Sources of Exposure and Control Strategies

July 2018

Qualitative Assessment of Sources for Likely Inhalation Hazard

Example Alloy Operations			
Abrasive Blasting Abrasive Processing Abrasive Sawing Annealing Brazing Bright Cleaning Brushing Buffing Burnishing Casting Centerless Grinding Chemical Cleaning Chemical Etching Chemical Milling Coolant Management Deburring (grinding) Destructive Testing	Dross Handling Electrical Chemical Machining (ECM) Electrical Discharge Machining (EDM) Electron Beam Welding (EBW) Forging Grinding Heat Treating (in air) High Speed Machining (>10,000 rpm) Honing Hot Forging Hot Rolling Investment Casting Lapping	Laser Cutting Laser Machining Laser Scribing Laser Marking Laser Welding Laundering Melting Photo-Etching Pickling Point and Chamfer Polishing Process Ventilation Maintenance Resistance Welding Roller Burnishing Sand Blasting Sand Casting	Sanding Scrap Management (Clean) Sectioning Slab Milling Soldering Solution Management Spot Welding Sputtering Swaging Torch cutting (i.e., oxy-acetylene) Water-jet Cutting Welding (ARC, TIG, MIG, etc.) Wire Electrical Discharge Machining (WEDM)

Qualitative Assessment of Sources for Low Inhalation Concen

Example Alloy Operations			
Adhesive Bonding	Drawing	Milling	Shipping
Age Hardening	Drilling	Packaging	Sizing
(<950^{o}F)	Dry Tumbling	Painting	Skiving
Assembly	Electroless Plating	Physical Testing	Slitting
Bending	Electroplating	Piercing	Stamping
Blanking	Extrusion	Pilger	Straightening
Bonding	Filing by Hand	Plating	Stretch Bend Leveling
Boring	Gun Drilling	Pressing	Stretcher Leveling
Broaching	Hand Solvent	Radiography/X-ray	Tapping
CNC Machining	Cleaning	Reaming	Tensile Testing
Cold Forging	Handling	Ring Forging	Thread Rolling
Cold Heading	Heading	Ring Rolling	Trepanning
Cold Pilger	Heat Treating	Roll Bonding	Tumbling
Cold Rolling	(inert atmosphere)	Rotary forging	Turning
Cutting	Inspection	Sawing (tooth blade)	Ultrasonic Cleaning
Deburring	Machining	Shearing	Ultrasonic Testing
(non-grinding)	Metallography		Upsetting
Deep Hole Drilling			

Exposure Control

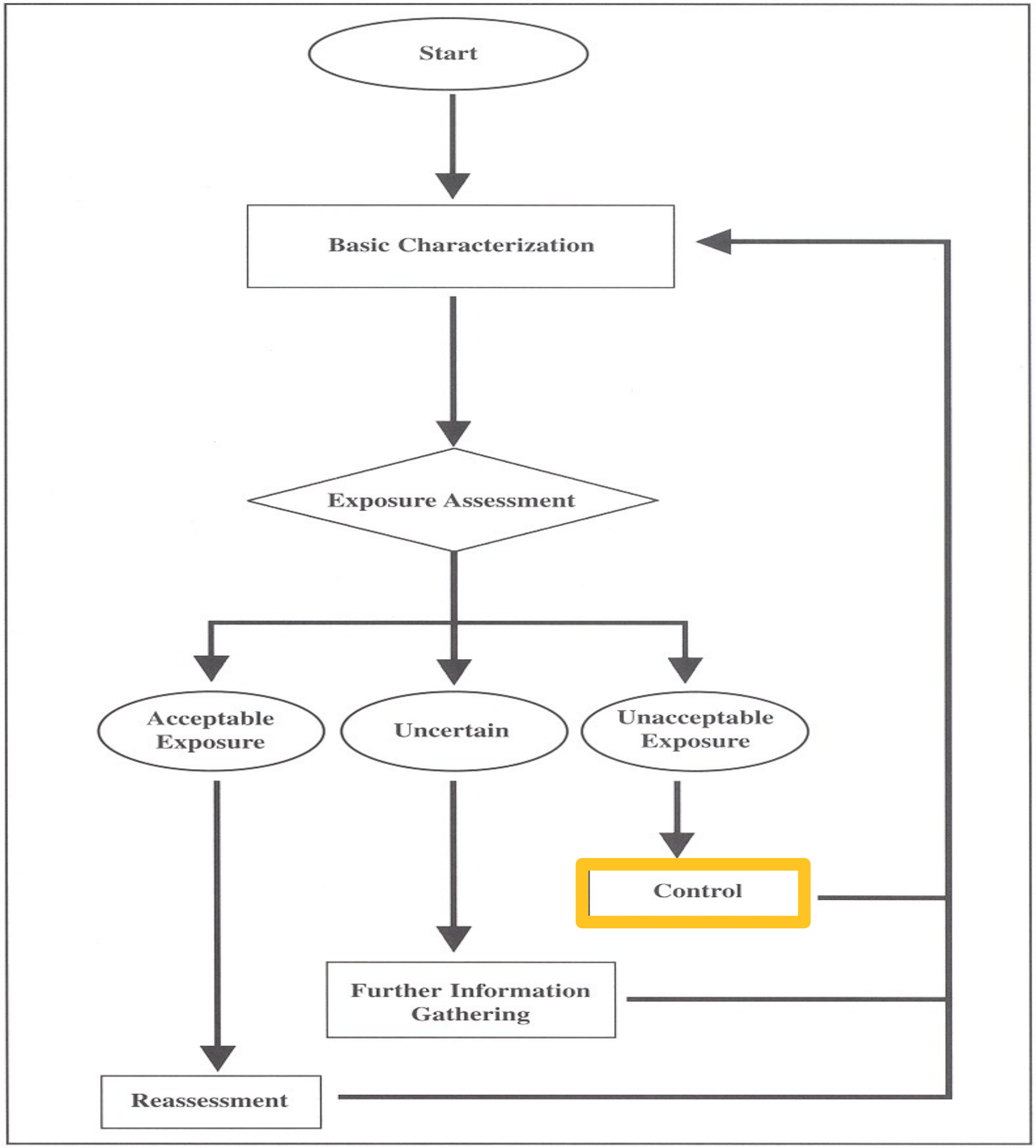


Figure 1.2 — A strategy for assessing and managing occupational exposures.

Sources of Exposure & Control Strategies

- CNC Machining

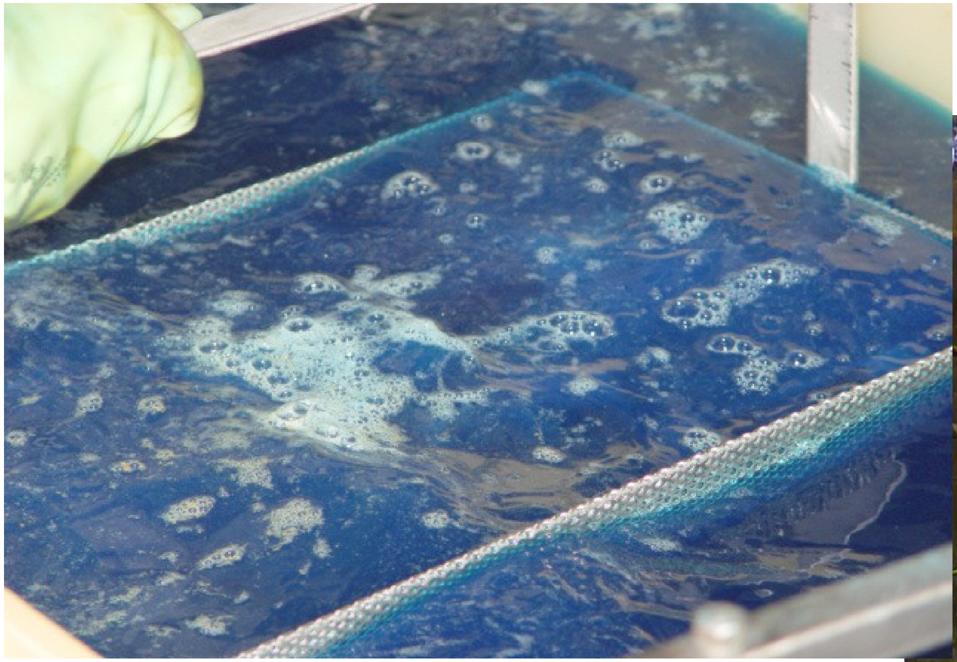
Sources of Exposure & Control Strategies

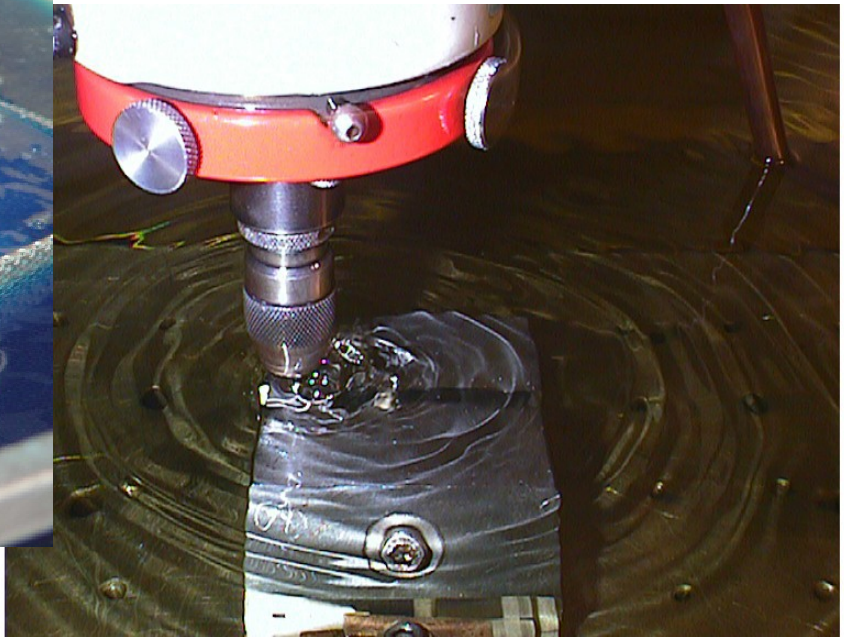
- CNC Machining – Control Criteria

Beryllium-Containing Alloys
Full enclosure (for chip containment)
Flood coolant
Local exhaust ventilation is generally not required

Sources of Exposure & Control Strategies

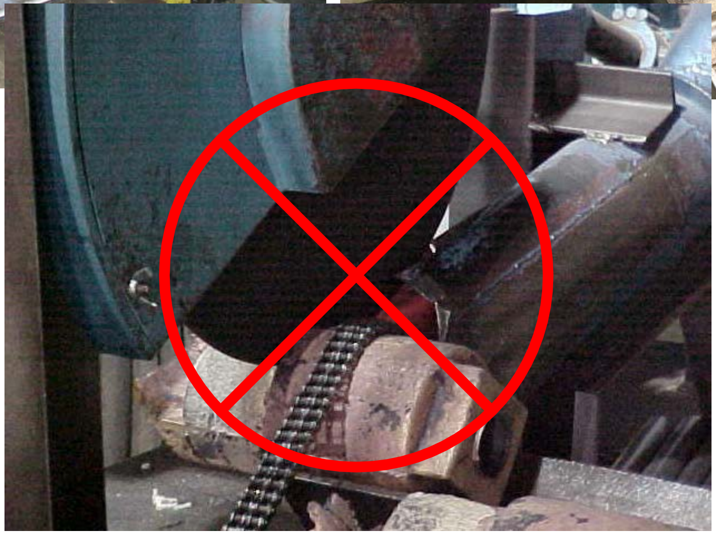
- Beware "Bubble Bursting" effect – Control Criteria





Sources of Exposure & Control Strategies

- Sawing



Sources of Exposure & Control Strategies

- Sawing – Control Criteria

Prohibit “dry” abrasive saws
Band saws whenever feasible
Flood coolant
Chip containment

Control - Benching

- Benching consists of handheld grinding and polishing tasks on internal injection mold cavity surfaces. Benching operators use a variety of tools to accomplish their tasks including: hand stones, scotch bright pads, high speed electric sanders, pneumatic grinders, sanders, and lubricants. Wheel surface speeds used are variable and can be as high as 20,000 rpm.

Exposure evaluation – baseline

Baseline Exposure Evaluation

Seventeen (17) full shift exposure samples were collected in the breathing zone of operators performing Benching on internal injection mold cavity surfaces containing CuBe Alloy 25.

Personal Sample Results (CFC Total Method)

Number of Samples	Range $\mu g/m^3$	Percent Exceedance[1] at 0.2 $\mu g/m^3$	$UTL_{(95/95)}$ [2] $\mu g/m^3$
17	0.012 - 0.900	43.5	2.62

[1]Percentage of exposures expected to exceed 0.2 µg/m³ (comparable to 0.6 µg/m³ – Inhalable). A percent exceedance of < 5% is considered to be "Well Controlled". [2]Upper Tolerance Limit – one can be ninety-five-percent confidence that fewer than 5% of measurements are above the UTL(95/95)

Controls in use during Baseline Characterization

The benching stations in use at the start of this evaluation were equipped with a Dust Kop type dust collection unit.   Some of the stations were equipped with a 6” flex duct on top of the benching table that could be positioned by the operator; two of the stations had “down draft” type tables.

All of the Dust Kop ventilation units were powered by “on/off” switches located at the operator’s work stations. The airflow provided by the existing Dust Kop ventilation units ranged from 310 to 777 cfm.

Exposure Characterization Summary

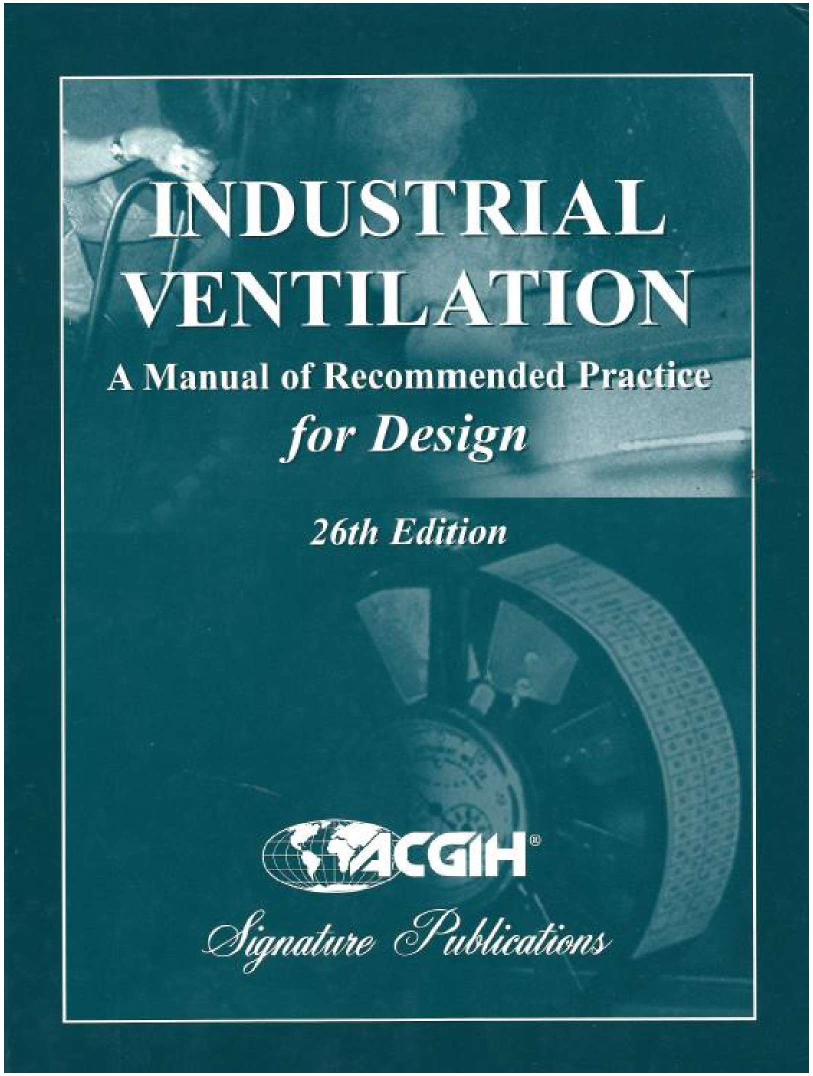
Evaluation Interpretations

- Airborne exposures to beryllium exceeding the BeST REG for airborne beryllium of 0.6 µg/m^3 were observed in Benching operations.
- Additional work practice and engineering controls, such as a redesign of the LEV capabilities, were necessary to improve particulate capture.

Exposure Control Improvements

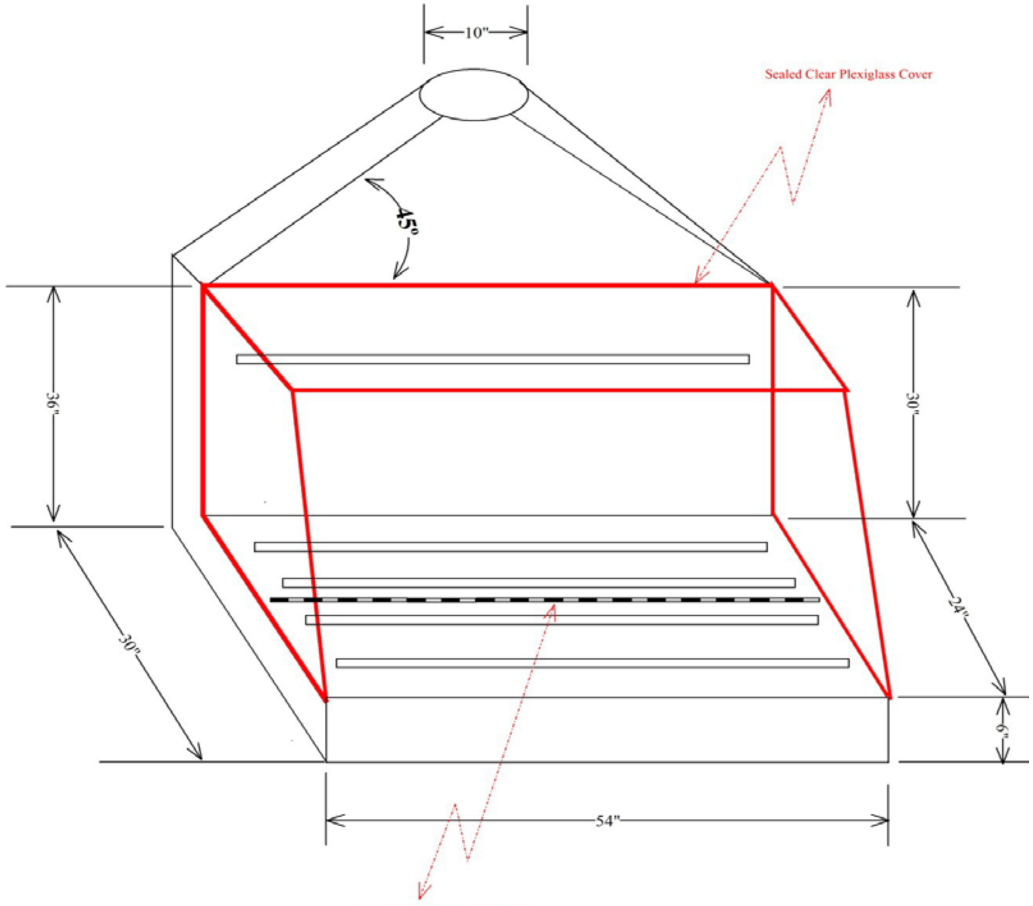
Post Intervention Work Station

The benching work stations were redesigned using the experience of benching operators, plant management and design criteria recommended by the American Conference of Industrial Hygienists® (ACGIH®) Industrial Ventilation Manual, 26th Edition.



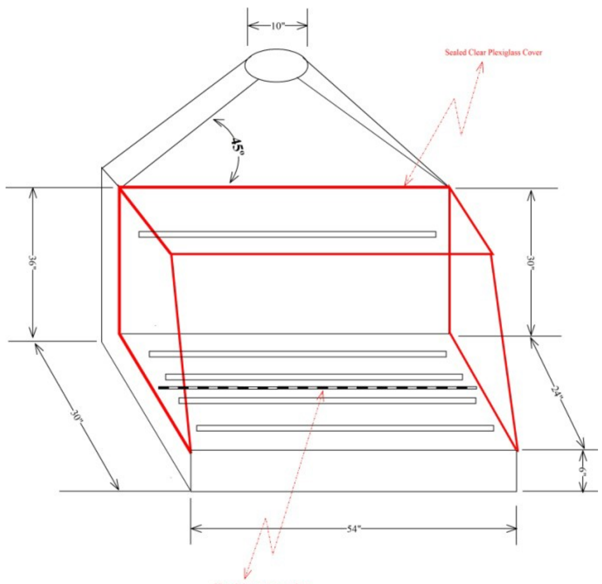
Sources of Exposure & Control Strategies

- CuBe Benching/Grinding/Deburring – Hood Design Criteria



Sources of Exposure & Control Strategies

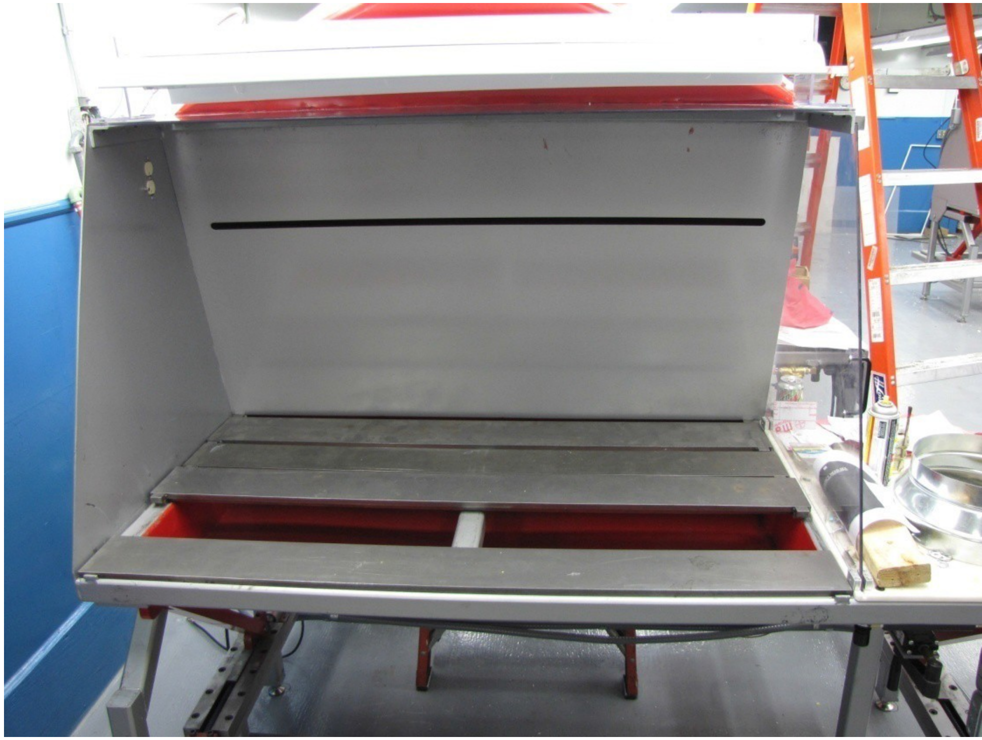
- CuBe Benching/Grinding/Deburring – Hood Design Criteria
  - Target Q_{hood} = 250 cfm/ft^2 of face opening
  - Open face area of hood = 54” x 30” x 24” = 11.25 ft^2
  - Required Q_{hood} = 250 fpm x 11.25 ft^2 = 2,813 cfm
  - Target V_{slot} minimum = 2000 fpm
  - 5 (52”x 0.75”) slots/hood = 1.354 ft^2 total slot area
  - V_{slot} = 2,813 cfm/1.354 ft^2 = 2,091 fpm



Control at the source

Partially enclosing style hoods were installed. These hoods were equipped with improved lighting to allow the operator better visibility, allowing the operator to work farther from the part.

Hoods were designed with a top and sides to reduce the effects of cross-drafts created by room air currents.



Control at the source

The hood was designed to be a combination of back draft and down draft slot hood. This style hood maximizes laminar air flow, significantly reduces the influence of eddies at the front of the hood (where the pieces are worked) and eliminates “dead” zones in the top of the hood.

The design airflow rate for each hood was in the range 250 cfm per square foot of hood face area.

Ductwork transport velocity target equals 4000 fpm.

Control at the source

Each station is activated by a single power switch, turning on lighting, all pneumatic and electrical power, and opening the hood blast gate. Tools are interlocked to the ventilation system and will not operate unless blast gate is open.

Removable plates make for easy cleaning of the downdraft hood drop-out plenum.

The entire hood tilts to allow better access to the part.

Post Intervention Work Station

Details of the redesigned benching ventilation system are listed below:

To accommodate variability in production levels a centralized, variable frequency drive (VFD) Donaldson Torit dust collection system was installed.

Sources of Exposure & Control Strategies

Post Intervention Exposure Evaluation

- Twenty-eight (28) full shift exposure samples were collected in the breathing zone of operators performing Benching on internal injection mold cavity surfaces containing CuBe Alloy 25.

Personal Sample Results (CFC Total Method)

Number of Samples	Range $\mu g/m^3$	Percent Exceedance[1] at 0.2 $\mu g/m^3$	$UTL_{(95/95)}$[2] $\mu g/m^3$
28	0.0084 - 0.0577	0.27%	0.088

[1]Percentage of exposures expected to exceed 0.2 $\mu g/m^3$ (comparable to 0.6 $\mu g/m^3$ – Inhalable). A percent exceedance of < 5% is considered to be "Well Controlled". [2]Upper Tolerance Limit – one can be ninety-five-percent confidence that fewer than 5% of measurements are above the UTL(95/95)

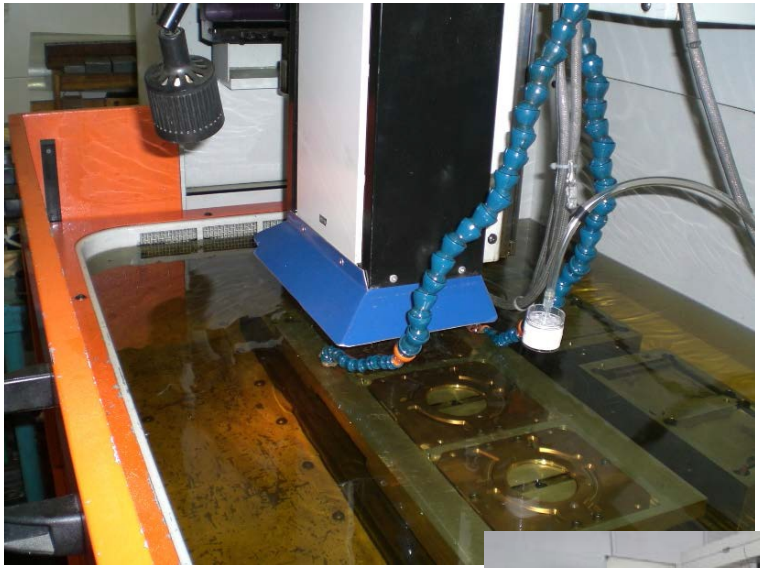
Sources of Exposure & Control Strategies

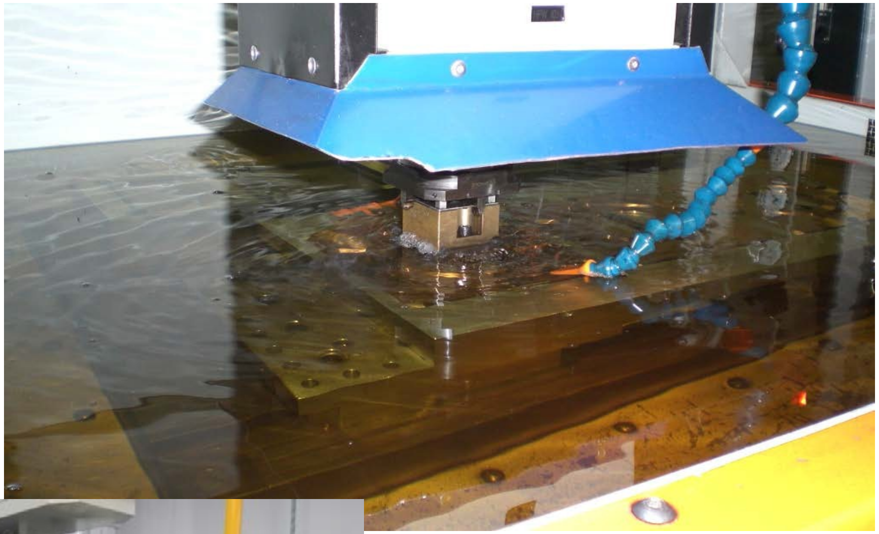
- Benching/Grinding/Deburring – Control Criteria

Beryllium-Containing Alloys
Partial LEV enclosure, backdraft/downdraft table
Minimum of 250 fpm average at face of hood
Must control cross drafts

Sources of Exposure & Control Strategies

- EDM





Sources of Exposure & Control Strategies

- EDM – Control Criteria
  - LEV hood to capture fumes
  - (CAUTION: don’t rely on OEM manufacturer LEV)
- Used EDM wire should deposit from machine into “final” disposal/recycle container. Eliminate manual handling of used EDM wire.
- Internal machine surface residues will dry out and must be controlled by strict cleaning/PPE methods prior to service and maintenance activities.

Exposure Control Strategies

- Welding

Exposure Control Strategies

- Welding – Control Criteria

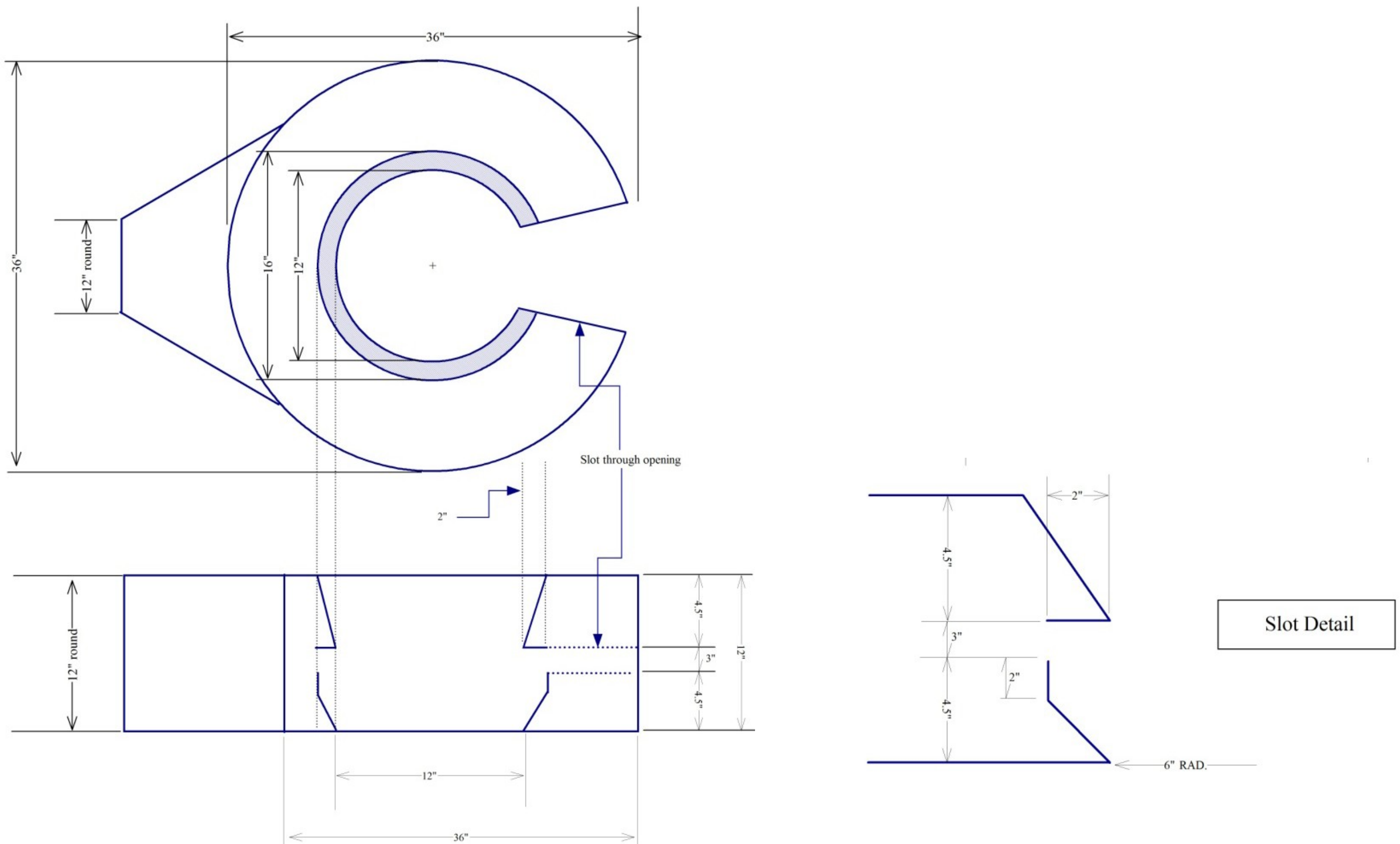
Beryllium-Containing Alloys
Partially enclosed back draft LEV hood (minimum 150 fpm average face velocity) (must balance LEV flow rate to shield gas requirements)
Must control cross drafts

Exposure Control Strategies

- CuBe Melting and Casting

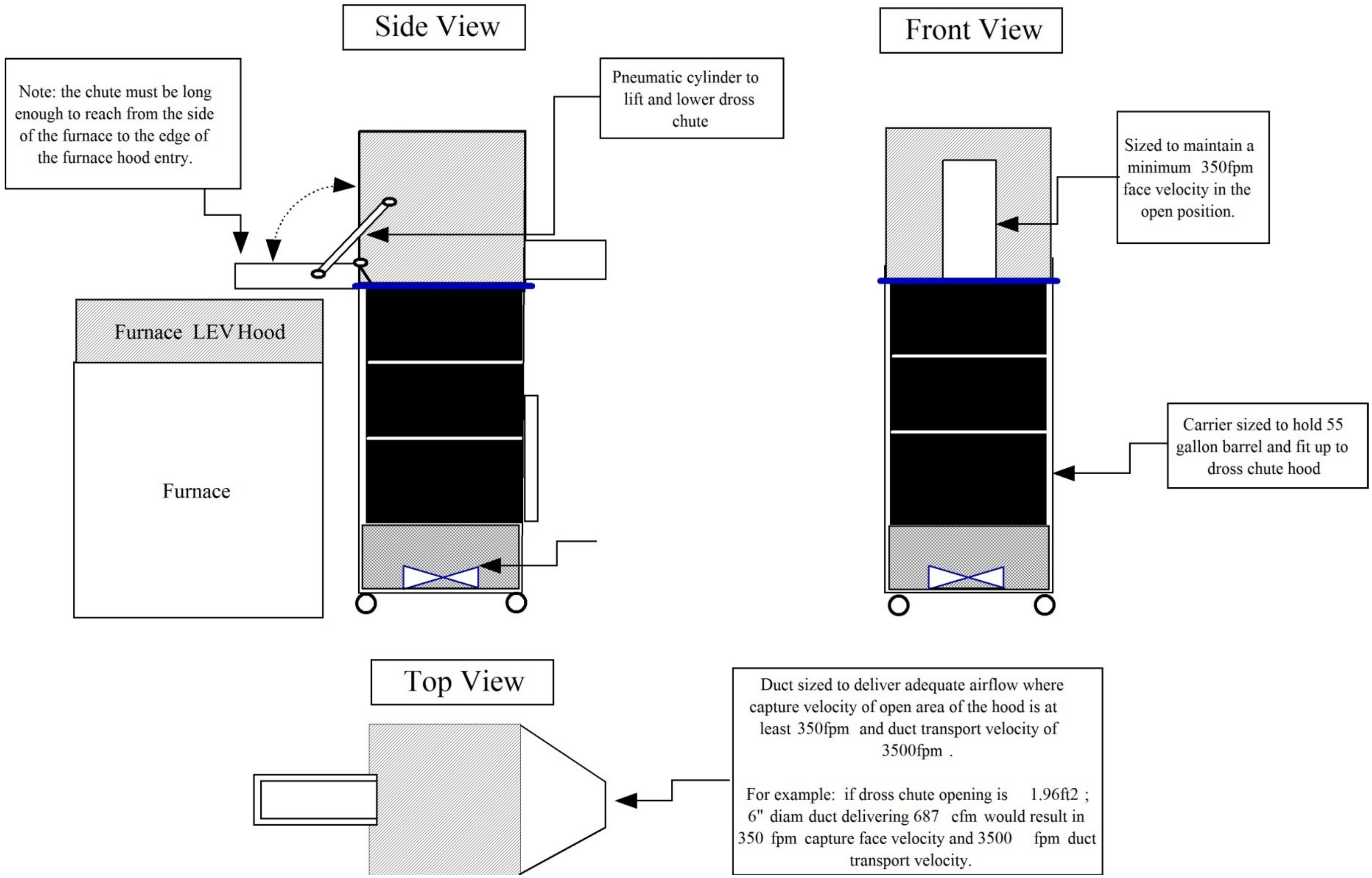
Exposure Control Strategies

- CuBe Melting and Casting



Exposure Control Strategies

- CuBeMelting and Casting – Dross Chute LEV hood



Exposure Control Strategies

- Melting and Casting

Beryllium-Containing Alloys
Mix makeup LEV hood (Minimum 250 fpm average capture velocity)
Melting furnace slot hood (Minimum 350 fpm at center line of furnace)
Partially enclosing dross hood (Minimum 350 fpm average face velocity; interfaced with melting furnace slot hood)
LEV hood for furnace tools (Minimum 250 fpm average face velocity)

Exposure Control Strategies

- Sandblasting

Exposure Control Strategies

- Sandblasting

Beryllium-Containing Alloys
Full enclosure
Minimum 250 fpm capture velocity at all enclosure openings
10 cabinet volume air changes before opening enclosure

Control: Problem Solving

Purpose: Discover tasks within job contributing to exposure profile magnitude

- Perform qualitative exposure assessment
- Rank tasks by potential for exposure
- Characterize priority tasks using high volume sampling methods
- Use solid problem solving skills (6 Sigma) to develop interventions

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Control

Ventilation BMPs

- Min cap vel 400 fpm
- 250 fpm for most other
- 150 fpm max for weld
- HVLV 15k fpm
- Use hevent for all design
- 4000 – 4500 fpm for transport velocity

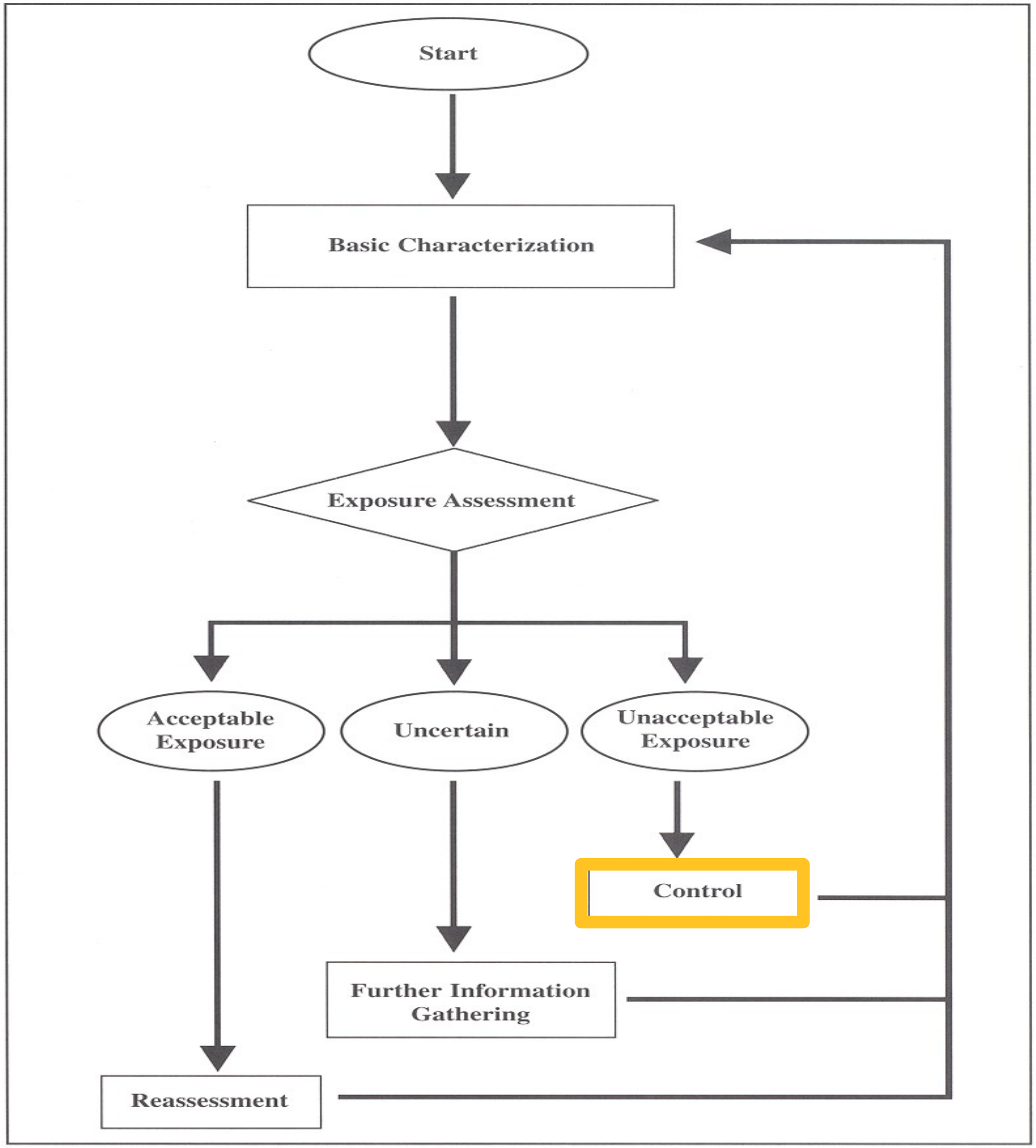

Figure 1.2 — A strategy for assessing and managing occupational exposures.

Sources of Exposure & Control Strategies

Maintenance

- Maintaining air cleaning equipment
- Maintenance of equipment containing or in contact with beryllium
- System leaks and inspections
- Tool care
- Furnace rebuilding

Sources of Exposure & Control Strategies

Maintenance

Maintaining air cleaning equipment

- emptying collectors
- changing filters
- gasket replacement
- cleaning ductwork
- inspection

Sources of Exposure & Control Strategies

Maintenance

Maintenance of beryllium processing equipment

- decontamination
- setup
- rebuild/repair
- inspection
- calibration
- preventive maintenance

Sources of Exposure & Control Strategies

Maintenance

System leaks, inspections, cleaning

- ventilation systems
- coolant systems
- process sludge/residue/waste

Tool care

- hand versus power
- decontamination and containment
- sharpening
- dedicated tooling

Sources of Exposure & Control Strategies

Housekeeping

- Brooms must not be used
  - Airborne exposures can result from the sweeping action.
- The use of compressed air for cleaning dust must be prohibited
  - Such activity can result in airborne dust exposure.

Sources of Exposure & Control Strategies

Housekeeping

- Rags or towels used to dry or wipe parts clean should not be allowed to dry
  - Used rags and towels should be containerized and disposed of in a manner which prevents airborne exposure during subsequent handling activities.
- The use of reusable rags is not recommended.
  - If an outside service is used, the rags should be properly containerized. The laundry should be warned in writing about the aforementioned precautions and they should be provided with an appropriate **Safety Data Sheet.**