Keep Beryllium at the Source

July 2018

Keep Beryllium at the Source

Keep Beryllium At the Source - Guiding Principles

- Employees are not exposed to levels of particulate that causes chronic beryllium disease.
- Most efficient and effective control of worker exposure is to keep the hazard from leaving the source.
- Systems are designed, installed and maintained as essential process equipment.

Keep Beryllium At the Source

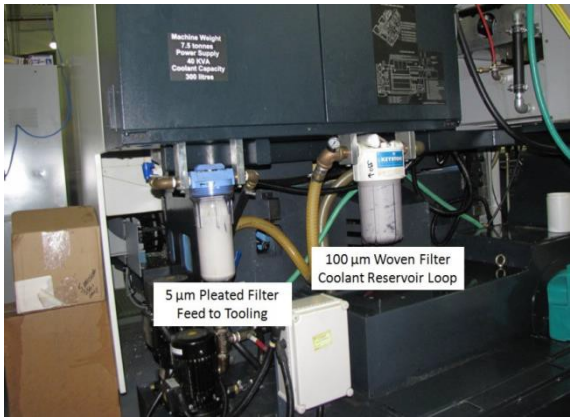
- Procedures are in place to evaluate work processes for the routes by which beryllium particulate or solutions may escape from manufacturing processes (e. g. on people, product, equipment, in air, cooling/lubricating fluids, or process water).

- A management process is in place to identify potential process and engineering changes and to prioritize and decide an implementation strategy.

Grinding LEV Hood

Furnace Slot Hood

Coolant Filtration



Control

Operator/process/ OEL

- Who is exposed
- Who is below OEL
- Operations typically above OEL
- Tasks typically above OEL
- Other potential sources that could contribute

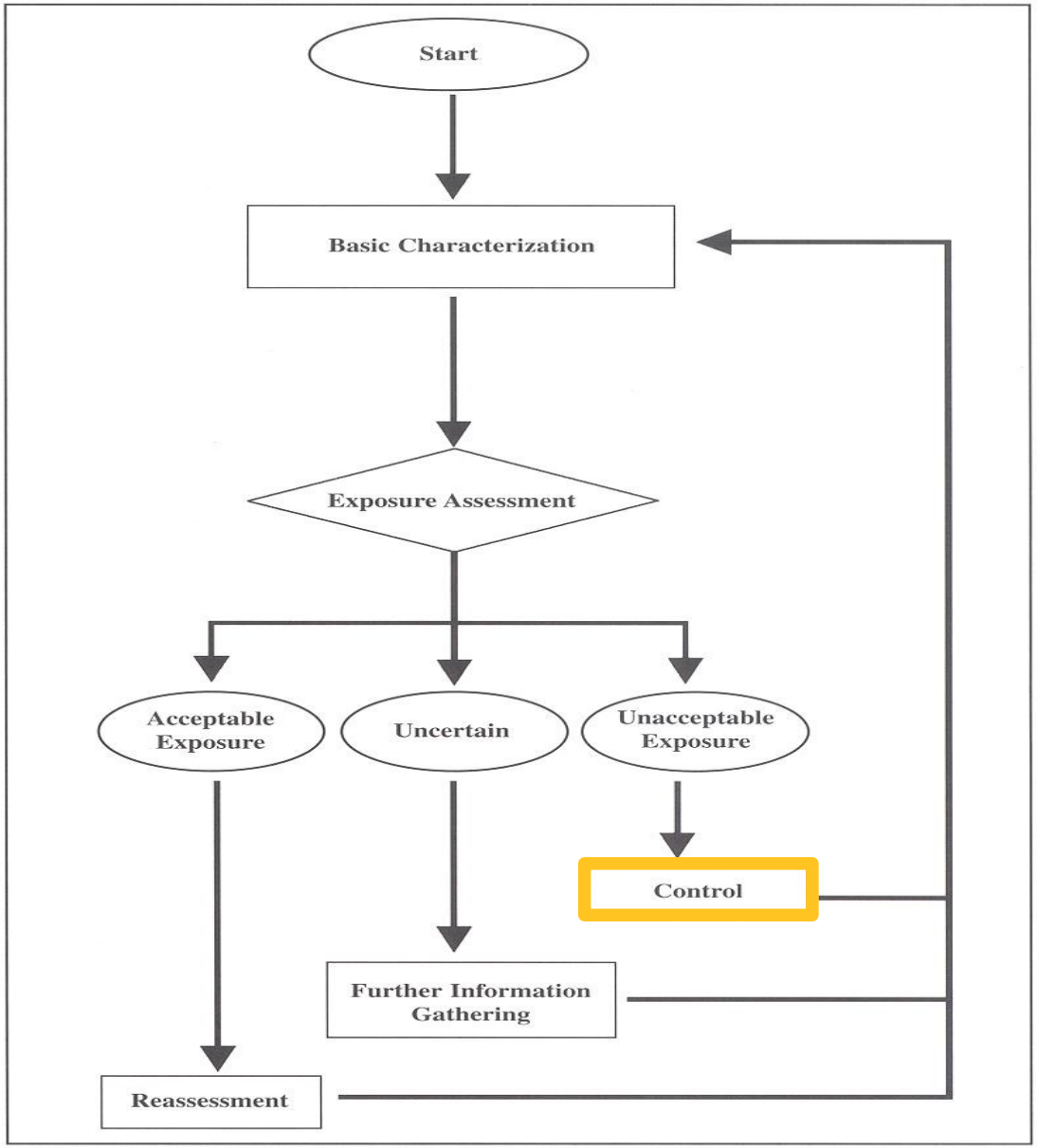


Figure 1.2 — A strategy for assessing and managing occupational exposures.

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

6

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

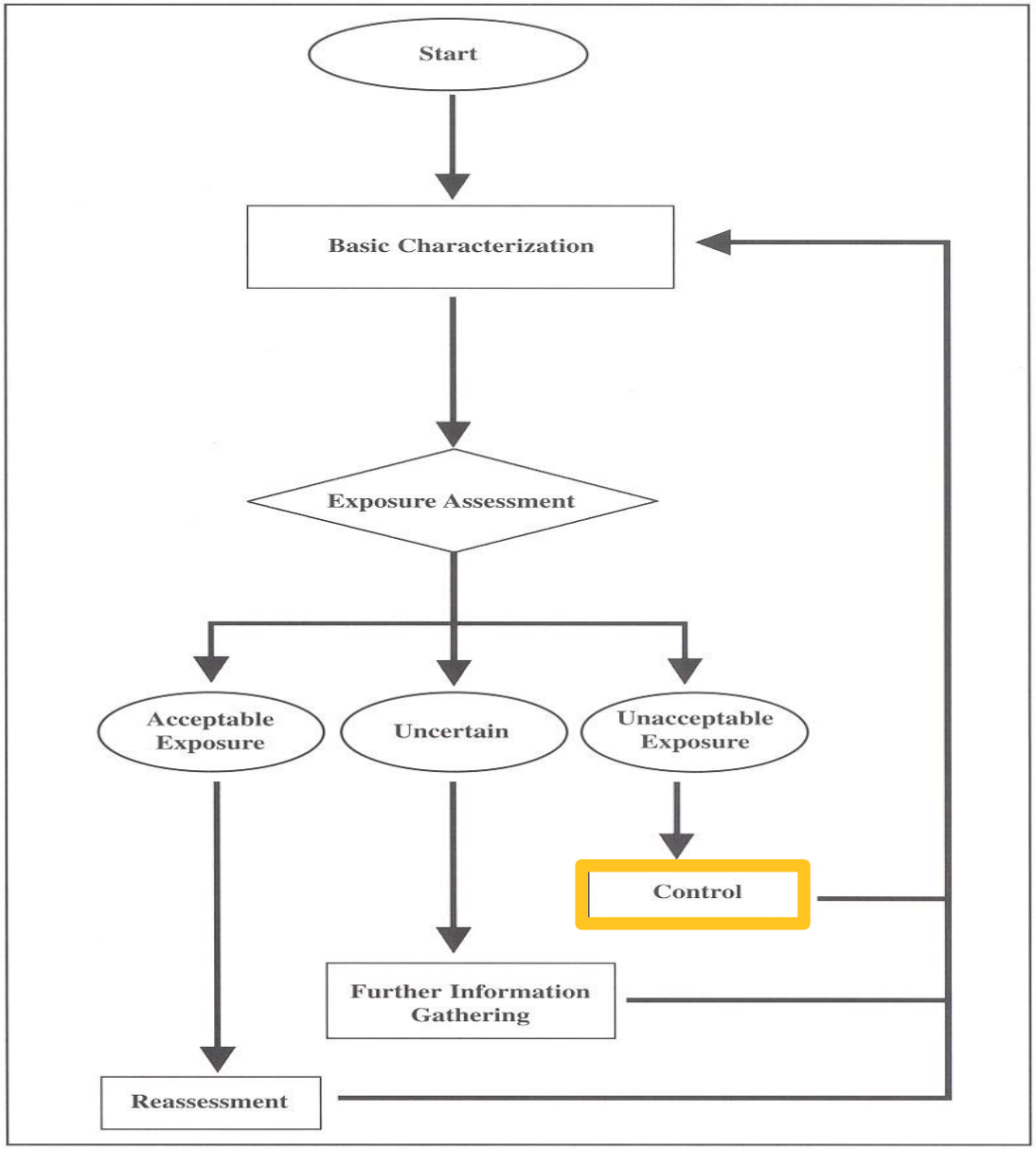
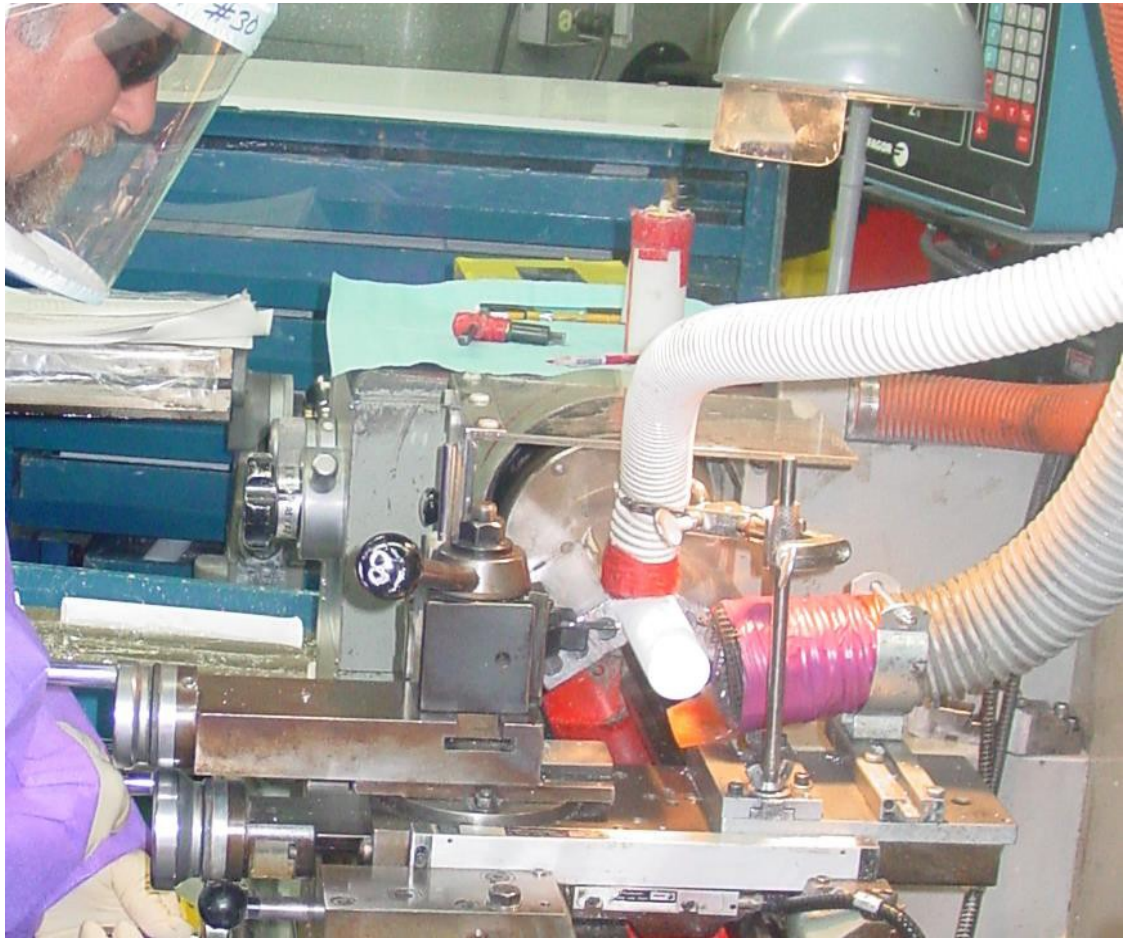


Figure 1.2 — A strategy for assessing and managing occupational exposures.

Example of High Velocity Low Volume

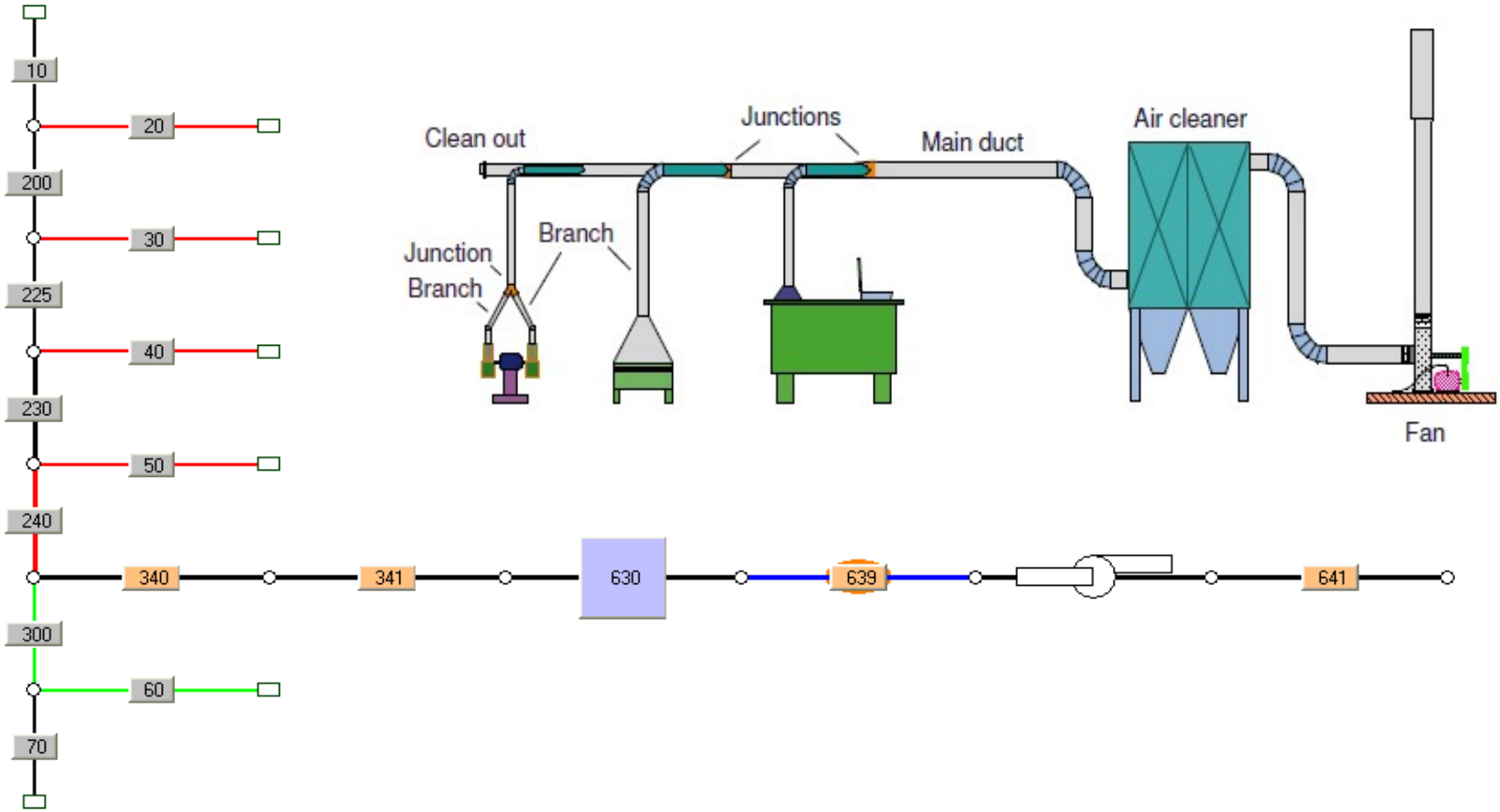
- Multiple pick ups
- Close to source
- Proximity to cutting tool is important
- Work station is better maintained



Schematic (Show Info)

File Project Components Action ShowValuesOnSchematic HideInputColumns In-lb Return Help Duct stuff

IDs



Zoom Pan

Refresh

id

Type		Duct cross-section					Airflow			Velocity		Hood losses		Slot/plenum	
ID	Type	Shape	Init.Dia.	Fix Dia	Dia	Width	Q basis	min.Q	%minQ	min.Vd	%minVd	Fhood	SPfilter	Slot basis	Nsl
639	Fan Inlet	Round	22.4	☐	22.0	n/a	----	----	100%	2400	105%	0.25	----	----	----

Duct 639: Qmin = 100% V = 105% of min. // Fan Q= 100% of min for 6662 cfm; FanSP= 2.68 in.wg

Don’t forget the make up air

Ventilation BMPs

- Polishing filtration
- HEPA filter inside air
- Min MERV 14 for outside make up
- Zone concept for pressures and flow of air
- Bag in Bag out is standard

Control: Intervention Verification

Purpose: Verify interventions have reduced exposure levels

- Resample priority tasks and compare with pre-intervention data set
- Conduct baseline sampling when satisfied
- Re-characterize profiles
- Adjust RP requirements if appropriate

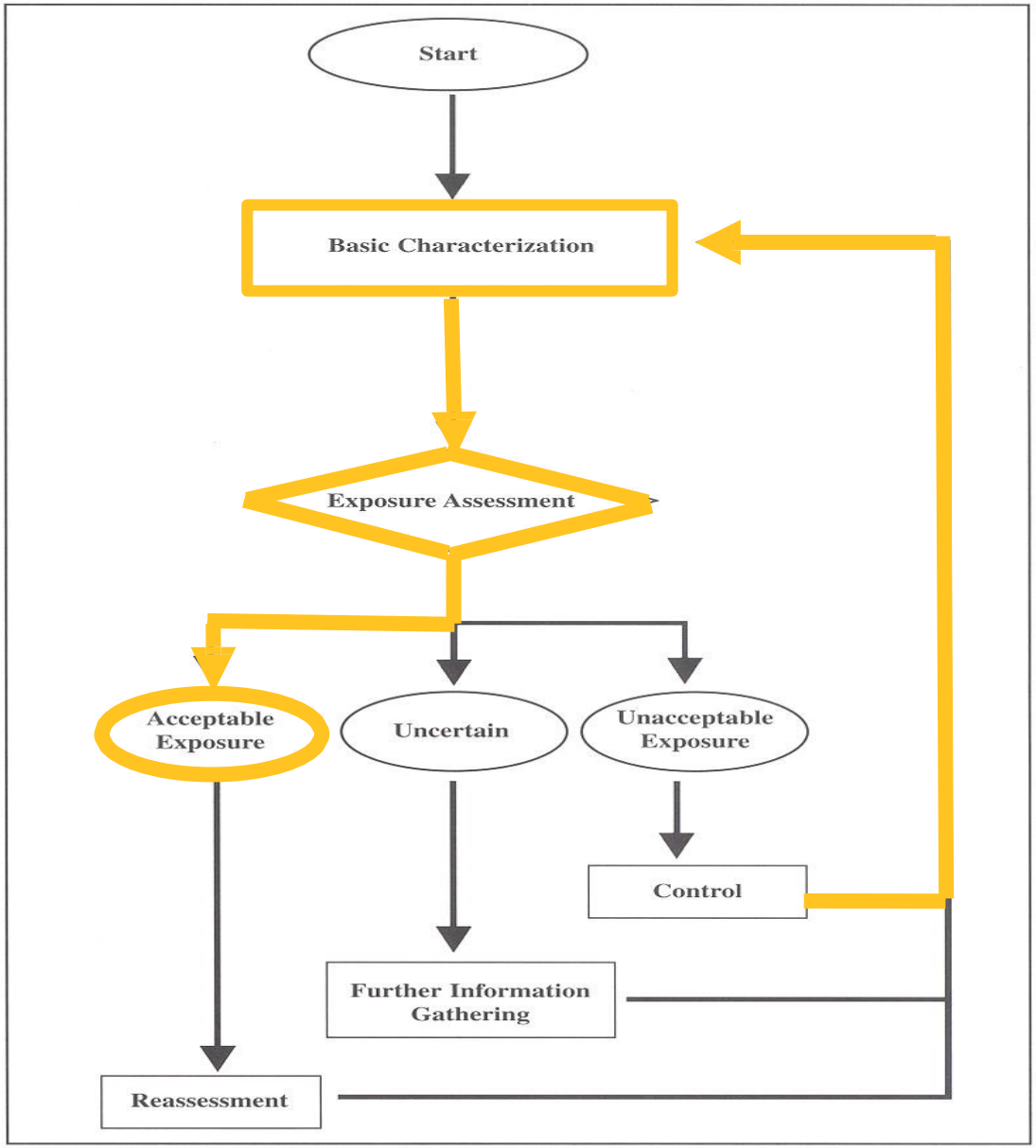


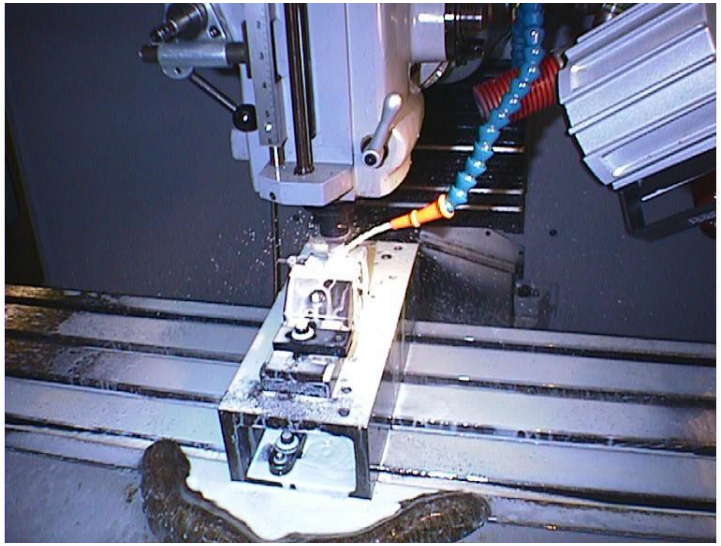
Figure 1.2 — A strategy for assessing and managing occupational exposures.

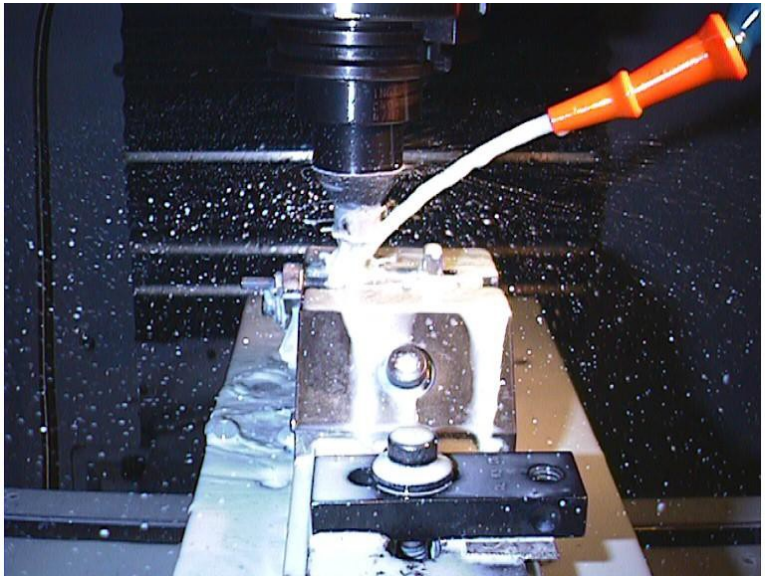
Specific Concerns – Powder Handling

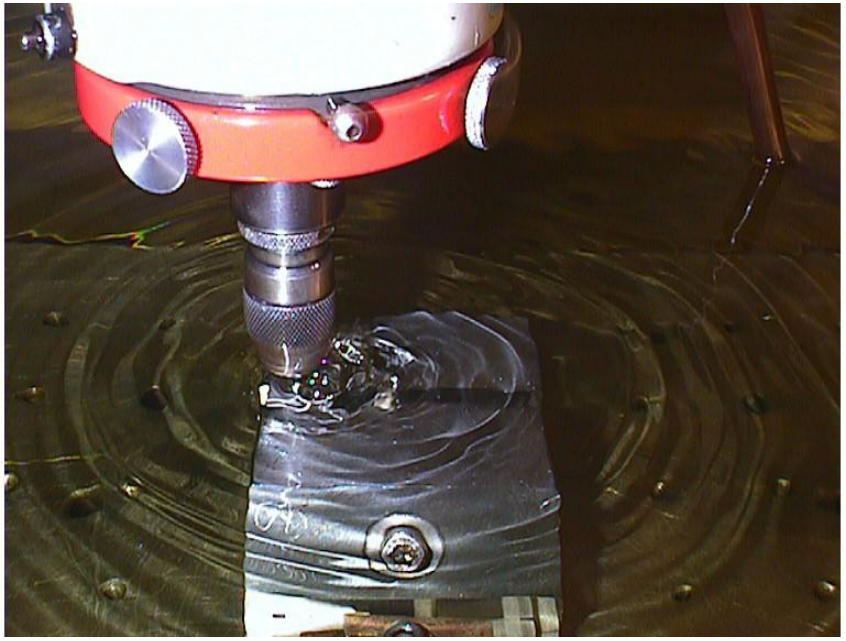
- Metallic Beryllium powder is combustible
- Open air transfers
- Contaminated tools

Specific Concerns – Machining Operations

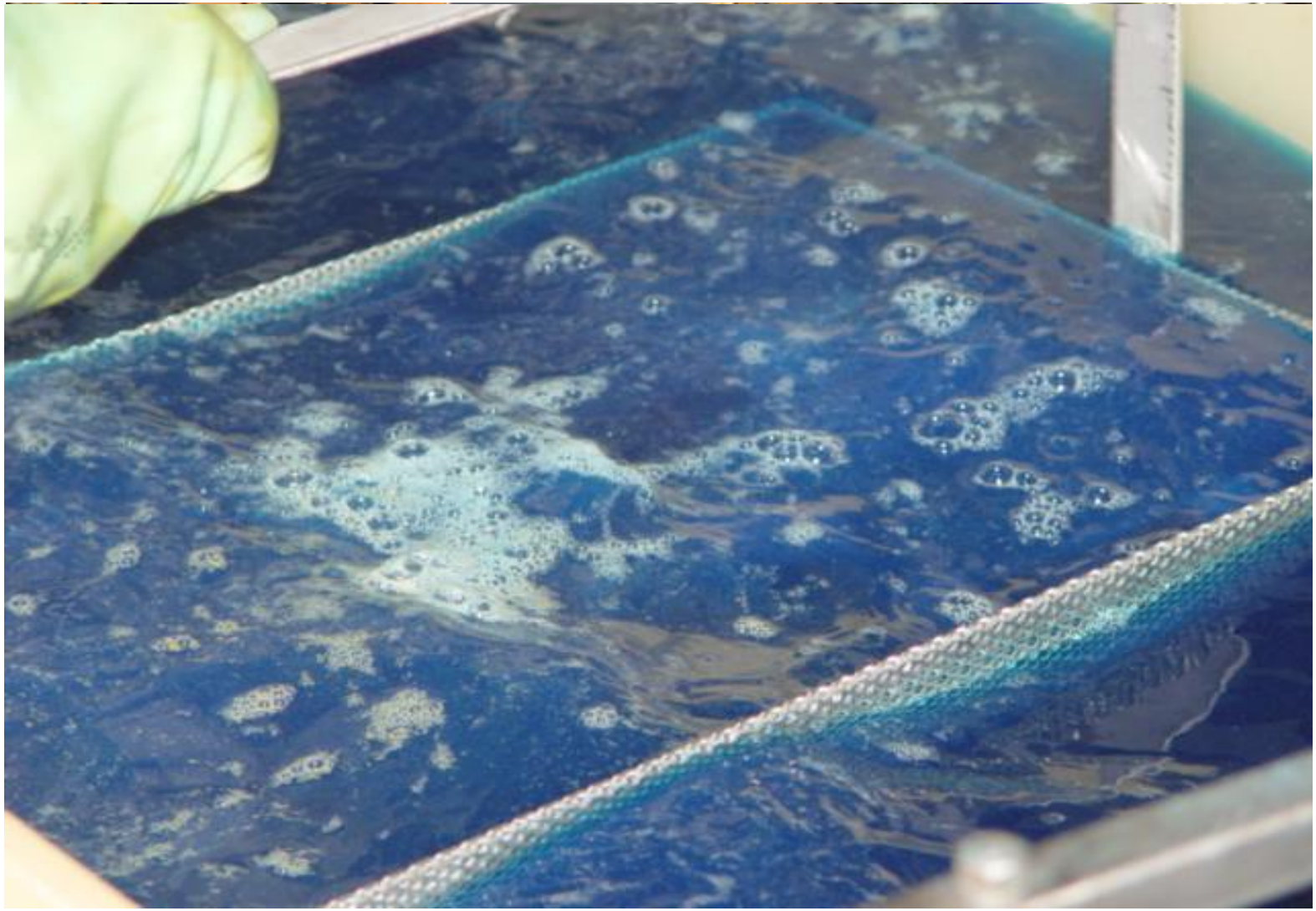
- Metallic beryllium is abrasive
  - System leaks/fire hazard
- Recycling of lubricant/coolant without a filtration system
- Particle speed/size
- Coolant splash
- Material identification
- Bubble bursting







Bubble Bursting – Plating & Chemical Cleaning



Maintenance Activities – Leaks, Inspections, Cleaning

- Process sludge/residue/waste
- Coolant systems
- Ventilation systems

Maintenance Activities – Tool Care

- Hand versus power
- Decontamination and containment
- Sharpening
- Dedicated tooling

Exposure Assessment

Today we will look at the following SEGs

- Bench Grinding
- CNC milling

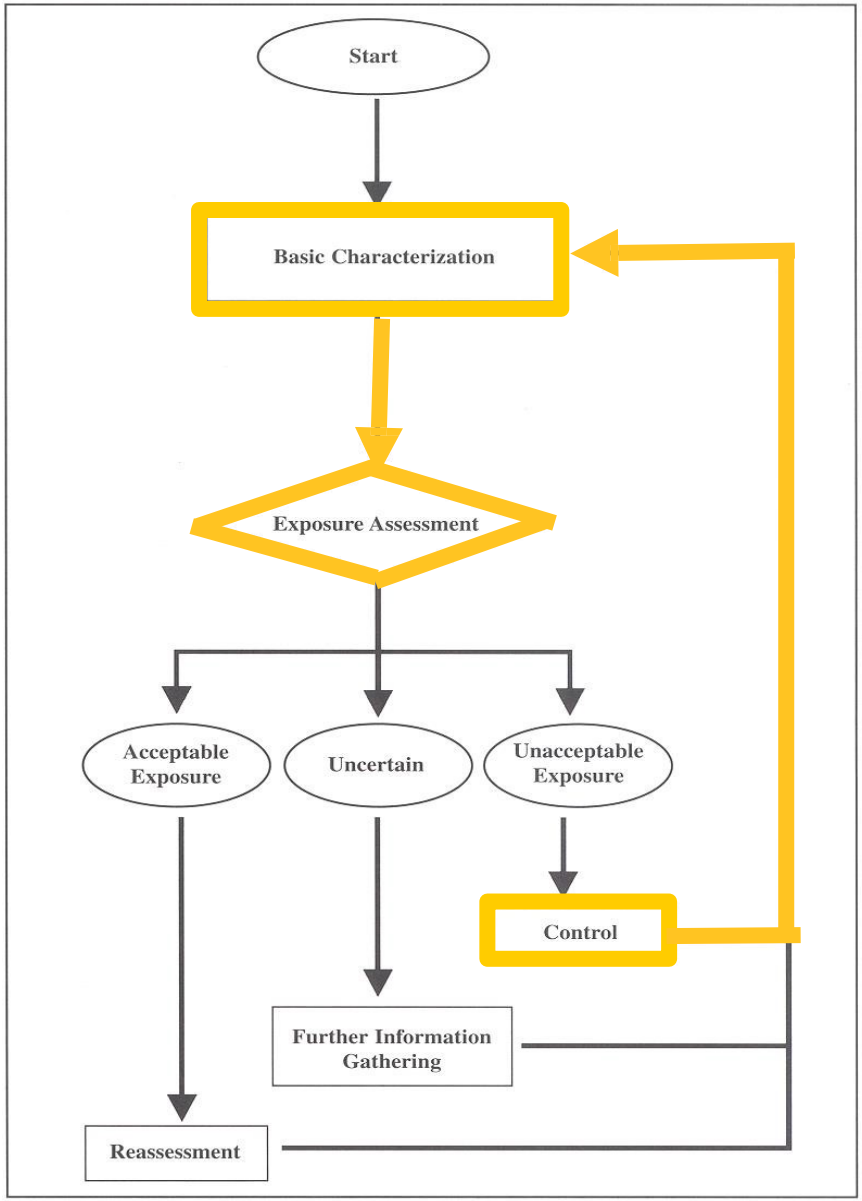


Figure 1.2 — A strategy for assessing and managing occupational exposures.

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 $\mu g/m^3$ (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)

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

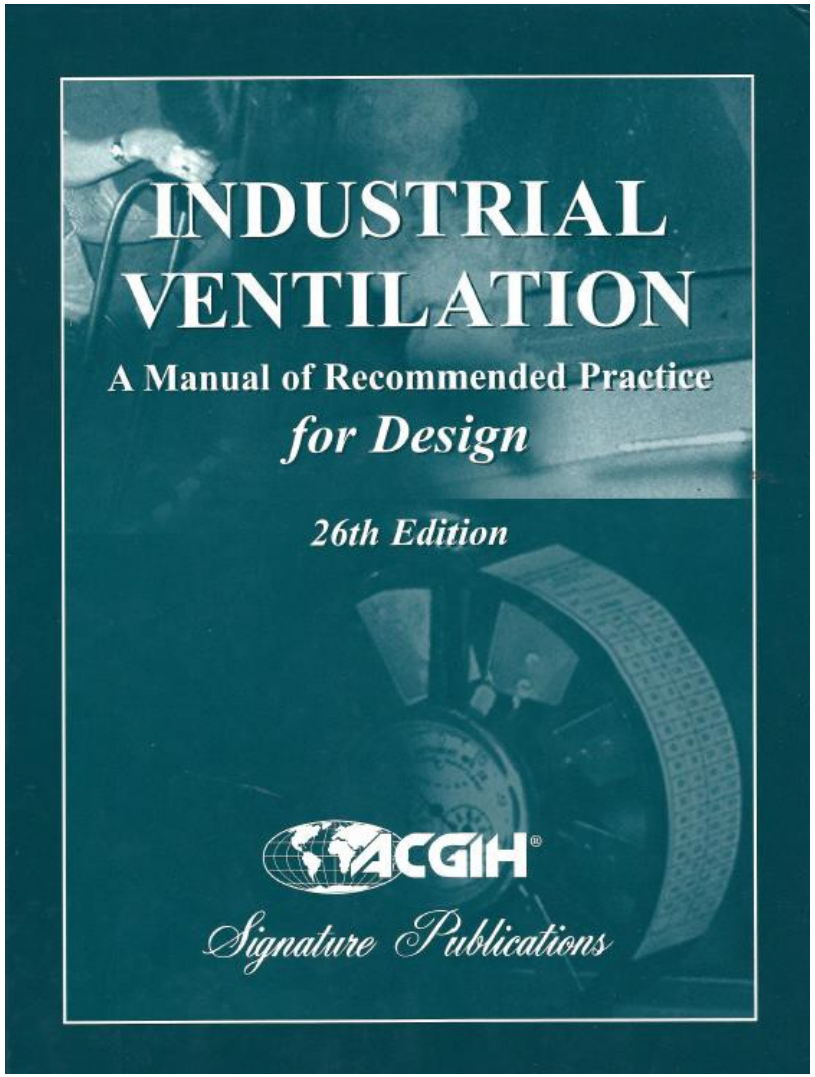
Evaluation Interpretations

- 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.



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.

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

Post intervention exposure evaluation

- 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)

Cost Information

The upgrades to the local exhaust ventilation included the following: Purchase and installation of 35,000 cfm Donaldson Torit Downflow dust collector, with:

- Ultralock HEPA After filter return air system
- Abrasion resistant AR inlet
- Lined air plenum
- Bag-In/Bag-Out filter maintainability
- Tribo Flow particle detection
- Fabrication and installation of insulated ductwork
- Fabrication and installation of HEPA filtered recirculation loop.
- Fabrication of custom hoods

The bottom line

The approximate cost for this installation was $6.25/cfm.

Benching Hood dimensions	54″x 30″x24″ Open face 11.25 ft^2
Qhoodt	250 cfm/ft^2 x 11.25 ft^2 ---2813 cfm
Vslot	5 slots 52″x 0.75″ – 1.354ft^2 Velocity = 2813 cfm/1.354 ft^2 2091 fpm
Benching Vdt	4000 fpm
Approximate Cost*	$15K

** This cost was derived from a project involving the installation of 10 benching hoods and engineering controls for a welding station and abrasive blasting operation.*

Exposure Assessment

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- CNC milling
- Bench Grinding

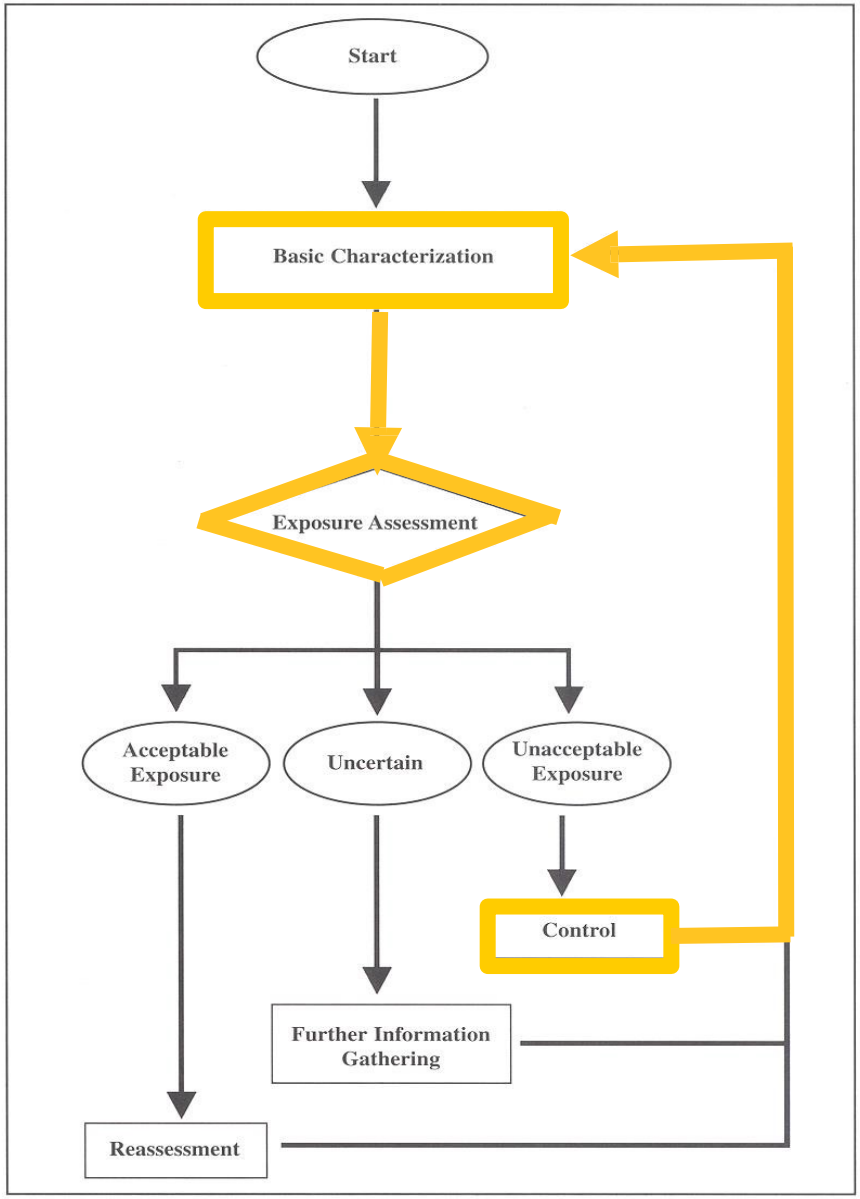


Figure 1.2 — A strategy for assessing and managing occupational exposures.

CNC Milling

- An airborne beryllium exposure assessment was conducted during CNC Milling of beryllium block or Aluminium Beryllium Composite. The intent of the study was to characterize worker exposure to airborne beryllium and identify work practice and local exhaust ventilation (LEV) controls necessary to maintain exposures to consistently below the BeST Recommended Exposure Guideline (REG).

Okuma Multus B-300

Makino S56

CNC Milling/Machining Center

CNC Milling involves digitally automated machining of a stationary part mounted onto a fixture. These machining centers allow for a variety of complex milling operations. The water soluble machining fluids are used to lubricate and cool the cut and to flush away the resulting swarf. This containment and flooding of swarf in the enclosed machining centers minimizes the release of particulate.

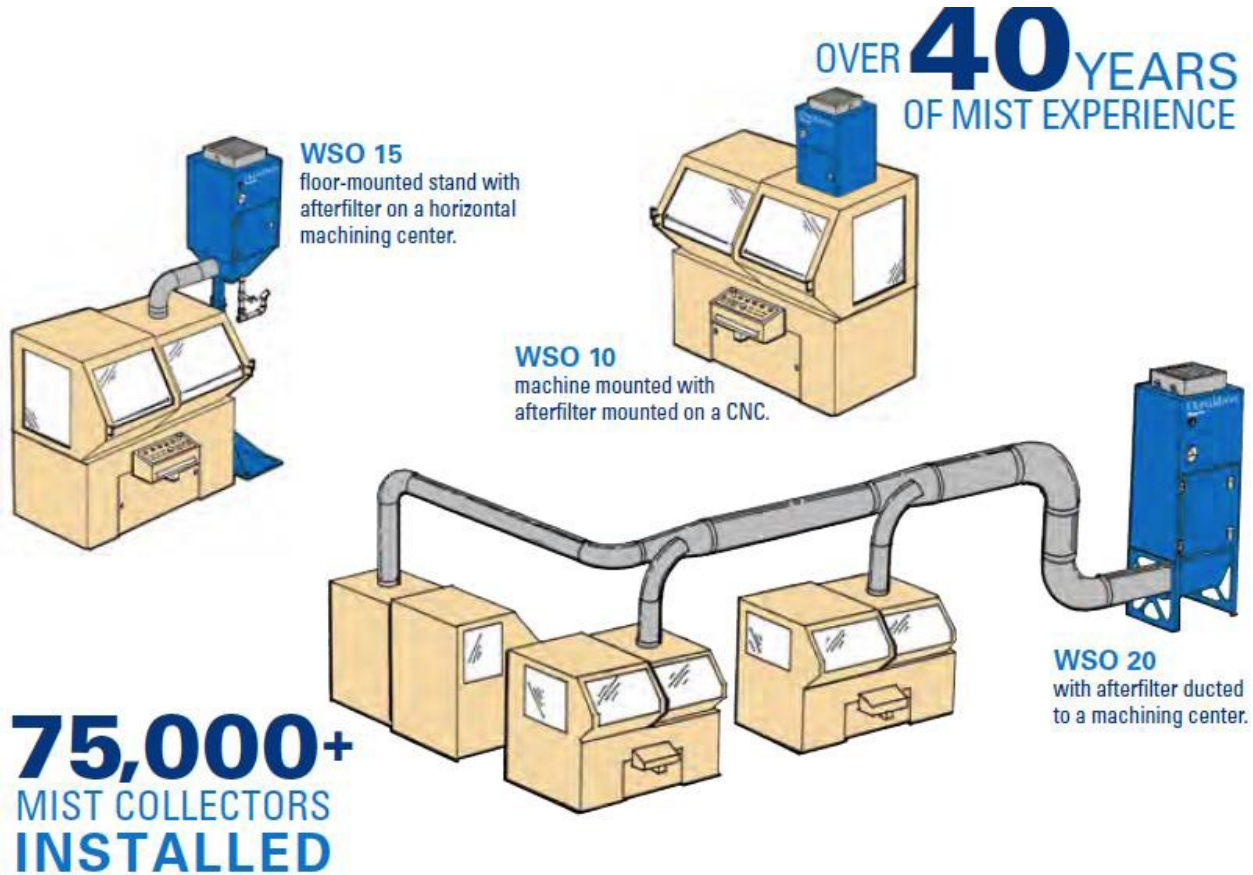
Control of the CNC using WSO

WATER SOLUBLE

SMOKE

OIL

WSO configuration options



Operating Conditions – Disposal Containers and Labeling

Designated containers for chip collection and contaminated waste (e.g., shop towels, gloves) were assigned to each AlBeMet® machining center. Warning signs were posted on machines, equipment, and containers identifying beryllium containing contents and precautions that need to be taken.

Exposure Controls for CNC Operation Next Generation

- 10 Air changes prior to opening doors on mill.
- Use of redundant systems for exhaust into work area
  - Particle counter with alarm in exhaust plenum
  - DP photohelic with alarm for filter management
  - Interlocks on mill

The operator's personal exposure results were reliably below the BeST REG for airborne beryllium.

At the Source

New facilities will be designed to limit lung exposure and skin contact opportunities, reduce clothing contamination and prevent beryllium migration away from processing areas.

Control at the design phase

- Keep beryllium contained.
- Most cost effective control method in the long run.
- Effects all of the goals except training and education

Execution

- Engineering controls
- Work practice improvements
- Job analysis
- Control plan
- Performance Auditing