APPENDIX A

EXAMPLES OF WORKPLACE PRACTICES QUESTIONNAIRES

WORKPLACE PRACTICES QUESTIONNAIRE
FOR
SCREEN PRINTERS

Prepared by
Screen Printing Association International
in cooperation with
University of Tennessee
Center for Clean Products and Clean Technologies,
and EPA Design for the Environment Staff

This questionnaire is designed to characterize typical screen printing facilities and workplace practices associated with the screen printing/reclamation process. The results of the questionnaire will be used to estimate exposure and characterize risk from this process and to help identify pollution prevention opportunities. Pollution Prevention is the use of materials, processes, practices or products that avoid, reduce or eliminate wastes or toxic releases, through activities such as material substitution, source reduction and closed loop recycling. *This information is being developed for industry use to help printers make informed choices about the environmental attributes of alternative cleaning and reclamation products and technologies.*

Please mail completed questionnaires to: Marcia Y. Kinter
Director of Government Affairs
Screen Printing Association International
10015 Main Street
Fairfax, VA 22031-3489

If you have questions about the questionnaire or would like a copy of the summary of results, please contact Lori Kincaid from the Center for Clean Products and Clean Technologies, University of Tennessee at 615/974-4251 (fax 615/974-1838).

Respondents to this questionnaire are guaranteed anonymity. Responses will not be attributed to any individual or company in reports or other written documentation of the results of this research. Company name and other information requested below are optional.

Company Name _____
Address _____
_____

Questionnaire Completed by _____
Title _____
Telephone Number _____

The purpose of this questionnaire is to characterize typical screen printing facilities and workplace practices associated with the screen printing/reclamation process. The business profile and general facility information requested below allows us to understand your workplace practices within the context of your overall printing business.

1) Business Profile

Approximately what percentage of your products are printed on the following substrates? (Please check the boxes that apply.)

	<50%	50-95%	95-100%
Plastics (rigid/flexible)	☐	☐	☐
Paper (coated or uncoated)	☐	☐	☐
Metal	☐	☐	☐
Ceramic	☐	☐	☐
Glass	☐	☐	☐
Other (specify below)	☐	☐	☐
_____			

2) Please list the major products produced at your facility.

_____

_____

_____

3) General Facility Information

How many staff do you employ? How many hours per day does your staff spend removing ink and cleaning/reclaiming screens? Ink removal is the removal of the bulk of the ink from the screens prior to further cleaning/reclamation. Screen cleaning/reclamation activities include residual ink removal, emulsion removal, and haze removal. Questions about ink removal do not pertain to press-side operations, unless this is the only site used for ink removal. Please assume a 5-day work week with one 8-hour shift each day. (Please check the boxes that apply.)

Number of Employees at this Location	Number of Employees Involved in Ink Removal	Number of Employees Involved in Screen Cleaning/Reclamation	Average time (hr/day) a single individual is involved w/ ink removal	Average time (hr/day) a single individual is involved w/ cleaning/reclaiming screens
0-5 ☐	1-3 ☐	1-3 ☐	<1 ☐	<1 ☐
6-10 ☐	4-6 ☐	4-6 ☐	1-2 ☐	1-2 ☐
11-15 ☐	7-10 ☐	7-10 ☐	2-4 ☐	2-4 ☐
16-30 ☐	>11 ☐	>11 ☐	4-6 ☐	4-6 ☐
31-50 ☐	specify ____	specify ____	6-8 ☐	6-8 ☐
>50 ☐			other ☐	other ☐

4) Equipment and Materials Use

A) What types of and how much ink do you use in your printing processes? What do you use as a reducer/retarder? What is the primary substrate you use with each ink type? (Please check or list all that apply)

Type of Ink	Volume of Ink Used/Year[b] (gallons)	Type of Reducer/Retarder	Primary Substrate
Traditional solvent-based			Plastic ☐ Paper ☐ Metal ☐ Glass ☐ Ceramic ☐ Other (specify) ☐
UV Curable			Plastic ☐ Paper ☐ Metal ☐ Glass ☐ Ceramic ☐ Other (specify) ☐
Water-based		Water ☐ Solvent ☐ Water/Solvent ☐ Mixture (specify trade name)	Plastic ☐ Paper ☐ Metal ☐ Glass ☐ Ceramic ☐ Other (specify) ☐
Other (specify)[a]			Plastic ☐ Paper ☐ Metal ☐ Glass ☐ Ceramic ☐ Other (specify) ☐

[a] Other types of ink include metallic inks, etc.
[b] If you do not use a type of ink, enter "0"

The remaining questions are only in reference to solvent- or UV-based inks printed on plastic/vinyl substrates. If your facility does not primarily use these types of substrates or inks, please do not complete the rest of the questionnaire.

B) - What is the average number of screens cleaned/reclaimed each day for future use? (Please check the appropriate box)

- ☐ 0 - 5
- ☐ 5 -10
- ☐ 10 -15
- ☐ > -15

Specify _____

C) Please specify the average size of frame used at your facility? _____
(Please specify units; e.g. ft x ft or in x in, ect.)

D) Do you have separate areas for ink removal and screen reclamation activities? ☐ yes ☐ no
If yes, please check all that apply in the following table.

Separate areas for ink removal and screen cleaning/reclamation activities*			
Size of Ink Removal Area (ft^2)	Type of Ventilation	Size of Screen Reclamation Area (ft^2)	Type of Ventilation
<20 ☐	local (mechanical) ☐	<20 ☐	local (mechanical) ☐
20-50 ☐	plant (facility-wide) ☐	20-50 ☐	plant (facility-wide) ☐
50-100 ☐	natural ☐	50-100 ☐	natural ☐
100-200 ☐	other (specify below) ☐	100-200 ☐	other (specify) ☐
>200 ☐		>200 ☐	
Specify size ____		Specify size ____	

* Screen cleaning/reclamation activities include residual ink removal, emulsion removal, and haze removal.

E) Do you have a combined area for ink removal and screen reclamation? ☐ yes ☐ no
If yes, please check all that apply in the following table.

Combined area for ink removal and screen reclamation activities	
Size of Combined Area (ft2)	Type of Ventilation
<20 ☐	local (mechanical) ☐
20-50 ☐	plant (facility-wide) ☐
50-100 ☐	natural ☐
100-200 ☐	other (specify) ☐
>200 ☐	
Specify Size ____	

5) **Ink Removal Procedures** (NOT press-side/process cleaning)

A) If you recycle ink removal products in-house, how much material was recycled in 1992? _____gal.

B) What ink removal products do you purchase? What type of personal protective equipment do you typically use when you remove ink? What are typical ink removal procedures at your facility? These questions do not apply to process cleaning (e.g., press-side operations such as ink removal before going to lunch.) (Please check all that apply.)

Ink Removal Product (Trade Name)	Annual Volume of Ink Removal Product Purchased (gallons)	Cost of Ink Removal Product ($/gallon)	Type of Ink with which Product Works Best	Personal Protective Equipment Used	Method of Applying Ink Removal Product	Equipment or Materials Used to Loosen Ink	Ave. No. of Rags Used Per Screen to Remove Ink
			Solvent-based ☐ UV Curable ☐ Either* ☐	Gloves ☐ Eye protection ☐ Aprons ☐ Respiratory protection ☐ Barrier Cream ☐ None Used ☐ Other (specify) ☐	Pour from container onto screen surface ☐ Dip rag or brush into container and wipe screen ☐ Spray on with nozzle from tank ☐ Spray on with spray bottle ☐ Use specialized spraying equipment (specify) ☐ Other (specify) ☐	Brush ☐ Squeegee ☐ Disposable Rag ☐ Reusable Rag ☐ Other (specify) ☐	0-2 ☐ 2-4 ☐ 4-6 ☐ 6-8 ☐ 8-10 ☐ Other ☐ (specify number_____)
			Solvent-based ☐ UV Curable ☐ Either* ☐				
			Solvent-based ☐ UV Curable ☐ Either* ☐				

* e.g., ink removal product works equally well with either type of ink.

6) Emulsion Removal Procedures

A) What percent of the time do you use the following types of stencils?

	<50%	50-95%	95-100%	Are these dual cured?	
Direct photo stencils	☐	☐	☐	yes ☐	no ☐
Indirect photo stencils	☐	☐	☐	yes ☐	no ☐
Capillary film	☐	☐	☐	yes ☐	no ☐

B) What emulsion removal products do you use? What type of personal protective equipment do you typically use when you remove emulsion? What are typical emulsion removal procedures at your facility? (Please check all that apply.)

Emulsion Removal Product (Trade Name)	Annual Volume of Emulsion Removal Product Used (gallons)	Cost of Emulsion Removal Product ($/gallon)	Personal Protective Equipment Used	Method of Applying Emulsion Removal Product	Equipment or Materials Used to Remove Emulsion	Ave. No. of Rags Used Per Screen to Remove Emulsion
			Gloves ☐	Pour from container onto screen surface ☐	Brush ☐	0-2 ☐
			Eye protection ☐	Dip rag or brush into container and wipe screen ☐	Low-pressure Water-spray ☐	2-4 ☐
			Aprons ☐	Spray on with nozzle from tank ☐	High-pressure Water-spray ☐	4-6 ☐
			Respiratory protection ☐	Spray on with spray bottle ☐	Water-blaster ☐	6-8 ☐
			None Used ☐	Use specialized spraying equipment (specify) ☐	Automatic Screen Cleaning System ☐	8-10 ☐
			Other (specify) ☐	Other (specify) ☐	Disposable Rag ☐	Other ☐
					Reusable Rag ☐	(Specify number _____)
					Other (specify) ☐	

7) **Haze Removal Procedures**

A) Please complete the following chart if you use haze remover to remove ghost images.

Haze Removal Product (Trade Name)	Annual Volume of Haze Removal Product Used (gallons)	Cost of Haze Removal Product ($/gallon)	Percent of Time Haze Remover Used	Personal Protective Equipment Used	Method of Applying Haze Removal Product	Equipment or Materials Used to Remove Haze	Ave. No. of Rags Used Per Screen to Remove Haze
			0-5 ☐	Gloves ☐	Pour from container onto screen surface ☐	Brush ☐	0-2 ☐
			5-25 ☐	Eye protection ☐	Dip rag or brush into container and wipe screen ☐	Low-pressure Water-spray ☐	2-4 ☐
			25-50 ☐	Aprons ☐	Spray on with nozzle from tank ☐	High-pressure Water-spray ☐	4-6 ☐
			>50 ☐	Respiratory protection ☐	Spray on with spray bottle ☐	Water-blaster ☐	6-8 ☐
			(specify ____)	Barrier Cream ☐	Use specialized spraying equipment (specify) ☐	Squeegee ☐	8-10 ☐
				None Used ☐	Other (specify) ☐	Disposable Rag ☐	Other (specify) ☐
				Other (specify) ☐		Reusable Rag ☐	
						Other (specify) ☐	

8) **Screen Cleaning/Reclamation Alternatives**

A) Do you use a screen degreaser? ☐ yes ☐ no
Trade Name of Product _____

B) Do you use a separate ink degradant before applying emulsion remover? (Answer yes only if the ink degradant is different than the primary ink removal product)? ☐ yes ☐ no
Trade Name of Product _____

9) Materials Storage

A) Where do you store ink removal and screen reclamation products and in what quantity? (Please check all that apply.)

Ink Removal and Screen Cleaning Area(s)	Ink/Chemical Storage Room
30- or 55-gallon drum with bung hole kept open ☐	30- or 55-gallon drum with bung hole kept open ☐
30- or 55-gallon drum with bung hole kept closed ☐	30- or 55-gallon drum with bung hole kept closed ☐
30- or 55-gallon drum with top removed ☐	30- or 55-gallon drum with top removed ☐
Open pail ☐	Open pail ☐
Closed pail ☐	Closed pail ☐
Quart or smaller squirt bottle ☐	Quart or smaller squirt bottle ☐
Safety can ☐	Safety can ☐
Safety cabinet ☐	Safety cabinet ☐
Not kept in the press room ☐	No separate storage area ☐
Other (specify below) ☐	Other (specify below) ☐
	Size of storage room ___ ft x ___

B) How do you retrieve ink removal and screen reclamation products from ink/chemical storage? If you keep both large and small containers in the ink removal and screen cleaning/reclamation areas, how do you transfer the products from large containe to small containers for use?

Retrieval from Storage Room	Transfer from Large to Small Container for Use
Entire container moved to press room ☐	Pumped into small container used at work station ☐
Pumped into smaller container ☐	Poured into smaller container ☐
Poured into smaller container ☐	Ladled into smaller container ☐
Ladled into smaller container ☐	Other (specify below) ☐
Other (specify below) ☐	

10) Waste Disposal

A) Please indicate the quantity of waste you dispose of annually as hazardous waste for:

spent solvent waste _____ (Number of 55 gal. drums) OR _____ (gal. in bulk)

ink waste _____ (Number of 55 gal. drums) OR _____ (gal. in bulk)

used shop rag waste _____ (Number of 55 gal. drums) OR _____ (gal. in bulk)

B) What quantity of wastes from ink removal and screen cleaning/reclamation operations do you generate annually? How are these waste materials treated or disposed of? (Please check all that apply.)

Ink Removal Wastes			Screen Cleaning/Reclamation Wastes		
Quantity Generated Annually (gallons)	Method of Storage Prior to Treatment and/or Disposal	Method of Treatment or Disposal	Quantity Generated Annually	Method of Storage Prior to Treatment or Disposal	Method of Treatmen and/or Disposal
	In closed containers ☐	Filter or treat prior to disposal or recycle ☐		In open containers ☐	Filter or treat prior to disposal or recycle ☐
	In open containers ☐	Send to recycler ☐		In closed containers ☐	Discharge to sewer ☐
	No specified container ☐	Recycle on site ☐		No specified containers ☐	Discharge to septic tank ☐
	Other (specify) ☐	Discharge to sewer ☐		Other (specify) ☐	Hazardous Waste ☐
		Dispose as hazardous waste ☐			Non-Hazardous waste ☐
		Dispose as non-hazardous waste ☐			
		Other (specify) ☐			

C) How are waste rags contaminated with ink removal and screen cleaning/reclamation products stored, treated or dispose of? (Please check all that apply.)

Method of Storage Prior to Pretreatment or Disposal		Method of Pretreatment		Method of Recycle or Disposal	
In open containers	☐	Centrifuge	☐	On-site water laundry	☐
In closed containers	☐	Allow liquid to drain out	☐	On-site dry cleaner	☐
No specified containers	☐	Other (specify)	☐	Off-site water laundry	☐
		None	☐	Off-site dry cleaner	☐
				Hazardous waste	☐
				Non-hazardous waste	☐
				Do not use rags	☐
				Other (specify)	☐

11) Pollution Prevention Opportunities

Please use the following table to describe the experiences at your facility with pollution prevention techniques. Pollution prevention is the use of materials, processes, practices or products that avoid, reduce or eliminate wastes or toxic releases, through activities such as toxic use reduction, source reduction, and closed loop recycling.

Do you have a pollution prevention, waste minimization, or source reduction program?	yes ☐ no ☐		If you answered yes, would you be willing to share a description of your program with the DFE Printing Project?	yes ☐ no ☐
Have you tried any different chemical products for environmental or worker safety reasons to replace your current ink removal or screen cleaning/reclamation products?	yes ☐ no ☐		If you answered yes, please list the product name:	
If you have tried a different chemical product, please check the box that best describes your experience with the product:[a]	Cleaner worked well: ☐ Cleaner was OK but not as good as old cleaner: ☐ Cleaner was not satisfactory: ☐ Other (please explain below): ☐		If you have not tried a different chemical product, please check the box that best describes your reason for not trying alternatives:	Lack adequate information to evaluate environmental performance of alternatives: ☐ Operators do not believe alternatives will work: ☐ Not impressed with product descriptions: ☐ Cost is prohibitive: ☐ Other (please explain below): ☐
Besides different chemical products, have you implemented any changes in equipment ☐, products ☐, processes ☐, or work practices ☐ that reduced your use of ink removal or screen cleaning/reclamation products? (If you have implemented changes, please check all boxes that apply.)	yes ☐ no ☐		If you answered yes, would you be willing to share the changes with the DFE Printing Project?	yes ☐ no ☐
		increased	decreased	no change
If you have implemented changes that reduced your use of ink removal or screen cleaning/reclamation products, how have these changes affected:	materials cost:	☐	☐	☐
	time required to clean the screen:	☐	☐	☐
	disposal costs:	☐	☐	☐
If you should decide or have decided to implement changes in your screen cleaning/reclamation process to incorporate pollution prevention opportunities, which of the following factors would have the greatest priority in this decision? Please rank these factors from 1 to 6, with 1 indicating the highest priority.	_____ cost _____ regulations _____ environmental hazard		_____ performance _____ health hazard _____ other (specify	

[a] If you have tried more than one different chemical product, please fill out a copy of this section for each product.

WORKPLACE PRACTICES QUESTIONNAIRE FOR THE MAKING HOLES CONDUCTIVE PROCESS

DESIGN FOR THE ENVIRONMENT (DfE) PRINTED WIRING BOARD PROJECT

This document is prepared by the University of Tennessee Center For Clean Products and Clean Technologies in Partnership with U.S. EPA Design for the Environment (DfE) Program, IPC, PWB manufacturers, and other DfE Partners

March 1995

**Note: This survey is not as long as it looks since you will only complete a part of it. This survey has 7 sections; however, we ask you to complete only sections 1,2,3 and the section that pertains to your making holes conductive (MHC) process.*

WORKPLACE PRACTICES QUESTIONNAIRE FOR THE MAKING HOLES CONDUCTIVE PROCESS

Design for the Environment Project

PLEASE RETURN BY FRIDAY, MARCH 31, 1995 TO: IPC — ATTN: STAR SUMMERFIELD, 7380 N. LINCOLN AVENUE, LINCOLNWOOD, IL 60646-1705

DO NOT COMPLETE ALL SECTIONS OF THE QUESTIONNAIRE. The following explains which sections you should complete based on the type of making holes conductive (MHC) process used at your facility, provides background information on the questionnaire, and describes how the data will be handled to ensure confidentiality.

1. This questionnaire was prepared by the University of Tennessee Center for Clean Products and Clean Products in partnership with the EPA DfE Program, IPC, PWB manufacturers, and other members of the DfE PWB Industry Project.

2. For the purposes of this survey and the DfE Project, the "Making Holes Conductive (MHC)" process is defined as beginning after the desmear and etchback steps and ending prior to the dry film resist outer layer step (if required) and copper electroplating step.

3. Shaded sections of the questionnaire denote areas where responses to questions should be entered. Unshaded sections are instructions or keys required to answer the question.

4. Throughout the questionnaire, many questions request specific data, such as chemical volumes, the amount of water consumed by the MHC line or the characteristics of wastewater from the MHC line. If specific data are not readily available, estimates based on your knowledge of the process and the facility, are adequate. In cases where no data are available and there is no basis for an accurate estimate, mark your response as "ND."

5. Please complete sections 1 through 3 of the questionnaire, regardless of which process is used at your facility to make drilled through-holes conductive prior to electroplating.

6. After completing Sections 1 through 3, please complete only the section(s) of the survey that corresponds to the MHC process(es) currently being operated at your facility, as listed below.

Electroless Copper ..... Section 4
Graphite-based ..... Section 5
Carbon-based ..... Section 6
Palladium-based ..... Section 7

If the MHC process used at your facility is not listed, you have completed the questionnaire.

7. If your responses do not fit in the spaces provided, please photocopy the section to provide more space or use ordinary paper and mark the response with the section number to which it applies.

8. Appendix A contains the definitions of certain terms and acronyms used in the survey form.

9. Confidentiality
All information and data entered into this survey form are confidential. The sources of responses will not be known by IPC, University of Tennessee, EPA, or other project participants. Any use or publication of the data will not identify the names or locations of the respondent companies or the individuals completing the forms.

Please use the following procedures to ensure confidentiality:

(1) Complete the survey form. Make a copy of the completed form and retain it for your records.
(2) Separate the facility and contact information page of the survey form from the remainder of the form. Place the facility and contact information into Envelope #1 and seal the envelope.
(3) Place the remainder of the survey form plus any additional sheets or exposure monitoring data into Envelope #2 and seal it.
(4) Place sealed Envelopes #1 and #2 into the larger return envelope and mail it to IPC.
(5) When the package is received by IPC, only Envelope #1 will be opened. IPC will place a code number on the outside of Envelope #2 and forward it to the Center for Clean Products and Clean Technologies at the University of Tennessee. Envelope #1 will not be sent to the University of Tennessee.
(6) Questions, clarifications, or requests for further information from the University of Tennessee will be relayed by code number to IPC, who will be able to contact the respondent. When it is determined that no further communications with respondents are necessary, the matrix of code numbers and respondents will be destroyed by IPC.

10. If you have any questions regarding the survey form, please contact Jack Geibig of the University of Tennessee Center for Clean Products and Clean Technologies at 615-974-6513 (e-mail: JGEIBIG@UTKVX.UTK.EDU).

PLEASE RETURN BY FRIDAY, MARCH 31, 1995 TO: IPC — ATTN: STAR SUMMERFIELD, 7380 N. LINCOLN AVENUE, LINCOLNWOOD, IL 60646-1705 (PH. 708/677-2850 ext. 347; FAX 708/677-9570)

Section 1. Facility Characterization

Estimate manufacturing data for the previous 12 month period or other convenient time period of 12 consecutive months (e.g., FY94). Only consider the portion of the facility dedicated to PWB manufacturing when entering employee and facility size data.

1.1 General Information

Size of portion of facility used for manufacturing PWB's :	sq.ft.	Number of days MHC line is in operation:	days/yr
Number of full-time equivalent employees (FTE's):		Total PWB panel sq. footage processed by the MHC process:	sq.ft./yr
Number of employee work days per year:	days/yr		

1.2 Facility Type

Type of PWB manufacturing facility (check one)	Independent		OEM	

1.3 Process Type

Estimate the percentage of PWBs manufactured at your facility using the following methods for making holes conductive (MHC). Specify "other" entry.

Standard electroless copper	%
Palladium-based system	%
Carbon-based system	%
Graphite-based system	%
Electroless nickel	%
Other:	%
TOTAL	100 %

Process Data	Shift			
	1	2	3	4
Number of hours per shift:				
Number of hours the MHC line is in operation per shift:				
Average square feet of PWB panel processed by the MHC line per shift:				

I.5 Process Area Employees

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the MHC line for each shift and for what length of time. Report the number of hours per employee by either the month or the shift, whichever is appropriate for the worker category. Consider only workers who have regularly scheduled responsibilities physically within the process room. Specify "other" entry.

Type of Process Area Worker	Number of Employees per Shift				Hours per Shift per Employee	Hours per Month per Employee
	1	2	3	4	in Process Area (first shift)	in Process Area (first shift)
Line Operators					Hrs	Hrs
Lab Technicians					Hrs	Hrs
Maintenance Workers					Hrs	Hrs
Wastewater Treatment Operators					Hrs	Hrs
Supervisory Personnel					Hrs	Hrs
Contract Workers					Hrs	Hrs
Other:					Hrs	Hrs
Other:					Hrs	Hrs

Section 2. General Process Data

The information in this section will be used to identify the physical parameters of the process equipment as well as any operating conditions common to the entire process line.

2.1 Process Parameters

MHC process line dimensions	Length:				ft.
	Width:				ft.
Average time for panel to complete process:					min.
Size of the room containing the process:					sq.ft.
Temperature of the process room:					°F
Is the process area ventilated (circle one)?		Yes		No	
Air flow Rate:					cu.ft./min.
Type of ventilation? (check one)	general		local		

2.2 General Water Usage

Amount of water used by the MHC process line when operating:	gal./day

2.3 Wastewater Characterization

Estimate the average and maximum values for the wastewater from the making holes conductive line.

	AVERAGE	MAXIMUM
Flow	gpm	gpm
TDS	mg/l	mg/l
pH		
Cu	mg/l	mg/l

	AVERAGE	MAXIMUM
Pd	mg/l	mg/l
Sn	mg/l	mg/l
TSS	mg/l	mg/l
TTO	mg/l	mg/l

2.4 Wastewater Discharge and Sludge Data

Wastewater discharge type (check one)	Direct		Indirect		Zero	
Annual quantity of sludge generated:						
Percent solids of sludge						
Percentage of total quantity generated by the MHC process:						
Method of sludge recycle/disposal (see key at right):						

Methods of Sludge Recycle/Disposal
[R]— Metals Reclaimed
[D]— Stabilized and Landfilled
[O]— Other

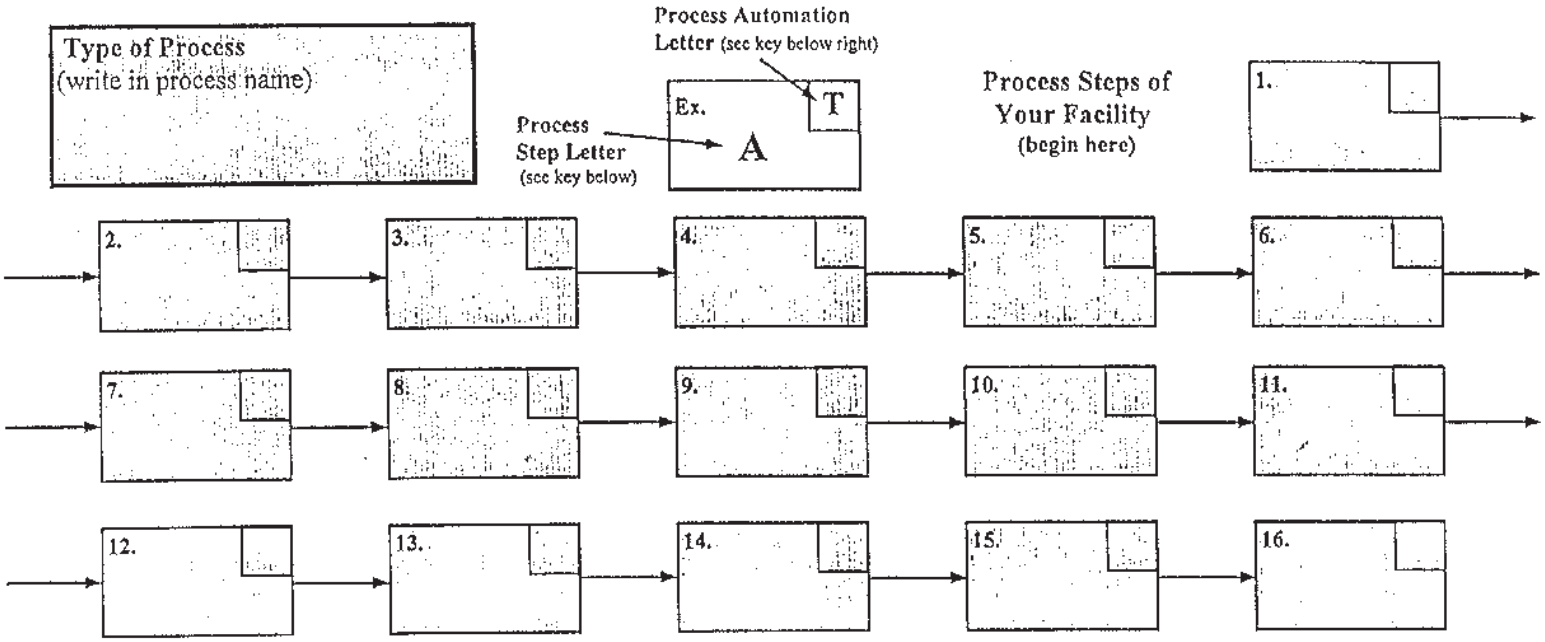
2.5 Panel Rack Specifications- (non-conveyorized MHC process only)

Average number of panels per rack:				
Average space between panels in rack:				in.
Average size of panel in rack:	Length	in.	Width	in.

Section 3. Process Description

3.1 Process Schematic

Fill in the table below by identifying what type of making holes conductive process (e.g., electroless copper) your facility uses. Then, using the proper key at the bottom of the page, identify which letter corresponds with the first step in your process and write that letter in the first box (see example). Continue using the key to fill in boxes for each step in your process until your entire making holes conductive process is represented. If your process is not represented by a key below, complete the chart by writing in the name of each process step in your particular making holes conductive line. Finally, consult the process automation key at bottom right and enter the appropriate type of automation for the MHC process line. If the process is partially automated, enter the appropriate process automation letter for each step in the upper right-hand corner box (see example).



ELECTROLESS COPPER PROCESS STEPS

[A]— Conditioner/Cleaner
[B] — Micro Etch
[C] — Pre-dip
[D]— Activator/Catalyst
[E]— Accelerator
[F]— Electroless Copper
[G]— Reducer/Neutralizer
[H]— Anti-tarnish/Anti-oxidant
[W] — Water rinse
[O]— Other (specify step)

GRAPHITE-BASED PROCESS STEPS

[A]— Cleaner/Conditioner
[B]— Graphite
[C]— Fixer
[D]— Air knife/Oven
[E]— Post-clean Etch
[F]— Anti-tarnish/Anti-oxidant
[W]— Water rinse
[O]— Other (specify step)

CARBON-BASED PROCESS STEPS

[A]— Cleaner
[B]— Conditioner
[C]— Carbon
[D]— Air knife/Oven
[E]— Post-clean Etch
[F]— Anti-tarnish/Anti-oxidant
[W]— Water rinse
[O]— Other (specify step)

PALLADIUM-BASED PROCESS STEPS

[A]— Conditioner/Cleaner
[B] — Pre-dip
[C] — Palladium Catalyst
[D]— Accelerator
[E]— Enhancer
[F]— Electroless Copper
[G]— Post-Clean Etch
[H]— High pressure Water
[J]— Anti-tarnish/Anti-oxidant
[W] — Water rinse
[O]— Other (specify step)

PROCESS AUTOMATION

TYPE OF PROCESS AUTOMATION FOR ENTIRE MHC PROCESS _____
(Consult the key below)

*** If the MHC process is partially automated (option R) enter 'R' on above line. Then, for each process step in chart above, consult the key below and enter the appropriate process automation letter in the box located in the upper right-hand corner of each process step (see example).**

Process Automation Key

[P]— Automated non-conveyorized
[Q]— Automated conveyorized
[R]— Partially automated*
[S]— Manually controlled hoist
[T]— Manual (no automation)
[V]— Other (specify)

3.2 Rinse Bath Water Usage

Consult the process schematic in section 3.1 to obtain the process step numbers associated with each of the water rinse baths present. Enter, in the table below, the process step number along with the flow control and flow rate data requested for each water rinse bath. If the water rinse bath is part of a cascade, you need only report the daily water flow rate of one bath in the cascade.

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a]**Process step number**- Consult the process schematic in question 4.1 and enter the process step number of the specific water rinse tank.

[b]**Flow control**- Consult key at right and enter the letter for the flow control method used for that specific rinse bath.

[c]**Daily water flow rate**- Enter the average daily flow rate for the specific water rinse tank.

[d]**Cascade Water Process Steps**- Enter the process step number for each water rinse tank in cascade with the present tank.

Flow Control Methods Key
[C]— Conductivity Meter
[P]— PH Meter
[V]— Operator control valve
[R]— Flow Restricter
[N]— None (continuous flow)
[O]— Other (explain)

3.3 Rack Cleaning- (non-conveyorized MHC process only)

Complete the following section by using the keys to the right of the table to identify the rack cleaning process used.

Frequency of cleaning:	
Number of personnel involved:	
Personal protective equipment (see key at right):	
Rack cleaning method used (see key at right): * If the above answer is [C], also enter the process step number from the process schematic (section 3.1) and do not complete section 3.4 below.	
Average time required to chemically clean rack (if applicable) :	min.
Cleaning schedule (see key at right):	
Is rack cleaning attended (circle one):	Yes No

Personal Protective Equipment Key
[E]— Eye protection [G]— Gloves
[L]— Labcoat/sleeved garment [A]— Apron
[R]— Respiratory protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

Rack Cleaning Methods Key
[C]— Chemical bath on making holes conductive line
[D]— Chemical bath on another line
[T]— Temporary chemical bath
[S]— Manual scrubbing with chemical
[M]— Non-chemical cleaning
[N]— None

Rack Cleaning Schedule
[A]— After Hours
[L]— During operating hours- in MHC process room
[M]— During operating hours-outside MHC process room

3.4 Rack Cleaning Chemical Composition (non-conveyorized MHC process only)

Chemical Name	Conc.	Volume
		gal.
		gal.
		gal.

3.5 Conveyor Equipment Cleaning

Complete the following table on conveyorized equipment cleaning in the MHC process line by providing the information requested for each cleaning operation performed. If more space is needed or more than two cleaning operations occur, report them on a separate sheet of paper.

Equipment Cleaning Data	Cleaning Operation no.1	Cleaning Operation no.2
Description of cleaning operation: (briefly describe equip. cleaned)		
Process steps affected [a]		
Frequency of cleaning:		
Duration of cleaning:	min.	min.
Number of personnel involved:		
Personal protective equipment (see key at right):		
Cleaning method used (see key at right):		
Cleaning chemical used [b]		

Personal Protective Equipment Key
[E]— Eye protection
[G]— Gloves
[L]— Labcoat/sleeved garment
[A]— Apron
[R]— Respiratory protection
[B]— Boots
[Z]— All except Respiratory Protection
[N]— None

Conveyor Cleaning Methods Key
[C]— Chemical rinsing or soaking
[S]— Manual scrubbing with chemical
[M]— Non-chemical cleaning
[N]— None

[a] **Process Steps Affected**-Consult the process schematic from section 4.1 and enter the process step numbers of the specific steps affected by the cleaning operation.

[b] **Cleaning Chemical Used**- Enter the name of the chemical or chemical product (or bath type, if applicable) used in the specific cleaning operation.

3.6 Filter Replacement

Complete the following table on filter replacement in the MHC process line by providing the information requested for each set of filters replaced.

Replacement Information	Filter Assembly no.1	Filter Assembly no.2	Filter Assembly no.3
Bath filtered (enter process step from 3.1) :			
Frequency of replacement:			
Duration of replacement:	min.	min.	min.
Number of personnel involved:			
Personal protective equipment (see key below):			
Type of filter (see key below):			
Number of filters changed in assembly:			
Area of Filter:	sq. in.	sq. in.	sq. in.

Personal Protective Equipment Key
[E]— Eye Protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory Protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

Filter Type Key
[B]— Bag Filter
[C]— Cartridge Filter
[O]— Other (specify)

3.7 Process History

Complete the table below by indicating what making holes conductive process(es) your facility has employed in the past. Briefly explain the reasons for the process change and summarize how the change has had an affect upon production.

FORMER MAKING HOLES CONDUCTIVE PROCESS	DATE OF CHANGE TO CURRENT PROCESS
ELECTROLESS COPPER	
PALLADIUM-BASED	
GRAPHITE-BASED	
CARBON-BASED	
COPPER SEED	
ELECTROLESS NICKEL	
OTHER (specify)	

REASONS FOR CHANGE AND RESULTS		
Reason (see key)		Result (see key)
	Water Consumption	
	Process Cycle- time	
	Cost	
	Worker Exposure	
	Performance	
	Customer Acceptance	
	Product Quality	
	Process Maintenance	
	Other:	
	Other:	
	Other:	

Reasons
[X]— Mark all of the selections that apply

Results of change
[B]— Better
[W]— Worse
[N]— No Change

The remainder of the survey is dedicated to questions that are strictly specific to the type of making holes conductive process operated at your facility. **You should complete only the section(s) of the survey that corresponds to the MHC process(es) that is currently being operated.**

Select the making holes conductive process(es) that your facility currently operates and complete only the section(s) listed. If your process is not listed, then you have completed the questionairre.

Electroless Copper..... Section 4 (pgs. 9-17)
Graphite-Based..... Section 5 (pgs. 19-26)
Carbon-Based..... Section 6 (pgs. 27-34)
Palladium-Based ..... Section 7 (pgs 35-43)

Section 4. Electroless Copper Process

The information requested below will allow us to generate an exposure assessment and risk characterization profile for each of the following baths and the associated activities involved in the operation and upkeep of the electroless copper process.

NOTE: You need to complete this section only if your facility uses an **electroless copper** process for making the holes conductive during the PWB manufacturing process.

4.1 Physical, Process, and Operating Conditions

Complete the table below by entering the data requested for each specific type of chemical bath listed. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH	PHYSICAL DATA			PROCESSING DATA		OPERATING CONDITIONS		
	LENGTH (inches)	WIDTH (inches)	NOMINAL VOLUME	IMMERSION [a] (seconds)	DRIP TIME [b] (seconds)	TEMP °F	AGITATION [c]	VAPOR CONTROL [d]
CLEANER/ CONDITIONER	in.	in.	gal.	sec.	sec.	°F		
MICRO ETCH	in.	in.	gal.	sec.	sec.	°F		
PRE-DIP	in.	in.	gal.	sec.	sec.	°F		
ACTIVATOR/ CATALYST	in.	in.	gal.	sec.	sec.	°F		
ACCELERATOR	in.	in.	gal.	sec.	sec.	°F		
ELECTROLESS COPPER	in.	in.	gal.	sec.	sec.	°F		
REDUCER/ NEUTRALIZER	in.	in.	gal.	sec.	sec.	°F		
ANTI-TARNISH/ ANTI-OXIDANT	in.	in.	gal.	sec.	sec.	°F		
OTHER(specify)	in.	in.	gal.	sec.	sec.	°F		

[a] Immersion Time- Enter the average elapsed time a rack of panels is immersed in the specific process bath.
[b] Drip Time- Enter the average elapsed time that a rack of panels is allowed to hang above the specific bath to allow chemical drainage from panels.
[c] Agitation - Consult the key at right and enter the letter for the agitation method used in the specific chemical bath.
[d] Vapor Control- Consult key at right and enter the letter of the vapor control method used for that specific chemical bath.

Agitation Methods Key
[P]— Panel Agitation
[F]— Fluid Circulation Pump
[A]— Air Sparge
[O]— Other (explain)

Vapor Control Methods Key
[P]— Push-Pull
[C]— Bath Cover (when not in use)
[B]— Plastic Balls (floating)
[E]— Fully Enclosed
[O]— Other (explain)

4.2 Initial Chemical Bath Make-Up Composition

Complete the chart below for each chemical component of the bath type listed. Provide the manufacturer name if the chemical used is known only by trade name. If more room is needed, please attach another sheet with the additional information. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED[c] (gallons)
CLEANER/ CONDITIONER	1.					
	2.					
	3.					
	4.					
MICRO-ETCH	1.					
	2.					
	3.					
	4.					
PRE-DIP	1.					
	2.					
	3.					
	4.					
ACTIVATOR/ CATALYST	1.					
	2.					
	3.					
	4.					
ACCELERATOR	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

4.2 Initial Chemical Bath Make-Up Composition- CONTINUED

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED[c] (gallons)
ELECTROLESS COPPER	1.					
	2.					
	3.					
	4.					
REDUCER/ NEUTRALIZER	1.					
	2.					
	3.					
	4.					
ANTI-TARNISH/ ANTI-OXIDANT	1.					
	2.					
	3.					
	4.					
OTHER (specify)	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

4.3 Chemical Bath Replacement

Complete the chart below by providing information on the process of replacing, treating, and disposing of a spent chemical bath.

Bath Type	Criteria for Replacement[a]	Frequency[b]	Duration of Replacement Procedure[c]	Number of People	Personal Protective Equipment[d]	On-Site Method of Treatment or Disposal [e]	Annual Volume Treated or Disposed [f]	Off-Site Method of Treatment or Disposal [e]
Cleaner/ Conditioner								
Micro Etch								
Pre-Dip								
Activator/ Catalyst								
Accelerator								
Electrolesss Copper								
Reducer/ Neutralizer								
Anti-Tarnish/ Anti-Oxidant								
Other (specify)								

[a] Criteria for Replacement- Consult the key at right and enter the letter for the criteria typically used to determine when bath replacement is necessary.

[b] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[c] Duration of Replacement- Enter the elapsed time from the beginning of bath removal until the replacement bath is finished.

[d] Personal Protective Equip.- Consult key at right and enter the letters of all the protective equipment worn by the workers physically replacing the spent bath.

[e] Methods of Treat. or Disp.- Consult keys at right and enter the letter of the method used.

[f] Annual Vol. Treat. or Disp.- Enter the yearly amount of the specific bath treated or disposed.

On-Site Method of Treatment or Disposal
[P]— Precipitation Pretreatment on-site
[N]— PH Neutralization Pretreatment on-site
[S]— Disposed directly to sewer with no treatment
[D]— Drummed for off-site treatment or disposal
[R]— Recycled on-site
[O]— Other (specify)

Off-Site Method of Treatment or Disposal
[R]— Sent to Recycle
[P]— Discharged to POTW
[O]— Other (specify)

Criteria for Bath Replacement
[S]— Statistical process control [T]— Time
[P]— Panel Sq.Ft. processed [O]— Other (specify)
[C]— Chemical testing

Personal Protective Equipment
[E]— Eye protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

4.4 Chemical Handling Activities:Chemical Bath Replacement

Complete the table below by indicating the options your facility uses to replace each type of spent chemical bath. **If the same options are used to replace each of the various chemical baths, enter 'ALL' as the type of bath and fill out only one table.** Otherwise, please photocopy and attach additional charts, as necessary.

TYPES OF BATHS *	

REMOVAL OF SPENT BATH			CLEANING OF EQUIPMENT			NEW BATH MAKE-UP		
Method of Removing Spent Bath	Pump:		Tank Cleaning Method	Chemical Flush:		Chemical Retrieval from	Pump:	
	Siphon :			Hand Scrub:		Stock into Container	Pour:	
	Drain/ Spigot:			Other (specify):			Scoop (solid):	
	Other (specify):						Other (specify):	
Remove Spent Bath	Directly to Wastewater Treatment:		CHEMICALS USED IN CHEMICAL FLUSH			Container Type	Open-top container:	
	Directly to sewer:		Chemical	Gallons Per Year			Closed-top container:	
	To open-top container:						Safety container:	
	To closed-top container:						Other (specify):	

* Types of Baths- Enter the types of baths where the activities are used. If the chemical handling activities are the same for each bath type, enter 'ALL'.

4.5 Chemical Bath Sampling

Provide information on the chemical bath sampling procedures used in your facility. Duration of sampling and personnel involved should include only the portion of the testing procedure involving the manual sampling of the chemical baths, not automated sampling or the testing that may occur in another part of the facility, such as the lab.

BATH TYPE	TYPE OF SAMPLING [a]	FREQUENCY[b]	DURATION OF SAMPLING [c]	NUMBER OF PEOPLE [d]	PROTECTIVE EQUIPMENT [e]
CLEANER/ CONDITIONER			min.		
MICRO ETCH			min.		
PRE-DIP			min.		
ACTIVATOR/ CATALYST			min.		
ACCELERATOR			min.		
ELECTROLESS COPPER			min.		
REDUCER/ NEUTRALIZER			min.		
ANTI-TARNISH/ ANTI-OXIDANT			min.		
OTHER (specify)			min.		

[a] **Type of Sampling**- Consult the key at right and enter the letter for the type of sampling performed on the specific chemical bath.

[b] **Frequency**- Enter the average amount of time elapsed or number of panel sq. ft. processed between samples. Clearly specify units (e.g., hours, square feet, etc.)

[c] **Duration of Sampling**- Enter the average time for manually taking a sample from the specific chemical tank. Consider only time spent at the chemical bath.

[d] **Number of People**- Enter the number of people actually involved in manually taking the chemical samples. Exclude people doing the testing but not the sampling.

[e] **Personal Protect. Equip.**- Consult key at right and enter the letters for <u>all</u> protective equipment worn by the people performing the chemical sampling.

<u>Type of Sampling Key</u>

[A]— Automated Sampling [B]— Both
[M]— Manual Sampling [N]— None

<u>Personal Protective Equipment Key</u>

[E]— Eye Protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory Protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

4.6 Chemical Handling Activities:Chemical Sampling

Complete the table below by indicating what method your facility uses to manually collect bath samples and the type of container used.

Method of Obtaining Samples	Drain/Spigot:	
	Pipette:	
	Ladle:	
	Other (Specify):	
Chemical Sample Container	Open-top container:	
	Closed-top container:	

4.7 Chemical Bath Additions

Complete the following chart detailing the typical chemical additions that are made to maintain the chemical balance of each specific process baths. If more than four chemicals are added to a specific bath, attach another sheet with the additional information. If chemical additions to a bath are made automatically, do not complete the last three columns for that bath. If two tanks of the same type are used within the process, list the data for a single tank only.

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
CLEANER/ CONDITIONER	1.								
	2.								
	3.								
	4.						min.		
MICRO ETCH	1.								
	2.								
	3.								
	4.						min.		
PRE-DIP	1.								
	2.								
	3.								
	4.						min.		
ACTIVATOR/ CATALYST	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key

[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key

[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

4.7 Chemical Bath Additions- CONTINUED

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
ACCELERATOR	1.								
	2.								
	3.								
	4.						min.		
ELECTROLESS COPPER	1.								
	2.								
	3.								
	4.						min.		
REDUCER/ NEUTRALIZER	1.								
	2.								
	3.								
	4.						min.		
ANTI-TARNISH/ ANTI-OXIDANT	1.								
	2.								
	3.								
	4.								
OTHER (specify)	1.								
	2.								
	3.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key
[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key
[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

4.8 Chemical Handling Activities: Chemical Additions

Complete the following table by indicating the methods your facility uses while performing chemical additions.

ACTIVITY	OPTIONS	
Chemical Retrieval from Stock into Container	Pump:	
	Pour:	
	Scoop (solid):	
	Other (specify):	
Container	Open-top container:	
	Closed-top container:	
	Safety container:	
	Other (specify):	
Method of Chemical Addition	Pour directly into tank:	
	Stir into tank:	
	Pour into automated chemical addition system:	
	Other (specify):	

4.9 Other Bath Related Activities

Complete the following table for any other bath related activities that your facility engages in.

BATH TYPE	TYPE OF ACTIVITY (describe)	FREQUENCY[a]	DURATION OF ACTIVITY[b]	NUMBER OF PEOPLE	PROTECTIVE EQUIPMENT[c]
CLEANER/ CONDITIONER					
MICRO ETCH					
PRE-DIP					
ACTIVATOR/ CATALYST					
ACCELERATOR					
ELECTROLESS COPPER					
REDUCER/ NEUTRALIZER					
ANTI-TARNISH/ ANTI-OXIDANT					
OTHER (specify)					

[a] Frequency- Enter the average amount of time elapsed or number of panel sq. ft. processed since the last time the activity was performed. Clearly specify units (e.g., hours, square feet, etc.)

[b] Duration of Activity- Enter the average time for performing the specified activity. Clearly specify units.

[c] Personal Protect. Equip.- Consult key on the previous page and enter the letters for all protective equipment worn by the people performing the activity.

Section 5. Graphite-Based Process

The information requested below will allow us to generate an exposure assessment and risk characterization profile for each of the following baths and the associated activities involved in the operation and upkeep of the graphite-based process.

NOTE: You need to complete this section only if your facility uses a graphite-based process for making the holes conductive during the PWB manufacturing process.

5.1 Physical, Process, and Operating Conditions

Complete the table below by entering the data requested for each specific type of chemical bath listed. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH	PHYSICAL DATA			PROCESSING DATA		OPERATING CONDITIONS		
	LENGTH (inches)	WIDTH (inches)	NOMINAL VOLUME	IMMERSION [a] (seconds)	DRIP TIME [b] (seconds)	TEMP °F	AGITATION [c]	VAPOR CONTROL [d]
CLEANER/ CONDITIONER	in.	in.	gal.	sec.	sec.	°F		
GRAPHITE	in.	in.	gal.	sec.	sec.	°F		
FIXER	in.	in.	gal.	sec.	sec.	°F		
POST-CLEAN ETCH	in.	in.	gal.	sec.	sec.	°F		
ANTI-TARNISH/ ANTI-OXIDANT	in.	in.	gal.	sec.	sec.	°F		
OTHER(specify)	in.	in.	gal.	sec.	sec.	°F		

[a] Immersion Time- Enter the average elapsed time a rack of panels is immersed in the specific process bath.
[b] Drip Time- Enter the average elapsed time that a rack of panels is allowed to hang above the specific bath to allow chemical drainage from panels.
[c] Agitation - Consult the key at right and enter the letter for the agitation method used in the specific chemical bath.
[d] Vapor Control- Consult key at right and enter the letter of the vapor control method used for that specific chemical bath.

Agitation Methods Key
[P]— Panel Agitation
[F]— Fluid Circulation Pump
[A]— Air Sparge
[O]— Other (explain)

Vapor Control Methods Key
[P]— Push-Pull
[C]— Bath Cover (when not in use)
[B]— Plastic Balls (floating)
[E]— Fully Enclosed
[O]— Other (explain)

AIR KNIFE/OVEN PROCESS STEP	
Air pressure:	psi.
Air temperature:	oF
Processing time per panel:	min.
Contained unit (circle one):	Yes No

5.2 Initial Chemical Bath Make-Up Composition

Complete the chart below for each chemical component of the bath type listed. Provide the manufacturer name if the chemical used is known only by trade name. If more room is needed, please attach another sheet with the additional information. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED [c] (gallons)
CLEANER/ CONDITIONER	1.					
	2.					
	3.					
	4.					
GRAHITE	1.					
	2.					
	3.					
	4.					
FIXER	1.					
	2.					
	3.					
	4.					
POST-CLEAN ETCH	1.					
	2.					
	3.					
	4.					
ANTI-TARNISH/ ANTI-OXIDANT	1.					
	2.					
	3.					
	4.					
OTHER (specify)	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

5.3 Chemical Bath Replacement

Complete the chart below by providing information on the process of replacing, treating, and disposing of a spent chemical bath.

Bath Type	Criteria for Replacement[a]	Frequency[b]	Duration of Replacement Procedure[c]	Number of People	Personal Protective Equipment[d]	On-Site Method of Treatment or Disposal [e]	Annual Volume Treated or Disposed [f]	Off-Site Method of Treatment or Disposal [e]
Cleaner/ Conditioner								
Graphite								
Fixer								
Post-Clean Etch								
Anti-Tarnish/ Anti-Oxidant								
Other (specify)								

[a] Criteria for Replacement- Consult the key at right and enter the letter for the criteria typically used to determine when bath replacement is necessary.

[b] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[c] Duration of Replacement- Enter the elapsed time from the beginning of bath removal until the replacement bath is finished.

[d] Personal Protective Equip.- Consult key at right and enter the letters of all the protective equipment worn by the workers physically replacing the spent bath.

[e] Methods of Treat. or Disp.- Consult keys at right and enter the letter of the method used.

[f] Annual Vol. Treat. or Disp.- Enter the yearly amount of the specific bath treated or disposed.

On-Site Method of Treatment or Disposal
[P]— Precipitation Pretreatment on-site
[N]— PH Neutralization Pretreatment on-site
[S]— Disposed directly to sewer with no treatment
[D]— Drummed for off-site treatment or disposal
[R]— Recycled on-site
[O]— Other (specify)

Off-Site Method of Treatment or Disposal
[R]— Sent to Recycle
[P]— Discharged to POTW
[O]— Other (specify)

Criteria for Bath Replacement
[S]— Statistical process control [T]— Time
[P]— Panel Sq.Ft. processed [O]— Other (specify)
[C]— Chemical testing

Personal Protective Equipment
[E]— Eye protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

5.4 Chemical Handling Activities:Chemical Bath Replacement

Complete the table below by indicating the options your facility uses to replace each type of spent chemical bath. If the same options are used to replace each of the various chemical baths, enter 'ALL' as the type of bath and fill out only one table. Otherwise, please photocopy and attach additional charts, as necessary.

TYPES OF BATHS*	

REMOVAL OF SPENT BATH			CLEANING OF EQUIPMENT		NEW BATH MAKE-UP		
Method of Removing Spent Bath	Pump:		Tank Cleaning Method	Chemical Flush:	Chemical Retrieval from	Pump:	
	Siphon :			Hand Scrub:	Stock into Container	Pour:	
	Drain/ Spigot:			Other (specify):		Scoop (solid):	
	Other (specify):					Other (specify):	
Remove Spent Bath	Directly to Wastewater Treatment:		CHEMICALS USED IN CHEMICAL FLUSH		Container Type	Open-top container:	
	Directly to sewer:		Chemical	Gallons Per Year		Closed-top container:	
	To open-top container:					Safety container:	
	To closed-top container:					Other (specify):	

* Types of Baths- Enter the types of baths where the activities are used. If the chemical handling activities are the same for each bath type, enter 'ALL'.

5.5 Chemical Bath Sampling

Provide information on the chemical bath sampling procedures used in your facility. Duration of sampling and personnel involved should include only the portion of the testing procedure involving the manual sampling of the chemical baths, not automated sampling or the testing that may occur in another part of the facility, such as the lab.

BATH TYPE	TYPE OF SAMPLING [a]	FREQUENCY[b]	DURATION OF SAMPLING [c]	NUMBER OF PEOPLE [d]	PROTECTIVE EQUIPMENT [e]
CLEANER/ CONDITIONER			min.		
GRAPHITE			min.		
FIXER			min.		
POST-CLEAN ETCH			min.		
ANTI-TARNISH/ ANTI-OXIDANT			min.		
OTHER (specify)			min.		

[a] **Type of Sampling**- Consult the key at right and enter the letter for the type of sampling performed on the specific chemical bath.

[b] **Frequency**- Enter the average amount of time elapsed or number of panel sq. ft. processed between samples. Clearly specify units (e.g., hours, square feet, etc.)

[c] **Duration of Sampling**- Enter the average time for manually taking a sample from the specific chemical tank. Consider only time spent at the chemical bath.

[d] **Number of People**- Enter the number of people actually involved in manually taking the chemical samples. Exclude people doing the testing but not the sampling.

[e] **Personal Protect. Equip.**- Consult key at right and enter the letters for <u>all</u> protective equipment worn by the people performing the chemical sampling.

<u>Type of Sampling Key</u>

[A]— Automated Sampling [B]— Both
[M]— Manual Sampling [N]— None

<u>Personal Protective Equipment Key</u>

[E]— Eye Protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory Protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

5.6 Chemical Handling Activities:Chemical Sampling

Complete the table below by indicating what method your facility uses to manually collect bath samples and the type of container used.

Method of Obtaining Samples	Drain/Spigot:	
	Pipette:	
	Ladle:	
	Other (Specify):	
Chemical Sample Container	Open-top container:	
	Closed-top container:	

5.7 Chemical Bath Additions

Complete the following chart detailing the typical chemical additions that are made to maintain the chemical balance of each specific process baths. If more than four chemicals are added to a specific bath, attach another sheet with the additional information. If chemical additions to a bath are made automatically, do not complete the last three columns for that bath. If two tanks of the same type are used within the process, list the data for a single tank only.

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
CLEANER/ CONDITIONER	1.								
	2.								
	3.								
	4.						min.		
GRAPHITE	1.								
	2.								
	3.								
	4.						min.		
FIXER	1.								
	2.								
	3.								
	4.						min.		
POST-CLEAN ETCH	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key

[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key

[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

5.7 Chemical Bath Additions- CONTINUED

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
ANTI-TARNISH/ ANTI-OXIDANT	1.								
	2.								
	3.								
	4.						min.		
OTHER (specify)	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key
[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key
[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

5.8 Chemical Handling Activities: Chemical Additions

Complete the following table by indicating the methods your facility uses while performing chemical additions.

ACTIVITY	OPTIONS	
Chemical Retrieval from Stock into Container	Pump:	
	Pour:	
	Scoop (solid):	
	Other (specify):	
Container	Open-top container:	
	Closed-top container:	
	Safety container:	
	Other (specify):	
Method of Chemical Addition	Pour directly into tank:	
	Stir into tank:	
	Pour into automated chemical addition system:	
	Other (specify):	

5.9 Other Bath Related Activities

Complete the following table for any other bath related activities that your facility engages in.

BATH TYPE	TYPE OF ACTIVITY (describe)	FREQUENCY[a]	DURATION OF ACTIVITY[b]	NUMBER OF PEOPLE	PROTECTIVE EQUIPMENT[c]
CLEANER/ CONDITIONER					
GRAPHITE					
FIXER					
POST-CLEAN ETCH					
ANTI-TARNISH/ ANTI-OXIDANT					
OTHER (specify)					

[a] Frequency- Enter the average amount of time elapsed or number of panel sq. ft. processed since the last time the activity was performed. Clearly specify units (e.g., hours, square feet, etc.)

[b] Duration of Activity- Enter the average time for performing the specified activity. Clearly specify units.

[c] Personal Protect. Equip.- Consult key on the previous page and enter the letters for all protective equipment worn by the people performing the activity.

Section 6. Carbon-Based Process

The information requested below will allow us to generate an exposure assessment and risk characterization profile for each of the following baths and the associated activities involved in the operation and upkeep of the carbon-based process.

NOTE: You need to complete this section only if your facility uses a carbon-based process for making the holes conductive during the PWB manufacturing process.

6.1 Physical, Process, and Operating Conditions

Complete the table below by entering the data requested for each specific type of chemical bath listed. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH	PHYSICAL DATA			PROCESSING DATA		OPERATING CONDITIONS		
	LENGTH (inches)	WIDTH (inches)	NOMINAL VOLUME	IMMERSION [a] (seconds)	DRIP TIME [b] (seconds)	TEMP °F	AGITATION [c]	VAPOR CONTROL [d]
CLEANER	in.	in.	gal.	sec.	sec.	°F		
CONDITIONER	in.	in.	gal.	sec.	sec.	°F		
CARBON	in.	in.	gal.	sec.	sec.	°F		
POST-CLEAN ETCH	in.	in.	gal.	sec.	sec.	°F		
ANTI-TARNISH/ ANTI-OXIDANT	in.	in.	gal.	sec.	sec.	°F		
OTHER(specify)	in.	in.	gal.	sec.	sec.	°F		

[a] Immersion Time- Enter the average elapsed time a rack of panels is immersed in the specific process bath.
[b] Drip Time- Enter the average elapsed time that a rack of panels is allowed to hang above the specific bath to allow chemical drainage from panels.
[c] Agitation - Consult the key at right and enter the letter for the agitation method used in the specific chemical bath.
[d] Vapor Control- Consult key at right and enter the letter of the vapor control method used for that specific chemical bath.

Agitation Methods Key
[P]— Panel Agitation
[F]— Fluid Circulation Pump
[A]— Air Sparge
[O]— Other (explain)

Vapor Control Methods Key
[P]— Push-Pull
[C]— Bath Cover (when not in use)
[B]— Plastic Balls (floating)
[E]— Fully Enclosed
[O]— Other (explain)

AIR KNIFE/OVEN PROCESS STEP	
Air pressure:	psi.
Air temperature:	oF
Processing time per panel:	min.
Contained unit (circle one):	Yes No

6.2 Initial Chemical Bath Make-Up Composition

Complete the chart below for each chemical component of the bath type listed. Provide the manufacturer name if the chemical used is known only by trade name. If more room is needed, please attach another sheet with the additional information. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED [c] (gallons)
CLEANER	1.					
	2.					
	3.					
	4.					
CONDITIONER	1.					
	2.					
	3.					
	4.					
CARBON	1.					
	2.					
	3.					
	4.					
POST-CLEAN ETCH	1.					
	2.					
	3.					
	4.					
ANTI-TARNISH/ ANTI-OXIDANT	1.					
	2.					
	3.					
	4.					
OTHER (specify)	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

6.3 Chemical Bath Replacement

Complete the chart below by providing information on the process of replacing, treating, and disposing of a spent chemical bath.

Bath Type	Criteria for Replacement[a]	Frequency[b]	Duration of Replacement Procedure[c]	Number of People	Personal Protective Equipment[d]	On-Site Method of Treatment or Disposal [e]	Annual Volume Treated or Disposed [f]	Off-Site Method of Treatment or Disposal [e]
Cleaner								
Conditioner								
Carbon								
Post-Clean Etch								
Anti-Tarnish/ Anti-Oxidant								
Other (specify)								

[a] Criteria for Replacement- Consult the key at right and enter the letter for the criteria typically used to determine when bath replacement is necessary.

[b] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[c] Duration of Replacement- Enter the elapsed time from the beginning of bath removal until the replacement bath is finished.

[d] Personal Protective Equip.- Consult key at right and enter the letters of all the protective equipment worn by the workers physically replacing the spent bath.

[e] Methods of Treat. or Disp.- Consult keys at right and enter the letter of the method used.

[f] Annual Vol. Treat. or Disp.- Enter the yearly amount of the specific bath treated or disposed.

On-Site Method of Treatment or Disposal
[P]— Precipitation Pretreatment on-site
[N]— PH Neutralization Pretreatment on-site
[S]— Disposed directly to sewer with no treatment
[D]— Drummed for off-site treatment or disposal
[R]— Recycled on-site
[O]— Other (specify)

Off-Site Method of Treatment or Disposal
[R]— Sent to Recycle
[P]— Discharged to POTW
[O]— Other (specify)

Criteria for Bath Replacement
[S]— Statistical process control [T]— Time
[P]— Panel Sq.Ft. processed [O]— Other (specify)
[C]— Chemical testing

Personal Protective Equipment
[E]— Eye protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

6.4 Chemical Handling Activities: Chemical Bath Replacement

Complete the table below by indicating the options your facility uses to replace each type of spent chemical bath. If the same options are used to replace each of the various chemical baths, enter 'ALL' as the type of bath and fill out only one table. Otherwise, please photocopy and attach additional charts, as necessary.

TYPES OF BATHS *	

REMOVAL OF SPENT BATH			CLEANING OF EQUIPMENT			NEW BATH MAKE-UP		
Method of Removing Spent Bath	Pump:		Tank Cleaning Method	Chemical Flush:		Chemical Retrieval from	Pump:	
	Siphon :			Hand Scrub:		Stock into Container	Pour:	
	Drain/ Spigot:			Other (specify):			Scoop (solid):	
	Other (specify):						Other (specify):	
Remove Spent Bath	Directly to Wastewater Treatment:		CHEMICALS USED IN CHEMICAL FLUSH			Container Type	Open-top container:	
	Directly to sewer:		Chemical	Gallons Per Year			Closed-top container:	
	To open-top container:						Safety container:	
	To closed-top container:						Other (specify):	

* Types of Baths- Enter the types of baths where the activities are used. If the chemical handling activities are the same for each bath type, enter 'ALL'.

6.5 Chemical Bath Sampling

Provide information on the chemical bath sampling procedures used in your facility. Duration of sampling and personnel involved should include only the portion of the testing procedure involving the manual sampling of the chemical baths, not automated sampling or the testing that may occur in another part of the facility, such as the lab.

BATH TYPE	TYPE OF SAMPLING [a]	FREQUENCY[b]	DURATION OF SAMPLING [c]	NUMBER OF PEOPLE [d]	PROTECTIVE EQUIPMENT [e]
CLEANER			min.		
CONDITIONER			min.		
CARBON			min.		
POST-CLEAN ETCH			min.		
ANTI-TARNISH/ ANTI-OXIDANT			min.		
OTHER (specify)			min.		

[a] **Type of Sampling**- Consult the key at right and enter the letter for the type of sampling performed on the specific chemical bath.

[b] **Frequency**- Enter the average amount of time elapsed or number of panel sq. ft. processed between samples. Clearly specify units (e.g., hours, square feet, etc.)

[c] **Duration of Sampling**- Enter the average time for manually taking a sample from the specific chemical tank. Consider only time spent at the chemical bath.

[d] **Number of People**- Enter the number of people actually involved in manually taking the chemical samples. Exclude people doing the testing but not the sampling.

[e] **Personal Protect. Equip.**- Consult key at right and enter the letters for all protective equipment worn by the people performing the chemical sampling.

Type of Sampling Key

[A]— Automated Sampling [B]— Both
[M]— Manual Sampling [N]— None

Personal Protective Equipment Key

[E]— Eye Protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory Protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

6.6 Chemical Handling Activities:Chemical Sampling

Complete the table below by indicating what method your facility uses to manually collect bath samples and the type of container used.

Method of Obtaining Samples	Drain/Spigot:	
	Pipette:	
	Ladle:	
	Other (Specify):	
Chemical Sample Container	Open-top container:	
	Closed-top container:	

6.7 Chemical Bath Additions

Complete the following chart detailing the typical chemical additions that are made to maintain the chemical balance of each specific process baths. If more than four chemicals are added to a specific bath, attach another sheet with the additional information. If chemical additions to a bath are made automatically, do not complete the last three columns for that bath. If two tanks of the same type are used within the process, list the data for a single tank only.

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
CLEANER	1.								
	2.								
	3.								
	4.						min.		
CONDITIONER	1.								
	2.								
	3.								
	4.						min.		
CARBON	1.								
	2.								
	3.								
	4.						min.		
POST-CLEAN ETCH	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key

[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key

[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

6.7 Chemical Bath Additions- CONTINUED

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
ANTI-TARNISH/ ANTI-OXIDANT	1.								
	2.								
	3.								
	4.						min.		
OTHER (specify)	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key
[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key
[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

6.8 Chemical Handling Activities: Chemical Additions

Complete the following table by indicating the methods your facility uses while performing chemical additions.

ACTIVITY	OPTIONS	
Chemical Retrieval from Stock into Container	Pump:	
	Pour:	
	Scoop (solid):	
	Other (specify):	
Container	Open-top container:	
	Closed-top container:	
	Safety container:	
	Other (specify):	
Method of Chemical Addition	Pour directly into tank:	
	Stir into tank:	
	Pour into automated chemical addition system:	
	Other (specify):	

6.9 Other Bath Related Activities

Complete the following table for any other bath related activities that your facility engages in.

BATH TYPE	TYPE OF ACTIVITY (describe)	FREQUENCY[a]	DURATION OF ACTIVITY[b]	NUMBER OF PEOPLE	PROTECTIVE EQUIPMENT[c]
CLEANER					
CONDITIONER					
CARBON					
POST-CLEAN ETCH					
ANTI-TARNISH/ ANTI-OXIDANT					
OTHER (specify)					

[a] Frequency- Enter the average amount of time elapsed or number of panel sq. ft. processed since the last time the activity was performed. Clearly specify units (e.g., hours, square feet, etc.)

[b] Duration of Activity- Enter the average time for performing the specified activity. Clearly specify units.

[c] Personal Protect. Equip.- Consult key on the previous page and enter the letters for all protective equipment worn by the people performing the activity.

Section 7. Palladium-Based Process

The information requested below will allow us to generate an exposure assessment and risk characterization profile for each of the following baths and the associated activities involved in the operation and upkeep of the palladium-based process.

NOTE: You need to complete this section only if your facility uses a **palladium-based** process for making the holes conductive during the PWB manufacturing process.

7.1 Physical, Process, and Operating Conditions

Complete the table below by entering the data requested for each specific type of chemical bath listed. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH	PHYSICAL DATA			PROCESSING DATA		OPERATING CONDITIONS		
	LENGTH (inches)	WIDTH (inches)	NOMINAL VOLUME	IMMERSION [a] (seconds)	DRIP TIME [b] (seconds)	TEMP °F	AGITATION [c]	VAPOR CONTROL [d]
CLEANER/ CONDITIONER	in.	in.	gal.	sec.	sec.	°F		
PRE-DIP	in.	in.	gal.	sec.	sec.	°F		
CATALYST	in.	in.	gal.	sec.	sec.	°F		
ACCELERATOR	in.	in.	gal.	sec.	sec.	°F		
ENHANCER	in.	in.	gal.	sec.	sec.	°F		
POST-CLEAN ETCH	in.	in.	gal.	sec.	sec.	°F		
ANTI-TARNISH/ ANTI-OXIDANT	in.	in.	gal.	sec.	sec.	°F		
OTHER(specify)	in.	in.	gal.	sec.	sec.	°F		

[a] Immersion Time- Enter the average elapsed time a rack of panels is immersed in the specific process bath.

[b] Drip Time- Enter the average elapsed time that a rack of panels is allowed to hang above the specific bath to allow chemical drainage from panels.

[c] Agitation - Consult the key at right and enter the letter for the agitation method used in the specific chemical bath.

[d] Vapor Control- Consult key at right and enter the letter of the vapor control method used for that specific chemical bath.

Agitation Methods Key
[P]— Panel Agitation
[F]— Fluid Circulation Pump
[A]— Air Sparge
[O]— Other (explain)

Vapor Control Methods Key
[P]— Push-Pull
[C]— Bath Cover (when not in use)
[B]— Plastic Balls (floating)
[E]— Fully Enclosed
[O]— Other (explain)

HIGH PRESSURE WATER RINSE	
Water pressure:	psi.
Water flow rate per day:	gal.
Processing time per panel:	min.
Contained unit (circle one):	Yes No

7.2 Initial Chemical Bath Make-Up Composition

Complete the chart below for each chemical component of the bath type listed. Provide the manufacturer name if the chemical used is known only by trade name. If more room is needed, please attach another sheet with the additional information. If two tanks of the same type are used within the process, list the data for a single tank only.

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED [c] (gallons)
CLEANER/ CONDITIONER	1.					
	2.					
	3.					
	4.					
PRE-DIP	1.					
	2.					
	3.					
	4.					
PALLADIUM CATALYST	1.					
	2.					
	3.					
	4.					
ACCELERATOR	1.					
	2.					
	3.					
	4.					
ENHANCER	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

7.2 Initial Chemical Bath Make-Up Composition- CONTINUED

BATH		CHEMICAL NAME	MANUFACTURER (if applicable)	WORKING VOLUME [a] (gallons)	CONCEN-TRATION [b]	ANNUAL QTY. USED[c] (gallons)
POST-CLEAN	1.					
ETCH	2.					
	3.					
	4.					
ANTI-TARNISH/	1.					
ANTI-OXIDANT	2.					
	3.					
	4.					
OTHER (specify)	1.					
	2.					
	3.					
	4.					

[a] Working Volume- Enter the volume of the chemical used in the initial make-up of the bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration - Enter the concentration of the chemical in the working volume and specify units (e.g. molarity, grams/litre, etc.) of the chemical used.

[c] Annual Quantity Used- If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

7.3 Chemical Bath Replacement

Complete the chart below by providing information on the process of replacing, treating, and disposing of a spent chemical bath.

Bath Type	Criteria for Replacement[a]	Frequency[b]	Duration of Replacement Procedure[c]	Number of People	Personal Protective Equipment[d]	On-Site Method of Treatment or Disposal [e]	Annual Volume Treated or Disposed [f]	Off-Site Method of Treatment or Disposal [e]
Cleaner/ Conditioner								
Pre-Dip								
Palladium Catalyst								
Accelerator								
Enhancer								
Post-Clean Etch								
Anti-Tarnish/ Anti-Oxidant								
Other (specify)								

[a] Criteria for Replacement- Consult the key at right and enter the letter for the criteria typically used to determine when bath replacement is necessary.

[b] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[c] Duration of Replacement- Enter the elapsed time from the beginning of bath removal until the replacement bath is finished.

[d] Personal Protective Equip.- Consult key at right and enter the letters of all the protective equipment worn by the workers physically replacing the spent bath.

[e] Methods of Treat. or Disp.- Consult keys at right and enter the letter of the method used.

[f] Annual Vol. Treat. or Disp.- Enter the yearly amount of the specific bath treated or disposed.

On-Site Method of Treatment or Disposal
[P]— Precipitation Pretreatment on-site
[N]— PH Neutralization Pretreatment on-site
[S]— Disposed directly to sewer with no treatment
[D]— Drummed for off-site treatment or disposal
[R]— Recycled on-site
[O]— Other (specify)

Off-Site Method of Treatment or Disposal
[R]— Sent to Recycle
[P]— Discharged to POTW
[O]— Other (specify)

Criteria for Bath Replacement
[S]— Statistical process control [T]— Time
[P]— Panel Sq.Ft. processed [O]— Other (specify)
[C]— Chemical testing

Personal Protective Equipment
[E]— Eye protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

7.4 Chemical Handling Activities: Chemical Bath Replacement

Complete the table below by indicating the options your facility uses to replace each type of spent chemical bath. If the same options are used to replace each of the various chemical baths, enter 'ALL' as the type of bath and fill out only one table. Otherwise, please photocopy and attach additional charts, as necessary.

TYPES OF BATHS*	

REMOVAL OF SPENT BATH			CLEANING OF EQUIPMENT			NEW BATH MAKE-UP		
Method of Removing Spent Bath	Pump:		Tank Cleaning Method	Chemical Flush:		Chemical Retrieval from	Pump:	
	Siphon :			Hand Scrub:		Stock into Container	Pour:	
	Drain/ Spigot:			Other (specify):			Scoop (solid):	
	Other (specify):						Other (specify):	
Remove Spent Bath	Directly to Wastewater Treatment:		CHEMICALS USED IN CHEMICAL FLUSH			Container Type	Open-top container:	
	Directly to sewer:		Chemical	Gallons Per Year			Closed-top container:	
	To open-top container:						Safety container:	
	To closed-top container:						Other (specify):	

* Types of Baths- Enter the types of baths where the activities are used. If the chemical handling activities are the same for each bath type, enter 'ALL'.

7.5 Chemical Bath Sampling

Provide information on the chemical bath sampling procedures used in your facility. Duration of sampling and personnel involved should include only the portion of the testing procedure involving the manual sampling of the chemical baths, not automated sampling or the testing that may occur in another part of the facility, such as the lab.

BATH TYPE	TYPE OF SAMPLING [a]	FREQUENCY[b]	DURATION OF SAMPLING [c]	NUMBER OF PEOPLE [d]	PROTECTIVE EQUIPMENT [e]
CLEANER/ CONDITIONER			min.		
PRE-DIP			min.		
PALLADIUM CATALYST			min.		
ACCELERATOR			min.		
ENHANCER			min.		
POST-CLEAN ETCH			min.		
ANTI-TARNISH/ ANTI-OXIDANT			min.		
OTHER (specify)			min.		

[a] Type of Sampling- Consult the key at right and enter the letter for the type of sampling performed on the specific chemical bath.

[b] Frequency- Enter the average amount of time elapsed or number of panel sq. ft. processed between samples. Clearly specify units (e.g., hours, square feet, etc.)

[c] Duration of Sampling- Enter the average time for manually taking a sample from the specific chemical tank. Consider only time spent at the chemical bath.

[d] Number of People- Enter the number of people actually involved in manually taking the chemical samples. Exclude people doing the testing but not the sampling.

[e] Personal Protect. Equip.- Consult key at right and enter the letters for all protective equipment worn by the people performing the chemical sampling.

Type of Sampling Key

[A]— Automated Sampling [B]— Both
[M]— Manual Sampling [N]— None

Personal Protective Equipment Key

[E]— Eye Protection [G]— Gloves
[L]— Labcoat/Sleeved garment [A]— Apron
[R]— Respiratory Protection [B]— Boots
[Z]— All except Respiratory Protection [N]— None

7.6 Chemical Handling Activities:Chemical Sampling

Complete the table below by indicating what method your facility uses to manually collect bath samples and the type of container used.

Method of Obtaining Samples	Drain/Spigot:	
	Pipette:	
	Ladle:	
	Other (Specify):	
Chemical Sample Container	Open-top container:	
	Closed-top container:	

7.7 Chemical Bath Additions

Complete the following chart detailing the typical chemical additions that are made to maintain the chemical balance of each specific process baths. If more than four chemicals are added to a specific bath, attach another sheet with the additional information. If chemical additions to a bath are made automatically, do not complete the last three columns for that bath. If two tanks of the same type are used within the process, list the data for a single tank only.

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
CLEANER/ CONDITIONER	1.								
	2.								
	3.								
	4.						min.		
PRE-DIP	1.								
	2.								
	3.								
	4.						min.		
PALLADIUM CATALYST	1.								
	2.								
	3.								
	4.						min.		
ACCELERATOR	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key

[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key

[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

7.7 Chemical Bath Additions- CONTINUED

Bath Type		Chemical Added	Average Volume Added [a]	Concentration [b]	Frequency [c]	Chemical Addition Method [d]	Duration of Addition [e] (minutes)	Number of People	Personal Protective Equipment [f]
ENHANCER	1.								
	2.								
	3.								
	4.						min.		
POST-CLEAN ETCH	1.								
	2.								
	3.								
	4.						min.		
ANTI-TARNISH/ ANTI-OXIDANT	1.								
	2.								
	3.								
	4.						min.		
OTHER (specify)	1.								
	2.								
	3.								
	4.						min.		

[a] Average Volume Added- Enter the average volume in gallons of each chemical added to maintain the specific bath. If the amount of a particular chemical used is measured by weight (i.e., crystalline chemicals) instead of volume, enter the weight in pounds and clearly specify the units (Lbs).

[b] Concentration- Enter the concentration (e.g. molarity, volume %, grams/litre, etc.) of the chemical in the volume being added.

[c] Frequency- Enter the average amount of time elapsed or number of square feet processed between bath replacements. Clearly specify units (e.g., hours, sq.ft., etc.).

[d] Chemical Addition Method- Consult key at right and enter the appropriate letter for the method used for that specific bath.

[e] Duration of Addition- Enter the average elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals.

[f] Personal Protective Equipment- Consult key at right and enter the letters for all of the protective equipment worn by the people physically making the addition.

Chemical Addition Method Key
[A]— Automatic*
[M]— Manual

* If additions are automatic [A] then do not complete the last 3 columns.

Personal Protective Equipment Key
[E]— Eye protection
[L]— Labcoat/Sleeved garment
[R]— Respiratory protection
[Z]— All except Respiratory Protection
[G]— Gloves
[A]— Apron
[B]— Boots
[N]— None

7.8 Chemical Handling Activities: Chemical Additions

Complete the following table by indicating the methods your facility uses while performing chemical additions.

ACTIVITY	OPTIONS	
Chemical Retrieval from Stock into Container	Pump:	
	Pour:	
	Scoop (solid):	
	Other (specify):	
Container	Open-top container:	
	Closed-top container:	
	Safety container:	
	Other (specify):	
Method of Chemical Addition	Pour directly into tank:	
	Stir into tank:	
	Pour into automated chemical addition system:	
	Other (specify):	

7.9 Other Bath Related Activities

Complete the following table for any other bath related activities that your facility engages in.

BATH TYPE	TYPE OF ACTIVITY (describe)	FREQUENCY[a]	DURATION OF ACTIVITY[b]	NUMBER OF PEOPLE	PROTECTIVE EQUIPMENT[c]
CLEANER/ CONDITIONER					
PRE-DIP					
PALLADIUM CATALYST					
ACCELERATOR					
ENHANCER					
POST-CLEAN ETCH					
ANTI-TARNISH/ ANTI-OXIDANT					
OTHER (specify)					

[a] Frequency- Enter the average amount of time elapsed or number of panel sq. ft. processed since the last time the activity was performed. Clearly specify units (e.g., hours, square feet, etc.)

[b] Duration of Activity- Enter the average time for performing the specified activity. Clearly specify units.

[c] Personal Protect. Equip.- Consult key on the previous page and enter the letters for all protective equipment worn by the people performing the activity.

Definitions and Abbreviations

Direct discharge	Wastewater discharge directly to a stream or river
Indirect discharge	Wastewater discharge to a publicly owned treatment works (POTW)
Zero discharge	No industrial wastewater discharge

Cu	copper
cu.ft.	cubic feet
DfE	Design for the Environment
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
ft.	feet
gal.	gallons
gal./day	gallons per day
gpm	gallons per minute
hrs.	hours
lbs.	pounds
MHC	making holes conductive
min.	minutes
mg/l	milligrams per liter
OEM	Original equipment manufacturer
Pd	palladium
PWB	printed wiring board
sec.	seconds
sq. ft.	square feet
sq. in.	square inch
Sn	tin
TDS	Total dissolved solids
TSS	Total suspended solids
TTO	Total toxic organics
yr.	year