | | | | | | | | | |
| | $H_2Cl_2$ | G | | HYDROFLUORIC ACID | L,G | | | | | | | | | | |
| | $H_2I_2$ | G | | METHANOL | L,G | | | | | | | | | | |
| | $H_2S$ | G | | NITRIC ACID | L,G | | | | | | | | | | |
| | TRACE $SnCl_2$ ? | G | | HYDROCHLORIC ACID | L,G | | | | | | | | | | |
| | TRACE WATER | G | | | | | | | | | | | | | |
| | TRACE HCl | G | | | | | | | | | | | | | |
| | TRACE Al | G | | | | | | | | | | | | | |
| | TRACE Cu | G,P | | | | | | | | | | | | | |
| | TRACE $CCl_2$ | G | | | | | | | | | | | | | |
| | AMPOULE FRAGMENTS | P | | | | | | | | | | | | | |
| | OBOULE FRAGMENTS | P | | | | | | | | | | | | | |

TABLE 7. CONTAMINATES PRODUCED BY VAPOR CRYSTAL FACILITY

| CONTAMINATE | EXPERIMENT | CREW | EQUIPMENT | REMARKS |
|---|---|---|---|---|
| Argon or Helium | 100% | See Remark | Purge gas which must remove contaminants from growth module. | See Section 5.1. May displace $O_2$ |
| $H_2O$ | | Contains extremely toxic particles (Hg, Cd, Te, Cl, Br, Ga, As, In, P, Zn, Se) or reactive chemicals (HF, $H_2O_2$, $CH_3OH$, $HNO_3$, and/or HCl). | Used in substrate pre-run preparation and post-run cleaning. | Must be completely removed from crystal surface after etching to prevent adverse effects on growth. |
| Cleaning Fluid | TBD | TBD | Must be completely removed from growth module before next run. | Probably (HF, $H_2O_2$, $CH_3OH$, $HNO_3$, and/or HCl). |
| Transport Gases | 100% | Very toxic to crew if inhaled. | Reactive at high temperatures with metals. | Defined candidates are $I_2$, HgI, $HgCl_2$, $HgBr_2$, $ZnCl_2$, HCl, HBr, and HI. |
| Sample | TBD | Toxic to crew. See Remark. | Produced by cleaning walls of growth module. | Expected candidates are GaAs, InP, ZnTe, CdSe, CdS, PbSnTe, and HgCdTe, and undefined materials. |

Run length = 16-21d.
—Full spectrum of materials based on primary IOC candidates.

| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH | MARSHALL SPACE FLIGHT CENTER | NAME: R. T. CONGO |
|---|---|---|
| CHART NO.: | DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY | DATE: NOVEMBER 1988 |

## DATABASE QUERIES FOR MSDS

- CHEM PRO
- HAZARD LINE
- CHEM ABSTRACTS
- NATIONAL INSTITUTE OF HEALTH
- HAZ MET ETC.

| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH | MARSHALL SPACE FLIGHT CENTER | NAME: R. T. CONGO |
|---|---|---|
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**LIQUIDS:**

- HYDROFLUORIC ACID
- NITRIC ACID
- ACETIC ACID
- SILVER NITRATE
- MAGNESIUM IODIDE
- HYDROGEN PEROXIDE
- WATER
- SODIUM HYDROXIDE
- CUPRIC NITRATE
- BROMINE
- SODIUM HYPOCHLORITE
- POTASSIUM HYDROXIDE
- POTASSIUM FERRICYANIDE
- HYDROCHLORIC ACID
- METHANOL
- PERCHLORIC ACID
- BENZENE
- TRICHLOROETHYLENE
- ACETONE
- TOLUENE
- FREON 22
- FREON 113
- ALLYL ALCOHOL
- N-BUTYL ALCOHOL
- CYCLOHEXANOL
- ISOPROPYL ALCOHOL
- PHENOL
- ACROLEIN
- TRIMETHYL BENZENE
- INDENE
- XYLENE
- DIISOBUTYL KETONE
- MEK
- FURAN
- BUTYL LACTATE

**LIQUIDS (CONT'D)**

- DICHLOROMETHANE
- TRICHLOROETHANE
- POLYPHENYLENE SULFIDES
- TRIGLYCINE SULFATE SOLUTION
- GLUTERALDEHYDE
- AMMONIA
- LATEX SOLUTION
- BUFFER SOLUTION
- CULTURE MEDIUM
- STAINING SOLUTION
- LIQUID CHROMATOGRAPHY CARRIER
- RAW PROTEIN SOLUTION
- DEVELOPER
- FIXER
- BIOCIDE/DISINFECTANT
- QUENCH SOLUTION
- BURN CATALYTIC AND SUPPRESSANT COMPOUNDS
- POLISHING SOLUTION
- MONOMER SOLUTION

**GASES:**

- OXYGEN
- NITROGEN
- HYDROGEN
- CARBON DIOXIDE
- CARBON MONOXIDE
- HELIUM
- ARGON
- WATER VAPOR
- XENON
- LIGHT HYDROCARBONS
- CHLORINE
- FLUORINE
- FREON 22
- FREON 113

**GASES (CONT'D):**

- HALON (1301, 1211, NOT SPECIFIED)
- VAPORS FROM OTHER LIQUID WASTES

**PARTICULATES:**

- GERMANIUM
- SILICON
- GALLIUM ARSENIDE
- SEED CRYSTAL FRAGMENTS
- METALLIC OXIDES
- BOULE FRAGMENTS
- GLASS AMPOULE FRAGMENTS
- GLASS FIBER PARTICLES
- SMOKE
- MICROBES
- MERCURY CADMIUM TELLURODE
- SODIUM HYDROXIDE
- CADMIUM SULFIDE
- TUNGSTEN
- BERYLLIUM
- PLASTIC ENCAPSULATION FRAGMENTS
- SOLDER
- RESIN POWDER
- ALUMINUM POWDER
- POLISHING ABRASIVES
- ZEOLITE
- PRODUCT FRAGMENTS
- LATEX SPHERES
- GRAPHITE
- POLYPHENYLENE SULFIDE SPHERES
- SODIUM ALUMINATE
- SODIUM HYPOCHLORITE
- LIQUID MERCURY
- MERCURY CADMIUM TELLURIDE

MATERIAL SAFETY DATA SHEET OHS23590 474

OCCUPATIONAL HEALTH SERVICES, INC.
450 SEVENTH AVENUE, SUITE 2407
NEW YORK, NEW YORK 10123
(800) 448-MSDS (212) 967-1100

EMERGENCY CONTACT:
JOHN S. BRANSFORD, JR. (615)292-1180

## SUBSTANCE IDENTIFICATION

CAS-NUMBER 108-88-3
RTEC-NUMBER XS5250000

SUBSTANCE: TOLUENE

TRADE NAMES/SYNONYMS:
TOLUOL: PHENYL METHANE: METHYL BENZENE: METHYLBENZOL: METHYLBENZIENE: PHENYLMETHANE: METHACIDE: U220: STCC 4909305: UN 1294: T-290: T-289: T-330: T-324: T-324-S: T-324-SK: T-323: T-323-S: BENZENE, METHYL-: ANTISALIA: OHS23590

CHEMICAL FAMILY:
HYDROCARBON, AROMATIC

MOLECULAR FORMULA: C7-H8 MOLECULAR WEIGHT: 92.0

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=3 REACTIVITY=0 PERSISTENCE=1
NFPA RATINGS (SCALE 0-4): HEALTH=2 FIRE=3 REACTIVITY=0

## COMPONENTS AND CONTAMINANTS

COMPONENT: TOLUENE PERCENT: >99

EXPOSURE LIMIT:
TOLUENE:
200 PPM OSHA TWA; 300 PPM OSHA ACCEPTABLE CEILING CONCENTRATION
500 PPM FOR 10 MINUTES OSHA ACCEPTABLE MAXIMUM PEAK ABOVE THE ACCEPTABLE CEILING CONCENTRATION FOR AN 8 HOUR SHIFT
100 PPM ACGIH TWA; 150 PPM ACGIH STEL
100 PPM NIOSH RECOMMENDED TWA; 200 PPM NIOSH RECOMMENDED 10 MINUTE CEILING
50 PPM ROHM AND HAAS RECOMMENDED TWA; 75 PPM ROHM AND HAAS RECOMMENDED STEL

1000 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY

## PHYSICAL DATA

DESCRIPTION: CLEAR, COLORLESS LIQUID WITH AN AROMATIC ODOR.

BOILING POINT: 231 F (111 C) MELTING POINT: -139 F ( [illegible] C)

SPECIFIC GRAVITY: 0.866 EVAPORATION RATE: (BUTYL ACETATE=1) 2.24

SOLUBILITY IN WATER: 0.05% VAPOR DENSITY: 3.2

VAPOR PRESSURE: 22 MMHG @ 20 C ODOR-THRESHOLD: 0.2-5 PPM

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
ACETONE, BENZENE, ALCOHOL, CHLOROFORM, ETHER, GLACIAL
ACETIC ACID, CARBON DISULFIDE, DIMETHYL SULFOXIDE, LIGROIN, OTHER HYDROCARBONS

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## FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
DANGEROUS FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL A CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK.

VAPOR-AIR MIXTURES ARE EXPLOSIVE ABOVE FLASH POINT.

DUE TO LOW ELECTROCONDUCTIVITY OF THE SUBSTANCE, FLOW OR AGITATION MAY GENERATE ELECTROSTATIC CHARGES RESULTING IN SPARKS WITH POSSIBLE IGNITION.

FLASH POINT: 40 F (4 C) (CC)  UPPER EXPLOSION LIMIT: 7.1%

LOWER EXPLOSION LIMIT: 1.2%  AUTOIGNITION TEMP.: 896 F (480 C)

FLAMMIBILITY CLASS (OSHA): IB

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, HALON, WATER SPRAY OR STANDARD FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR STANDARD FOAM (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. COOL FIRE-EXPOSED CONTAINERS WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT. STAY AWAY FROM STORAGE TANK ENDS. FOR MASSIVE FIRE IN STORAGE AREA, USE UNMANNED HOSE HOLDER OR MONITOR NOZZLES, ELSE WITHDRAW FROM AREA AND LET FIRE BURN. WITHDRAW IMMEDIATELY IN CASE OF RISING SOUND FROM VENTING SAFETY DEVICE OR ANY DISCOLORATION OF STORAGE TANK DUE TO FIRE (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 27).

EXTINGUISH ONLY IF FLOW CAN BE STOPPED; USE WATER IN FLOODING QUANTITIES AS FOG, SOLID STREAMS MAY SPREAD FIRE. COOL CONTAINERS WITH FLOODING AMOUNTS OF WATER, APPLY FROM AS FAR A DISTANCE AS POSSIBLE. AVOID BREATHING TOXIC VAPORS. KEEP UPWIND.

WATER MAY BE INEFFECTIVE (NFPA FIRE PROTECTION GUIDE ON HAZARDOUS MATERIALS, EIGHTH EDITION).

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## TRANSPORTATION

DEPARTMENT OF TRANSPORTATION HAZARD CLASSIFICATION 49CFR172.101:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS 49CFR172.101 AND 172.402:
FLAMMABLE LIQUID

DEPARTMENT OF TRANSPORTATION PACKAGING REQUIREMENTS: 49CFR173.119
EXCEPTIONS: 49CFR173.118

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## TOXICITY

TOLUENE:
300 PPM EYE-HUMAN IRRITATION; 500 MG SKIN-RABBIT MODERATE IRRITATION; 435 MG SKIN-RABBIT MILD IRRITATION; 2 MG/24 HOURS EYE-RABBIT SEVERE IRRITATION; 870 UG EYE-RABBIT MILD IRRITATION; 100 MG/30 SECONDS RINSED EYE-RABBIT MILD IRRITATION; 200 PPM INHALATION-HUMAN TCLO; 100 PPM INHALATION-MAN TCLO; 50 MG/KG ORAL-HUMAN LDLO; 5000 MG/KG ORAL-RAT LD50; 4000 PPM/4 HOURS INHALATION-RAT LCLO; 12,124 MG/KG SKIN-RABBIT LD50; 1600 PPM INHALATION-GUINEA PIG LCLO; 800 MG/KG INTRAPERITONEAL-RAT LDLO; 1960 MG/KG INTRAVENOUS-RAT LD50; 5320 PPM/8 HOURS INHALATION-MOUSE LC50; 1126 MG/KG INTRAPERITONEAL-MOUSE LD50; 2000 MG/KG UNREPORTED-MOUSE LD50; 6900 MG/KG UNREPORTED-RAT LD50; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS).
CARCINOGEN STATUS: NONE.
TOLUENE IS A SKIN, EYE, AND MUCOUS MEMBRANE IRRITANT, CENTRAL NERVOUS SYSTEM DEPRESSANT, AND NEUROTOXIN. POISONING MAY AFFECT THE HEART, LIVER, KIDNEYS, AND BLOOD. STIMULENTS SUCH AS EPINEPHRINE OR EPHEDRINE MAY INDUCE VENTRICULAR FIBRILLATION. TOLUENE INHIBITS MITOCHONDRIAL OXIDATIVE PHOSPHORYLATION. CONSUMPTION OF ALCOHOLIC BEVERAGES MAY ENHANCE THE TOXIC EFFECTS.

EPIDEMIOLOGICAL STUDIES INVOLVING PETROLEUM REFINERY WORKERS INDICATE PERSONS WITH ROUTINE EXPOSURE TO PETROLEUM OR ONE OF ITS CONSTITUENTS MAY BE AT AN INCREASED RISK TO THE DEVELOPMENT OF BENIGN NEOPLASMS, DIGESTIVE SYSTEM CANCERS, AND SKIN CANCER, PARTICULARLY MELANOMA.

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## HEALTH EFFECTS AND FIRST AID

INHALATION:
TOLUENE:
IRRITANT/NARCOTIC/NEUROTOXIN.
2000 PPM IMMEDIATELY DANGEROUS TO LIFE OR HEALTH.
ACUTE EXPOSURE- THE LEVEL REQUIRED TO PRODUCE NARCOSIS CAN EXIST WITHOUT ASSOCIATED RESPIRATORY TRACT IRRITATION. ODOR DETECTION IS INSUFFICIENT FOR WARNING DUE TO OLFACTORY FATIGUE. 200-600 PPM FOR UP TO 8 HOURS CAUSED MILD UPPER RESPIRATORY TRACT IRRITATION, FATIGUE, WEAKNESS, CONFUSION, HEADACHE, NAUSEA, IMPAIRED COORDINATION AND REACTION TIME, PARESTHESIAS OF THE SKIN, EUPHORIA, DIZZINESS, AND DILATED PUPILS. 800 PPM CAUSED RAPID IRRITATION, NASAL MUCOUS SECRETION, METALLIC TASTE, DROWSINESS, AND IMPAIRED BALANCE. AFTEREFFECTS INCLUDING NERVOUSNESS, MUSCULAR FATIGUE, AND INSOMNIA LASTED FOR SEVERAL DAYS. A WORKER FOUND UNCONSCIOUS AFTER EXPOSURE TO HIGH VAPOR CONCENTRATIONS FOR 18 HOURS DEVELOPED HEPATIC AND RENAL DAMAGE WITH MYOGLOBINURIA. RECOVERY WAS COMPLETE WITHIN 6 MONTHS. HEMATOLOGIC EFFECTS OCCUR RARELY WITH EXPOSURE TO HIGH CONCENTRATIONS. RECOVERY USUALLY FOLLOWS REMOVAL FROM EXPOSURE. EXTREME INHALATION MAY CAUSE DEATH BY PARALYSIS OF THE RESPIRATORY CENTER.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSES MUCOUS MEMBRANE IRRITATION, VOMITING, INSOMNIA, NOSEBLEEDS, CHEST PAIN, EUPHORIA, HEADACHE, VERTIGO, NAUSEA, ANOREXIA, BAD TASTE, MOMENTARY LOSS OF MEMORY, PALPITATIONS, EXTREME WEAKNESS, LOSS OF COORDINATION AND IMPAIRMENT OF

REACTION TIME, TINNITUS, ALCOHOL INTOLERANCE, PETECHIAE AND ABNORMAL BLEEDING. LEUKOPENIA WITH BONE MARROW HYPOPLASIA HAS BEEN REPORTED OCCASIONALY, BUT MAY BE DUE TO BENZENE CONTAMINATION. EXAMINATION OF WORKERS EXPOSED TO 100-1100 PPM REVEALED HEPATUMEGALY, MILD MACROCYTOSIS, MODERATE ERYTHROPENIA, AND ABSOLUTE LYMPHOCYTOSIS, BUT NO LEUKOPENIA. OTHER WORKERS EXPOSED TO TOLUENE FUMES DEVELOPED LEUKOPENIA AND ESPECIALLY NEUTROPENIA. WITHIN 6 MONTHS, THEY SHOWED INCREASED COAGULATION TIME AND DECREASED PROTHROMBIN LEVEL. PERIODONTAL EFFECTS WERE ALSO NOTED. CARDIAC SENSITIZATION MAY OCCUR AND MAY RESULT IN CARDIAC ARREST DUE TO VENTRICULAR FIBRILLATION. REPEATED INHALATION OF TOLUENE TO THE POINT OF EUPHORIA HAS CAUSED IRREVERSIBLE ENCEPHALOPATHY WITH CEREBELLAR ATAXIA, RHYTHMIC LIMB MOVEMENTS, UNSTEADINESS, BIZZARE BEHAVIOR, EMOTIONAL LABILITY AND OPTIC ATROPHY, AND DIFFUSE CEREBRAL ATROPHY. OTHER NEUROPSYCHIATRIC EFFECTS MAY INCLUDE LETHARGY, HALLUCINATIONS, COMA, DIZZINESS, SYNCOPE, PARESTHESIAS, AND PERIPHERAL NEUROPATHY. INTENTIONAL SNIFFING CAN PRODUCE RENAL TUBULAR DEFECTS WITH METABOLIC ACIDOSIS, ELECTROLYTE ABNORMALITIES AND POTASSIUM LOSS. SEVERE MUSCLE WEAKNESS LEADING TO LIMB PARALYSIS AND CARDIAC ARRHYTHMIAS MAY RESULT FROM THE HYPOKALEMIA; HOWEVER, SENSORY FUNCTION AND TENDON REFLEXES ARE NOT IMPAIRED. GASTROINTESTINAL EFFECTS MAY INCLUDE ABDOMINAL PAIN, NAUSEA, VOMITING, AND HEMATEMESIS. CHROMOSOME CHANGES WERE OBSERVED IN SOME WORKERS UP TO TWO YEARS AFTER CESSATION OF EXPOSURE TO TOLUENE. WOMEN OCCUPATIONALLY EXPOSED TO TOLUENE AND OTHER VARNISH SOLVENTS HAVE REPORTED MENSTRUAL DISORDERS, UNDERWEIGHT OFFSPRING WHO DID NOT NURSE WELL, AND FETAL ASPHYXIA. DYSMENORRHEA HAS BEEN REPORTED IN WOMEN OCCUPATIONALLY EXPOSED TO TOLUENE LEVELS OF 60-100 PPM. EFFECTS ON THE FETUS AND FETAL DEVELOPMENTAL ABNORMALITIES HAVE BEEN REPORTED IN OFFSPRING OF FEMALE RATS AND MICE FOLLOWING REPEATED EXPOSURE DURING GESTATION.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
TOLUENE:
IRRITANT.
ACUTE EXPOSURE- CONTACT WITH THE LIQUID MAY CAUSE IRRITATION, SCALING, CRACKING AND DERMATITIS. SKIN ABSORPTION DOES OCCUR, BUT IT IS GENERALLY TOO SLOW TO PRODUCE SIGNS OF ACUTE SYSTEMIC TOXICITY. PARESTHESIAS OF THE SKIN MAY OCCUR FROM VAPOR EXPOSURE.
CHRONIC EXPOSURE- REPEATED OR PROLONGED CONTACT WITH THE LIQUID MAY CAUSE DEFATTING OF THE SKIN, RESULTING IN A DRY, FISSURED DERMATITIS. TEN TO TWENTY APPLICATIONS TO RABBIT SKIN PRODUCED SLIGHT TO MODERATE IRRITATION AND SLIGHT NECROSIS.

AN EPIDEMIOLOGICAL STUDY OF PETROLEUM REFINERY WORKERS HAS REPORTED ELEVATIONS IN STANDARD MORTALITY RATIOS FOR SKIN CANCER ALONG WITH A DOSE-RESPONSE RELATIONSHIP WHICH INDICATES AN ASSOCIATION BETWEEN ROUTINE WORKPLACE EXPOSURE TO PETROLEUM OR ONE OF ITS CONSTITUENTS AND SKIN CANCER, PARTICULARLY MELANOMA.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
TOLUENE:
IRRITANT.

ACUTE EXPOSURE- CONTACT WITH THE LIQUID MAY CAUSE CORNEAL BURNS IF NOT PROMPTLY REMOVED. VAPORS MAY CAUSE NOTICEABLE IRRITATION AND LACRIMATION AT 300-800 PPM, AND EXTREMELY HIGH CONCENTRATIONS MAY CAUSE BLURRING OF VISION. CORNEAL LESIONS, VERY FINE VACOULES, HAVE BEEN REPORTED IN WORKERS EXPOSED TO A SOLVENT MIXTURE CONTAINING TOLUENE. THE LESIONS SUBSIDED FOLLOWING SEVERAL DAYS OF NON-EXPOSURE. SIMILAR LESIONS HAVE BEEN PRODUCED IN CATS FOLLOWING EXPOSURE TO TOLUENE.

CHRONIC EXPOSURE- REPEATED OR PROLONGED CONTACT MAY CAUSE CONJUNCTIVITIS. RARELY, SYSTEMIC OCULAR DISTURBANCES, SUCH AS "REDDENING OF THE VISION", HAVE OCCURRED.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
TOLUENE:
NARCOTIC.

ACUTE EXPOSURE- MAY CAUSE NAUSEA, VOMITING, COLIC, DIARRHEA, BURNING SENSATION IN THE EPIGASTRIUM, HEADACHE, TINNITUS, DIZZINESS, WEAKNESS, EUPHORIA, DROWSINESS AND INCOORDINATION. IF LARGE AMOUNTS ARE INGESTED, SYMPTOMS MAY PROGRESS TO INCLUDE SHALLOW, RAPID RESPIRATION, TREMORS, VENTRICULAR IRREGULARITIES WITH FIBRILLATION, CONVULSIONS, STUPOR AND UNCONSCIOUSNESS. METABOLIC ACIDOSIS AND LIVER AND KIDNEY DAMAGE MAY OCCUR. APPROXIMATELY 15-30 MILLILITERS, IS THE HUMAN LETHAL DOSE. ASPIRATION OF THE LIQUID INTO THE LUNGS MAY CAUSE COUGHING, GAGGING, ACUTE HEMORRHAGIC PNEUMONITIS AND RAPIDLY PULMONARY EDEMA.

CHRONIC EXPOSURE- NO EFFECTS WERE REPORTED IN RATS FEED UP TO 590 MG/KG/DAY FOR 193 DAYS. EFFECTS ON THE FETUS AND FETAL DEVELOPMENTAL ABNORMALITIES HAVE BEEN REPORTED FOLLOWING REPEATED ADMINISTRATION TO PREGNANT MICE.

FIRST AID- EXTREME CARE MUST BE USED TO PREVENT ASPIRATION. USE GASTRIC LAVAGE WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE WITHIN 15 MINUTES. IN THE ABSENCE OF DEPRESSION OR CONVULSIONS OR IMPAIRED GAG REFLEX, IPECAC EMESIS CAN BE DONE. WHEN VOMITING BEGINS, KEEP HEAD BELOW THE HIPS TO PREVENT ASPIRATION. AFTER VOMITING STOPS, GIVE 30-60 MILLILITERS OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. MAINTAIN AIRWAY, BLOOD PRESSURE AND RESPIRATION. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.) GET MEDICAL ATTENTION. TREATMENT MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

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REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
TOLUENE:

ALLYL CHLORIDE + DICHLOROETHYL ALUMINUM OR ETHYLALUMINUM SESQUICHLORIDE: POSSIBLE EXPLOSION.
BROMINE TRIFLUORIDE (SOLID): VIOLENT REACTION.
DINITROGEN TETRAFLUORIDE: FORMS EXPLOSIVE MIXTURE.
NITRIC ACID: INTENSE REACTION.
NITRIC ACID + MIXED ACIDS: POSSIBLE RUNAWAY OR EXPLOSIVE REACTION.

NITRIC ACID + SULFURIC ACID: EXPLOSIVE REACTION.
NITROGEN TETROXIDE: EXPLOSIVE REACTION.
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.
PLASTICS, RUBBER, AND COATINGS: MAY BE ATTACKED.
SILVER PERCHLORATE: FORMATION OF SHOCK SENSITIVE COMPLEX.
SULFURIC ACID: EXOTHERMIC REACTION.
TETRANITROMETHANE: EXTREMELY VIOLENT EXPLOSIVE REACTION.
URANIUM HEXAFLUORIDE: VIGOROUS REACTION WITH THE SEPARATION OF CARBON.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF CARBON.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

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## STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE.

### **STORAGE**

STORE IN ACCORDANCE WITH 29 CFR 1910.106.

PROTECT AGAINST PHYSICAL DAMAGE. OUTSIDE OR DETACHED STORAGE IS PREFERABLE. INSIDE STORAGE SHOULD BE IN A STANDARD FLAMMABLE LIQUIDS STORAGE ROOM OR CABINET. SEPARATE FROM OXIDIZING MATERIALS (NFPA 49, HAZARDOUS CHEMICALS DATA, 1975).

BONDING AND GROUNDING: SUBSTANCES WITH LOW ELECTROCONDUCTIVITY, WHICH MAY BE IGNITED BY ELECTROSTATIC SPARKS, SHOULD BE STORED IN CONTAINERS WHICH MEET THE BONDING AND GROUNDING GUIDELINES SPECIFIED IN NFPA 77-1977, RECOMMENDED PRACTICE ON STATIC ELECTRICITY.

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

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## CONDITIONS TO AVOID

MAY BE IGNITED BY HEAT, SPARKS OR FLAMES. VAPORS MAY TRAVEL TO A SOURCE OF IGNITION AND FLASH BACK. CONTAINER MAY EXPLODE IN HEAT OF FIRE. VAPOR EXPLOSION HAZARD INDOORS, OUTDOORS OR IN SEWERS. RUNOFF TO SEWER MAY CREATE FIRE OR EXPLOSION HAZARD.

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## SPILLS AND LEAKS

SOIL-RELEASE:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

DIKE FLOW OF SPILLED MATERIAL USING SOIL OR SANDBAGS OR FOAMED BARRIERS SUCH AS POLYURETHANE OR CONCRETE.

USE CEMENT POWDER OR FLY ASH TO ABSORB LIQUID MASS.

IMMOBILIZE SPILL WITH UNIVERSAL GELLING AGENT.

REDUCE VAPOR AND FIRE HAZARD WITH FLUOROCARBON WATER FOAM.

AIR-RELEASE:
KNOCK DOWN VAPORS WITH WATER SPRAY. KEEP UPWIND.

WATER-SPILL:
LIMIT SPILL MOTION AND DISPERSION WITH NATURAL BARRIERS OR OIL SPILL CONTROL BOOMS.

APPLY DETERGENTS, SOAPS, ALCOHOLS OR ANOTHER SURFACE ACTIVE AGENT TO THICKEN SPILLED MATERIAL.

APPLY UNIVERSAL GELLING AGENT TO IMMOBILIZE TRAPPED SPILL AND INCREASE EFFICIENCY OF REMOVAL.

IF DISSOLVED, APPLY ACTIVATED CARBON AT TEN TIMES THE SPILLED AMOUNT IN THE REGION OF 10 PPM OR GREATER CONCENTRATION.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

USE MECHANICAL DREDGES OR LIFTS TO EXTRACT IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES.

OCCUPATIONAL-SPILL:
SHUT OFF IGNITION SOURCES. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA. KEEP UNNECESSARY PEOPLE AWAY; ISOLATE HAZARD AREA AND RESTRICT ENTRY.

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PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS. VENTILATION EQUIPMENT MUST BE EXPLOSION-PROOF.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS OR NIOSH CRITERIA DOCUMENTS; OR DEPARTMENT OF LABOR, 29CFR1910 SUBPART I.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION.

TOLUENE:
1000 PPM- ANY CHEMICAL CARTRIDGE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE(S).
ANY SUPPLIED-AIR RESPIRATOR.
ANY POWERED AIR-PURIFYING RESPIRATOR WITH ORGANIC VAPOR

CARTRIDGE(S).
ANY SELF-CONTAINED BREATHING APPARATUS.

2000 PPM- ANY SUPPLIED-AIR RESPIRATOR OPERATED IN A CONTINUOUS FLOW MODE.
ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.
ANY SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE.
ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT OR BACK-MOUNTED ORGANIC VAPOR CANISTER.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH A CHIN-STYLE OR FRONT OR BACK-MOUNTED ORGANIC VAPOR CANISTER.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE DEMAND OR OTHER POSITIVE PRESSURE MODE.

SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

AUTHORIZED - OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 10/23/84 REVISION DATE: 03/22/88

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MATERIAL SAFETY DATA SHEET ACC14370 502

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN, NJ 07410 (201) 796-7100

EMERGENCY CONTACT:
GASTON L. PILLORI
(201) 796-7100

## SUBSTANCE IDENTIFICATION

CAS-NUMBER 71-55-6

SUBSTANCE: **1,1,1-TRICHLOROETHANE**

TRADE NAMES/SYNONYMS:
METHYL CHLOROFORM: ETHYLIDYNE CHLORIDE: UN 2831: T-391: T-398:
ACC14370

CHEMICAL FAMILY:
HYDROCARBON, ALIPHATIC

MOLECULAR FORMULA: C2-H3-CL3 MOL WT: 133.41

CERCLA RATINGS (SCALE 0-3): HEALTH=2 FIRE=0 REACTIVITY=2 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=1 REACTIVITY=1

## COMPONENTS AND CONTAMINANTS

COMPONENT: 1,1,1-TRICHLOROETHANE PERCENT: >95

COMPONENT: INHIBITOR TO PREVENT CORROSION OF METALS PERCENT: <5

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
350 PPM OSHA TWA
350 PPM ACGIH TWA; 450 ACGIH STEL
350 PPM NIOSH RECOMMENDED 15 MINUTE CEILING

## PHYSICAL DATA

DESCRIPTION: COLORLESS LIQUID WITH A MILD CHLOROFORM-LIKE ODOR.

BOILING POINT: 165 F (74 C) MELTING POINT: -36 F.(-32 C)

SPECIFIC GRAVITY: 1.3 EVAPORATION RATE: (CCL4=1) 1 TTE

SOLUBILITY IN WATER: 0.44% VAPOR DENSITY: 4.6

VAPOR PRESSURE: 100 MMHG @ 20 C ODOR-THRESHOLD: 20-100 PPM

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
ACETONE, BENZENE, CCL4, METHANOL, AND ETHER.

## FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
NEGLIGIBLE FIRE HAZARD AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FLASH POINT: NONFLAMMABLE UPPER EXPLOSION LIMIT: 10.5%

LOWER EXPLOSION LIMIT: 8.0% AUTOIGNITION TEMP.: 998 F (537 C)

FLAMMIBILITY CLASS (OSHA): IIIA

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE OR HALON
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR STANDARD FOAM
(1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4).

FIREFIGHTING:
STAY AWAY FROM STORAGE TANK ENDS. COOL CONTAINERS EXPOSED TO FLAMES WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT (1987 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.4, GUIDE PAGE 74).

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TOXICITY

27 GM/M3/10 MIN INHALATION-MAN LCLO; 1000 PPM INHALATION-RAT LCLO; 10300 MG/KG ORAL-RAT LD50; 11240 ORAL-MOUSE LD50; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS); INDEFINITE ANIMAL CARCINOGEN (IARC). DATA AVAILABLE DO NOT PERMIT EVALUATION OF CARCINOGENICITY OF 1,1,1-TRICHLOROETHANE TO BE MADE.
1,1,1-TRICHLOROETHANE IS A SKIN IRRITANT AND CENTRAL NERVOUS SYSTEM DEPRESSANT. EXPOSURE MAY IRRITATE THE EYES AND MUCOUS MEMBRANES. POISONING MAY AFFECT THE CARDIOVASCULAR SYSTEM AND LIVER. ALCOHOLIC BEVERAGES MAY ENHANCE THE SYSTEMIC EFFECTS.

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HEALTH EFFECTS AND FIRST AID

INHALATION:
NARCOTIC. 1000 PPM IS IMMEDIATELY DANGEROUS TO LIFE AND HEALTH.
ACUTE EXPOSURE- INDIVIDUALS EXPOSED TO 900-1000 PPM FOR 20 MINUTES EXPERIENCED LIGHT-HEADEDNESS, INCOORDINATION, AND IMPAIRED EQUILIBRIUM. EXPOSURE TO A HIGHER CONCENTRATIONS OF EXTINDED PERIODS OF TIME MAY CAUSE CENTRAL NERVOUS SYSTEM DEPRESSION WITH DIZZINESS, INCOORDINATION DROWSINESS, INCREASED REACTION TIME, UNCONSCIOUSNESS, AND DEATH. "SUDDEN DEATHS" MAY OCCUR DUE TO SENSITIZATION OF THE MYOCARDIUM TO EPINEPHRINE. (CAUSING CARDIAC ARRYTHMIA). DEATH MAY ALSO BE CAUSED BY ASPHYXIA DUE TO THE REDUCTION IN OXYGEN AGAILABLE FOR BREATHING. AT EXTREMELY HIGH CONCENTRATIONS, LIVER AND KIDNEY INJURY MAY OCCUR. REPEATED EXPOSURE TO THE POINT OF ANESTHESIA MAY CAUSE REVERSIBLE HEPATITIS (ANIMAL).

CHRONIC EXPOSURE- IN EXPERIMENTAL ANIMALS, LIVER AND KIDNEY DAMAGE HAVE BEEN MINIMAL. SEE ANIMAL MUTAGENIC AND REPRODUCTIVE EFFECTS REFERENCES IN TOXICITY SECTION. AT 1000 TO 10,000 PPM:

3-MONTH EXPOSURES OF ANIMALS CAUSED SOME PATHOLOGIC CHANGES IN THE LIVERS AND LUNGS OF SOME SPECIES. WHEN REPEATED, REDUCED TO 500 PPM: PATHOLOGIC CHANGES WERE ELIMATED, BUT THERE WAS SOME GROWTH LOSS.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. IF BREATHING WITH DIFFICULTY, GIVE OXYGEN. REMOVE ANY CONTAMINATED CLOTHING. DO NOT GIVE EPINEPHRINE (ADRENALIN). KEEP AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
IRRITANT.

ACUTE EXPOSURE- CONTACT WITH THE LIQUID MAY CAUSE IMMEDIATE IRRITATION AND REDNESS. THE SUBSTANCE CAN BE ABSORBED TO A MODERATE DEGREE PRODUCING SYSTEMIC EFFECTS OF DIZZINESS, HEADACHE, INCOORDINATION, AND DROWSINESS.

CHRONIC EXPOSURE- REPEATED SKIN CONTACT MAY PRODUCE A DRY, SCALY, FISSURED DERMATITIS DUE TO THE DEFATTING PROPERTIES OF THE LIQUID. SEE ANIMAL MUTAGENIC AND REPRODUCTIVE REFERENCES IN TOXICITY SECTION.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
IRRITANT.

ACUTE EXPOSURE- HIGH VAPOR CONCENTRATIONS (800-1000 PPM) MAY CAUSE IRRITATION AND REDDNESS. DIRECT CONTACT OF THE LIQUID MAY CAUSE TEMPORARY INJURY WITH COMPLETE RECOVERY EXPECTED IN 48 HOURS. DIRECT APPLICATION TO THE EYES OF RABBITS HAS CAUSED CONJUNCTIVAL IRRITATION, BUT NO CORNEAL DAMAGE.

CHRONIC EXPOSURE- NO EFFECTS KNOWN IN HUMANS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 10-20 MINUTES). GET MEDICAL ATTENTION.

INGESTION:
NARCOTIC.

ACUTE EXPOSURE- SYMPTOMS PROGRESS THROUGH HEADACHE, DIZZINESS, NAUSEA, FAINTING, RESPIRATORY DEPRESSION, HYPOTENSION, ARRHYTHMIAS, AND UNCONSCIOUSNESS. LIVER AND KIDNEY DAMAGE MAY OCCUR. THE ADULT FATAL DOSE IS ESTIMATED TO BE 5 ML.

FIRST AID- GET MEDICAL ATTENTION IMMEDIATELY. IF MEDICAL ATTENTION IS NOT IMMEDIATELY AVAILABLE, AND IF VICTIM IS CONSCIOUS, ATTEMPT TO INDUCE VOMITING BY TOUCHING FINGER TO BACK OF THROAT.

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REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL CONDITIONS. REACTS VIOLENTLY WITH ALKALI, EARTH-ALKALINE,

AND WITH VARIOUS METAL POWDERS. THE SUBSTANCE CAN BE HYDROLYZED BY WATER TO FORM HYDROCHLORIC ACID AND ACETIC ACID. THE SUBSTANCE WILL REACT WITH STRONG CAUSTICS, SUCH AS CAUSTIC SODA OR CAUSTIC POTASH TO FORM FLAMMABLE OR EXPLOSIVE MATERIAL. AN INHIBITOR IS REQUIRED TO PREVENT THE CORROSION OF METALS.

INCOMPATIBILITIES:

ACETONE + BASE: EXPLOSION.
LIQUID OXYGEN + IGNITION SOURCE: EXPLOSION.
SODIUM-POTASSIUM ALLOY + LIQUID OXYGEN WITH AN ENERGY SOURCE: EXPLOSION.
STRONG OXIDIZERS: VIOLENT REACTION.
STRONG CAUSTICS: VIOLENT REACTION.
CHEMICALLY ACTIVE METALS (ALUMINUM POWDER, SODIUM, POTASSIUM, MAGNESIUM POWDER): VIOLENT REACTION.
NATURAL RUBBER: DECOMPOSES.
SODIUM: SPONTANEOUSLY FLAMMABLE COMPOUND FORMED.
SODIUM HYDROXIDE: SPONTANEOUSLY FLAMMABLE COMPOUND FORMED.
NITROGEN TETRAOXIDE: EXPLODES.

DECOMPOSITION:
THE SUBSTANCE WILL DECOMPOSE AT HIGH TEMPERATURES UPON CONTACT WITH HOT METAL OR UNDER ULTRAVIOLET RADIATION TO PRODUCE TOXIC AND CORROSIVE GASES SUCH AS HYDROGEN CHLORIDE, DICHLOROACETYLENE, AND VERY SMALL AMOUNTS OF CHLORINE AND PHOSGENE.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

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## CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. CONTAINER MAY EXPLODE IN HEAT OF FIRE. AVOID ULTRAVIOLET RADIATION. AVOID OPEN FLAMES, WELDING ARCS OR OTHER HIGH TEMPERATURE SOURCES, WHICH INDUCE THERMAL DECOMPOSITION OR EXPLOSION. AVOID AUTOIGNITION TEMPERATURE, 537 C.

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## SPILLS AND LEAKS

OCCUPATIONAL-SPILL:
SHUT OFF IGNITION SOURCES. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. FOR SMALL LIQUID SPILLS, TAKE UP WITH SAND, EARTH OR OTHER ABSORBENT MATERIAL. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. NO SMOKING, FLAMES OR FLARES IN HAZARD AREA! KEEP UNNECESSARY PEOPLE AWAY.

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## PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION SYSTEM TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:

500 PPM- CHEMICAL CARTRIDGE RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE.
SUPPLIED-AIR RESPIRATOR.
SELF-CONTAINED BREATHING APPARATUS.

1000 PPM- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE, OR EQUIVILENT RESPIRATOR.

ESCAPE- ANY ESCAPE SELF-CONTAINED BREATHING APPARATUS.

FIREFIGHTING- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - FISHER SCIENTIFIC

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CREATION DATE: 05/15/85 REVISION DATE: 09/16/87

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| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH | MARSHALL SPACE FLIGHT CENTER | NAME: R. T. CONGO |
|---|---|---|
| CHART NO.: | DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY | DATE: NOVEMBER 1988 |

## FLUIDS COMMONLY USED IN THE LAB MODULE

- CARBON DIOXIDE
- OXYGEN
- NITROGEN
- ARGON
- HELIUM
- HYDROGEN
- WATER

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# PMMS WASTE MANAGEMENT METHODOLOGY

- SOLID EFFLUENTS
  - FILTER PARTICULATES
  - BAG AND STORE
- GASEOUS EFFLUENTS
  - SINGLE MANIFOLD
  - PROCESS AND/OR STORE
  - PERIODIC VENTING
- LIQUID EFFLUENTS
  - PREPROCESS
  - SINGLE MANIFOLD TO ACCUMULATOR/WATER RECLAMATION SYSTEM
    - OR
  - SEGREGATE AND STORE

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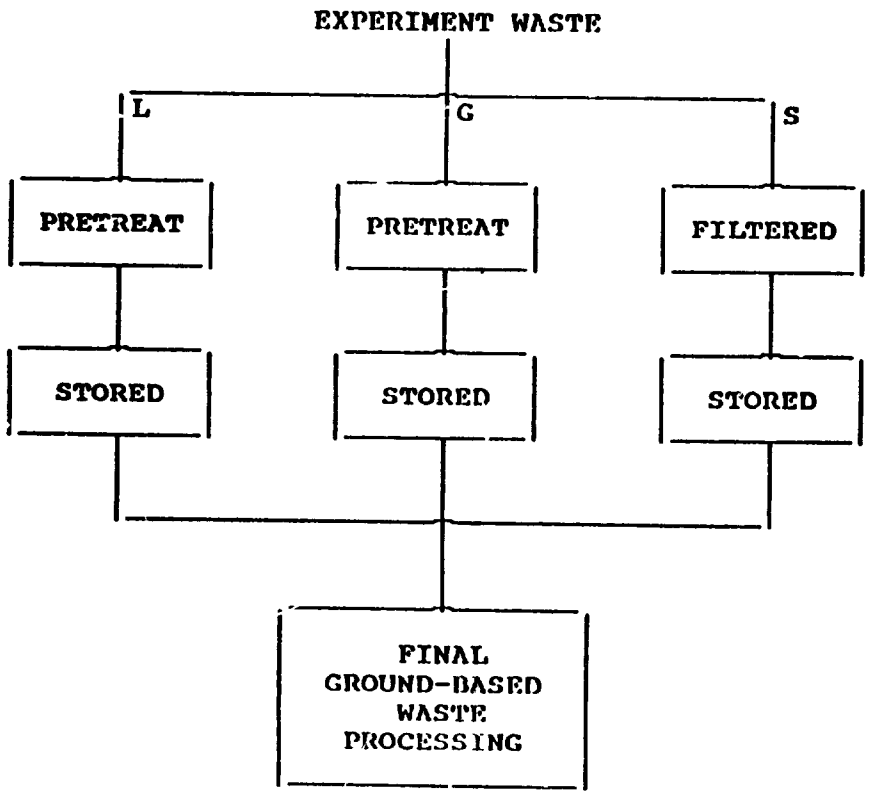

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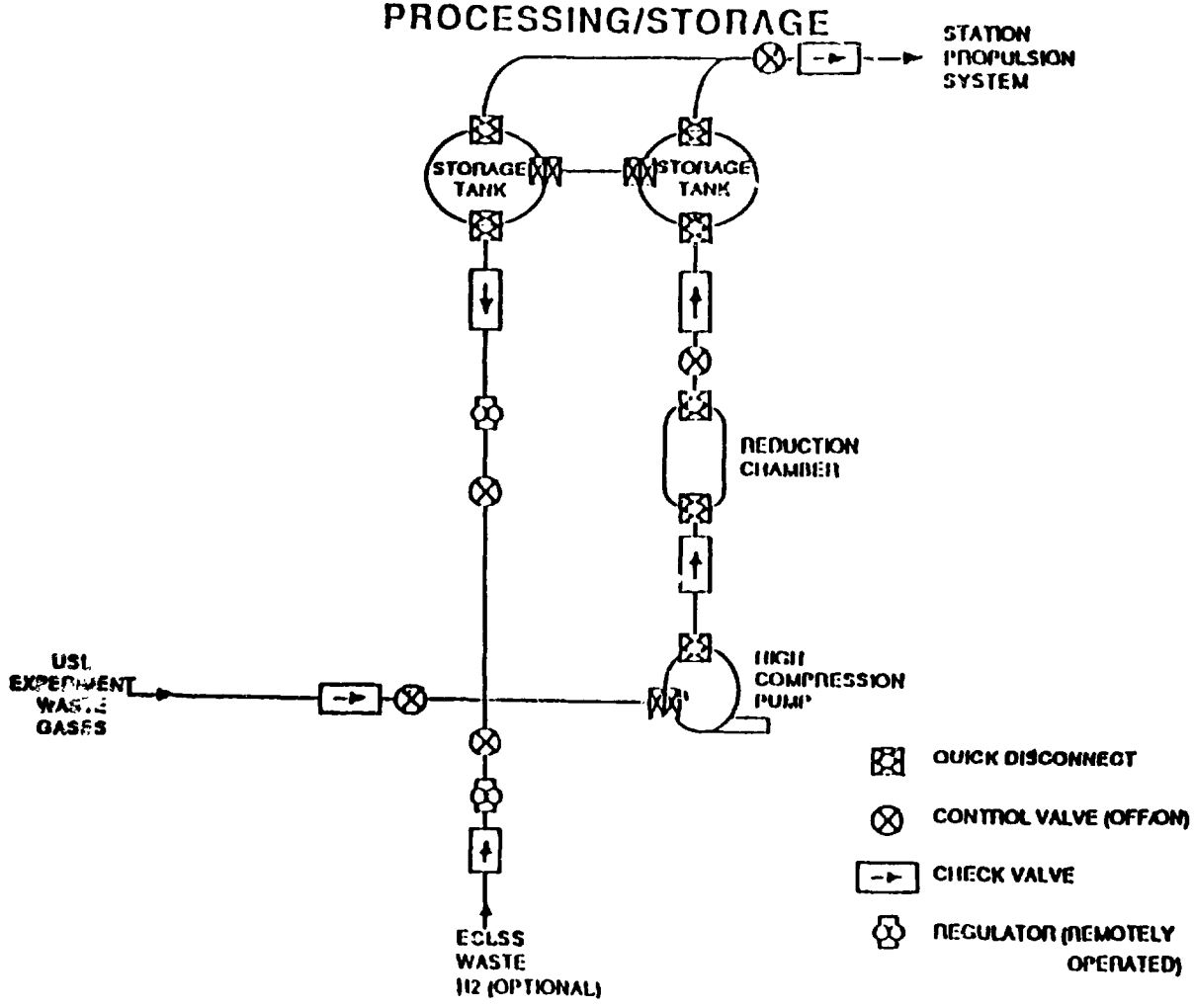
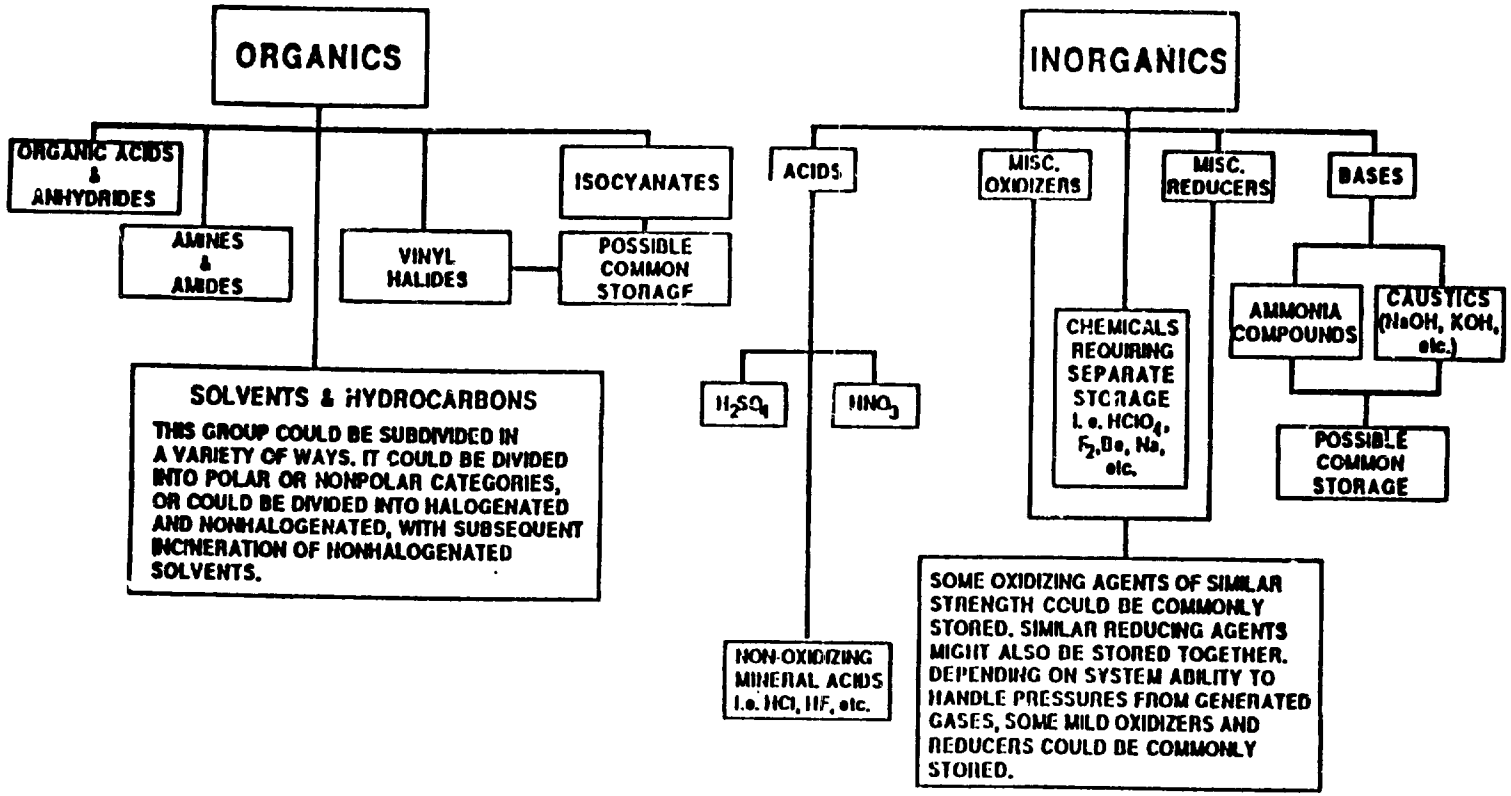
## EXTERNAL USL WASTE GAS PROCESSING/STORAGE



| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH<br>CHART NO.: | MARSHALL SPACE FLIGHT CENTER<br>DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY | NAME: R. T. CONGO<br>DATE: NOVEMBER 1988 |
|---|---|---|

# SYSTEM FOR GROUPING COMPATIBLE WASTES



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# MATERIALS INCOMPATIBILITY

- EFFLUENT/SYSTEM
- EFFLUENT/EFFLUENT

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# HAZARDOUS EFFLUENT/SYSTEM COMPONENT INTERACTIONS

- IN THE PRESENCE OF $F_2$, HCl CAN FORM $ClF_3$. UNDER DYNAMIC CONDITIONS, $ClF_3$ BREAKS DOWN TEFLON. ($ClF_3$ ALSO REACTS VIOLENTLY WITH $HNO_3$, $H_2SO_4$, METALS, METAL OXIDES, ORGANICS, AND $H_2O$)
- HCl, $HNO_3$, AND HF ARE CORROSIVE TO METAL FITTINGS. $HClO_4$ COULD BE INCOMPATIBLE WITH ORGANIC COMPONENTS.
- $H_2O_2$ HANDLING SYSTEMS MUST BE FREE OF IRON, BRASS, COPPER, AND MONEL.
- THE COMPLEXITY OF SEPARATE PLUMBING FROM GLOVEBOXES TO VARIOUS WASTE CONTAINERS COULD INCREASE THE RISK OF AN EXPERIMENTER DISCARDING WASTE INTO THE WRONG CHANNEL. IN A WORST CASE SCENARIO, AN EXPLOSION WOULD OCCUR.

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# HAZARDOUS EFFLUENT/EFFLUENT INTERACTIONS

COMMON STORAGE COULD RESULT IN DANGEROUS REACTIONS:

- AMMONIA REACTS EXPLOSIVELY WITH HALOGENS.
- AMMONIUM HYDROXIDE REACTS WITH HYDROGEN PEROXIDE TO LIBERATE LARGE AMOUNTS OF OXYGEN, AND FORMS EXPLOSIVE PRODUCTS WITH NITRIC ACID.
- FLUORINE GAS CAUSES MANY ORGANICS, METALS, AND HALOGENS TO IGNITE; AND MAY BE EXPLOSIVE WHEN COMBINED WITH NITRIC ACID, OXYGEN, CARBON MONOXIDE, AND PERCHLORIC ACID.
- PERCHLORIC ACID REACTS VIOLENTLY WITH GRAPHITE, DEHYDRATING AGENTS SUCH AS SULFURIC ACID, ACETIC ACID, AND POTASSIUM HYDROXIDE; KEYTONES; AND OTHERS. FIRES HAVE BEEN KNOWN TO ERUPT YEARS AFTER A SPILL.
- HYDROGEN PEROXIDE REACTS EXPLOSIVELY WITH MANY ORGANICS, PARTICULARLY SOLVENTS.

# HAZARDOUS EFFLUENT/EFFLUENT INTERACTIONS

STORAGE I.I CATEGORIES IS HAZARDOUS:

- HYDROCHLORIC AND SULFURIC ACIDS, OFTEN MIXED IN LABS, HAVE BEEN KNOWN TO CAUSE EXPLOSIONS WHEN STORED IN COMMON WASTE CONTAINERS.
- NITRIC ACID MIXED WITH ACETIC ACID FORMS EXPLOSIVE PRODUCTS AT TEMPERATURES ABOVE 60°C.
- NOT ALL ORGANICS ARE COMPATIBLE (ANHYDRIDES INCOMPATIBLE WITH AMINES, AROMATIC AMINES INCOMPATIBLE WITH ALDEHYDE, ETC.).
- CATEGORIZED STORAGE ACCORDING TO EPA REGULATIONS HAS RESULTED IN NUMEROUS INCIDENTS IN EH32. THESE INCIDENTS WERE NOT DANGEROUS IN AN EARTH BOUND LAB, BUT WOULD BE CATASTROPHIC IN A CLOSED ENVIRONMENT.

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## SPACE STATION WASTE MANAGEMENT PROBLEMS:

- RELIES ON SINGLE SYSTEM
- WIDE VARIETY OF REACTIVE AND CORROSIVE WASTES
- PERIODIC VENTING
- CONFLICT BETWEEN "USER-FRIENDLY" AND SAFE:
  - —CONTROL BY LIMITING MATERIALS AND TIMELINING

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HAZARDOUS MATERIALS COMPATIBILITY RESEARCH
IS REQUIRED TO ADDRESS THE FOLLOWING:

- WHAT MATERIALS ARE AVAILABLE FOR USE IN THE VARIOUS COMPONENTS (LINES, TANKS, VALVES, FITTINGS, ETC.) OF THE PMMS?
- WHAT DEGRADATION OF THESE MATERIALS WILL OCCUR DUE TO DIRECT ACTION OF WASTES?
- HOW WOULD THESE MATERIALS RESPOND TO SUDDEN EXPOSURE TO HIGH PRESSURES AND TEMPERATURES IN THE EVENT OF AN EXPLOSIVE REACTION WITHIN THE LINE?
- WHAT PROCESS WASTES MUST BE PROHIBITED FROM THE SYSTEM ENTIRELY? OR WHAT LEVEL OF DILUTION WOULD ALLOW THEIR DISPOSAL?

| ORGANIZATION: ANALYTICAL AND PHYSICAL CHEMISTRY BRANCH | MARSHALL SPACE FLIGHT CENTER | NAME: R. T. CONGO |
|---|---|---|
| CHART NO.: | DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIAL SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY | DATE: NOVEMBER 1988 |

## RESEARCH OBJECTIVES

- DEVELOP DATABASE OF PROCESS AND WASTE MATERIALS AND POTENTIAL REACTION PRODUCTS
- DEVELOP DATABASE OF CANDIDATE SYSTEM MATERIALS
- IDENTIFY CANDIDATE COMPONENTS FOR PROPOSED AND ALTERNATE DISPOSAL TECHNOLOGIES
- ESTABLISH CATAGORIES OF COMPATIBLE WASTES
- ESTABLISH APPROPRIATE SYSTEM MATERIALS FOR WASTE CATAGORIES
- EVALUATE COMPONENTS FOR EFFECTIVENESS AND MATERIAL PERFORMANCE
- EVALUATE PRETREATMENTS, POST TREATMENTS, AND ALTERNATE TECHNOLOGIES
- FLAG CORROSION PROBLEM AREAS WITHIN SYSTEM

## Acknowledgements

I would like to thank those individuals whose inputs into the development of the Materials Compatibility Laboratory at MSFC and Core Module Integration Facility Systems Evaluation has been most appreciative. These are Ms. Dinah Higgins, Ms. Wendy Alter, Mr. Jimmy Perkins, Ms. Stephania Darby, and Mr. Jay Perry. Exerpts from our combined efforts were used in some of the figures and tables presented earlier.

**TOPIC:** SPACE STATION HAZARDOUS MATERIALS DEFINITION, LABELING, AND OTHER SAFETY-RELATED ISSUES

**PRESENTED TO:** SPACE STATION TOXIC AND REACTIVE MATERIALS HANDLING WORKSHOP

**PRESENTED BY:** PAUL GALLOWAY
TELEDYNE-BROWN ENGINEERING

TELEDYNE
BROWN ENGINEERING

NOVEMBER 30, 1988

# SPACE STATION FREEDOM HAZARDOUS MATERIALS HANDLING

## TOPICS OF PRESENTATION

1) HAZARDOUS MATERIAL DEFINITION

2) PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM

3) CONCEPTUALIZED SPACE STATION USL CHEMICAL SPILL SCENARIO



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# SUMMARY OF AN EXISTING HAZARDOUS MATERIALS DEFINITION

REFERENCE: "PRUDENT PRACTICES FOR DISPOSAL OF CHEMICALS FROM LABORATORIES", 1983

- EXPLOSIVE
  - E.G., COMMERCIAL EXPLOSIVES

USL
- COMPRESSED GAS - FLAMMABLE
  - GAS UNDER PRESSURE > 40 PSIA @ 70 F OR 104 PSIA @ 130 F
  - LIQUID WITH VAPOR PRESSURE > 40 PSIA @ 100 F

USL
- COMPRESSED GAS - NONFLAMMABLE
  - GAS UNDER PRESSURE > 40 PSIA @ 70 F OR 104 PSIA @ 130 F

- POISONOUS GAS OR LIQUID - POISON CLASS A
  - SPECIFIC LIST OF TEN DEADLY COMPOUNDS

USL
- IGNITABLE LIQUID
  - LIQUID HAVING A CLOSED CUP FLASH POINT < 200 F

- ORGANIC PEROXIDE

USL DENOTES THE POTENTIAL USE THIS CLASS OF MATERIAL ON THE USL



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# SPACE STATION FREEDOM HAZARDOUS MATERIALS HANDLING

## SUMMARY OF AN EXISTING HAZARDOUS MATERIALS DEFINITION

REFERENCE: "PRUDENT PRACTICES FOR DISPOSAL OF CHEMICALS FROM LABORATORIES", 1983

- USL ● FLAMMABLE SOLID
- USL ● CORROSIVE MATERIAL
  - ▶ pH < 2 OR >12.5
- USL ● POISONOUS LIQUID OR SOLID - POISON CLASS B
  - ▶ LD50 < 50 mg/kg — ALBINO RAT - ORAL - 200 TO 300 g WEIGHT
  - ▶ LD50 < 200 mg/kg — ALBINO RABBIT - DERMAL - 2 TO 3 kg WT - 24 HR EXP.
  - ▶ LC50 < 200 mg/kg — ALBINO RAT - INHAL. - 200 TO 300 g WT - 1 HR EXP.
- USL ● OXIDIZER
- ● RADIOACTIVE MATERIAL
- ● ETIOLOGIC AGENTS
  - ▶ MICRO-ORGANISMS AND THEIR TOXINS WHICH CAUSE HUMAN DISEASE

USL DENOTES THE POTENTIAL USE THIS CLASS OF MATERIAL ON THE USL



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# SPACE STATION FREEDOM HAZARDOUS MATERIALS HANDLING

**THE PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM IS A COMBINATION OF THREE EXISTING U.S. GROUND-BASED LABELING SYSTEMS**

- **DEPARTMENT OF TRANSPORTATION (DOT) HAZARDOUS MATERIAL WARNING LABELS**
- **NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD IDENTIFICATION SYSTEM**
- **COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (CERCLA) HAZARD RANKING SYSTEM**



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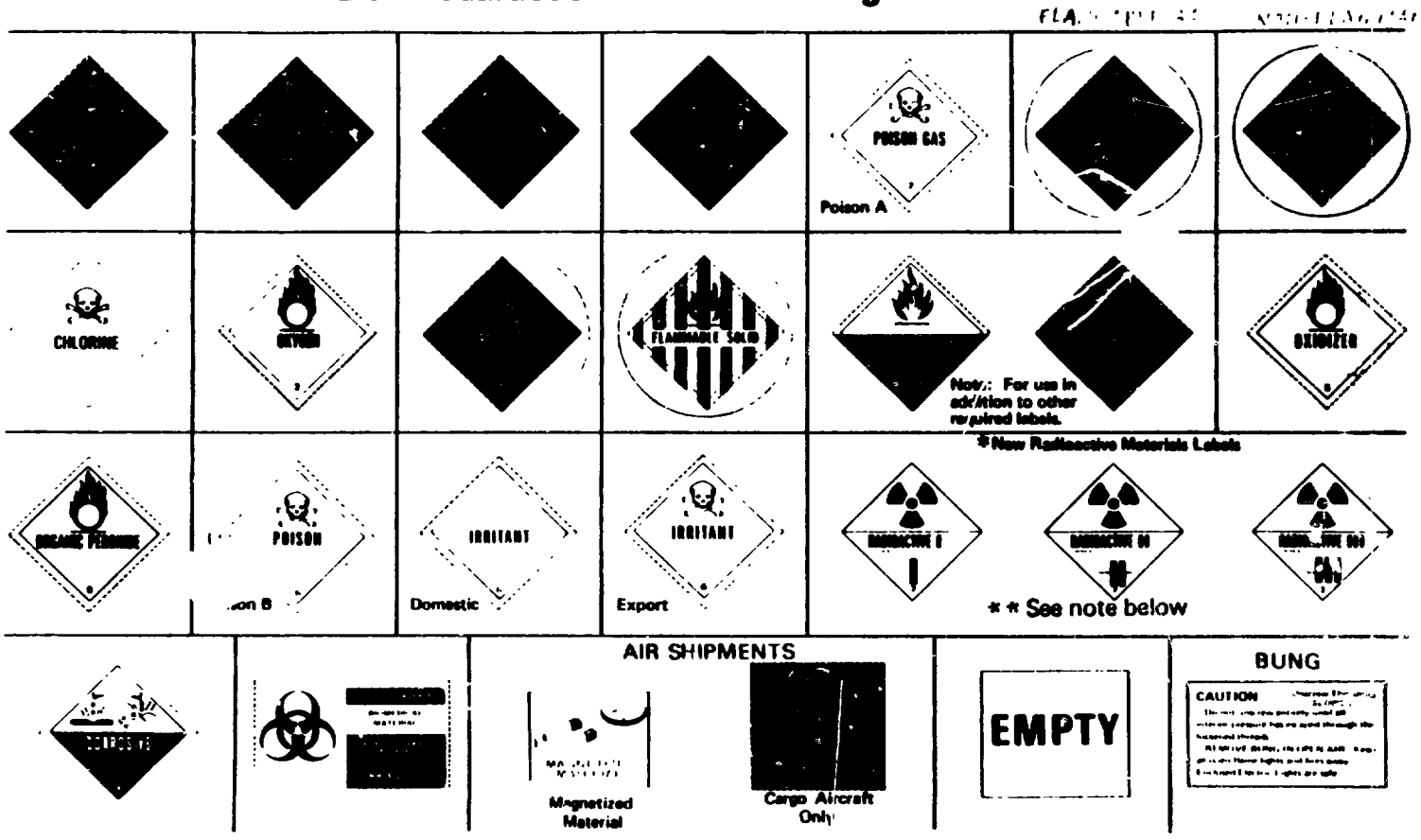
# SPACE STATION HAZARDOUS MATERIALS HANDLING

## DOT Hazardous Materials Warning Lables




○ DENOTES ANTICIPATED SPACE STATION MATERIALS

REFERENCE: TITLE 49, CODE OF FEDERAL REGULATIONS, PART 172

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# SPACE STATION HAZARDOUS MATERIALS HANDLING

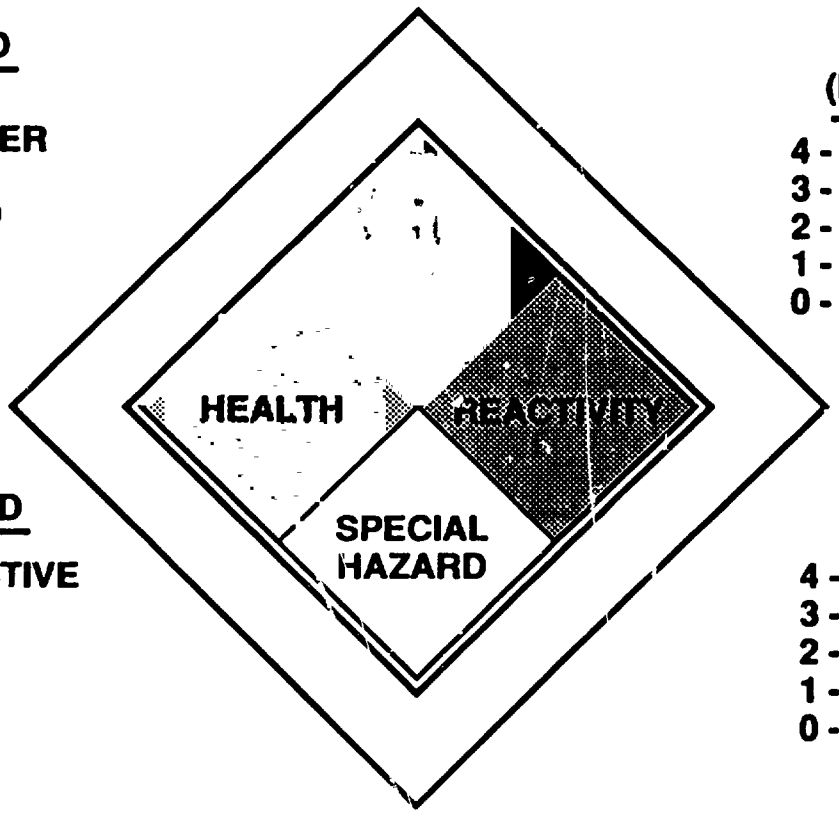
## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD IDENTIFICATION SYSTEM

**HEALTH HAZARD**

4 - DEADLY
3 - EXTREME DANGER
2 - DANGEROUS
1 - SLIGHT HAZARD
0 - NO HAZARD

**FIRE HAZARD (FLASH POINTS)**

4 - BELOW 73°F
3 - BELOW 100°F
2 - BELOW 200°F
1 - ABOVE 200°F
0 - WILL NOT BURN




**SPECIAL HAZARD**

W - WATER REACTIVE
OX - OXIDIZER
☢ - RADIOACTIVE

**REACTIVITY**

4 -MAY DETONATE
3 - EXPLOSIVE
2 - UNSTABLE
1 - NORMALLY STABLE
0 - STABLE

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# SPACE STATION FREEDOM HAZARDOUS MATERIALS HANDLING

## CERCLA HAZARD RANKING SYSTEM

### TOXICITY

3 - SEVERE TOXICITY
2 - MODERATE TOXICITY
1 - SLIGHT TOXICITY
0 - NO TOXICITY

### FLAMMABILITY

3 - FLASH POINT BELOW 100 °F
2 - FLASH POINT >100 °F AND < 200 °F
1 - FLASH POINT ABOVE 200 °F
0 - WILL NOT BURN

### PERSISTENCE (BIODEGRADABILITY)

3 - HIGHLY PERSISTENT COMPOUND
2 - PERSISTENT COMPOUND
1 - SOMEWHAT PERSISTENT COMPOUND
0 - NONPERSISTENT COMPOUND

### REACTIVITY

3 - MAY DETONATE
2 - UNSTABLE
1 - NORMALLY STABLE
0 - STABLE

REFERENCE: CODE OF FEDERAL REGULATIONS (CFR) 40, PART 300



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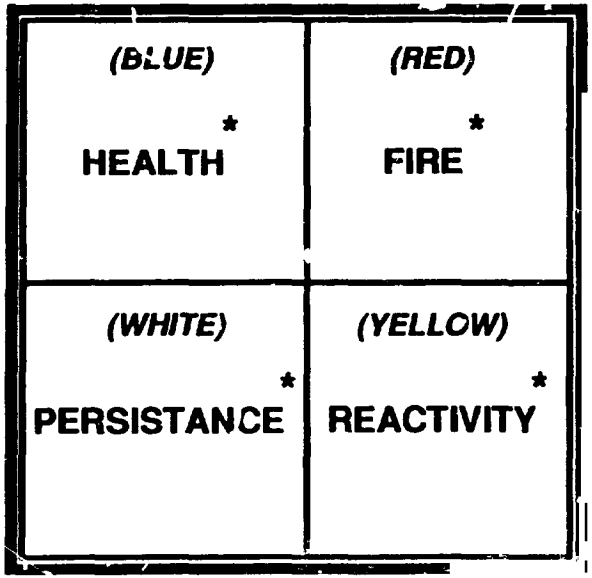
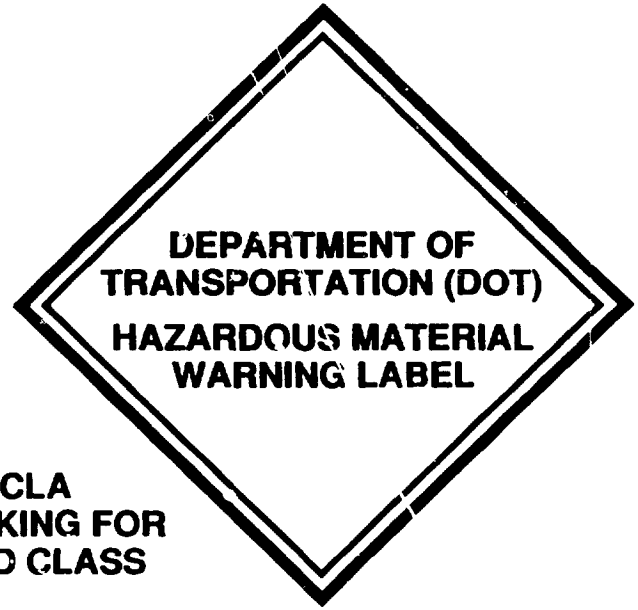
# Space Station Hazardous Materials Handling

## PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM




CHEMICAL NAME

* USE 0-3 CERCLA HAZARD RANKING FOR EACH HAZARD CLASS




SPACE STATION HAZARD DATA BASE 4- DIGIT CODE



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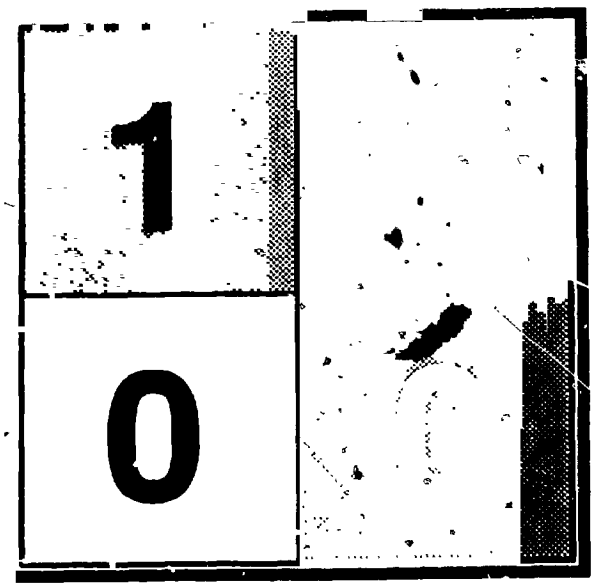
## PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM




**POLYETHYLENE GLYCOL**

**XXXX**



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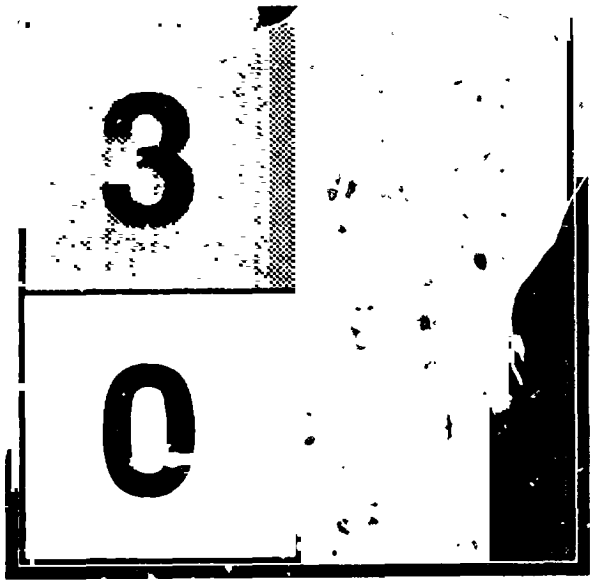
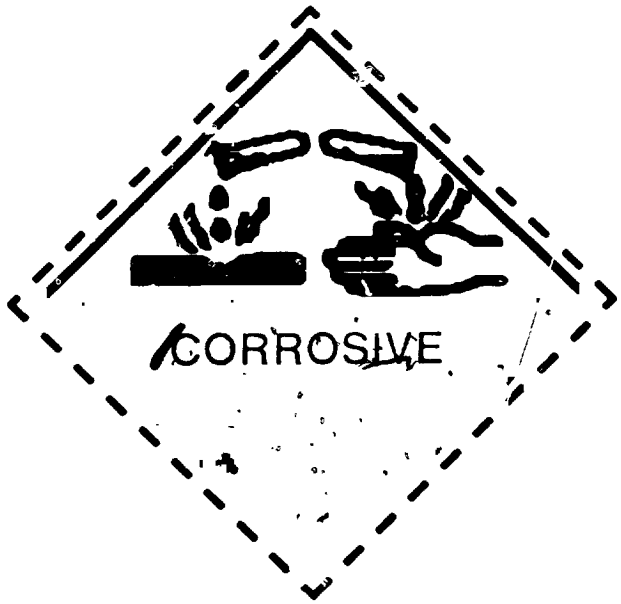
# Space Station Hazardous Materials Handling

## PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM




HYDROGEN FLUORIDE

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# Space Station Hazardous Materials Handling

## PROPOSED SPACE STATION CHEMICAL CONTAINER LABELING SYSTEM



**MERCURIC IODIDE**

**XXXX**



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# SPACE STATION FREEDOM HAZARDOUS MATERIALS HANDLING

## CONCEPTUALIZED USL SPILL SCENARIO

1) A CREWMAN IS CHANGING OUT AN EXPERIMENT RACK FOR RETURN TO EARTH

2) A QUICK-DISCONNECT ON THE WASTE LINE FAILS UPON REMOVAL AND EXPOSES THE CREW MEMBER TO AN ORGANIC LIQUID

3) THE CREWMAN OR OTHER CREW MEMBERS DECIDE TO UTILIZE THE EMERGENCY SHOWER WHICH IS LOCATED IN THE USL

4) WHILE THE CREWMAN IS USING THE EMERGENCY SHOWER, THE RELEASED ORGANIC IS DIFFUSING THROUGHOUT THE USL AND TO OTHER STATION MODULES

5) THE CREW MEMBER EMERGING FROM THE EMERGENCY SHOWER MUST RE-ENTER A CONTAMINATED USL MODULE, THEN, EXIT THE USL BEFORE IT CAN BE ISOLATED

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**PRIMARY QUESTION:** IS THE USL MODULE THE OPTIMAL LOCATION FOR THE EMERGENCY SHOWER?

**POTENTIAL SOLUTION:** LOCATE THE EMERGENCY SHOWER IN A NODE. THIS WILL PERMIT IMMEDIATE ISOLATION OF THE USL. PROVIDE A PORTABLE AIRLOCK FOR INITIAL RE-ENTRY OF THE USL

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# SESSION 3

# SUMMARY AND KEY ISSUES IDENTIFICATION

by

Session 3 Chairman: Richard Tyson

NASA - Code R

## SESSION 3

### SUMMARY

Session 3 presentations addressed various chemical and contamination detection methods currently under study, under development, and those used in industry. In a general overview of chemical detection, several existing detection devices were shown along with their specifications and capabilities. Applications of MS/MS technology for Space Station internal contamination detection was addressed by Teledyne CME. A presentation on the applications of fiber optics technology for chemical containment detectors discussed Ramam scattering, fluorescence-based optrodes, absorbance-based pH sensors, organochloride optrodes, remote fiber optics spectroscopy, general categories of fibers, and bending losses and other limitations. Another presentation on particulate detection technology discussed optical particle counters, condensation nucleation counters, electrical aerosol analyzers, electrostatic precipitators, a cascade impactor, aerodynamic particle sizers, and a summary of optical, electrical, and mechanical detector methods. Also, overviews of both the Space Station Freedom life sciences glovebox and materials processing glovebox were given. These presentations touched lightly on glovebox contamination control systems, potential hazardous materials, and material handling issues affecting design. A presentation on USL chemical hazard remediation addressed the objectives of the PMMS, USL chemical storage, USL chemical handling, USL chemical isolation, USL waste handling requirements, potentially hazardous operations in the USL, hazard remediation approach, criteria for USL experiment materials screening, development of USL material classification and waste remediation techniques, PMMS approach to handling hazardous chemicals, rack-level waste handling methodology, and personal protective equipment. A presentation on the safety practices of ground-based electronic crystal growth discussed considerations in selection of facility, equipment, and personnel. Facility safety, equipment safety, personnel protection, and training were also addressed in this presentation. A presentation addressing the importance of biological systems in treatment discussed treatment methods for toxic chemicals in water, soil, sediment, and sludge. Among the methods discussed were: microbial reduction of metals, bacterial reduction of metals, sulfate reduction, solubility of metal sulfides, and filtration methods. A presentation on exhaust gas conditioning equipment and technology addressed issues of growing concerns, causes of fires at semiconductor plants, and central conditioning methods and equipment. The last presentation in Session 3 discussed reactive bed plasma systems for contamination control. This method addressed phosgene decomposition, benzene decomposition, and aerosol removal mechanisms.

## KEY ISSUES

1. Combining all wastes into one pipeline or tank is a concept that has been abandoned on the ground. Ground systems similar to the needs of Space Station Freedom use dedicated treatment and processing at each facility location. Combining wastes may create too much of an explosion potential.

2. Development of a hazardous materials classification system that astronauts can quickly and easily use in emergency situations needs to be implemented early in the Space Station program.

3. Applying biological systems for combating waste treatment in the Space Station modules seemed to be a new idea for many of the attendees. Comments suggested that this method be investigated for application to the Station.

4. The Space Station Program should fully utilize existing technology and where no existing technology meets all the requirements, new technology should be developed and then shared with the ground-based industrial and scientific communities.