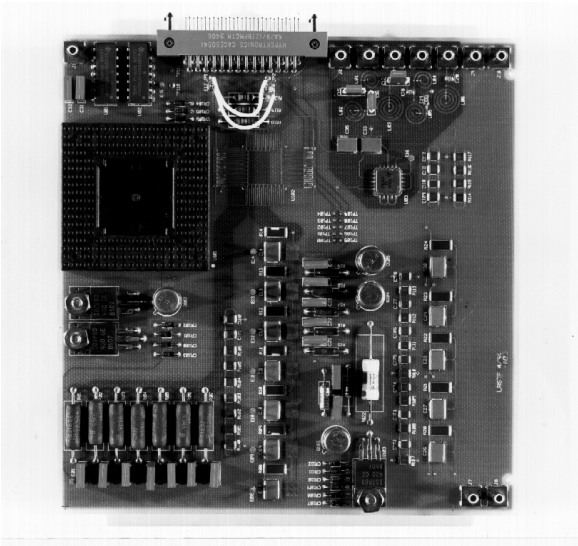
Printed Wiring Board
Surface Finishes



DRAFT
Cleaner Technologies Substitutes Assessment

VOLUME 2: Appendices

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and the
PWB Engineering Support Team

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Appendix A

Data Collection Sheets

Contents

Workplace Practices Questionnaire A-1

Facility Background Information Sheet A-58

Observer Data Sheet A-67

Supplier Data Sheet A-74

Design for the Environment

Printed Wiring Board Project
Workplace Practices Questionnaire

Please complete this questionnaire, make a copy for your records, and send the original to:

Jack Geibig
UT Center for Clean Products
311 Conference Center Building
Knoxville TN 37996
Phone: (423) 974-6513
Fax: (423) 974-1838

FACILITY AND CONTACT INFORMATION

Facility Identification

Company Name:					
Site Name:					
Street Address:					
City:		State:		Zip:	

Contact Identification Enter the names of the persons who can be contacted regarding this survey.

Name:		
Title:		
Phone:		
Fax:		
E-Mail:		

—INSTRUCTION SHEET—

FOR THE DESIGN FOR THE ENVIRONMENT (DFE) ALTERNATIVE SURFACE FINISHES (ASF) PROJECT

WORKPLACE PRACTICES QUESTIONNAIRE

INTRODUCTION
This questionnaire was prepared by the University of Tennessee Center for Clean Products and Clean Technologies in partnership with The US EPA Design for the Environment (DfE) Printed Wiring Board (PWB) Program, IPC, and other members of the DfE PWB Industry Project Work Groups.

The purpose of this questionnaire is to collect data that will be used in preparation of a Design for the Environment (DfE) Alterative Surface Technologies report. This report will present an analysis and evaluation of the risk, performance, and costs associated with operating each of the alternative surface finish processes. Much of this report will be based on data submitted by PWB manufacturing facilities. You can obtain more information about this project and other DfE PWB projects from the US EPA's website at http://www.epa.gov/opptintr/dfe/pwb/pwb.html).

CONFIDENTIALITY
All information and data that is entered into this questionnaire is confidential. The sources of responses are only known to the IPC and have been coded by the IPC for industry research purposes. Any use or publication of the data will not identify the names or locations of the respondent companies or the individuals completing the forms.

INSTRUCTIONS

Respondents must complete Sections 1 (Facility Characterization) and Section 2 (HASL Process) of this questionnaire.

Section 3 is divided into five processes (3A through 3E) as shown below:

3A. Organic Solder Preservative (OSP) Process
3B. Immersion Silver Process
3C. Immersion Tin Process
3D. Electroless Nickel/Immersion Gold Process
3E. Electroless Nickel/Electroless Palladium/Immersion Gold Process

Of these five subsections, 3A-3E, please fill out only the top two alternative processes, based on PWB through-put, that are currently being implemented at your facility.

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.

Please make a copy of the completed sections and retain them for your records.

If you have questions regarding the survey, please contact Jack Geibig of the University of Tennessee Center for Clean Products and Clean Technologies at (telephone 423/975-6513; fax 423/974-1838; email jgeibig@utk.edu) or Star Summerfield at IPC (telephone 847/790-5347; fax 847/509-9798; email summst@ipc.org).

Please return the completed questionnaire by January 8, 1999 to:
Star Summerfield, IPC
2215 Sanders Road, Northbrook, IL 60062-6135
Phone: 847/790-5347, FAX 847/509-9798, email summst@ipc.org

A RETURN LABEL TO IPC IS ENCLOSED FOR YOUR CONVENIENCE.

Section 1. Facility Characterization

This section focuses on general information specific to the facility. This information is not process-specific. Please estimate manufacturing data for the previous 12 month period, or other convenient time period of 12 consecutive months (e.g., FY97). 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 PWBs:	sq. ft.	Overall amount of PWB produced in surface square feet (ssf):	ssf/yr

1.2 Process Type

Estimate the percentage of PWBs manufactured at your facility using the following methods for surface finishing (SF). Specify "other" entry.

Surface Finish Process	Percent of Total	Surface Finish Process	Percent of Total
HASL	%	Electroless Nickel/ Immersion Gold	%
OSP-Thick	%	Electroless Nickel/Electroless Palladium/ Immersion Gold	%
OSP-Thin (benzotriazole-based)	%	Other:	%
Immersion Tin	%	Other:	%
Electroless Palladium	%	Other:	%
Immersion Silver	%	**Total**	100%

1.3 Wastewater Discharge and Sludge Data

Wastewater discharge method (circle one):	Direct (to stream) Indirect (to POTW) Zero
Throughput of facility wastewater treatment system:	gals/day
Annual weight of sludge generated:	lbs
Is sludge dewatered prior to disposal (circle one)?	Yes No
Water content **prior** to dewatering:	%
Water content **after** dewatering:	%

Section 2. HASL Process

2.1 Process Schematic: HASL

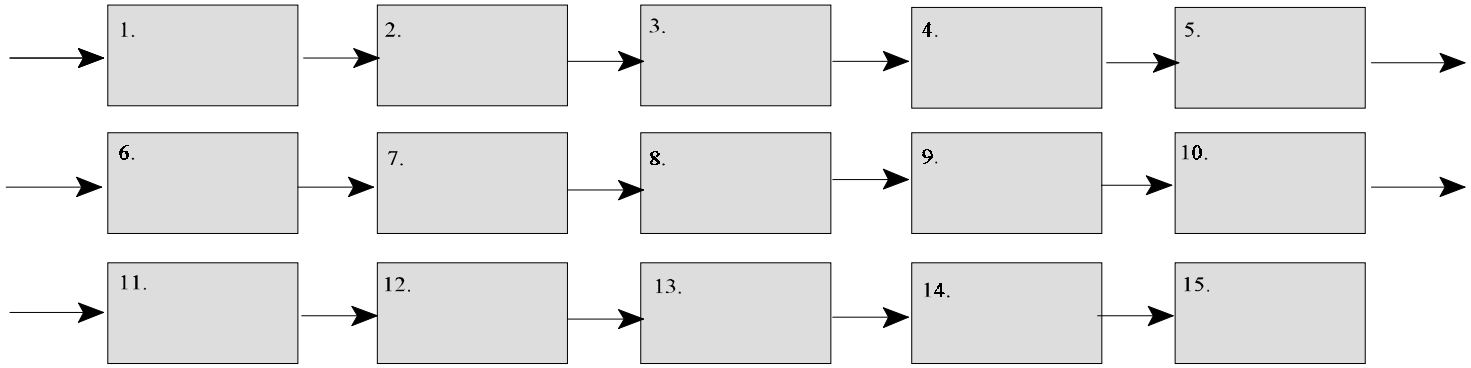
Fill in the figure below for your HASL surface finishing processses. Using the key at the bottom of the page, identify which letter corresponds w the first step in your HASL process and write that letter in the first box (see example). Continue using the key to fill in boxes for each step intil y entire HASL process is represented. If your particular process step is not represented by the key below, complete the figure by writing in the na of the process step in your particular surface finishing line in the corresponding box(es). Finish by responding, to the questions at the bottom of page.

Type of Process

Process Step Letter (see key below) → Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____



Is the entire HASL process, as described in the chart above, co-located in the same room: Yes _____ No _____

* If no (process steps performed in more than one room), please circle the steps above that are in a separate room.

Type of Process Automation for the HASL line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

HASL Process Step Key

[A] - Cleaner	**[G] - Post-cleaner**
[B] - Microetch	**[H] - Dryer**
[C] - Flux	**[I] - Water Rinse**
[D] - Solder	**[J] - Air Knife**
[E] - Air Cool	**[K] - Other (Specify in the appropriate box)**

2.2 General Data--HASL

Number of days HASL line is in operation:	days/yr	Number of hours per day the HASL line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for HASL process:	%	Total of PWB surface square feet processed by HASL line per year:	ssf/yr

2.3 Process Area Employees--HASL

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the HASL line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of HASL Area Worker	Number of Employees in HASL Process Area	Average Hours per Week per Employee in HASL Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

2.4 Physical Settings--HASL

Size of the room containing the HASL process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

2.5 Rack Dimensions--HASL

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

2.6 Rinse Bath Water Usage--HASL

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your HASL process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the HASL line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8→6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

2.7 Filter Replacement--HASL

					Not Applicable ☐
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

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

2.8 Rack or Conveyor Cleaning--HASL

Not Applicable ☐	
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

2.9 Solder Unit Maintenance and Waste disposal

Complete the following maintenance and waste disposal questions for only the unit of the process that performs the hot air solder leveling

Frequency of maintenance:		Method of dross removal:	
Duration of maintenance :	min.	Frequency of dross removal:	
Personal protective equipment (see key):		Quantity of solder waste disposed (per day):	
Number of personnel involved:		Method of solder waste disposal (see key):	

[d] **Personal Protective Equipment** - Enter the letters of **all** the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

Method Of Solder Waste Disposal - Indicate method of solder waste disposal from key below:
[M] - Metals reclaimed off-site
[R] - Recycled on-site
[RO] - Recycled off-site
[D] - Drummed and treated as hazardous waste
[O] - Other (specify)

2.10 Physical Data and Operating Conditions--HASL

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire HASL process (includes cleaning and post cleaning steps, if any):	**min.**

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time[a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Cleaner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Flux	in.	in.	gal.	sec.	sec.	ºF		
Solder	in.	in.	gal.	sec.	sec.	ºF		
Post-Clean	in.	in.	gal.	sec.	sec.	ºF		
Other (specify)								

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA]- Panel agitation
[CP]- Circulation pump
[AS]- Air sparge
[O]- Other (explain)

Vapor Control Methods Key:
[BC]- Bath cover
[FE]- Fully enclosed
[VO]- Vent to outside
[VC]- Vent to control
[PP]- Push pull
[O]- Other (explain)

2.11 Initial Chemical Bath Make-Up Composition--HASL

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used[a] (gallons)
Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Flux	**1.**			
	2.			
	3.			
	4.			
Solder	**1.**			
	2.			
	3.			
	4.			
Post-Clean	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

2.12 Chemical Bath Bailout and Additions--HASL

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]	Chemical Products Added		Criteria for Addition[a]	Method of Chemical Addition[b] to Tank	Duration of Addition[c] (minutes)
Cleaner		min.			1				min.
					2				
					3				
Microetch		min.			1				min.
					2				
					3				
Flux		min.			1				min.
					2				
					3				
Solder		min.			1				min.
					2				
					3				
Post-Clean		min.			1				min.
					2				
					3				
Other (specify)		min.			1				min.
					2				
					3				

[a] **Criteria for Additions -** Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank -** Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition -** Enter the elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

2.13 Chemical Bath Replacement -- HASL

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]	Replacement Frequency[b]	Method of Spent Bath Removal [c]	Tank Cleaning Method[d]	Duration of Replacement Procedure[e]	Personal Protective Equipment[f]
Cleaner					**min.**	
Microetch					**min.**	
Flux					**min.**	
Solder					**min.**	
Post-Clean					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[F] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

2.14 Chemical Bath Sampling--HASL

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Cleaner					
Microetch					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling**: Enter the average time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
[L] - Ladle
[O] - Other (specify)

2.15 Process Waste Disposal -- HASL

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Cleaner				
Microetch				
Flux				
Solder				
Post-Clean				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***

[B] **Methods 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
[RN] - Recycled on-site
[RF] - Recycled off-site
[O] - Other (specify)

Container Type -
Indicate the type of container used for disposal of bath wastes
[OH]- Open-head drum
[CH]- Closed-head drum
[T]- Chemical tote
[O]- Other (specify)

Section 3. Electroless Nickel/Immersion Gold Process

3.1 Process Schematic: Nickel/Gold

Fill in the figure below for your electroless nickel/immersion gold surface finishing processses. Using the key at the bottom of the page, iedntify 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 bo for each step until your entire electroless nickel/immersion gold process is represented. If a particular process step is not represented by the key below, complete the figure by writing in the name of the process step in your particular surface finishing line in the corresponding box(es). Finis by responding to the questions at the bottom of the page.

Type of Process

Process Step Letter (see key below) → Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____

1.	2.	3.	4.	5.
6.	7.	8.	9.	10.
11.	12.	13.	14.	15.

Is the entire electroless nickel/immersion gold, as described in the chart above, co-located in the same room:
Yes _____ No _____

* If no (process steps performed in more than one room), please circle the steps above that are in a separate room.

Type of Process Automation for the nickel/gold line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

Electroless Nickel/Immersion Gold Process Step Key

[A] - Conditioner/Cleaner
[B] - Microetch
[C] - Catalyst
[D] - Acid Dip
[E] - Activator
[F] - Predip
[G] - Electroless Nickel
[H] - Immersion Gold
[I] - Water Rinse
[J] - Other (Specify in the appropriate box)

3.2 General Data--Nickel/Gold

Number of days the nickel/gold line is in operation:	days/yr	Number of hours per day the nickel/gold line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for the nickel/gold process:	%	Total of PWB surface square feet processed by the nickel/gold line per year:	ssf/yr

3.3 Process Area Employees--Nickel/Gold

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the nickel/gold line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of Surface Finish Area Worker	Number of Employees in Surface Finish Process Area	Average Hours per Week per Employee in Surface Finish Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

3.4 Physical Settings--Nickel/Gold

Size of the room containing the surface finish process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

3.5 Rack Dimensions--Nickel/Gold

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

3.6 Rinse Bath Water Usage--Nickel/Gold

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your nickel/gold process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the surface finish line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8 -> 6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

3.7 Filter Replacement--Nickel/Gold

	Not Applicable ☐				
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

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

3.8 Rack or Conveyor Cleaning--Nickel/Gold

Not Applicable	☐
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

3.9 Chemical Bath Sampling --Nickel/Gold

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Cleaner/ Conditioner					
Microetch					
Catalyst					
Acid Dip					
Acivator					
Electroless Nickel					
Immersion Gold					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:** Enter the a verage time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
{L] - Ladle
[O] - Other (specify)

3.10 Physical Data and Operating Conditions--Nickel/Gold

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire nickel/gold process (includes cleaning and post cleaning steps, if any):	min.

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time [a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Cleaner/ Conditioner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Catalyst	in.	in.	gal.	sec.	sec.	ºF		
Acid Dip	in.	in.	gal.	sec.	sec.	ºF		
Activator	in.	in.	gal.	sec.	sec.	ºF		
Electroless Nickel	in.	in.	gal.	sec.	sec.	ºF		
Immersion Gold	in.	in.	gal.	sec.	sec.	ºF		
Other (specify);	in.	in.	gal.	sec.	sec.	ºF		

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA] - Panel agitation
[CP] - Circulation pump
[AS] - Air sparge
[O] - Other (explain)

Vapor Control Methods Key:
[BC] - Bath cover
[FE] - Fully enclosed
[VO] - Vent to outside
[VC] - Vent to control
[PP] - Push pull
[O] - Other (explain)

3.11 Initial Chemical Bath Make-Up Composition --Nickel/Gold

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used [a] (gallons)
Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Catalyst	**1.**			
	2.			
	3.			
	4.			
Acid Dip	**1.**			
	2.			
	3.			
	4.			
Activator	**1.**			
	2.			
	3.			
	4.			
Electroless Nickel	**1.**			
	2.			
	3.			
	4.			
Immersion Gold	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

3.12 Chemical Bath Bailout and Additions--Nickel/Gold

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]	Chemical Products Added		Criteria for Addition[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)
Cleaner/ Conditioner		**min.**			**1**				**min.**
					2				
					3				
Microetch		**min.**			**1**				**min.**
					2				
					3				
Catalyst		**min.**			**1**				**min.**
					2				
					3				
Acid Dip		**min.**			**1**				**min.**
					2				
					3				
Activator		**min.**			**1**				**min.**
					2				
					3				
Electroless Nickel		**min.**			**1**				**min.**
					2				
					3				
Immersion Gold		**min.**			**1**				**min.**
					2				
					3				
Other (specify)		**min.**			**1**				**min.**
					2				
					3				

[a] **Criteria for Additions** - Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank** - Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition - Enter the elapsed time from the retrieval of the chemical stock** through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment** - Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

3.13 Chemical Bath Replacement -- Nickel/Gold

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]	Replacement Frequency [b]	Method of Spent Bath Removal [c]	Tank Cleaning Method [d]	Duration of Replacement Procedure [e]	Personal Protective Equipment [f]
Cleaner/Conditioner					**min.**	
Microetch					**min.**	
Catalyst					**min.**	
Acid Dip					**min.**	
Activator					**min.**	
Electroles Nickel					**min.**	
Immersion Gold					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

3.14 Process Waste Disposal -- Nickel/Gold

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Cleaner/Conditioner				
Microetch				
Catalyst				
Acid Dip				
Activator				
Electroless Nickel				
Immersion Gold				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***	[b] **Methods 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 [RN] - Recycled on-site [RF] - Recycled off-site [O] - Other (specify)	**Container Type** - Indicate the type of container used for disposal of bath wastes [OH]- Open-head drum [CH]- Closed-head drum [T]- Chemical tote [O]- Other (specify)

Section 4. Electroless Nickel/Electroless Palladium/Immersion Gold Process

4.1 Process Schematic: Nickel/Palladium/Gold

Fill in the figure below for your electroless nickel/ electroless palladium/immersion gold surface finishing processses. Using the key at the botto 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 usin the key to fill in boxes for each step until your entire nickel/palladium/gold process is represented. If a particular process step is not represented the key below, complete the figure by writing in the name of the process step in your particular surface finishing line in the corresponding boxe(Finish by responding to the questions at the bottom of the page.

Type of Process

Process Step Letter (see key below)

Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____

1.	2.	3.	4.	5.
6.	7.	8.	9.	10.
11.	12.	13.	14.	15.

Is the entire nickel/palladium/gold, as described in the chart above, co-located in the same room:
Yes _____ **No** _____

*** If no (process steps performed in more than one room), please circle the steps above that are in a separate room.**

Type of Process Automation for the nickel/palladium/gold line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

Nickel/Palladium/Gold Process Step Key

[A] - Conditioner/Cleaner
[B] - Microetch
[C] - Catalyst
[D] - Acid Dip
[E] - Activator
[F] - Electroless Nicke.
[G] - Electroless Palladium
[H] - Immersion Gold
[I] - Water Rinse
[J] - Other (Specify in the appropriate box)

4.2 General Data--Nickel/Palladium/Gold

Number of days the nickel/palladium/gold line is in operation:	days/yr	Number of hours per day the nickel/palladium/gold line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for the nickel/palladium/gold process:	%	Total of PWB surface square feet processed by the nickel/palladium/gold line per year:	ssf/yr

4.3 Process Area Employees--Nickel/Palladium/Gold

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the nickel/palladium/gold line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of Surface Finish Area Worker	Number of Employees in Surface Finish Process Area	Average Hours per Week per Employee in Surface Finish Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

4.4 Physical Settings--Nickel/Palladium/Gold

Size of the room containing the surface finish process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

4.5 Rack Dimensions--Nickel/Palladium/Gold

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

4.6 Rinse Bath Water Usage--Nickel/Palladium/Gold

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your nickel/palladium/gold process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the surface finish line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8→6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

4.7 Filter Replacement--Nickel/Palladium/Gold

	Not Applicable ☐				
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

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

4.8 Rack or Conveyor Cleaning--Nickel/Palladium/Gold

Not Applicable ☐	
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

4.9 Chemical Bath Sampling --Nickel/Palladium/Gold

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Cleaner/ Conditioner					
Microetch					
Catalyst					
Acid Dip					
Acivator					
Electroless Nickel					
Electroless Palladium					
Immersion Gold					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:** Enter the a verage time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
{L] - Ladle
[O] - Other (specify)

4.10 Physical Data and Operating Conditions--Nickel/Palladium/Gold

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire surface finish process (includes cleaning and post cleaning steps, if any):	min.

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time [a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Cleaner/Conditioner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Catalyst	in.	in.	gal.	sec.	sec.	ºF		
Acid Dip	in.	in.	gal.	sec.	sec.	ºF		
Activator	in.	in.	gal.	sec.	sec.	ºF		
Electroless Nickel	in.	in.	gal.	sec.	sec.	ºF		
Electroless Palladium	in.	in.	gal.	sec.	sec.	ºF		
Immersion Gold	in.	in.	gal.	sec.	sec.	ºF		
Other (specify);	in.	in.	gal.	sec.	sec.	ºF		

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA] - Panel agitation
[CP] - Circulation pump
[AS] - Air sparge
[O] - Other (explain)

Vapor Control Methods Key:
[BC] - Bath cover
[FE] - Fully enclosed
[VO] - Vent to outside
[VC] - Vent to control
[PP] - Push pull
[O] - Other (explain)

4.11 Initial Chemical Bath Make-Up Composition --Nickel/Palladium/Gold

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used [a] (gallons)
Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Catalyst	**1.**			
	2.			
	3.			
	4.			
Acid Dip	**1.**			
	2.			
	3.			
	4.			
Activator	**1.**			
	2.			
	3.			
	4.			
Electroless Nickel	**1.**			
	2.			
	3.			
	4.			
Electroless Palladium	**1.**			
	2.			
	3.			
	4.			
Immersion Gold	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

4.12 Chemical Bath Bailout and Additions--Nickel/Palladium/Gold

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]		Chemical Products Added	Criteria for Addition[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)
Cleaner/ Conditioner		min.			1				min.
					2				
					3				
Microetch		min.			1				min.
					2				
					3				
Catalyst		min.			1				min.
					2				
					3				
Acid Dip		min.			1				min.
					2				
					3				
Activator		min.			1				min.
					2				
					3				
Electroless Nickel		min.			1				min.
					2				
					3				
Electroless Palladium		min.			1				
					2				
					3				
Immersion Gold		min.			1				min.
					2				
					3				
Other (specify)		min.			1				min.
					2				
					3				

[a] **Criteria for Additions** - Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank -** Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition -** Enter the elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

4.13 Chemical Bath Replacement -- Nickel/Palladium/Gold

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]	Replacement Frequency [b]	Method of Spent Bath Removal [c]	Tank Cleaning Method [d]	Duration of Replacement Procedure [e]	Personal Protective Equipment [f]
Cleaner/Conditioner					**min.**	
Microetch					**min.**	
Catalyst					**min.**	
Acid Dip					**min.**	
Activator					**min.**	
Electroless Nickel					**min.**	
Electroless Palladium					**min.**	
Immersion Gold					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

4.14 Process Waste Disposal -- Nickel/Palladium/Gold

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Cleaner/ Conditioner				
Microetch				
Catalyst				
Acid Dip				
Activator				
Electroless Nickel				
Electroless Palladium				
Immersion Gold				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***	[b] **Methods 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 [RN] - Recycled on-site [RF] - Recycled off-site [O] - Other (specify)	**Container Type** - Indicate the type of container used for disposal of bath wastes [OH]- Open-head drum [CH]- Closed-head drum [T]- Chemical tote [O]- Other (specify)

Section 5. Organic Solder Preservative (OSP) Process

5.1 Process Schematic: OSP

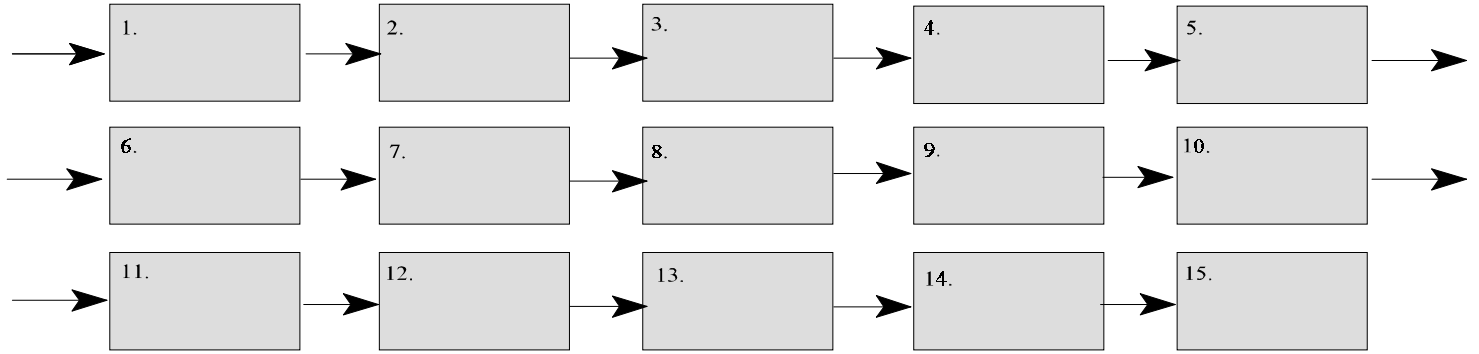
Fill in the figure below for your OSP surface finishing process. Using the key at the bottom of the page, identify which letter corresponds with tl first step in your process and write that letter in the first box (see example). Continue using the key to fill in boxes for each step until your entir process is represented. If a particular step is not represented by the key below, complete the figure by writing in the name of the process step in your particular surface finishing line in the corresponding box(es). Finish by responding to the questions at the bottom of the page.

Type of Process

Process Step Letter (see key below) → Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____



Is the entire OSP process, as described in the chart above, co-located in the same room:
Yes _____ **No** _____

*** If no (process steps performed in more than one room), please circle the steps above that are in a separate room.**

Type of Process Automation for the OSP line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

OSP Process Step Key

[A] - Cleaner
[B] - Microetch
[C] - Predip
[D] - OSP
[E] - Water Rinse
[F] - Air Knife
[G] - Other (Specify in the appropriate box)

5.2 General Data--OSP

Number of days the OSP line is in operation:	days/yr	Number of hours per day the OSP line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for the OSP process:	%	Total of PWB surface square feet processed by the OSP line per year:	ssf/yr

5.3 Process Area Employees--OSP

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the OSP line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of Surface Finish Area Worker	Number of Employees in Surface Finish Process Area	Average Hours per Week per Employee in Surface Finish Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

5.4 Physical Settings--OSP

Size of the room containing the surface finish process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

5.5 Rack Dimensions--OSP

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

5.6 Rinse Bath Water Usage--OSP

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your OSP process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the surface finish line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8→6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

5.7 Filter Replacement--OSP

	Not Applicable ☐				
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

Personal Protective Equipment Key:

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

5.8 Rack or Conveyor Cleaning--OSP

Not Applicable ☐	
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

5.9 Chemical Bath Sampling --OSP

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Cleaner					
Microetch					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:** Enter the a verage time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
{L] - Ladle
[O] - Other (specify)

5.10 Physical Data and Operating Conditions--OSP

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire OSP process (includes cleaning and post cleaning steps, if any):	min.

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time [a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Cleaner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Flux	in.	in.	gal.	sec.	sec.	ºF		
Solder	in.	in.	gal.	sec.	sec.	ºF		
Post-Clean	in.	in.	gal.	sec.	sec.	ºF		
Other (specify);	in.	in.	gal.	sec.	sec.	ºF		

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA] - Panel agitation
[CP] - Circulation pump
[AS] - Air sparge
[O] - Other (explain)

Vapor Control Methods Key:
[BC] - Bath cover
[FE] - Fully enclosed
[VO] - Vent to outside
[VC] - Vent to control
[PP] - Push pull
[O] - Other (explain)

5.11 Initial Chemical Bath Make-Up Composition -OSP

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used [a] (gallons)
Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Flux	**1.**			
	2.			
	3.			
	4.			
Solder	**1.**			
	2.			
	3.			
	4.			
Post-Clean	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

5.12 Chemical Bath Bailout and Additions--OSP

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]		Chemical Products Added	Criteria for Addition[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)
Cleaner		**min.**			**1**				**min.**
					2				
					3				
Microetch		**min.**			**1**				**min.**
					2				
					3				
Flux		**min.**			**1**				**min.**
					2				
					3				
Solder		**min.**			**1**				**min.**
					2				
					3				
Post-Clean		**min.**			**1**				**min.**
					2				
					3				
Other (specify)		**min.**			**1**				**min.**
					2				
					3				

[a] **Criteria for Additions -** Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank -** Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition -** Enter the elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

5.13 Chemical Bath Replacement -- OSP

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]	Replacement Frequency [b]	Method of Spent Bath Removal [c]	Tank Cleaning Method [d]	Duration of Replacement Procedure [e]	Personal Protective Equipment [f]
Cleaner					**min.**	
Microetch					**min.**	
Flux					**min.**	
Solder					**min.**	
Post-Clean					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

5.14 Process Waste Disposal -- OSP

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Cleaner				
Microetch				
Flux				
Solder				
Post-Clean				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***	[b] **Methods 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 [RN] - Recycled on-site [RF] - Recycled off-site [O] - Other (specify)	**Container Type -** Indicate the type of container used for disposal of bath wastes [OH]- Open-head drum [CH]- Closed-head drum [T]- Chemical tote [O]- Other (specify)

Section 6. Immersion Silver Process

6.1 Process Schematic: Immersion Silver

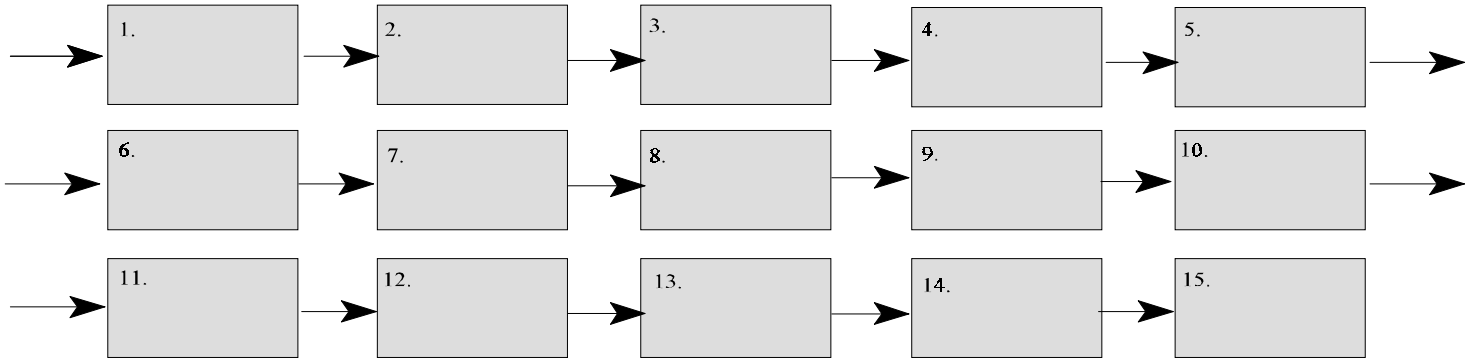
Fill in the figure below for your immersion silver surface finishing process. Using the key at the bottom of the page, dentify which letter corresponds with the first step in your process and write that letter in the first box (see example). Continue using the key to fill in boxes for each step until your entire immersion silver process is represented. If a particular process step is not represented by the key below, complete the figu by writing in the name of the process step in your particular surface finishing line in the corresponding bbox(es) . Finish by responding to the questions at the bottom of the page.

Type of Process

Process Step Letter (see key below) → Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____



Is the entire immersion silver process, as described in the chart above, co-located in the same room:
Yes _____ No _____

*** If no (process steps performed in more than one room), please circle the steps above that are in a separate room.**

Type of Process Automation for the immersion silver line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

Immersion Silver Process Step Key

[A] - Pre-Cleaner
[B] - Microetch
[C] - Pre-Conditioner
[D] - Immersion Silver
[E] - Water Rinse
[F] - Other (Specify in the appropriate box)

6.2 General Data--Immersion Silver

Number of days the immersion silver line is in operation:	days/yr	Number of hours per day the immersion silver line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for the immersion silver process:	%	Total of PWB surface square feet processed by the immersion silver line per year:	ssf/yr

6.3 Process Area Employees--Immersion Silver

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the immersion silver line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of Surface Finish Area Worker	Number of Employees in Surface Finish Process Area	Average Hours per Week per Employee in Surface Finish Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

6.4 Physical Settings--Immersion Silver

Size of the room containing the surface finish process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

6.5 Rack Dimensions--Immersion Silver

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

6.6 Rinse Bath Water Usage--Immersion Silver

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your nickel/gold process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the surface finish line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8→6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

6.7 Filter Replacement--Immersion Silver

	Not Applicable ☐				
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

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

6.8 Rack or Conveyor Cleaning--Immersion Silver

Not Applicable ☐	
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

6.9 Chemical Bath Sampling --Immersion Silver

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Pre-Cleaner					
Microetch					
Pre-Conditioner					
Immersion Silver					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:** Enter the a verage time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
{L] - Ladle
[O] - Other (specify)

6.10 Physical Data and Operating Conditions--Immersion Silver

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire immersion silver process (includes cleaning and post cleaning steps, if any):	min.

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time [a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Pre-Cleaner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Pre-Conditioner	in.	in.	gal.	sec.	sec.	ºF		
Immersion Silver	in.	in.	gal.	sec.	sec.	ºF		
Other (specify):	in.	in.	gal.	sec.	sec.	ºF		

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA] - Panel agitation
[CP] - Circulation pump
[AS] - Air sparge
[O] - Other (explain)

Vapor Control Methods Key:
[BC] - Bath cover
[FE] - Fully enclosed
[VO] - Vent to outside
[VC] - Vent to control
[PP] - Push pull
[O] - Other (explain)

6.11 Initial Chemical Bath Make-Up Composition --Immersion Silver

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used [a] (gallons)
Pre-Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Pre-Conditioner	**1.**			
	2.			
	3.			
	4.			
Immersion Silver	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

6.12 Chemical Bath Bailout and Additions--Immersion Silver

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]		Chemical Products Added	Criteria for Addition[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)
Pre-Cleaner		**min.**			**1**				**min.**
					2				
					3				
Microetch		**min.**			**1**				**min.**
					2				
					3				
Pre-Conditioner		**min.**			**1**				**min.**
					2				
					3				
Immersion Silver		**min.**			**1**				**min.**
					2				
					3				
Other (specify)		**min.**			**1**				**min.**
					2				
					3				
		min.			**1**				**min.**
					2				
					3				

[a] **Criteria for Additions -** Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank -** Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition -** Enter the elapsed time from the retrieval of the chemical stock through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

6.13 Chemical Bath Replacement --Immersion Silver

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]	Replacement Frequency [b]	Method of Spent Bath Removal [c]	Tank Cleaning Method [d]	Duration of Replacement Procedure [e]	Personal Protective Equipment [f]
Pre-Cleaner					**min.**	
Microetch					**min.**	
Pre-Conditioner					**min.**	
Immersion Silver					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

6.14 Process Waste Disposal -- Immersion Silver

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Pre-Cleaner				
Microetch				
Pre-Conditioner				
Immersion Silver				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***	[b] **Methods 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 [RN] - Recycled on-site [RF] - Recycled off-site [O] - Other (specify)	**Container Type** - Indicate the type of container used for disposal of bath wastes [OH]- Open-head drum [CH]- Closed-head drum [T]- Chemical tote [O]- Other (specify)

Section 7. Immersion Tin Process

7.1 Process Schematic: Immersion Tin

Fill in the figure below for your immersion tin surface finishing processses. Using the key at the bottom of the page, dentify 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 intil your entire immersion tin process is represented. If a particular process step is not represented by the key below, complete the figure b writing in the name of the process step in your particular surface finishing line in the corresponding boxe(s). Finish by responding to the questions at the bottom of the page.

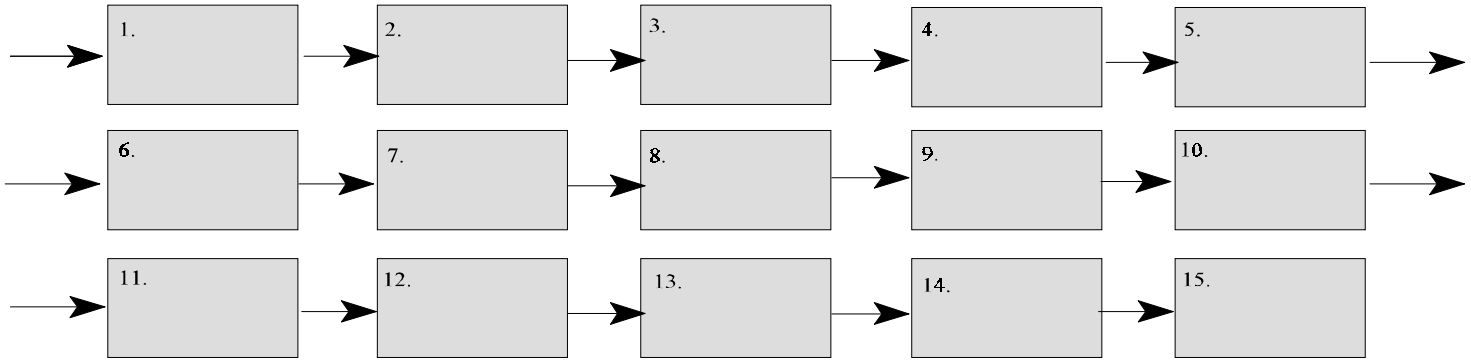
Type of Process

Process Step Letter (see key below)

Ex. **A**

Chemical Supplier: _____

Process Line Installation Date:_____



Is the entire immersion tin process, as described in the chart above, co-located in the same room:
Yes _____ No _____

*** If no (process steps performed in more than one room), please circle the steps above that are in a separate room.**

Type of Process Automation for the immersion tin line: (circle one)

Conveyorized Automated non-conveyorized Manually-controlled hoist

Manual (no automation) Other (specify):_____

Immersion Tin Process Step Key

[A] - Cleaner
[B] - Microetch
[C] - Predip
[D] - Immersion Tin
[E] - Water Rinse
[F] - Dry
[G] - Other (Specify in the appropriate box)

7.2 General Data--Immersion Tin

Number of days the immersion tin line is in operation:	days/yr	Number of hours per day the immersion tin line is in operation:	hrs/day
Estimated scrap rate (% of defective product) for the immersion tin process:	%	Total of PWB surface square feet processed by the immersion tin line per year:	ssf/yr

7.3 Process Area Employees--Immersion Tin

Complete the following table by indicating the number of employees of each type that perform work duties in the same process room as the immersion tin line, and for what length of time. Consider only workers who have regularly scheduled responsibilities that require them to be physically within the process room. Specify "other" entry. Enter "N/A" in any category that is not applicable.

Type of Surface Finish Area Worker	Number of Employees in Surface Finish Process Area	Average Hours per Week per Employee in Surface Finish Process Area
Line Operators		hrs
Lab Technicians		hrs
Maintenance Workers		hrs
Wastewater Treatment Operators		hrs
Supervisory Personnel		hrs
Other (specify):		hrs

7.4 Physical Settings--Immersion Tin

Size of the room containing the surface finish process:	sq. ft.	Height of room:	ft.
Are the overall process areas/rooms ventilated (circle one)?	Yes No	Air flow rate:	cu. ft./min.
Do you have local vents (circle one)?	Yes No	Local vent air flow rate:	cu. ft./min.
Overall surface finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):			

7.5 Rack Dimensions--Immersion Tin

Average number of panels per rack:		Average space between panels in rack:	in.
Average size of panel in rack:	Length (in.):	Width (in.):	
Do you purposely slow the withdraw rate of your panels from process baths to reduce drag-out? (Circle one)			Yes No

7.6 Rinse Bath Water Usage--Immersion Tin

Consult the process schematic in section 2.1 to obtain the process step numbers associated with each of the water rinse baths present in your immersion tin process. Enter, in the table below, the process step number along with the flow control method 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.**

Total volume of water used by the surface finish line when operating:	gal./day

Process Step Number [a]	Flow Control [b]	Daily Water Flow Rate [c]	Cascade Water Process Steps [d]
Example: 8	**R**	**2,400 gal./day**	**8→6**
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	
		gal./day	

[a] **Process step number** - Consult the process schematic in question 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

7.7 Filter Replacement--Immersion Tin

	Not Applicable ☐				
Bath(s) filtered (enter process step # from flow diagram in 2.1)					
Frequency of replacement:					
Duration of replacement process:					
Personal protective equipment (see key):					

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

7.8 Rack or Conveyor Cleaning--Immersion Tin

Not Applicable ☐	
Rack Cleaning Method (see key): **OR**	
Conveyor Cleaning Method (see key):	
Frequency of rack or conveyor cleaning:	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	min.

Rack Cleaning Method:
[C]-Chemical bath on SF process line
[D]-Chemical bath on another line
[T]-Temporary chemical bath
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Conveyor Cleaning Method:
[C]-Chemical rinsing or soaking
[S]-Manual scrubbing with chemical
[M]-Non-chemical cleaning
[N]-None
[O]-Continuous cleaning

Personal Protective Equipment:
[E]-Eye Protection [G]-Gloves
[L]-Lab coat/Sleeved garment [A]-Apron
[R]-Respiratory Protection [B]-Boots
[O]-Continuous Cleaning [N]-None
[Z]-All except Respiratory Protection

7.9 Chemical Bath Sampling -Immersion Tin

Bath Type	Type of Sampling [a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Example:	**A**	**3 per day**	**5 min**	**E, G, A**	**P**
Cleaner					
Microetch					
Predip					
Immersion Tin					
Other (specify):					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:** Enter the a verage time required to manually take a sample from the tank.

[d] **Protective Equipment:** Consult the key for the above table and enter the letters for all protective equipment used by the person performing the chemical sampling.

[e] **Method of Sampling:**
[D] - Drain or spigot
[P] - Pipette
{L] - Ladle
[O] - Other (specify)

7.10 Physical Data and Operating Conditions--Immersion Tin

Complete the tables 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 each tank separately.

Average cycle time for a panel to complete entire immersion tin process (includes cleaning and post cleaning steps, if any):	min.

Bath	Physical Data			Process Data		Operating Conditions		
	Length (inches)	Width (inches)	Nominal Volume (gal)	Immersion Time [a] (seconds)	Drip[b] Time (seconds)	Temp (ºF)	Agitation (see key)	Vapor Control (see key)
Cleaner	in.	in.	gal.	sec.	sec.	ºF		
Microetch	in.	in.	gal.	sec.	sec.	ºF		
Predip	in.	in.	gal.	sec.	sec.	ºF		
Immersion Tin	in.	in.	gal.	sec.	sec.	ºF		
Other (specify):	in.	in.	gal.	sec.	sec.	ºF		

[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 process bath to allow drainage from panels.

Agitation Methods Key:
[PA] - Panel agitation
[CP] - Circulation pump
[AS] - Air sparge
[O] - Other (explain)

Vapor Control Methods Key:
[BC] - Bath cover
[FE] - Fully enclosed
[VO] - Vent to outside
[VC] - Vent to control
[PP] - Push pull
[O] - Other (explain)

7.11 Initial Chemical Bath Make-Up Composition --Immersion Tin

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 Product Name	Manufacturer (if applicable)	Annual Quantity Used [a] (gallons)
Cleaner	**1.**			
	2.			
	3.			
	4.			
Microetch	**1.**			
	2.			
	3.			
	4.			
Predip	**1.**			
	2.			
	3.			
	4.			
Immersion Tin	**1.**			
	2.			
	3.			
	4.			
Other (specify)	**1.**			
	2.			
	3.			
	4.			

[a] **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).

7.12 Chemical Bath Bailout and Additions--Immersion Tin

Complete the following chart detailing the typical bath bailout and chemical additions that are made to maintain the chemical balance of each specific process bath. If more than three 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	Bailout Frequency	Bailout Duration [c] (minutes)	Bailout Quantity	Personal Protective Equipment [d]	Chemical Products Added		Criteria for Addition[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)
Cleaner		**min.**			**1**				**min.**
					2				
					3				
Microetch		**min.**			**1**				**min.**
					2				
					3				
Predip		**min.**			**1**				**min.**
					2				
					3				
Immersion Tin		**min.**			**1**				**min.**
					2				
					3				
Other (specify)		**min.**			**1**				**min.**
					2				
					3				
		min.			**1**				**min.**
					2				
					3				

[a] **Criteria for Additions** - Enter the letter for the criteria typically used to determine when bath additions are necessary.
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other

[b] **Method of Chemical Addition to Tank** - Enter the letter for the method typically used to add chemicals to the tanks.
[PR] - Poured [S] - Scooped
[P] - Pumped manually [O] - Other

[c] **Duration of Bailout or Addition - Enter the elapsed time from the retrieval of the chemical stock** through the completion of the addition of all chemicals. For bailout, enter the time required to bailout the bath prior to making additions.

[d] **Personal Protective Equipment** - Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection [B] - Boots
[A] - Apron [G] - Gloves
[L] - Lab coat/Sleeved garment
[R] - Respiratory protection
[Z] - All except Respiratory Protection
[N] - None

7.13 Chemical Bath Replacement -- Immersion Tin

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]	Replacement Frequency [b]	Method of Spent Bath Removal [c]	Tank Cleaning Method [d]	Duration of Replacement Procedure [e]	Personal Protective Equipment [f]
Cleaner					**min.**	
Microetch					**min.**	
Predip					**min.**	
Immersion Tin					**min.**	
Other (specify)					**min.**	

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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.).

[c] **Methods of Spent Bath Removal-**
[P] - Pump spent bath from tank
[S] - Siphon spent bath from tank
[D] - Drain spent bath from tank
[O] - Other (specify)

[d] **Tank Cleaning Method -**
[C] - Chemical flush
[W] - Water rinse
[H] - Hand scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -** Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.

[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

7.14 Process Waste Disposal -- Immersion Tin

Bath Type	Annual Volume Treated or Disposed [a]	Method of Treatment or Disposal [b]	RCRA Waste Code (if applicable)	Container Type
Cleaner				
Microetch				
Predip				
Immersion Tin				
Other (specify):				

[a] **Annual Volume Treated or Disposed** - Enter the yearly amount of the specific bath treated or disposed. ***Be sure to consider the volume treated from both bath change outs and bailout before entering the total.***	[b] **Methods 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 [RN] - Recycled on-site [RF] - Recycled off-site [O] - Other (specify)	**Container Type -** Indicate the type of container used for disposal of bath wastes [OH]- Open-head drum [CH]- Closed-head drum [T]- Chemical tote [O]- Other (specify)

Design for the Environment

Printed Wiring Board Project

Performance Demonstration Questionnaire

Please complete this questionnaire, make a copy for your records, and send the original to:

Ellen Moore
Abt Associates
55 Wheeler St.
Cambridge, MA 02138
Fax: (617) 349-2660

Note: The completed questionnaire must be returned <u>PRIOR TO</u> the scheduled site visit.

FACILITY AND CONTACT INFORMATION

Facility Identification:

Company Name:					
Site Name:					
Street Address:					
City:		State:		Zip:	

Contact Identification: Enter the names of the persons who can be contacted regarding this survey.

Name:		
Title:		
Phone:		
Fax:		
E-Mail:		

Section 1. Facility Characterization

Estimate manufacturing data for the previous 12 month period or other convenient time period of 12 consecutive months (e.g., FY96). 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 PWBs.	Sq. Ft.	Number of days Surface Finish line is in operation:	days/yr
Size of portion of facility used for surface finishing.	Sq. Ft.		

1.2 Process Type

Estimate the percentage of PWBs manufactured at your facility using the following methods for surface finishing (SF). Specify "other" entry.

Type of PWB process	Percent of total	Type of PWB process	Percent of Total
HASL	%	Electroless Palladium	%
OSP-Thick	%	Electroless Nickel/Immersion Gold	%
OSP-Thin	%	Other:	%
Immersion Tin	%	Other:	%
Immersion Silver	%	TOTAL	100%

1.3 General Process Line Data

Process Data	Hours
Number of hours the Surface Finishing line is in operation per day:	

1.4 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 Surface Finishing line and for what length of time. Report the number of hours per employee. Consider only workers who have regularly scheduled responsibilities physically within the process room. Specify "other" entry. Enter "N/A" in any category not applicable.

Type of Process Area Worker	**Number of Employees in Process Area**	**Average Hours per Week per Employee in Process Area**
Line Operators		Hrs.
Lab Technicians		Hrs.
Maintenance Workers		Hrs.
Wastewater Treatment Operators		Hrs.
Supervisory Personnel		Hrs.
Other:		Hrs.
Other:		Hrs.

1.5 Wastewater Discharge and Sludge Data

Wastewater discharge type (check one)	Direct		Indirect		Zero	
Annual weight (quantity in pounds) of sludge generated:						
Is sludge dewatered prior to disposal?						
% water content **prior** to dewatering:						
% water content **after** dewatering:						

Section 2. Process Description: Immersion Tin

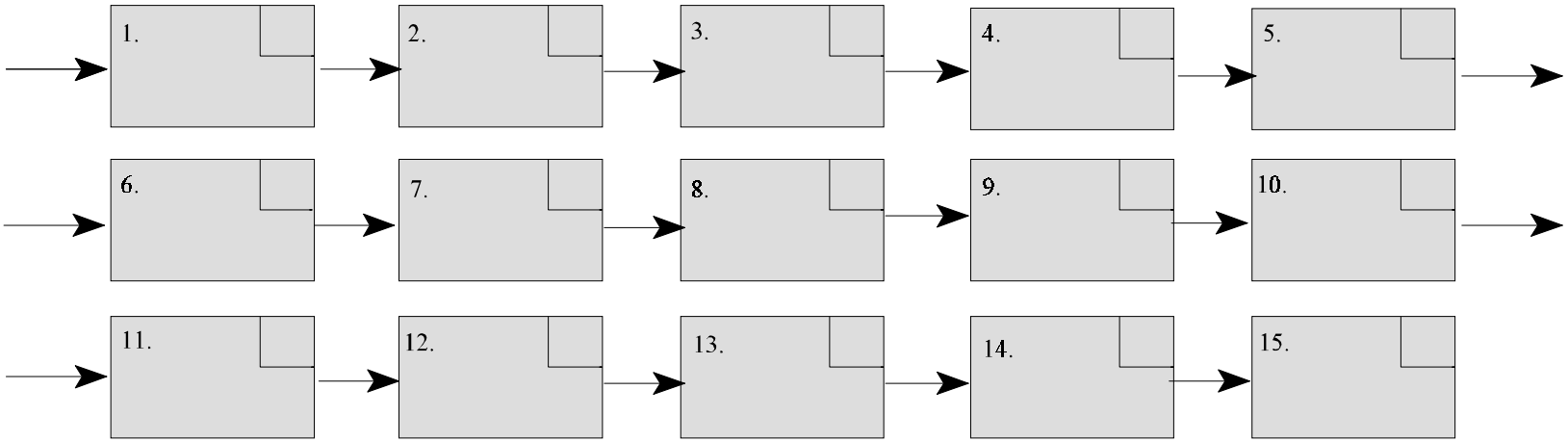
2.1 Process Schematic

Fill in the following table by identifying what type of surface finishing process (e.g., HASL) 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 surface finishing 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 surface finishing line.

Name of Process:

Process Step Letter
(see key below)

Ex.
A



Immersion Tin Process Step Key

[A] - Cleaner	[D] - Immersion Tin
[B] - Microetch	[E] - Water Rinse
[C] - Predip	[F] - Other (specify step)

2.2 Rinse Bath Water Usage

Consult the process schematic in section 2.1 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 method 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.**

Amount of water used by the surface finishing line when operating:			**gal/day**
Process Step Number [a]	**Flow Control [b]**	**Daily Water Flow Rate [c]**	**Cascade Water Process Steps [d]**
Example: 8	**R**	**2,400 gal./day**	**8 6**
		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 2.1 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** - Use the step numbers for rinses that are cascaded together.

Flow Control Methods Key
[C] - Conductivity Meter
[P] - pH Meter
[V] - Operator Control Valve
[R] - Flow Restricter
[N] - None (continuous flow)
[O] - Other (explain)

2.3 Process Parameters

Size of the room containing the process	sq. ft.
	Height of room
Are the overall process areas (not tank vent) ventilated? (Circle one)	No
Air flow rate:	cu.ft.min.
Do you have local vents?	No
Local vent air flow rate:	cu. Ft./min.

Type of process automation for surface finishing line: (circle one)

Automated non-conveyorized Automated conveyorized Manually controlled hoise

Manual (no automation) Other, specify:

2.4 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	LENGTH (inches)	WIDTH (inches)	NOMINAL VOLUME
Acid cleaner	in.	in..	gal.
Microetch	in.	in..	gal.
Acid predip	in.	in..	gal.
Immersion tin	in.	in..	gal.
Other (specify)	in.	in..	gal.
	in.	in..	gal.
	in.	in..	gal.
	in.	in..	gal.

2.5 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 PRODUCT NAME	MANUFACTURER (if applicable)	ANNUAL QUANTITY USED [a] (gallons)
CLEANER	1.			
	2.			
	3.			
	4.			
MICROETCH	1.			
	2.			
	3.			
	4.			
ACID PREDIP	1.			
	2.			
	3.			
	4.			
IMMERSION TIN	1.			
	2.			
	3.			
	4.			
OTHER (specify)	1.			
	2.			
	3.			
	4.			

[a] **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).**

2.6 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]	Tank Cleaning Method [c]	Duration of Replacement Procedure [d]	Personal Protective Equipment [e]	Method of Treatment or Disposal [f]	Annual Volume Treated or Disposed [g]
ACID CLEANER					**min.**		
MICROETCH					**min.**		
ACID PREDIP					**min.**		
IMMERSION TIN					**min.**		

[a] **Criteria for Replacement -**
[S] - Statistical process control
[P] - Panel square feet processed
[C] - Chemical testing
[T] - Time
[O] - Other (specify)

[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] **Tank Cleaning Method**
[C] - Chemical Flush
[W] - Water Rinse
[H] - Hand Scrub
[O] - Other (specify)

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

[f] **Personal Protective Equip. -**
Enter the letters of all the protective equipment used by the workers who physically replace the spent bath.
[E] - Eye protection
[G] - Gloves
[L] - Lab coat/sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except respiratory protection
[N] - None

[f] **Methods of Spent Bath Removal -**
[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
[RN] - Recycled on-site
[RF] - Recycled off-site
[O] - Other (specify)

[g] **Annual Vol. Treat. Or Disp. -**
Enter the yearly amount of the specific bath treated or disposed. Needed only if water testing is not done.

2.7 Chemical Bath Additions

Complete the following chart detailing the typical chemical additions that are made to maintain the chemical balance of each specific process bath. 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 Products Added	Criteria for Replacement[a]	Method of Chemical Addition to Tank[b]	Duration of Addition[c] (minutes)	Personal Protective Equipment[d]
CLEANER	**1.**					
	2.					
	3.					
	4.					
MICROETCH	**1.**					
	2.					
	3.					
	4.					
ACID PREDIP	**1.**					
	2.					
	3.					
	4.					
IMMERSION TIN	**1.**					
	2.					
	3.					
	4.					
OTHER (specify):	**1.**					
	2.					
	3.					
	4.					

[a]**Criteria for Replacement -**
Enter the letter for the criteria typically used to determine when bath replacement is necessary.
[S] - Statistical Process Control
[P] - Panel Square Feet Processed
[C] - Chemical Testing
[T] - Time
[O] - Other

[b]**Method of Chemical Addition to Tank -**
Enter the letters for the method typically used to add chemicals to the tanks.
[P] - Pumped Manually
[PR] - Poured
[S] - Scooped
[O] - Other

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

[d]**Personal Protective Equipment -** Enter the letters of all the protective equipment worn by the workers physically replacing the spent bath.
[E] - Eye protection
[G] - Gloves
[L] - Labcoat/Sleeved garment
[A] - Apron
[R] - Respiratory protection
[B] - Boots
[Z] - All except Respiratory Protection
[N] - None

Observer Data Sheet
DfE PWB Performance Demonstrations

Facility name and location: _____

Surface finishing process type and name: _____ Installation date: _____

Date: _____ Contact Name: _____

Test Panel Run	
Overall Surface Finishing process line dimensions Length (ft.): Width (ft.): Height (ft.):	
Average number of panels per rack:	Average space between panels in rack:
Average size of panel in rack: Length(in): Width (in.):	
At what % of capacity is the line currently running?	At what % of capacity is the line typically running?
What is the overall throughout? surface sq.ft./year How is it calculated:	
Estimated yield for surface finishing line:	
Number of thermal cycles the finished board can withstand:	
Note any unusual storage conditions or oxidation. Load system with layer 4 facing up or toward the operator.	
While running the test panels, verify each process step and complete the table on the next page.	

Test Panel Serial Numbers					
Test Board	**Serial #**	**Test Board**	**Serial #**	**Test Board**	**Serial #**
1.		3.		5.	
2.		4.		6.	

Test Panel Run				
Bath Name (from schematic)	**Equipment**[a]	**Bath Temp**	**Immersion Time**	**Drip Time**
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				

Overall System Time:

[a] List Number, type of

Agitation:
[PA] - Panel agitation
[CP] - Circulation Pump
[AS] - Air Sparge

Vapor Control:
[BC] - Bath Cover
[]FE} - Fully Enclosed
[VO] - Vent to Outside
[VC] - Vent to Control

Filter Type:
[BF] - Bag
[CF] - Cartridge

Heater Control:
[TH] - Thermostat
[TM] - Timer
[PR] - Programmed

Water Rinses:
[CN] - Continuous
[DP] - Continuous During Process
[PP] - Partial During Process

Verification of Part A (mark any changes on working copy of Part A):
Ventilation: Verify the type of ventilation as recorded in the Questionnaire:
Tank Volumes: Verify the length, width, and volume of each tank, as recorded in the Questionnaire:
Water use: Verify water use data, for each tank: Daily water flow rate verified ☐ Cascade process steps verified ☐
Pollution Prevention: Have you used any other pollution prevention techniques on the surface finishing line (e.g., covered tanks to reduce evaporation, measures to reduce dragout, changes to conserve water, etc.)? If yes, describe and quantify results (note: if results have not been quantified, please provide an estimate): If your throughput changed during the time new pollution prevention techniques were implemented, estimate how much (if any) of the pollution reductions are due to the throughput changes:

Filter Replacement						
Bath(s) filtered (enter process step #)						
Frequency of replacement:						
Duration of replacement process:						
Personal protective equipment (see key):						

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

Equipment Maintenance
Estimate the maintenance requirements (excluding filter changes and bath changes) of the surface finishing process equipment for both outside services calls (maintenance by vendor or service company) and in-house maintenance (by facility personnel).
Describe the typical maintenance activities associated with the surface finishing process line (e.g., motor repair/replacement, conveyor repairs, valve leaks, etc.)
Average time spent per week:
Average downtime:
If there a recurring maintenance problem? If yes, describe:

Rack or Conveyor Cleaning	Not Applicable ☐
Frequency of rack or conveyor cleaning:	
Rack Cleaning Method (see key): OR	
Conveyor Cleaning Method (see key):	
Number of personnel involved:	
Personal protective equipment (see key):	
Average time required to clean:	

Rack Cleaning Method:
[C] - Chemical bath on SF process line
[D] - Chemical bath on another line
[T] - Temporary chemical bath
[S] - Manual scrubbing with chemical
[M] - Non-chemical cleaning
[N] - None
[O] - Continuous cleaning

Conveyor Cleaning Method:
[C] - Chemical rinsing or soaking
[S] - Manual scrubbing with chemical
[M] - Non-chemical cleaning
[N] - None
[O] - Continuous cleaning

Personal Protective Equipment:
[E] - Eye Protection
[G] - Gloves
[L] - Labcoat/Sleeved garment
[R] - Respiratory Protection
[O] - Continuous Cleaning
[Z] - All except Respiratory Protection
[A] - Apron
[B] - Boots
[N] - None

Chemical Bath Sampling

Bath Type	Type of Sampling[a]	Frequency [b]	Duration of Sampling [c]	Protective Equipment [d]	Method of Sampling [e]
Cleaner					
Microetch					
Flux					
Solder					
Post Clean					
Other (specify)					
Other (specify)					

[a] **Type of Sampling**
[A] - Automated
[M] - Manual
[N] - None

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

[c] **Duration of Sampling:**
Enter the average time for manually taking a sample from the tank

[d] **Protective Equipment:**
Consult the key for the above table and enter the letters for all protective equipment worn by the person performing the chemical sampling.

[e] **Method of Obtaining Samples:**
[D] - Drain or spigot
[p] - Pipette
[L] - Ladle
[O] - Other (specify)

Process Description

Process Schematic

Fill in the table below by identifying what type of alternative surface finishing process (e.g., immersion tin) your company uses. Then, using the key at the bottom left of the page, identify which letter corresponds with the first bath 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 alternative surface finishing process is represented. If your process step is not represented by the key below, complete the chart by writing in the name of the process step in your particular surface finishing line.

Process Automation Letter (see key below right)

Type of Process
(write in process name)

Ex. A T

Process Steps of Your Facility
(begin here)

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16.

Standard Bath Types		
[A] - Center	[G] - Accelerator	[P] - Immersion Tin
[B] - Conditioner	[H] - Enhancer	[Q] - Immersion Silver
[C] - Micro Etch	[J] - Electroless Nickel	[R] - OSP
[D] - Pre-dip	[K] - Electroless Gold	[S] - Anti-tarnish
[E] - Catalyst	[L] - Electroless Palladium	[W] - Water rinse
[F] - Activator	[M] - Immersion Palladium	[O] - Other (specify step)
	[N] - Immersion Gold	

Process Automation
Please list all the process types with which the above process may be operated in:_____

Process Automation Key

[P] - Automated on-conveyorized	[S] - Manually controlled hoist	[V] - Other (specify)
[Q] - Automated conveyorized	[T] - Manual (no information)	
[R] - Partially automated	[A] - All of the above	

Comparative Evaluation: If the facility has switched from a previous system to the current system, complete this page.
Product Quality: What, if any, changes were noticed in the quality of the boards produced? (Yield change?)
Installation: How long was the debug period when this system was installed? What were the types of problems encountered:
Manufacturing Process Changes: How did you change your upstream or downstream processes when this system was installed (e.g., did you have to make changes in your solder mask)?
Waste Treatment: Have any of your waste treatment methods or volumes changed due to the installation of this system (not associated with volume changes due to throughput changes)? If yes, describe the change(s) and attach quantitative information, if available:
Process Safety: Have any additional OSHA-related procedures or issues arisen as a result of changing to the present system (e.g., machinery lock-outs while cleaning, etc)? If so, describe:
Customer Acceptance: Have customers accepted the new process? Why or why not:
Other: Describe any other issues that have arisen as a result of the new process.

Supplier Data Sheet

DfE Printed Wiring Board Project
Alternative Technologies for Surface Finishing

Manufacturer/Supplier Product Data Sheet

Manufacturer Name: _____

Address: _____

_____

Contact: _____

Phone: _____

Fax: _____

How many alternative making holes conductive product lines will you submit for testing? _____

Please complete a Data Sheet for each product line you wish to submit for testing. In addition, if you have not already done so, please submit the material safety data sheets (MSDS), product literature, and the standard manufacturer instructions for each product line submitted.

Product Line Name: _____ Category:*_____

*** Categories of Product Lines:**

A. HASL
B. Immersion Tin
C. Immersion Palladium
D. Electroless Nickel/Immersion Gold
E. Nickel/Palladium/Immersion Gold
F. OSP - (Thin)
G. OSP - (Thick)

For the product line listed above, please identify one or two facilities that are currently using the product line at which you would like your product demonstrated. Also, identify the location of the site (city, state) and whether the site is 1) a customer production site, 2) a customer test site, or 3) your own supplier testing site.

Facility 1 Name and Location:_____

Type of Site: _____

Facility Contact: _____

May we contact the facility at this time (yes or no):_____

Facility 2 Name and Location: _____

Type of Site: _____

Facility Contact: _____ Phone: _____

May we contact the facility at this time (yes or no): _____

Energy Usage						
For each piece of equipment in the surface finishing line using energy, complete the table below:						
Equipment Type	**Tank or Station # [a]**	**Power Rating (from nameplate)**	**Load (1% capacity in use)**	**Equipment Cost**	**Period of Usage**	**Machine Control**
					_ continuous _ continuous during process cycle _ partial during process cycle. If partial, record how often: _ other:	_ timer _ program _ operator/manual _ other:
					_ continuous _ continuous during process cycle _ partial during process cycle. If partial, record how often: _ other:	_ timer _ program _ operator/manual _ other:
					_ continuous _ continuous during process cycle _ partial during process cycle. If partial, record how often: _ other:	_ timer _ program _ operator/manual _ other:
					_ continuous _ continuous during process cycle _ partial during process cycle. If partial, record how often: _ other:	_ timer _ program _ operator/manual _ other:
					_ continuous _ continuous during process cycle _ partial during process cycle. If partial, record how often: _ other:	_ timer _ program _ operator/manual _ other:

[a] **Specify whether tank number of process flow diagram step numbers are used.**

Special Product Characteristics

1. Does the process operate as a vertical process, horizontal process, or either?
_____

2. Average number of thermal excursions the finished board can withstand?
_____

_____

3. Most likely process step preceding the beginning of the surface finish application?
_____

_____

4. Should the application of solder mask occur after the application of the surface finish, or before?
_____

_____

5. Which of the following technologies is the surface finish compatible with?
(Circle all applicable choices.)

A. SMT
B. Flip Chip
C. BGA
D. Gold Wire Bonding
E. Aluminum Wire Bonding
F. Other, Explain:
_____

6. Please state cycle time of surface finish process line. _____

7. Please describe any special process equipment recommended (e.g., high pressure rinse, air knife, dryer, aging equipment, etc.).
_____
_____

Product Line Constraints

1. Please list any substrate incompatibilities (e.g., BT, cyanate ester, Teflon, Kevlar, copper invar copper, polyethylene, other [specify]) _____

2. Please list compatibilities with solder masks.
_____
_____

3. Are there any special requirements needed for the soldering process (e.g., type of flux, etc.)?
_____
_____

4. Average shelf-life of finished boards?
_____

5. Other general comments about the product line (include any known impacts on other process steps).____
_____
_____

Bath Life

Please fill in the following table (for bath listings, please refer back to your process description on page 2).

Bath	Recommended Treatment/Disposal Method [a]	Criteria for Dumping Bath (e.g., time, surface sq ft of panel processed, concentration, etc.)	Recommended Bath Life (in terms of criteria listed at left)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

[a] Attach and reference materials, if necessary.

Costs:

Chemical Cost
Please provide the cost per gallon (or pound) of chemical for each chemical product required to operate this alternative surface finishing product line. It is recognized that the cost of chemicals is, in part, dependant on the amount of chemical purchased (i.e., volume discounts) and may vary accordingly. If cost would decrease, please write decreased cost in margin along with volume of chemical required for pricing discount.

Bath Name	Product Name	Chemical Cost ($/gal or $/lb)
1.	A.	
	B.	
	C.	
2.	A.	
	B.	
	C.	
3.	A.	
	B.	
	C.	
4.	A.	
	B.	
	C.	
5.	A.	
	B.	
	C.	
6.	A.	
	B.	
	C.	
7.	A.	
	B.	
	C.	

Equipment Cost

Do you recommend or suggest any specific equipment manufacturers to customers for obtaining process equipment to operate this surface finish line? If so, why? Please provide the contact information for equipment manufacturer below.

Equipment Company # 1
Company Name: _____
Contact Name: _____
Phone number: _____
Equipment Type: _____

Equipment Company # 2
Company Name: _____
Contact Name: _____
Phone number: _____
Equipment Type: _____

Do either of the companies listed above manufacture equipment specifically designed for your product line? Which one?
_____

If so, what is special or different about the equipment design?
_____

_____
_____