



GREEN AMERICA
**CLEAN ELECTRONICS
PRODUCTION NETWORK**
A project of the Center for Sustainability Solutions

Clean Electronics Production Network

Qualitative Exposure Assessment Process Guide

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Responsible Business Alliance*



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Introduction

The Clean Electronics Production Network (CEPN), a multi-stakeholder collaboration addressing complex workplace health and safety challenges in the electronics supply chain, has developed this Qualitative Exposure Assessment (QEA) Guide to aid companies in assessing the potential risk of worker exposure to harmful chemicals during electronics manufacturing and assembly operations. CEPN serves as a platform for collaborative innovation where diverse stakeholders—including technology suppliers, brands, labor and environmental advocates, governments and other leading experts—work together to understand, address, and eliminate worker exposures to toxic chemicals in electronics production.

The QEA is a tool that can be used by a range of facilities, including those that have little to no experience assessing worker exposure risks. The QEA rapidly identifies “high risk” chemical exposure operations that may require immediate corrective actions, allowing facilities to target limited resources and more sophisticated monitoring on the most hazardous condition. In addition, the QEA provides documentation of a facility’s exposure assessment program and which may be required to demonstrate compliance with Chemical Management programs.

Benefits of using the QEA include:

- **Simple and Low Cost:** QEA consists of simple forms and detailed instructions for documenting chemical use, hazards control systems, and worker tasks. The Assessment can be completed by EHS Staff with limited industrial hygiene expertise.
- **Reduce Risk:** Identify Job Tasks with a high risk of chemical exposures that might otherwise go unnoticed.
- **Improvement:** Generates an Overall Risk Ranking that can be used to determine necessary controls, ways to improve performance, and reduce exposure risk.
- **Documentation:** Provides documentation and completion of a critical element in chemical management system to proactively identify risk and mitigation methods.

This guide contains a description of the QEA, including the 4 steps in the methodology, as well as an example of a completed QEA Data Collection Form (see Appendix A). A blank editable QEA Data Collection Form is provided in a separate document. If parts or this document as a whole is incorporated in other manuals, CEPN would appreciate attribution.

QEA Overview

A QEA is workplace exposure risk assessment based on integration of information and judgment, and not based on a rigorous quantitative analysis of workplace sampling/analytical data. Qualitative assessments use professional judgment to assess and manage occupational exposure to chemical agents based on information regarding physical and toxicological properties of the chemicals being utilized and the workplace conditions/practices involving the use of the chemicals. Qualitative assessments allow preliminary decisions to be made

concerning potential occupational exposures without necessarily performing a QEA. Quantitative Assessments require a rigorous measurements of workplace exposures utilizing air sampling/analysis techniques.

The term "professional judgment" implies that the risk assessment is based on the evaluations of an Environmental Health & Safety (EHS) professional who has sufficient education, training and knowledge to determine the:

- a) Health hazard classification of chemical products
- b) Physical/chemical properties of the chemical products
- c) Effectiveness of workplace chemical exposure controls

Workplace exposure controls include engineering controls, administrative work practices and the use of Personal Protective Equipment (PPE) to prevent chemical exposures. A basic understanding of Industrial Hygiene workplace evaluation principles and practices is required to conduct an accurate Qualitative Exposure Assessment.

QEA Scope

The use of this QEA process is limited to workplace operations that involve volatile liquids, vapors or gasses. This QEA should not be used to estimate exposure risk to solid materials, nonvolatile dust, physical hazards, radiological or biological agents.

QEA Methodology – 4 Steps

The QEA methodology includes the following four steps. These are outlined in detail in the subsequent section.

Step	Description
Step 1	Identification of the individual process flow steps (i.e. "Job Task") for the manufacturing process being evaluated
Step 2	Identification of all manufacturing/processing materials (product names) which are utilized in each of the identified manufacturing process flow steps (i.e. "Job Task")
Step 3	Completing a QEA of the Job Task to determine the Qualitative Risk Ranking of potential chemical exposures
Step 4	Determination of Recommendations/Next Steps based on the Qualitative Risk Ranking results

Qualitative Risk Ranking

The QEA will determine a Qualitative Risk Ranking for each of the Job Task evaluated, as follows:

- **Acceptable:** A Qualitative Risk Ranking of "Trivial" or "Low" indicates the existing exposure controls are considered acceptable. Employee exposures to the Job Task's process chemicals can be assumed to be below the applicable Occupational Exposure Limits. ***No quantitative exposure measurements are necessary.***
- **Uncertain:** A Qualitative Risk Ranking assessment of "Moderate" indicates an uncertain exposure potential. There is a potential for chemical exposures to exceed the applicable Occupational Exposure Limit during the performance of the Job Task. ***Additional Quantitative assessments may be necessary to better understand the employee exposure levels.***
- **Unacceptable:** A Qualitative Risk Ranking assessment of "High" or "Very High" indicates a potential for employee exposures to exceed the applicable Occupational Exposure Levels. ***Additional exposure controls are required to reduce the potential for chemical exposures to employees.***

Recommended Chemical Exposure Control Strategies to reduce the Qualitative Risk Ranking from "Unacceptable" or "Uncertain" to "Acceptable" are outlined in Step 4 below.

QEA INSTRUCTION GUIDE

Step 1:

Identification of the individual process flow steps (i.e. "Job Task") for the selected manufacturing process being evaluated:

- Interview the Process Line Manager, Process Engineer and employees to obtain the information necessary to characterize the Job Task and determine the chemical exposure potential during the performance of the Job Task. Employees who perform the Job Task should be interviewed and asked to describe all tasks involving process chemicals (including task performed during prep work, clean up, chemical disposal or maintenance activities involving the use of chemical products). Employees should be asked to describe any protective measures they undertake to prevent chemical exposures.
- Review manufacturing Standard Operating Procedures, product Build of Materials (BOM) or other manufacturing process descriptions to identify all manufacturing processes (Job Task) that utilize chemical products (e.g. manufacturing processing materials/products, adhesives, bonding agents, fluxes, lubricants, cleaning solvents and tool maintenance products)

- Conduct a thorough walkthrough of the job site and observe the employees while they perform the Job Task to ensure a full understanding of the chemical handling processes and potential chemical exposures is known
- Observe work site for exposure controls (e.g. engineering controls, administrative controls, such as the use of Personal Protective Equipment (PPE) that are utilized to control employee exposures to the process chemicals during the Job Task
- Document findings on the **QEA Data Collection Form** (see example in Appendix A; blank editable form in a separate document)

JOB TASK DESCRIPTION:

- **Production Line / Manufacturing Process:** *Document the name of Production Line or Manufacturing Process being assessed*
- **Job Task name:** *Document the name of the Job Task being assessed*
- **Job Task Specification #:** *Document the Job Task Specification (Spec Number) or work procedure number*
- **Job Task workstation description:** *Provide brief description of workstation and manufacturing equipment*
- **Job Task description:** *Provide brief description of work activities involving the use and handling of Chemical Products that are performed by the employee at the workstation during completion of Job Task*
- **Job Task duration, frequency, variability:** *Provide description of the length of time, frequency and variability of the Job Task operations involving the identified Chemical Products*

JOB TITLE

- **Job title(s) of employees performing Job Task:** *Provide the Job Titles of all employees performing the Job Task that will have similar chemical exposure potentials*
- **Number of employees with Job Title who perform the Job Task**

EXPOSURE CONTROLS

- **Engineering Controls:** *Provide description of engineering controls employed to control employee chemical exposures (e.g. process enclosures, local exhaust ventilation, general room exhaust etc.)*
- **Administrative Controls** *Provide description of administrative controls employed to control employee chemical exposures (e.g. production limits, Job Task rotation, chemical use rate limitations etc.)*

- **Personal Protective Equipment:** *Provide description of any Personal Protective Equipment (PPE) utilized by employees during the Job Task (e.g. name and type of chemical protective gloves, splash proof chemical goggles, chemical apron, chemical protective suits, chemical protective boots, name and type of respiratory protection, etc.)*
- **Notes/Observations:** *If applicable, describe any additional workplace observations of the Job Task relevant to the chemical exposure controls or factors that could affect potential employee chemical exposures*

Step 2

Identification of all manufacturing/processing materials (product names), which are utilized in each of the identified manufacturing process flow steps (Job Task):

- Obtain a Global Harmonized System (GHS) formatted Safety Data Sheet (SDS) for all process materials utilized during the Job Task being evaluated
- Document the manufacturing process chemical product information (chemical product manufacturer's name and product name(s)) on the **QEA Data Collection Form** (see example in Appendix A; blank editable form is available in a separate document)

CHEMICAL INVENTORY:

- **Chemical products used during the Job Task (Product's Manufacturer's Name, Product Name):** *List the production Chemical products that are utilized during the Job Task. Include Manufacturer's Name and Product Name*
- **Usage rate of Chemical Products used during Job Task:** *Provide information on quantities and usage rates of the chemical products utilized during the Job Task*

Step 3

Completing QEA of the Job Task to determine the Qualitative Risk Ranking of potential chemical exposures:

A) DETERMINE THE HEALTH EFFECTS RATING:

To account for the inherent toxicity of a chemical product, a Health Effects Rating of 0 - 4 is determined according to Table 1. Relevant acute and chronic toxicity data should be considered when scoring a chemical's Health Effect Rating. Scoring should be based on the product's GHS Health Hazard classification or published toxicology testing results (e.g. GHS Acute Toxicity, GHS Carcinogenicity, GHS Reproductive Toxicity, Lethal Dose 50% oral, Lethal Concentration 50% Inhalation 4 hr, etc.).

















Review the product's Safety Data Sheet (SDS) to determine the United Nations Globally Harmonized System of Classification and Labeling (GHS) Health Hazard Classification* for the product/mixture. The SDS's Section 2 (Hazard Identification) and Section 11 (Toxicological Information) list the GHS Health Hazard Classification and toxicity information of the product. It may be necessary to contact the chemical product's manufacturer for additional toxicity information if the SDS does not include the GHS Health Hazard Classification or has insufficient information to determine the GHS Health Hazard Classification or Health Hazard Rating.

If the SDS withholds the chemical ingredient information as Confidential Business Information or Proprietary ingredients contact the product's supplier/manufacturer and request the chemical ingredient information for the purposes of conducting an employee chemical exposure assessment. It may be necessary to enter into a Non-Disclosure Agreement with the product's manufacturer/supplier to obtain release of the chemical ingredients. If the GHS SDS provides a GHS Health Hazard Classification, it may not be necessary to obtain full disclosure of proprietary ingredients as the QEA Health Effects Rating can be determined by the GHS Health Hazard Classification listed on the SDS.

If the chemical product is a mixture (2 or more chemical ingredients) the Health Effects Rating is based on the toxicity of the mixture. Consult the GHS of Classification¹ for additional guidance on GHS Health Hazard classification of mixtures.

¹United Nations Globally Harmonized System of Classification and Labeling (GHS)
http://www.unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev07/English/ST_SG_AC10_30_Rev7e.pdf

Table 1

Health Effects Rating	GHS* Acute Toxicity	GHS Carcinogenicity or Reproductive Toxicity	GHS Skin Irritant, Corrosive or Serious Eye Damage	GHS Respiratory Sensitization	GHS Skin Sensitization	GHS Germ Cell Mutagen	GHS Specific Target Organ Toxicity - Single or Repeated Exposure	Lethal Dose Oral 50% (LD50) (mg/kg)	Lethal Concentration 50% (LC50) 4 hr inhalation (ppm)	Description
0								> 2,000	>20,000	Practically non-toxic
1	Category 4 							>300 and ≤ 2,000	>2500 and ≤ 20,000	Slightly toxic
2	Category 3 		Category 3 				Category 3 	> 50 and ≤ 300	>500 and ≤2500	Moderately toxic
3	Category 2 	Category 2 	Category 2 			Category 2 	Category 2 	>5 and ≤ 50	>100 and ≤500	Highly toxic
4	Category 1 	Category 1A and 1B 	Category 1 	Category 1A and 1B 	Category 1 	Category 1A and 1B 	Category 1 	≤ 5	≤100	Extremely toxic

B) DETERMINE THE EXPOSURE RATING:

The Exposure Rating (0-4) is based on the vapor pressure of the chemical product of concern, the current engineering/administrative exposure controls employed and the frequency/duration of the potential chemical exposure during the Job Task being evaluated. The Exposure Rating is determined by multiplying the individual ratings for each of the following three variables; Dispersion Rating, Level of Control Rating and Frequency/Duration Rating).

B-1 Dispersion Rating:

Review the product's SDS Section 9 (Chemical and Physical Properties) to obtain the vapor pressure of the chemical product/mixture. If the processing material is a mixture of different chemical ingredients, obtain or calculate the vapor pressure for the mixture.

Dispersion Rating	Vapor Pressure @ 20C	
1	<25 mmHg	33 mbar
2	25 - 100 mmHg	33 - 133 mbar
3	100 - 250 mmHg	133 - 333 mbar
4	>250 mmHg	> 333 mbar

B-2 Level of Control Rating:

Determine the Level of Control Rating based on the chemical exposure controls utilized:

Level of Control Rating	Level of Control
0	closed system; minimal potential for release to work environment
1	semi-closed system; release potential at identified points; effective engineering controls in place at identified points
2	open system; effective engineering controls in place to contain/remove airborne contaminants. effective use of administrative and PPE controls
3	open system; some degree of engineering controls
4	open system; ineffective or no exposure controls

B-3 Frequency/Duration Rating

Determine the Frequency/Duration Rating based on the Task Duration and Frequency that the Job Task is performed (e.g. monthly, less than monthly, or daily).

Job Task Duration	Frequency of Job Task		
	>1/month	>daily/<monthly	daily
<15 min	1	1	1
15 min - 1 hour	1	2	2
1-2 hour	1	2	3
2-4 hour	1	3	4
>4 hour	1	4	5

B-4. Calculate the Exposure Rating

Multiply the "Dispersion Rating" x "Level of Control Rating" x "Freq/Duration Rating" to obtain the "Multiplied Total" (i.e. "Dispersion Rating" x "Level of Control Rating" x "Freq/Duration Rating" = "Multiplied Total").

Based on the Multiplied Total, determine the Exposure Rating (0-4):

Multiplied Total	Exposure Rating
<10	0
10 - 20	1
21 - 30	2
31 - 40	3
>40	4

C) DETERMINE THE QUALITATIVE RISK RANKING:

Using the Health Effects and Exposure Ratings from Steps A and B, use the Qualitative Risk Ranking Matrix to determine the Qualitative Risk Ranking (i.e. Trivial, Low, Moderate, High or Very High).

Qualitative Risk Ranking Matrix

HEALTH Effects Rating	4				Very High	RISK RANKING Trivial to Low Moderate High to Very High	
	3			High			
	2		Moderate				
	1	Low					
	0	Trivial					
		0	1	2	3	4	
Exposure Rating							

- Document the Health Effects Rating, Exposure Rating, and the calculated Qualitative Risk Ranking results on the **QEA Data Collection Form** (see example in Appendix A; blank editable form is available in a separate document)

Step 4

Recommendations/Next Steps are determined based on the Qualitative Risk Ranking results for each Job Task evaluated:

Acceptable: A Qualitative Risk Ranking of "Trivial" or "Low" indicates the existing exposure controls are considered acceptable. Employee exposures to the Job Task's process chemicals can be assumed to be below the applicable Occupational Exposure Limits. ***No quantitative exposure measurements are necessary.***

In the event the process chemicals change over time, or if the exposure controls are changed, the Qualitative Risk Assessment should be repeated to ensure the revised Job Task remains in "Trivial" or "Low" category.

Uncertain: A Qualitative Risk Ranking assessment of "Moderate" indicates an uncertain exposure potential. There is a potential for chemical exposures to exceed the applicable Occupational Exposure Limit during the performance of the Job Task. ***Additional Quantitative assessments may be necessary to better understand the employee exposure levels.***

To reduce the Qualitative Risk Ranking to "Acceptable" facilities may elect to utilize additional exposure controls (listed below) in lieu of conducting a QEAs. A new Qualitative Risk assessment would be required to verify the additional exposure controls are sufficient to reduce the Risk Ranking to Acceptable.

Unacceptable: A Qualitative Risk Ranking assessment of "High" or "Very High" indicates a potential for employee exposures to exceed the applicable Occupational Exposure Levels. ***Additional exposure controls are required to reduce the potential chemical exposures to employees.***

The implementation of additional exposure controls (listed below) should be instituted to reduce potential employee chemical exposures.

Recommended Exposure Controls

Additional exposure control strategies to reduce employee chemical exposures include any of the following actions:

- Manufacturing Process Modifications
 - ✓ Process modifications to eliminate the use of hazardous chemical materials/products from the manufacturing process
 - ✓ Substitution of the hazardous chemical products with less toxic ingredients
 - ✓ Substitution of the hazardous chemical products with a product that has a lower percentage of the hazardous ingredients and corresponding lower toxicity.
 - ✓ Substitution of the hazardous chemical products with an alternative production material with a lower vapor pressure.
- Engineering Exposure Controls
 - ✓ Installation of Process Enclosures (no open chemical use)
 - ✓ Installation of Local Exhaust Ventilation
 - Local exhaust ventilated enclosure
 - Local exhaust fume hood
 - Local exhaust fume extractor
- Administrative Exposure Controls
 - ✓ Use of Personnel Protective Equipment (PPE) to prevent chemical contact/exposure with employees
 - Skin Protection
 - Chemical Resistant Gloves
 - Chemical resistant clothing (e.g. chemical aprons, gowns)
 - Chemical resistant boots/footwear
 - Eye/Face Protection
 - Splash proof chemical goggles
 - Chemical Face Shields
 - Respiratory Protection
 - Supplied Air Respirator

- Air Purifying Respirators
- Note: Reliance on Respiratory Protection to control occupational exposures requires implementation of a comprehensive Respiratory Protection Program. Quantitative Exposures measurements of the work place may be necessary to ensure the use of the selected Respirator is sufficient to control employee exposures.
- Additional information on implementation of a comprehensive respiratory protection program can be found at the following websites:
 - US OSHA Respiratory Protection Guidance
<https://www.osha.gov/SLTC/respiratoryprotection/guidance.html>
 - US NIOSH Respiratory Protection Selection
<https://www.cdc.gov/niosh/docs/2005-100/pdfs/2005-100.pdf>
 - Common Challenges of a Global Respiratory Protection Program
<http://www.oh-2018.com/files/2017/05/Session-15a-McCullough-27.04.17-14.25.pdf>
- Document the Health Effects Rating, Exposure Rating, the calculated Qualitative Risk Ranking results, and the Recommendations/Corrective Actions on the **QEA Data Collection Form** (see example in Appendix A; blank editable form is available in a separate document)
- Repeat the Qualitative Risk Ranking for each of the chemical products utilized during the Job Task

Appendix A – Example of Completed QEA Data Collection Form

A Qualitative Exposure Assessment is completed for each job task. Use one QEA Data Collection Form for each job task.

Job Task Description

Production Line or Manufacturing Process name: XYZ Laptop Production

Job Task name: Monitor Screen Assembly

Job Task Specification #: XYZ 123456

Job Task workstation description:

Workstation consists of flat work table. The workstation has a movable magnifying glass with built in work light. Parts bins are located on top of table. Employee sits on chair in front of workstation table. Two workstation solvent dispense pump canister (50 ml each) are located on the work station table. Bulk solvent containers (1 liter bottles) are stored in Flammable Storage Cabinet located next to the workstation. A solvent waste trash can with lid is located on the floor below workstation. Tubes (20 ml each) of Ace Superglue adhesive are stored in parts bin.

Job Task description:

Employee installs LCD screen on clam shell lid and connects ribbon connector to LCD screen. Employee wipes outer perimeter of clam shell (around the LCD screen) with cleaning solvent (Acetone) with a saturated wiper. Solvent is dispensed onto wiper from solvent dispense pump canister. After solvent evaporates, employee opens one 2 ml tube of Ace Superglue and places bead of adhesive (Ac e Superglue) around perimeter of LCD screen. Employee places cover glass screen on top of adhesive. After 1 minute dry time, employee uses adhesive remover solvent (Benzene) to remove excess adhesive from perimeter of cover glass. Employee places waste solvent wipers into solvent waste trash can. Employees refill the solvent dispense pump canister at the workstation by hand pouring solvents from the bulk containers into the dispense pump containers.

Job Task duration, frequency, variability:

Assembly of one PC glass cover on upper clam shell takes approximately 5 minutes. Employees process 12 units per hour. Employee performs same task for 8 hours/day. Employees are given one 15 minute morning break and one 15 minute afternoon break. Employees are given 30 minutes for lunch. The work shift, including break time, is 9 hrs per day. Employee's work 6 days per week. The is very little variation in work process between employees

Job Title Description

Job title(s) of employees performing the Job Task: Manufacturing Technician Level 2

Number of employees performing Job Task: 50

Exposure Controls

Engineering Controls:

Workstation is located on factory floor. Factory floor is an air-conditioned space (22 degree C 50% Relative Humidity, HVAC system provides 10% makeup air). No local exhaust is provided at workstation (General Exhaust of factory floor only).

Administrative Controls:

None

Personal Protective Equipment (PPE):

Safety glasses, Chemical resistant gloves Brand: Ajax Model XYZ, Latex, 8'cuff, 1 mill thick

Notes/Observations or results of any prior Quantitative Exposure Assessment findings:

Solvent odors present during application of adhesive cleaning solvent to remove waste adhesive and during refilling of solvent dispense canisters with bulk solvent bottles. Employees state they have eye irritation at end of work shift which they attribute to use of solvents.

Chemical Inventory

Chemical products used during the Job Task: Product's Manufacturer's Name, Product Name:

- 1.) Ace Chemical Company, Acetone Reagent Grade 99%)
- 2.) Ace Chemical Company, Benzene Reagent Grade 99%)
- 3.) Ace Chemical Company, Ace Superglue

Usage rate of Chemical Products used during Job Task:

10 ml of Acetone are used to clean each unit. (1.2 liters during one work shift).
20 ml of Benzene are used to clean waste adhesive from each unit (2.4 liters during one work shift)
2 ml of Ace Superglue is applied to each unit (24 ml during one work shift)

Qualitative Exposure Assessment Risk Ranking

Product Name (1): Ace Chemical Company, Acetone Reagent Grade 99%

Health Effects Rating: "0" based on LD50 Oral - Rat - 5,800 mg/kg

Calculated Exposure Rating: "4" based on exposure score of 45

- Vapor Pressure: 184.0 mmHg
- Dispersion Rating: 3
- Level of Control Rating: 3
- Frequency/Duration Rating: 5

Overall Risk Ranking: TRIVAL

- Low to Trivial / Acceptable
- Moderate / Uncertain
- Very High to High / Unacceptable

Recommendations/Future Actions:

There is no potential for overexposure to Acetone during process or solvent dispense can refill. Recommend changing glove type to acetone compatible chemical resistant gloves (Butyl rubber, minimum 2 mill thick).

Product Name(2): Ace Chemical Company, Benzene Reagent Grade 99

Health Effects Rating: "4" based on GHS Carcinogen Category 1

Calculated Exposure Rating: "4" based on exposure score of 45

- Vapor Pressure: 100 mm Hg at 25C
- Dispersion Rating: 3
- Level of Control Rating: 3
- Frequency/Duration Rating: 5

Overall Risk Ranking: VERY HIGH

- Low to Trivial / Acceptable
- Moderate / Uncertain
- Very High to High / Unacceptable

Recommendations/Future Actions:

Initiate search for substitution adhesive cleaner that does not contain Benzene or other carcinogenic/reproductive toxic ingredients. Until substitute material is utilized, install local exhaust to remove Benzene vapors at point of application. Pore bulk benzene into solvent dispenser or container within ventilated hood rated for solvent use. Utilize NIOSH certified or equivalent respiratory protection for Benzene. Conduct Quantitative Industrial Hygiene assessment to determine adequacy of local exhaust ventilation and respiratory protection. Inform Plant Manager of potential for Benzene exposure and recommended corrective actions.

Product Name(3): Ace Chemical Company, Ace Superglue

Health Effects Rating: "0" based on LD50 > 5000 mg/kg

Calculated Exposure Rating: "1" based on exposure score of 15

- Vapor Pressure: < 0.2 mm Hg
- Dispersion Rating: 1
- Level of Control Rating: 3
- Frequency/Duration Rating: 5

Overall Risk Ranking: Trivial

- Low to Trivial / Acceptable
- Moderate / Uncertain
- Very High to High / Unacceptable

Recommendations/Future Actions:

No potential for overexposure to chemical components of Ace Superglue. Recommend changing glove type to acetone compatible gloves (Nitrile, minimum 2 mill thick)

If required, add additional Risk Ranking evaluations for other Products utilized during the task.

Assessor Name: John Smith

Date of Assessment: 29 MAR 2018