National Aeronautics and Space Administration

NASA Independent Assessment Team Report: Response to the U.S. Office of Special Counsel Memo OSC File No. DI–09–1621 Dated May 19, 2009

Lead, Independent Assessment Team

10/09/09

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Introduction

The National Aeronautics and Space Administration (NASA) Independent Assessment Team report conforms to the requirements stated in 5 U.S.C.§1213(d) per the May 19, 2009 U.S. Office of Special Counsel's OSC File No. DI–09–1621 memorandum to Mr. Christopher Scolese, Acting Administrator. This report consists of four sections:

Section 1.0: Executive Summary—The Executive Summary provides the background for initiating the Independent Assessment (IA), the IA Team structure, the investigative process, and the investigation results.

Section 2.0: Investigation Details and Results—This section addresses the IA Team's assessment of the NASA Goddard Space Flight Center's (GSFC's) actions in response to Mr. Bassey Udofot's technical concerns during his employment at GSFC; the IA Team's response to Mr. Udofot's concerns as stated in the Office of Special Counsel's (OSC) letter; and Mr. Udofot's additional request to evaluate the use of tap water during the final rinse operation. **Mr. Udofot confirmed on June 17, 2009 that the IA Team's list of areas to assess completely covered his technical concerns**. The results of the IA Team's list of areas to assess are documented in Section 2.2.2 of this report.

Section 3.0: Supporting Documentation—Corroborative materials listed as attachments referenced in the report are included in Section 3.0 (e.g., OSC letter, e-mails, and reports).

Section 4.0: Acronyms—A list of acronyms (and their definitions) used throughout the report is provided in this section.

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1.0 Executive Summary

In a letter dated May 19, 2009, the Acting Special Counsel, U.S Office of Special Counsel (OSC) requested that the National Aeronautics and Space Administration (NASA) conduct an investigation into a "whistleblower's disclosure that officials at the NASA Goddard Space Flight Center (GSFC), Greenbelt, Maryland, are engaging in conduct which may constitute a violation of a law, rule, or regulation and a substantial and specific danger to public health and safety."

Mr. Bassey Udofot, a former employee at the GSFC, alleged that he witnessed "practices that placed employees in danger of exposure to hazardous chemicals and compromised the quality and safety of the products that the Plating Group handled." Pursuant to 5 U.S.C. 1213(c) and (g), NASA chartered an independent assessment team to look into Mr. Udofot's allegations. As a result of this investigation, the Independent Assessment (IA) Team concluded that there was **no violation of law, rule, or regulation and that Mr. Udofot's allegations that operating practices placed employees in danger and compromised the quality and safety of the products were not founded and did not constitute a substantial and specific danger to public health or safety**. However, the investigation revealed that there was one non-compliance with documentation procedures set forth in the work instructions. Specifically, the team found that the GSFC electroplating laboratory did not document in writing the final test results of the gold plating and nickel strike plating thickness, as expressed by Mr.Udofot in the OSC letter (Attachment 1: OSC Letter). The plating process was developed in accordance with the International Organization for Standardization (ISO) 9001 (Quality Management System). According to NASA Policy Directive 1280.1 (NASA Management System Policy), ISO 9001 is a type of management system. The management system provides a structure whereby NASA can measure how effectively it is performing its mission and meeting its objectives; focus on where improvements are needed; and ensure that value is delivered to its customers.

Despite this non-compliance, there was no risk to the final product or any risk to employees. As a result of this investigation, the IA Team has prepared a number of recommendations for GSFC to implement and is referring this report to the Administrator for his review.

1.1 Background: Mr. Udofot's Concerns

Mr. Udofot was employed at GSFC from March–December 2008. He was the Aerospace Engineer Group Leader at GSFC's Advanced Manufacturing Branch Plating Group. The Plating Group conducts its activities in GSFC's Electroplating Facility in Building 5 (Plating Lab).

Mr. Udofot raised concerns to OSC in the following two technical areas: Industrial Hygiene (IH) and Quality Assurance (QA). With respect to IH, Mr. Udofot raised two specific areas of concern. The first area of concern pertained to employee exposure to acid mists, cyanides, and heavy metals, specifically hexavalent chromium, through inhalation while working at the electroplating tanks and during the use of shop air for parts drying. The second area of concern pertained to employee exposures to heavy metals and acids through skin exposure while working at the electroplating tanks and during the use of shop air to dry parts.

With respect to QA, Mr. Udofot alleged that there were problems with maintenance of the plating tanks in the GSFC Plating Lab that could compromise the quality and safety of the Plating Group product. During the IA Team's interview with Mr. Udofot, he made clear his concerns relating to the final product were mainly associated with the way the rinse tanks were being managed.

1.2 Background: Independent Assessment Team Activities

Since GSFC had already conducted an investigation into Mr. Udofot's concerns in 2008, NASA decided to charter an independent assessment team to review and assess GSFC's data and to focus on Mr. Udofot's concerns as documented in the OSC letter. A principal objective of this investigation was to determine whether Mr. Udofot's allegations that the plating operation presented any hazard to the workforce or produced gold plated product not conforming to the customer's specification occurred. If any concerns expressed by Mr. Udofot in the OSC letter could be validated or any other technical safety or quality concerns emerged during the investigation, the IA Team was to recommend the appropriate corrective action to GSFC's management.

On June 4, 2009, NASA Headquarters chartered the IA Team. After reviewing the allegations raised by Mr.Udofot, the IA Team determined the need for detailed assessments in the areas of IH, QA, and the electroplating process to assure the safety of people and equipment as well as the quality characteristics of the products to be plated. The IA Team also determined that the IH and the QA experts on the team would thoroughly address the electroplating process concerns as part of the team's investigative work.

The IA Team members and their functions or areas of expertise are as follows:

- IA Team Lead—Cheevon (Mi-Mi) B. Lau, Director of Audits and Assessments at the NASA Safety Center (NSC) located in Cleveland, OH
- Industrial Hygiene (IH)—Angela Windau, Certified Industrial Hygienist (IH) responsible for the Occupational Safety and Health Program in the NASA Glenn Research Center's (GRC's) Manufacturing Facility located in Cleveland, OH
- Electroplating Process—Steven B. Hudson, Metallic Materials Engineering Team Lead at the NASA Marshall Space Flight Center (MSFC) located in Huntsville, AL
- Quality Assurance (QA)—James (Brian) Jackson, Quality Audit Program Manager for Safety and Mission Assurance (S&MA) requirements at the NSC located in Cleveland, OH

In June 2009, the IA Team conducted four teleconferences with the appropriate GSFC personnel to address the following matters:

- IA Team structure
- GSFC's points of contact (POCs) for the independent assessment
- GSFC's timeline of technical events regarding Mr. Udofot's tenure
- GSFC's documented actions regarding Mr. Udofot's concerns
- Technical information needed to assess the safety and quality of the electroplating process and operation
- Personnel to be interviewed during the IA Team's planned site visit to GSFC the week of June 22, 2009

In accordance with the OSC letter, the IA Team was required to interview Mr. Udofot as part of the investigation. On approximately June 12, 2009, NASA Senior Attorney Shari R. Feinberg provided Mr. Udofot with the following information that would be referenced during his teleconference with the IA Team:

- OSC's May 19, 2009 letter to Mr. Christopher Scolese, Acting Administrator for NASA (Attachment 1: OSC Letter)
- GSFC's Building 5 Plating Lab Facility Drawing (Attachment 2: Facility Drawing)

– GSFC's November 2008 Follow-Up Survey of the Plating Group (Code 547.5) (Attachment 3: 2008 Follow-Up Survey of the Plating Group)

On June 15, 2009, Mr. Udofot notified Ms. Feinberg by e-mail of his agreement with the entire content attributed to him in the OSC letter.

On June 17, 2009, the IA Team held a teleconference with Mr. Udofot. The IA Team Lead explained the purpose of the teleconference was to reconfirm the IA Team's understanding of the practices Mr. Udofot believed he witnessed and his concerns as documented in the OSC letter. The results from the teleconference confirmed the IA Team's understanding of Mr. Udofot's concerns as stated in the OSC letter. Throughout the teleconference, the IA Team asked Mr. Udofot if he agreed with the IA Team's statements about its understanding of his concerns, and in every instance, he confirmed that the IA Team's statements were correct. The IA Team Lead also asked Mr. Udofot if the team completely covered his concerns as stated in the OSC's May 19, 2009 letter. He confirmed that the IA Team did, but he also requested the team to review the use of tap water during the final rinse operation, which was not specifically addressed in the OSC letter. The IA Team agreed to review this matter.

On June 22, 2009, the IA Team traveled to GSFC and conducted a series of interviews. (See Attachment 4: IA Team Interview List for the interviewees and schedule.) Approximately 25 people were interviewed from June 22–24, 2009 and July 1, 2009. In general, the IA Team conducted each interview in a private room with only the interviewee and the IA Team members in attendance.

The IA Team thoroughly investigated each of Mr. Udofot's specific technical concerns. The detailed results are documented in Section 2.0 Investigation Details and Results of this report.

Based on the IA Team's review and assessment as described, the IA Team **found no violations of law, rule, or regulation** based on Mr. Udofot's allegations. The IA team found that the concerns Mr. Udofot raised **did not present a substantial or specific danger to public health and safety.**

The IA Team did confirm and identify **an ISO 9001 requirement non-compliance to document final test results with regard to gold plating nickel strike plating thickness. The non-compliance on the thickness constitutes low risk to the form and fit of the plated part. A functional test is performed on the plated part to validate it meets the requirements.** (See Section 2.2.2.2.3 Certification Documentation for the details.) The IA Team provided GSFC with some specific recommendations for electroplating process improvements, which are included in Section 2.2.2.2.3.

The worker exposure and process controls, safety and health support, and procedures used in the GSFC's Plating Lab are appropriate and comprehensive. For the electroplating process and QA, the GSFC's Plating Lab appears to be satisfactory. The Plating Lab is very clean and maintained in good condition. Even so, the lab needs to update its documentation used to define the plating validation requirements of the plated product. In addition, the QA function for the lab needs to define and implement the proper methodology to certify that the plating requirements are met.

2.0 Investigation Details and Results

2.1 Goddard Space Flight Center's Timeline of Events

At the IA Team's request, GSFC generated a timeline of events pertinent to Mr. Udofot's technical concerns and any actions GSFC took in response to those concerns prior to the IA Team's review. GSFC's provided timeline is addressed in Section 2.2 Independent Assessment Team. The IA Team's independent review of GSFC actions is documented specifically after each timeline entry.

The following is the list of GSFC employees referenced in the timeline and their functions:

Name	Title	Organization	Major Function
Adams, C.	Sr. Plating Lab Technician	Code 547, Bastion	Served as Plating Lab Group Lead before retiring from Civil Service and before Mr. Udofot became Group Lead
Bidnick, T., Dr.	Medical Director	Code 250	Administer Center Occupational Medicine program
Bien, C.	Industrial Hygienist	Code 250	Provide Industrial Hygiene contract support
Blount, G.	Asst. Director for Eng. Support (former Branch Head for the Advanced Manufacturing Branch)	Code 500	Served as Plating Lab Supervisor when Mr. Udofot worked for GSFC
Bolt, R.	Systems Safety Engineer	Code 321	Provide System Safety support for flight programs and the Center
Cody, R.	Astrophysicist	Code 691	Serve as Chemical Safety Committee Chairperson
Dalhoff, J.	Industrial Hygienist	Code 250	Perform Industrial Hygiene functions for the Center
Deza, R.	Industrial Hygienist	Code 250	Serve as Lead, Industrial Hygiene contract support
Hall, J.	Ashley Labs representative	—	Employed by Ashley Labs
Harvey, K.	Acting Group Lead, Plating Lab	Code 547	Served as Lab Technician during the time Mr. Udofot was the Group Lead
Hidrobo, G.	Mechanical Technician	Code 541 (formerly, in Code 547)	Assigned to (and co-located with) the Sample Analysis at Mars (SAM) project while a member of Code 547
Hunt, C.	Plating Lab Technician	Code 547	Provide technician support in the Plating Lab
Joy, P.	Materials Engineer	Code 541 (retired)	Perform process engineering functions
Loughlin, J.	Branch Head for the Advanced Manufacturing Branch	Code 547	Serve as Branch Head after G. Blount
Mitchell, J.	Aerospace Engineering Technician	Code 547	Perform process engineering functions
Mooney, T.	Member and Certified AESF Instructor, Professional Engineer and Author	American Electroplaters and Surface Finishers Society (AESF)	Assist as electroplating and metal finishing resource
Scofield, M.	Safety Manager	Code 500	Oversee Safety for the Directorate
Simonds, S.	Associate Branch Head	Code 547 (retired)	Served as Associate Branch Head when Mr. Udofot was hired
Taylor, J.	Ashley Labs representative	—	Employed by Ashley Labs
White, B.	Plating Lab Technician	Code 547, Jackson & Tull, Inc.	Perform facility maintenance and technician duties in Plating Lab
White, L.	Plating Lab Technician	Code 547, Jackson & Tull, Inc.	Perform facility maintenance in Plating Lab
Wolfe, J.	Plating Lab Technician	Code 547	Perform lab technician duties in Plating Lab

2.2 Independent Assessment Team

2.2.1 Goddard Space Flight Center Site Visit—Response to Timeline of Events

The IA Team conducted interviews, toured the Building 5 Plating Lab, and oversaw the independent collection of air and water samples on June 22–24, 2009 and July 23, 2009.

The air and water sampling conducted by GSFC in 2008 and the ones conducted by the IA Team in June and July 2009 are analogous. The IA team sought to replicate the conditions that were existent at the time of Mr. Udofot's water sampling. During the air sample collection in June and July 2009, sample parts or test plates were intermittently processed. All process tanks were at the operational temperature and their respective agitation/ventilation systems were functioning. This condition maximized the process tank aerosol generation; therefore, the conservative air contaminant concentration measurements were obtained. GSFC IHs previously performed their air sampling under the same conditions as those that existed when Mr. Udofot first raised his concerns in 2008. Both the IA Team IH and GSFC's IHs performed area air sampling to collect worse case concentrations. In addition, GSFC IHs performed personal air monitoring.

No parts were processed while the water samples were collected. This inactivity was not a concern since the Plating Lab personnel and management had previously stated low throughput and periods of inactivity were the norm. Therefore, the collected water samples represent typical Plating Lab operating conditions. They do not necessarily encompass operational extremes. In both instances (June 22–24, 2009 and July 23, 2009), the Plating Lab conditions were similar to those during the GSFC's sampling in 2008. Mr. Udofot collected and stored water samples for analysis rather than allowing commercial lab personnel to do so. Moreover, the samples were not provided to the laboratory until more than a month after they were collected. Consequently, the integrity of Mr. Udofot's samples may have been compromised and, therefore, the data from the September 12, 2008 report from Ashley Labs are suspect. (See the July 23, 2008 timeline entry.)

The IA Team provides additional information (**IA Team** sections) to GSFC's timeline of events.

GSFC Timeline of Events

March 3, 2008	Mr. Udofot is hired at GSFC.
April 8, 2008	Mr. Udofot and others observe a "white mist cloud" in the Plating Lab facility at approximately 4:30 p.m. EST. Mr. Udofot and others are instrumental in leading an evacuation of the building as a safety precaution. The follow-up investigation determined that the white cloud was water vapor generated by a faulty building humidification system. Mr. Udofot and others received public recognition/award for their safety response from GSFC's Deputy Center Director.
	IA Team: Refer to Attachment 5: "White Cloud Mist" Incident Report
July 23, 2008	Mr. Udofot collected rinse water samples for analysis. (See Attachment 6a: IA—Water Sample Report July 23, 2008). It is not clear from what tanks the samples were taken. Ashley Labs picked up the samples for analysis on August 26, 2008. The following is consistent with a conversation between Ms. Melonie Scofield (Code 500 Safety Manager) and Mr. Josh Taylor (Ashley Labs): Ms. Jane Hall (Ashley Labs) handled the samples for Mr. Udofot. Mr. Taylor indicated Ms. Hall had several conversations with Mr. Udofot about the samples he had requested, indicating the request did not make much sense to them (Ashley Labs). Mr. Taylor overheard Ms. Hall telling Mr. Udofot that he needed

more than one water sample for the various types of analyses that he had requested (chloride, cyanide, chromium, and pH) and that there were concerns with the manner used to collect and store the samples. Ms. Hall logged the "samples" in as solutions since they were not properly handled as samples.

The samples were not handled or preserved to ensure their integrity prior to the analysis. This was the concern. *Note:* Samples obtained on July 23 and August 18 were picked up on August 26.

Ashley Labs did an original analysis on the solutions and sent the report to Mr. Udofot on September 12, 2008. Sometime later, Mr. Udofot called and asked that chloride be added to the analysis list. Ashley Labs personnel do not recall the date of this request, but indicated the samples were still in possession there. Some chemicals, such as cyanide, will decay over time.

When Ms. Scofield asked about the pH level of the solutions that the laboratory assayed, Mr. Taylor indicated that the pH levels (3.3, 4.1, and 4.9) were less acidic than a carbonated soda such as Coca Cola.

IA Team: Based on this information, the IA Team conducted another independent water sampling on June 24, 2009 (see Attachment 6b: IA—Water Sample Report June 24, 2009 for results) and July 23, 2009 (see Attachment 6c: IA—Water Sample Report July 23, 2009 for results). The sampling was funded by the NSC and sent to Water Testing Laboratories of Maryland, Inc. The results were sent directly to the IA Team. *Note:* A different lab was used to ensure the independence of the testing.

On June 24, 2009, four rinse tanks, two cold and two final hot rinses, were sampled for conductivity and pH testing. Three of the four exhibited conductivities below the lab's detection limit, 10 µmhos/cm, and pH's ranging from 4.6 to 4.9. The deoxidizer cold rinse tank, A5, had a reported conductivity of 290 µmhos/cm and the lowest pH, 3.1. Although the latter conductivity is significantly larger than the former, it is still well within industry practice. More important, the hot final rinse tanks' conductivities are excellent. (Very low conductivity allows little chance for salts to form on the part's surface during drying.) The pH values are lower than ideal, 6 to 8, but not a reason for concern. Typically, GSFC Plating Lab personnel follow cold immersion rinses with spray rinses. This practice serves two purposes: It lowers the part's surface fluid conductivity; and, it neutralizes the surface's pH, thus minimizing "drag out." (Drag out is defined as any process whereby fluid from one process tank is inadvertently transferred to another process tank by the part being processed.) Since hot final rinse tanks are the last tanks utilized in processing, drag out from these tanks is not an issue. Finally, parts are exposed to the hot final rinses for a short time. For most metals, this combination of pH and very low oxidizing power is not a concern; that is, little or no chemical reaction occurs. (For aluminum parts, pH less than the ideal target of 6 to 8 can actually be beneficial since aluminum's minimum solubility occurs at pH 5.)

While reviewing the pH and conductivity data noted, a concern was raised that the very low water sample conductivities might interfere with Water Testing Laboratories of Maryland, Inc.'s test methodology, resulting in inaccurate pH measurements. Consequently, Water Testing Laboratories of Maryland, Inc. sampled the same tanks on July 23, 2009 to repeat the pH and conductivity testing. Prior to the pH measurement, a supporting electrolyte was added to the samples. This standard practice ensures conductivity is high enough to prevent pH electrode junction potentials from adversely affecting the pH measurement. Test data showed tank A5, again, had the lowest pH and highest conductivity of the four tanks tested, 4.52 and 30 µmhos/cm, respectively. The other three tanks exhibited conductivities at the detection limit, 10 µmhos/cm, and pH's ranging from 6 to 7.2. Comparison with previous sampling test data (June 24, 2009) showed all tanks except A5 had essentially the same conductivities and more neutral pH's.

Although tank A5 values differed substantially from the initial to the final IA Team sample, both samples exhibited conductivities and pH's within reasonable operational limits.

In summary, GSFC's Plating Lab does not attempt to adhere to a specific water quality standard; however, all observed sample test data indicate the lab meets the generally accepted surface finishing industry practices. (See Attachment 10: Ted Mooney E-mail on Final Rinse Tank Composition.)

August 2, 2008

Garcia Blount (Plating Lab Supervisor when Mr. Udofot worked at GSFC) authorizes Mr. Udofot to initiate an investigation of spray drying plated parts on the same day Mr. Udofot raised the concern to him.

IA Team: Mr. Blount provided the following information during the interview with the IA Team:

"Once Mr. Udofot informed me [Mr. Blount] of what he perceived to be an issue with the Iridite rinse tank, I responded by asking him to investigate the issue further, document the findings, and we would discuss and assess the findings at a later date. A day or so later, I was in the Electroplating Lab [Plating Lab] and asked Ben White (Plating Lab Technician) to show me what he thought Mr. Udofot's concern was with the Iridite rinse tanks. He explained and demonstrated Mr. Udofot's concern by dipping a sample witness plate in the two rinse tanks and blowing it off with an air hose. He also explained, in his opinion, why he felt they did not need to purchase any "conductivity probes." He stated they run clean water to the Iridite rinse tanks in the mornings and evenings for approximately thirty minutes each. By doing this he felt it was not necessary to have the conductivity probes active or even in use. Nevertheless, I supported Mr. Udofot and allowed him to investigate his concerns. I did not learn until much later that Mr. Udofot asked the Applied Engineering and Technology Directorate (AETD) Safety Manager (Melonie Scofield) to head or conduct the investigation. "

Refer to September 18, 2008 for Ms. Scofield's response.

September 16, 2008

Close Call incident (see Attachment 7: Close Call Report—De-Ionization Tank Burst Incident) occurred with the water treatment system within the Plating Shop (Building 5). The incident occurred when the reverse osmosis portion of the system was switched from automatic mode to manual mode. This caused pressure to build in the line and resulted in the bursting of a de-ionized (DI) tank and the cracking of another tank. There was no damage done to the surrounding equipment (other than the DI tanks), nor were there any personnel injuries.

<u>IA Team</u>: The following is stated in Attachment 7: Close Call Report—De-Ionization Tank Burst Incident:

"Two employees went over to the RO (reverse osmosis) system in the Electroplating Lab [Plating Lab] and turned the RO system from automatic mode to manual mode. About one minute later pressure released around the cylinder heads. Shortly thereafter one cylinder burst and another cracked. The system was then immediately turned off. There was about a 4-inch hole in the one that burst, and a small amount of resin came out."

The **IA Team** asked Jim Loughlin to identify the two employees. He identified Mr. Udofot and Larry White.

Also, the Close Call report states this:

"Causal Factor: Lack of knowledge on system design/operation by lab personnel.

Interviews with several members of the Electroplating Lab staff reflected limited understanding of the RO/DI [reverse osmosis/de-ionization] water treatment system operation. System operation and maintenance are delegated to an offsite service contractor. Documentation and training on the system is lacking. Generally the system functions in a "hands-off" mode. While poor engineering is the root cause for the tank failure, operating the system in "manual" mode triggered over pressurization of the system. Based on interviews, the operator lacked full understanding of the system design and impact of the mode change."

The **IA Team** asked Jim Loughlin to identify the operator. He identified Mr. Udofot.

September 17. 2008 Mr. Udofot sends e-mail titled "Customer Complains" to Larry White (Plating Lab Technician), Ben White, John Wolfe (Plating Lab Technician), Katrina Harvey (currently, Acting Group Lead, Plating Lab), and Charlie Adams (Senior Plating Lab Technician), with copies to Mr. Blount and Ms. Scofield. The bottom of the e-mail indicated that the complaints constituted a safety issue.

E-mail (addendum) from Mr. Udofot included customer complaints: "The Customer was pleased with the outward appearance of the plated component but soon found the product corroded and not fit for the intended critical application."

<u>IA Team</u>: Mr. Udofot's e-mail appears on the following page.

From: "Udofot, Bassey J. (GSFC-547.0)" <Bassey.J.Udofot@nasa.gov>
Date: Wed, 17 Sep 2008 11:12:01 -0500
To: "White, Larry A. (GSFC-551.0)" <larry.a.white@nasa.gov>, "White, Benjamine J. (GSFC-540.0)[J+T]" <benjamine.j.white@nasa.gov>, "Adams, Charles S. (GSFC-547.0)[BTI]" <charles.s.adams@nasa.gov>, "Wolfe, John E. (GSFC-547.0)" <john.e.wolfe@nasa.gov>, "Harvey, Katrina F. (GSFC-547.0)" <katrina.f.harvey@nasa.gov>
Cc: "Blount, Garcia J. (GSFC-547.0)" <garcia.j.blount@nasa.gov>, "Scofield, Melonie E. (GSFC-500.0)" <melonie.e.scofield@nasa.gov>
Conversation: Customer Complains
Subject: Customer Complains

Dear Plating Group,

Addendum on Customer Complains

Good morning,
I am sorry to bear this bad news in spite of all the good works done here by the group.
At about 10 AM yesterday (9/16/08), I received two Customers in my office. A complains was made to me in regard product quality we plated for the Customer.
The Customer was pleased with the outward appearance of the plated component but soon found the product corroded not fit for the intended critical application.
Similarly, in the about the month of April 2008 at our usual 9 am (Planner's) meeting, Mr. Stephen Simonds, informed every one in the meeting that a Customer negatively complained about our poor plating quality. I was made aware that there are many other dissatisfy Customers with similar complaint and I have encouraged these incidences to be reported and on time so we could service them better in the future.
As per my concern remarks last week, possibility exists to co-deposit interstitial organic elements (chlorides, fluorides, H+ , hydrides and etc) with the actual metal films on component, if the final product was poorly rinsed.
A finished product may appear impressive on the exterior lusture but the hidden corrosive inclusion in the deposits is usually one of the causes of failures.
In addition to the above, I like to mention that the final neutral de- ionized rinse water samples sent to the external laboratory for analysis is in.
It shows that the 3 hot final de-ionized rinse water from bath in the plating lines "N and " B" contains total dissolved

- cyanide ions at (0.06mg/l), toxic level, each,
- hexa-chromic ions at less than 0.5 mg/l toxic level, respectively
- The final hot rinse neutral water taken from the tanks at different times/days are found to be pH 3.3, 4.1, and 4.9, respectively.
- The result of chloride and fluoride corrosive ions is yet to be analyzed for concentration.

These are some of the reasons I have showed concerns that the wet toxic fluids on parts be blown dry in a hood and not in an open air as currently practiced. Recent plans encouraged by Mr. Garcia to improve our plating process approaches would greatly improve the quality of NASA space components, our exposed health and environmental safety.

Let's be proactive and continue to improve our plating processes for our Customers satisfaction.

Thank you every one and keep the good work.

Bassey Udofot
(Engineer Group Leader)

Using Mr. Udofot's input, the IA Team interviewed the customer Mr. Greg Hidrobo (Mechanical Technician assigned to and co-located with the SAM project while a member of Code 547). Mr. Hidrobo explained the reason for his visit to the Plating Lab:

"The nature of my visit to the Plating Lab was to have diagnostics/corrective action taken on a previously plated flight project. Mr. Udofot introduced himself to me as the Code 547 Plating Lab group leader on the same day that I was bringing the (SAM project) bellows to Charlie Adams for inspection/corrective action (the bellows manifested some green substance in the plated area). (These bellows had been initially plated approximately 3 weeks earlier, awaiting further processing (brazing by Dr. Yuri Flom in Code 541). In the interim, they had been stored: wrapped in (SAM Project Contamination approved) UHV [Ultra-High Vacuum] foil, inside a covered stainless steel container (SAM Project Contamination approved), inside a cabinet within a controlled environment in Building 33)."

Note: Mr. Hidrobo picked up these same bellows later. (They were stripped and re-plated).

See Section 2.2.2.2.2 Rinse Water Quality, Concern 2 and Section 2.2.2.2.4 Customers and Goddard Space Flight Center Plating Lab Personnel Complaints, Concern 1 for more details.

September 18, 2008 — Mr. Udofot verbally informs Ms. Scofield of his safety concerns with air-drying parts in the Plating Lab.

IA Team: Regarding Mr. Udofot's concerns about air-drying the parts in the Plating Lab, Ms. Scofield provided the following response:

"While investigating the employee's complaint about possible exposure to chemicals when blow-drying parts in the Plating Lab, I [Ms. Scofield] had Ben White demonstrate exactly how the process was done. Mr. White took a scrap piece of metal and simulated the plating process, going through the dip and rinse process, including blow-drying. What he showed me, was once they finished with the hot water rinse, they walked from one plating line to a designated area where they had an air line set up and blew off the part. The process of blow drying was not aimed at anyone, but mostly down at the floor."

Note from the IA Team: Since the final rinse is heated, the part dries on its own once it is removed. There should not be much water removed during the blow-dry process. Both GSFC IH and the IA Team IH conducted air sampling tests to verify the chemicals to which the employees in the Plating Lab could be exposed. The data points from the air samples show that exposure to the employees is below the detection limits or orders of magnitude below the legal permissible exposure limits. (See Section 2.2.2.1.2 Exposure to Airborne Contaminants in the Electroplating Room, Concern 2.)

September 24, 2008 — The GSFC cross-directorate team meets with the Plating Lab personnel to start an investigation of the safety issue raised by Mr. Udofot (e-mail: Scofield, September, 25, 2008; see Attachment 8a: Possible Employee Exposure Plan (e-mail)—a summarization of the meeting and proposed investigation plan).

GSFC Team convened to investigate the complaint. Team consisted of Garcia Blount/547, Richard Bolt/321 (Systems Safety Engineer supporting flight projects), Pilar

Joy/541 (Materials Engineer), Jeff Dalhoff/250 (IH), Roy Deza/250 (Lead IH support contractor), Regina Cody/691 (Chemical Safety Committee Chairperson), and Melonie Scofield/500 (AETD Safety Manager). Team interviewed Plating Lab personnel including Mr. Udofot, Ben White, and Katrina Harvey. An IH air sampling plan was developed.

<u>IA Team</u>: See Attachment 8a: Possible Employee Exposure Plan (e-mail) dated September 25, 2008; and report issued June 2009 Attachment 8b: Final AETD Investigation Report on Potential Employee Exposure.

<u>Background</u>: On September 7, 2008, Mr. Udofot contacted his organization's safety manager with a variety of safety concerns within the lab. In response, the safety manager gathered a multi-disciplinary team consisting of Plating Lab management, IHs, chemists (including a former Plating Lab chemist and operator), and Facility Manager. Mr. Udofot walked the team through the lab to point out his concerns. In response to the concerns Mr. Udofot identified, an air sampling strategy was identified and implemented.

Note: The GSFC team had conducted air monitoring in the Plating Lab over the past 22 years. The sample results consistently showed the majority of the **data points were below the method detection limits**. The remainder of the data points has consistently been found to be orders of magnitude below legal permissible exposure limits (PELs) set by the Occupational Safety and Health Administration (OSHA) and the more stringent Threshold Limit Values (TLVs) established as recommendations by the American Conference of Governmental Industrial Hygienists (ACGIH). The concentrations detected and the TLVs for the contaminants found are presented in Table 2 (page 2-19). Contaminants that were sampled represent the most harmful materials being used in the lab.

The IA Team also conducted additional air sampling under the supervision of the IA Team IH. For the details of the process and results, see Section 2.2.2.1 Industrial Hygiene. The sample results all came back below detectable limits with the exception of hexavalent chromium, which was shown to be orders of magnitude below the OSHA PEL and ACGIH TLV. (See Table 1, page 2-18, for IA Team air sampling results.)

September 25, 2008

Rinse tank water sample analysis results (requested by Mr. Udofot) sent to the investigation team. Results showed water/rinse tank sample report (amended) with results indicating pH of 3.3 and 4.9, chromium less than 0.5 mg/l, cyanide 0.006 mg/l, chloride < 1 mg/l. Since GSFC had no specified acceptance criteria for pH or residual chemicals in the rinse tanks, it is the Plating Lab's practice to drain and replenish the tanks on a weekly basis. This approach has demonstrated over many years to produce quality plating results and has not been shown to be a health hazard to employees.

<u>IA Team</u>: Because of the water sampling handling and storage concerns previously discussed (see July 23, 2008 entry), these results are suspect even though Plating Lab sampling conditions were comparable. Chromium, cyanide, and chloride presence in the final rinse is neither unexpected nor detrimental to processing at the reported concentrations. Regardless, the reported values are within standard practice for these types of plating operations. In addition, review of certification packages for over 520 plating jobs did not produce any evidence to support the conjecture that any part processed at GSFC was rejected as a result of improper rinse pH. (See Section 2.2.2.2.2

	Rinse Water Quality, Concern 2 for more details.) Conductivity rather than a specific ion's concentration is a better measure of rinse water quality. Further, the IA Team's and GSFC's air sampling has shown chromium and cyanide concentrations are orders of magnitude below the legal PELs, thus alleviating the primary health concern, inhalation. (See Section 2.2.2.1.2 Exposure to Airborne Contaminants in the Electroplating Room for more details.)
September 29, 2008	Inputs by Dr. Bidnick (GSFC Medical Director) to determine the necessity of biological monitoring after an air sampling is conducted. Dr. Bidnick states that monitoring is usually reserved for those with exposures above the action level or following a sudden significant exposure incident. **<u>IA Team</u>**: Dr. Bidnick wrote that he called the employee (Mr. Udofot) to discuss the IH exposure assessment, but Mr. Udofot was not available and did not return the call. Dr. Bidnick also stated that in the months prior to, during, and subsequent to this time period, no workers from the Plating Lab at GSFC were seen in the GSFC clinic complaining of symptoms that would have been attributable to respirable or airborne droplet toxic chemical exposure; no medical documentation was forwarded to the GSFC clinic from physicians in the local community suggesting possible toxic chemical exposure in any workers.
September 30, 2008	Ted Mooney (member and Certified AESF instructor, Professional Engineer, and author) was contacted by Jeff Dalhoff to evaluate the Plating Lab design. He replied with the common practice for determining acceptable concentrations for metals and cyanide in the rinse tanks. This followed an e-mail to Mr. Mooney from Jeff Dalhoff (GSFC IH) requesting information on acceptable concentrations of cyanide and hexavalent chromium in final rinse baths. **<u>IA Team</u>**: Refer to Attachment 10: Ted Mooney E-mail on Final Rinse Tank Composition.
October 22, 2008	GSFC IH began to perform air sampling as a follow-up to Mr. Udofot's September 17, 2008 safety concern for nickel, sodium hydroxide (as sodium), gold, and potassium (gold and potassium were sampled to calculate the cyanide from the material potassium gold cyanide). Sampling occurred between October 22, 2008 and January 16, 2009. Results reported in May 2009 (Attachment 11: Bldg. 5 Plating Lab Air Sampling Report May 2009) were less than the method detection levels with the exception of sodium hydroxide, which was detected but at a level well below the occupational exposure limit (OEL). *Note:* The detection limit is based on the analytical method and not the instrument. The method detection limits are included in Tables 1 and 2, pages 2-18 and 2-19, in Section 2.2.2.1.2 Exposure to Airborne Contaminants in the Electroplating Room. **<u>IA Team</u>**: Refer to Attachment 11: Bldg. 5 Plating Lab Air Sampling Report May 2009. The IA Team's IH sampled for sodium hydroxide and hydrogen cyanide. The samples were below the method detection limit. (See Attachment 13a: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-029; Attachment: 13b: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-018; Attachment 13c: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-012; Attachment 13d: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-017; Attachment 13e: Bldg. 5 Plating Lab Air

	Monitoring Oct 2008 Group No. M309-027; Attachment 13f: Bldg. 5 Plating Lab Air Monitoring Nov 2008 Group No. M316-054.)
October 23, 2008	GSFC IH air sampling conducted for nickel, sodium hydroxide (as sodium), gold, and potassium. Results reported were less than the method's detection limit. *Note:* Samples are often repeated as a means of validation; therefore, one knows this not as a one-time event, but as sample events with consistency between them. **IA Team**: Refer to Attachment 11: Bldg. 5 Plating Lab Air Sampling Report May 2009. The IA Team IH sampled for sodium hydroxide and hydrogen cyanide. The samples were below the method detection limit.
October 28, 2008	GSFC IH air sampling conducted for hexavalent chromium, sodium hydroxide (as sodium), and zinc oxide (as zinc). Results were less than the method's detection limit, with the exception of sodium hydroxide, which was well below the OEL. **IA Team**: Refer to Attachment 11: Bldg. 5 Plating Lab Air Sampling Report May 2009. The IA Team IH sampled for hexavalent chromium and sodium hydroxide. Sodium hydroxide was below the method detection limit. Hexavalent chromium was detected at low concentrations (0.00006 mg/m^3 and 0.000097 mg/m^3). These concentrations are just at the method detection limit. These concentrations equate to an 8-hr time-weighted average (TWA) of 0.00003 mg/m^3 and 0.000046 mg/m^3. This is well below the ACGIH TLVs and OSHA permissible exposure limit of 0.05 mg/m^3 as an 8-hr TWA.
October 29, 2008	GSFC IH air sampling conducted for chromium, copper, nickel, barium, hydrochloric acid, and nitric acid. Results reported were less than the method detection limit. Other sampling for nitric acid and hydrochloric acid were also less than the method detection limits. **IA Team:** Refer to Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009. The IA Team IH sampled for hydrochloric acid. The samples were below the method detection limit.
October 30, 2008	GSFC IH air sampling conducted for chromium, hexavalent chromium, nickel, hydrofluoric acid, hydrochloric acid, and sulfuric acid. Results reported were less than the method detection limit. **IA Team**: Refer to Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009. The IA Team IH sampled for hexavalent chromium, hydrofluoric acid, hydrochloric acid, and sulfuric acid. The acid samples were below the method detection limit. Hexavalent chromium was detected at low concentrations (0.00006 mg/m3 and 0.000097 mg/m3). These concentrations are just at the method detection limit. These concentrations equate to an 8-hr TWA of 0.00003 mg/m3 and 0.000046 mg/m3. This is well below the OSHA permissible exposure limit of 0.05 mg/m3 as an 8-hr TWA.
November 10, 2008	GSFC IH air sampling conducted for phosphoric acid. Results reported on November 13, 2008 were less than the method detection limit. **IA Team**: Refer to Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009.
November 17, 2008	2008 Follow-Up Survey of the Plating Group (Organizational Code 547.5) provided to Code 547 from Ching-tsen Bien (GSFC IH support contractor) of the Industrial Hygiene

	Office (IHO). Results indicated that all samples were below the OSHA PEL and ACGIH TLV. The report was updated and submitted as the May 12, 2009 report. The follow-up report included additional sampling data collected in January.
	IA Team: Refer to Attachment 3: 2008 Follow-Up Survey of the Plating Group and the final report Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009.
	Refer to Attachment 11b: Reconciliation Between the Goddard Space Flight Center Industrial Hygiene Report Draft Recommendations and Final Report Recommendations.
November 19, 2008	Mr. Udofot requested a copy of Baseline IH Survey report from Jeff Dalhoff.
	IA Team: Refer to Attachment 12: Code 547 Baseline IH Survey October 2003.
December 1, 2008	First GSFC IH report of sample results released with recommendations. Refer to Attachment 3: 2008 Follow-Up Survey of the Plating Group.
January 16, 2009	GSFC IH air sampling conducted for gold, barium nitrate (as barium), chromium, potassium gold cyanide (as potassium and gold), sodium hydroxide (as sodium), and nickel. Results were reported on January 23, 2009. (See Attachment 14: Bldg. 5 Plating Lab Air Monitoring January 2009 Group No. N019-027.) The samples results were less than the method detection limit.
	IA Team: The IA Team IH sampled for hydrogen cyanide, hexavalent chromium, and sodium hydroxide. Hydrogen cyanide and sodium hydroxide samples were below the method detection limit. Hexavalent chromium was detected at low concentrations (0.00006 mg/m^3 and 0.000097 mg/m^3). These concentrations are just at the method detection limit. These concentrations equate to an 8-hr TWA of 0.00003 mg/m^3 and 0.000046 mg/m^3. This is well below the OSHA permissible exposure limit of 0.05 mg/m^3 as an 8-hr TWA.
May 12, 2009	Health Hazard Evaluation of the Plating Group (Code 547) report sent from Ching-tsen Bien to Garcia Blount, et al. (See Attachment 11: Bldg. 5 Plating Lab Air Sampling Report May 2009.) Report concludes GSFC's IH air monitoring and observations related to Mr. Udofot's concerns. Air sampling results for hydrochloric acid, hydrofluoric acid, nitric acid, phosphoric acid, sulfuric acid, sodium hydroxide, barium, copper, hexavalent chromium, nickel, and cyanide indicated that concentrations were very low or non-detectable and that the general ventilation system should be sufficient to control contaminants.
	Note: The general ventilation system is not checked regularly; however, the push-pull ventilation system is checked annually. Since concentrations were so low or non-detectable, this approach is adequate.
	Recommendations regarding Personal Protection Equipment (PPE) and blowing off parts were included in the report.
	IA Team: Refer to Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009. To understand the differences between the draft November 2008 report (Attachment 3: 2008 Follow-Up Survey of the Plating Group) and the May 2009 report (Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009), see Attachment 11b: Reconciliation

	Between the Goddard Space Flight Center Industrial Hygiene Report Draft Recommendation and Final Report Recommendations.
June 12, 2009	Final report (see Attachment 8b: Final AETD Investigation Report on Potential Employee Exposure) issued for AETD investigation of employee exposure. The report's conclusion is as follows: Based on the sampling results, levels of selected contaminants appear to be well below occupational exposure limits. Moreover, concentrations of most of the sampled contaminants of concern were not detectable. This may be due in part to limited workload in the Plating Lab, the existence of push-pull local exhaust and general room exhaust ventilation systems, and tendency of the contaminants of concern to remain in the liquid or solid phase. Covers for the plating baths were discussed to limit potential exposures even further, although it would be difficult to demonstrate a measurable benefit. Activity levels never increased enough for personal sampling so that area sampling was the most protective sampling that could be performed. The processes currently in place for blow-drying parts appear to provide adequate protection for employees since the air sampling results are well below exposure limits and indicate personnel are not placed at risk from inhalation hazards. Employees must continue to wear required PPE, perform blow-drying at specified locations, and not aim drying operations toward other employees.

2.2.2 Goddard Space Flight Center Site Visit—Response to Mr. Udofot's Concerns as Stated in the Office of Special Counsel Letter

2.2.2.1 Industrial Hygiene

Mr. Udofot stated his safety and health concerns in the OSC letter. On June 17, 2009, the IA Team spoke with Mr. Udofot by teleconference. During the teleconference, the IA Team IH confirmed with Mr. Udofot that his concerns were in two main areas:

1. The first area of concern pertained to employee exposure to acid mists, cyanides, and heavy metals, specifically hexavalent chromium, through inhalation while working at the electroplating tanks and during the use of shop air for parts drying.
2. The second area of concern pertained to employee exposures to heavy metals and acids through skin exposure while working at the electroplating tanks and during the use of shop air to dry parts.

The IA Team IH also asked for additional information to narrow the scope of the investigation such as specific contaminants that concerned him and the specific tanks. Mr. Udofot stated he was concerned about tanks N-1 and N-2, hexavalent chromium (Iridite), and the cyanide line and gold room, both of which use cyanides. He also expressed concern for exposure to potassium hydroxide, sodium hydroxide, and sulfuric acid. The information was used by the IA Team IH in conducting additional air samples and in formulating questions during interviews.

The evidence provided under each concern stated further in this section is based on the following:

- Interviews with employees (Plating Lab employees and managers; and GSFC IHs and Safety Engineers)
- Review of laboratory procedures and hazard analysis
- Review of past personal and area air samples collected in the Plating Lab as well as new samples collected

Note: The following items and documents were reviewed prior to or during the visit to GSFC:

- Ventilation Surveys for the local exhaust system used in the Plating Lab
    - Attachment 12: Code 547 Baseline IH Survey October 2003
    - Attachment 22: Copy of LEV GSFC Working Copy
    - Attachment 23: Bldg. 5 Plating Lab Push-Pull Ventilation Survey 2008
- General IH Hazards Assessment of Plating Lab
    - Attachment 12: Code 547 Baseline IH Survey October 2003
    - The Chemical Hygiene Plan for the Plating Lab (viewed onsite)
- Employee Training Records for Respiratory Protection, Personal Protective Equipment, and Hazard Communication (viewed onsite)
- Air Sampling Reports as follows:
    - Attachment 3: 2008 Follow-Up Survey of the Plating Group
    - Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009

- Attachment 11b: Reconciliation between the Goddard Space Flight Center Industrial Hygiene Report Draft Recommendations and Final Report Recommendations
- Attachment 13a: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-029
- Attachment 13b: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-018
- Attachment 13c: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-012
- Attachment 13d: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-017
- Attachment 13e: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-027
- Attachment 13f: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M316-054
- Attachment 14: Bldg. 5 Plating Lab Air Monitoring Jan 2009 Group No. N019-027
- Attachment 15: Bldg. 5 Plating Lab Field Activity Report Oct 1987(3)
- Attachment 16: Bldg. 5 Plating Lab Field Activity Report Oct 1987 _01(3)
- Attachment 17a: Bldg. 5 Plating Lab Air Monitoring Oct 1987 Feb 1988(4)
- Attachment 17b: Bldg. 5 Plating Lab Field Activity Report Feb 1988(3)
- Attachment 18: Bldg. 5 Plating Lab Field Activity Report July 1988(2)
- Attachment 19: Bldg. 5 Plating Lab Air Monitoring Aug 1999(3)

- "Employee Possible Exposure Issue" e-mail issued September 25, 2008; final report issued June 2009
    - Attachment 8a: Possible Employee Exposure Plan (e-mail)
    - Attachment 8b: Final AETD Investigation Report on Potential Employee Exposure
- Building 5 Plating Facility Bath Profiles—April 2009
    - Attachment 21: Copy of Tank Info April 2009

2.2.2.1.1 Methods

To address Mr. Udofot's concerns regarding potential inhalation hazards in the lab, the IA Team IH collected personal and area air samples in the Plating Lab. Sampling and analysis was performed in accordance with approved OSHA or National Institute for Occupational Safety and Health (NIOSH) methods and submitted to an American Industrial Hygiene Association (AIHA) certified laboratory for analysis. All like chemicals were sampled on the same day to account for the cumulative effects from working within different areas in the lab.

The IA Team IH determined the sampling methods and analysis. The methods were selected to be able to detect the lowest possible concentrations. The methods used by the IA Team IH (and previously by the GSFC IH Team) are all OSHA and NIOSH approved sampling and analytical methods. The GSFC IH Office supplied the sampling equipment. The IA Team IH observed the sampling setup and operation.

The chemicals to be sampled and the sample locations were chosen based on the contaminants of concern that Mr. Udofot mentioned during the telephone interview and those that the IA Team IH recommended. The IA Team IH added hydrofluoric acid based on the unique hazards the product poses to skeletal tissue. Sample locations were selected based also on tank concentrations of those contaminants listed in the April 2009 Plating Facility Bath Profile document, which reflected the current bath profile. (See Attachment 21: Copy of Tank Info April 2009.)

Personal air samples directly reflect the concentration of a contaminant to which an individual is exposed. During personal air sampling, an individual voluntarily wears a small air pump on his or her waist. A piece of Tygon tubing, or other approved material, connects the air pump to a collection media attached to the individual's shirt collar, which is located in the individual's breathing zone. A pump draws air through the collection media. The collection media is selected based on the sampling methodology so that it is able to capture the contaminant of interest. The sampling methodology determines the airflow rate (the speed at which air is passed through the media). The IH sets and records the airflow using a primary calibration standard. An individual wears the pump for the entire shift. At the end of the shift, the pump and collection media are removed from the individual. The pump is post-calibrated, and the final airflow rate is recorded. The collection media is then treated and preserved as required by the sampling methodology and shipped to the analytical lab for analysis. Laboratory results are then compared with OSHA PELs and ACGIH TLVs to determine if exposure limits have been exceeded. Figure 1 shows the sampling apparatus and setup that was used.

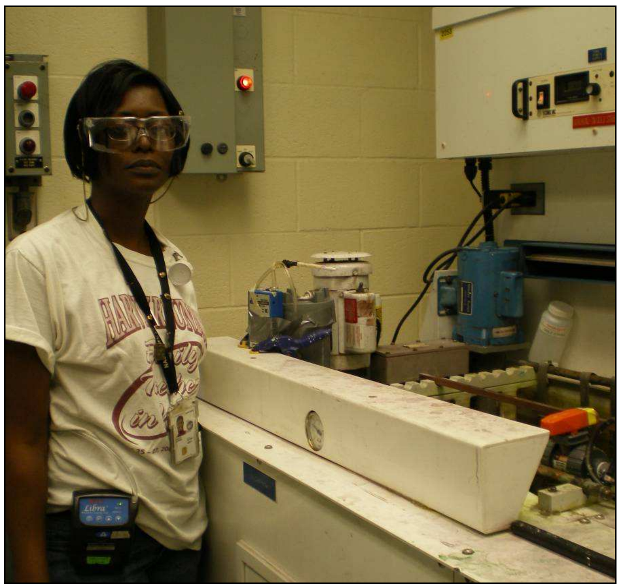

Figure 1: Personal air sample setup.
Note collection media near worker's breathing zone.

The OSHA permissible exposure limit is established to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air to which a worker is permitted exposure. OSHA PELs are based on an 8-hr TWA exposure. The ACGIH TLV is the 8-hr TWA exposure recommended as the concentration to which it is believed nearly all workers can be exposed daily over a working lifetime without suffering adverse health effects. While not a legal requirement, the TLVs do represent the most current information in scientific study and are often more stringent than the OSHA PELs. The IA Team IH compared sample results with the more stringent ACGIH TLVs.

2.2.2.1.2 Exposure to Airborne Contaminants in the Electroplating Room

Concern 1: Employee exposure to acid mists, cyanides, and heavy metals, specifically hexavalent chromium, through inhalation while working at the electroplating tanks

***Evidence*:** The employees interviewed did not experience respiratory signs and symptoms relating to exposure to acids, bases, and heavy metals. They also felt the local exhaust and ventilation (LEV) was adequate. The IA Team

IH visited the Plating Lab and did not notice any tell-tale chemical odors one would expect in a Plating Lab, which supported the LEV surveys, smoke tube test results, and employee statements. The IA Team IH reviewed previous air sampling data and performed additional air sampling, all showing air concentrations below the OSHA PELs and ACGIH TLVs.

The area sampling pumps were located over the tanks, which potentially would emit the vapors specifically addressed in the OSC letter (cyanide, hexavalent chromium, potassium hydroxide, sodium hydroxide, and sulfuric acid), as well as near the bench where the parts are blown off. The collection media was placed in the breathing zone where an individual working over the tank the entire shift would be located. The IA Team IH requested that the tanks run at standard temperature and pH, and the local exhaust system operate in its normal mode. Figures 2 and 3 show the area sampling apparatus and setups. Figure 4 shows sample locations.

Figure 2: Sampling apparatus and setup.

Figure 3: Sampling apparatus and setup.

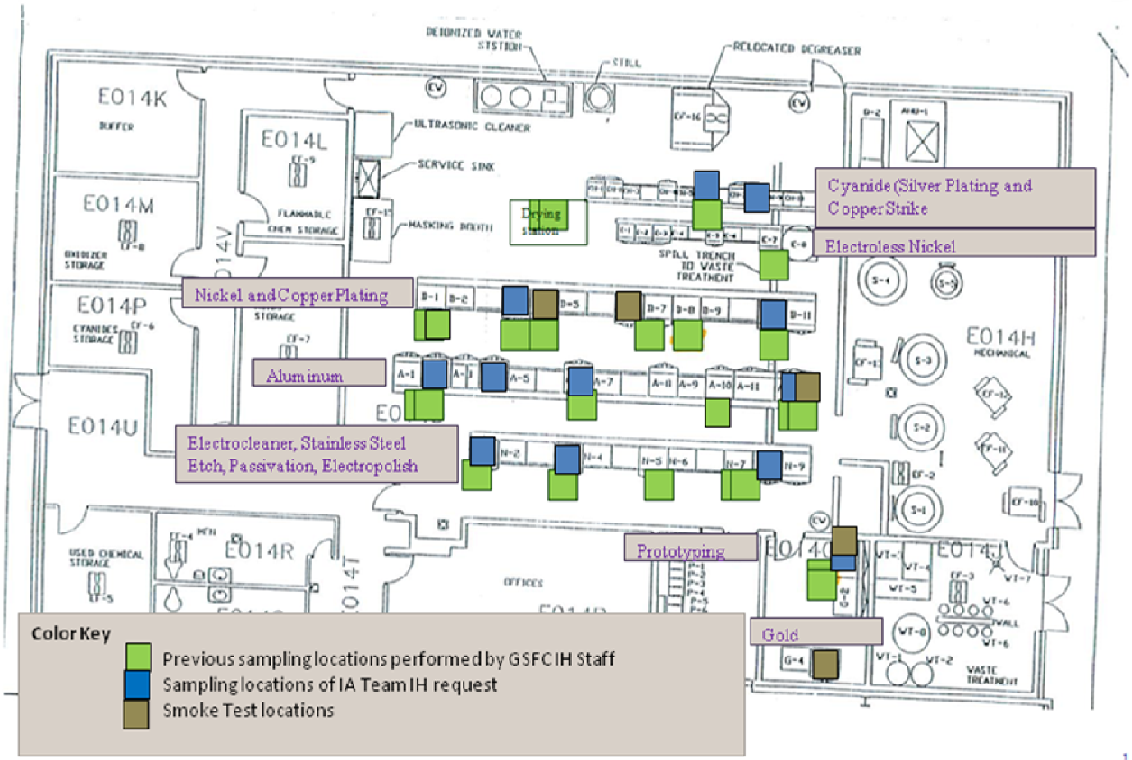

Figure 4: Comprehensive view of sample locations.

The personal air sample and the area samples were collected the same day to allow for comparison between the worst-case scenarios (the area samples at the tanks) and actual exposure. The personal sample pump was located on an individual who spent time in the Plating Lab performing plating operations typical of those on a standard workday. Since the lab did not have a "typical" amount of work available, sample coupons were plated to simulate a typical workday.

On the day of sampling, the IA Team IH confirmed the location, placement, and operation of the pumps. The IA Team IH confirmed with the Plating Lab personnel being sampled that the time in the lab and the type of work being performed the day of sampling was consistent with a typical workday; therefore, the sample results are representative of the daily environment. These data were recorded on GSFC air sampling field sheets (Attachment 20: GSFC Bldg. 5 Plating Lab Air Sampling Field Sheets June 2009). **Sample results all came back below detectable limits with the exception of hexavalent chromium, which was shown to be orders of magnitude below the permissible exposure limit** (Attachment 9: IA—Air Sample Report). Table 1 shows the June 2009 air sample results. Table 2 shows the historic air sample results. Table cells containing data with detectable levels of contaminants are highlighted in green.

Table 1: 2009 Air Sampling Results (Collected by the IA Team IH)

Sample Date	Sample Type	Person/Location	Analyte	Sample ID/Analytical Method	Analytical Results	Sample Time, ACGIH TLV
06/24/2009	Personal	Katrina Harvey	Hexavalent Chromium	1 OSHA-215	0.00006 mg/m^3	266 minutes, TLV = 0.05 mg/m^3
06/24/2009	Area	G-1 Gold Strike	Hydrogen Cyanide	3 NMAM 6010M	<MDL (2.6 µg)	344 minutes
06/24/2009	Area	A-6 Sulfuric Anodize	Sulfuric Acid	5 NMAM 7903	<MDL (5µg)	311 minutes
06/24/2009	Area	B-10 Acid Copper	Sulfuric Acid	6 NMAM 7903	<MDL (5µg)	308 minutes
06/24/2009	Area	A-2 Aluminum Etch	Sodium Hydroxide	8 NMAM 7401	<MDL (40 µg)	269 minutes
06/24/2009	Area	B-3 Aluminum Zircate	Sodium Hydroxide	9 NMAM 7401	<MDL (40 µg)	275 minutes
06/24/2009	Area	N-1 Electrocleaner	Sodium Hydroxide	10 NMAM 7401	<MDL (40 µg)	279 minutes
06/24/2009	Area	A-12 Aluminum Iridite	Hexavalent Chromium	14 NMAM 215	0.000097 mg/m3	226 minutes, TLV = 0.05 mg/m^3
06/25/2009	Area	CN-8 Silver Strike	Hydrogen Cyanide	21 NMAM 6010M	<MDL (2.6 µg)	360 minutes
06/25/2009	Area	CN-6 Silver Plating Bath	Hydrogen Cyanide	22 NMAM 6010M	<MDL (2.6 µg)	358 minutes
06/25/2009	Personal	Katrina Harvey	Sulfuric Acid	24 NMAM 7903	<MDL (5µg)	218 minutes
			Hydrochlic Acid	24 NMAM 7903	<MDL (2.5 µg)	218 minutes
			Hydrofluoric Acid	24 NMAM 7903	<MDL (5µg)	218 minutes
06/25/2009	Area	A-4 Aluminum Deoxidizer	Hydrofluoric Acid	25 NMAM 7903	<MDL (5µg)	283 minutes
06/26/2009	Area	N-3A Stainless Steel Etch	Hydrofluoric Acid	31 NMAM 7903	<MDL (5µg)	210 minutes

ACGIH —American Conference of Governmental Industrial Hygienists

NMAN—NIOSH Manual of Analytical Methods

TLV—Threshold Limit Value—ACGIH TLV is the 8-hr time-weighted average exposure recommended as the concentration to which it is believed nearly all workers can be exposed daily over a working lifetime without suffering adverse health effects. While not a legal requirement, the TLVs do represent the most current information in scientific study and are often more stringent than the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs).

MDL—Method Detection Limit—The MDL is the lowest quantity of a substance that can be distinguished from the absence of that substance (a blank value) within a stated confidence limit. <MDL means it's less than the limit.

Note: Cells highlighted in **green** contain data reflecting detectable contaminant concentrations.

Table 2: Historic Air Sampling Results (Collected by GSFC IHO)						
Date	**Type of Sample**	**Location of Sample**	**Analyte**	**Method**	**Results**	**Sample Time/PEL**
10/27/1987	Area	Breathing zone between anodizing strip and Aluminum Polish (center aisle)	Chromic Acid	NMAM 5317	<MDL	15 minute STEL
10/27/1987	Personal	Cleophus Hunt - worked mainly in center aisle	Chromic Acid	NMAM 5317	<MDL	351 minutes
10/27/1987	Area	Breathing zone between anodizing strip and Aluminum Polish (center aisle)	Phosphoric Acid	NMAM 3601	<MDL	
10/27/1987	Personal	Ben White - worked mainly in center aisle	Phosphoric Acid	NMAM 3601	<MDL	
10/28/1987	Personal	Joel Mitchell worked mainly in center aisle between Aluminum Etch and Oakite	Sodium Hydroxide	NMAM 4202	<MDL	270 minutes
02/02/1988	Personal	Cleophus Hunt - worked mainly in center aisle above anodize bath	Sulfuric Acid		<MDL	481.5 minutes
02/02/1988	Area	Breathing zone, center aisle, anodize sealer bath	Sulfuric Acid		0.02 mg/m^3	120 minutes, TLV = 1 mg/m^3
02/02/1988	Personal	Charlie Adams, center aisle, anodize sealer bath	Soluble Nickel		<MDL	332 minutes
02/02/1988	Area	Breathing zone, center aisle, above anodized sealer bath	Soluble Nickel		<MDL	60 minutes
02/02/1988	Area	Breathing zone, northwest aisle, above Hydrogen Chloride dip	Hydrogen Chloride		<MDL	15 minute STEL
09/18/1996	Personal	Cleophus Hunt, Nickel plating line	Hydrofluoric Acid	NMAM 7903	<MDL (5 µg)	120 minutes
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	120 minutes
			Sulfuric Acid	NMAM 7903	0.12 mg/m^3	120 minutes, TLV = 1 mg/m^3
			Nitric Acid	NMAM 7903	<MDL (5 µg)	120 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	120 minutes
09/18/1996	Personal	John Wolfe, Aluminum anodized line	Hydrofluoric Acid	NMAM 7903	<MDL (5 µg)	108 minutes
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	108 minutes
			Sulfuric Acid	NMAM 7903	0.19mg/m^3	108 minutes, TLV = 1 mg/m^3
			Nitric Acid	NMAM 7903	<MDL (5 µg)	108 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	108 minutes

Table 2: Historic Air Sampling Results (Collected by GSFC IHO)

Date	Type of Sample	Location of Sample	Analyte	Method	Results	Sample Time/PEL
10/08/1996	Personal	Cleophus Hunt, Copper plating line	Hydrofluoric Acid	NMAM 7903	0.053 ppm	260 minutes, TLV = 3 ppm
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	260 minutes
			Sulfuric Acid	NMAM 7903	<MDL (5 µg)	260 minutes
			Nitric Acid	NMAM 7903	<MDL (5 µg)	260 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	260 minutes
10/08/1996	Personal	Charles Adams, Aluminum anodized line	Hydrofluoric Acid	NMAM 7903	<MDL (5 µg)	282 minutes
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	282 minutes
			Sulfuric Acid	NMAM 7903	<MDL (5 µg)	282 minutes
			Nitric Acid	NMAM 7903	<MDL (5 µg)	282 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	282 minutes
10/08/1996	Personal	Charles Adams, Aluminum anodized line	Sodium Hydroxide		<MDL	282 minutes
10/08/1996	Personal	Cleophus Hunt, Copper plating line	Nickel	OSHA-125	<MDL (2.0 µg)	260 minutes
			Zinc	OSHA-125	<MDL (0.5µg)	260 minutes
			Copper	OSHA-125	0.003 mg/m^3	260 minutes, TLV = 1 mg/m^3
11/13/1996	Personal	Cleophus Hunt, Nickel plating line	Hydrofluoric Acid	NMAM 7903	<MDL (5 µg)	327 minutes
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	327 minutes
			Sulfuric Acid	NMAM 7903	<MDL (5 µg)	327 minutes
			Nitric Acid	NMAM 7903	<MDL (5 µg)	327 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	327 minutes
11/13/1996	Personal	Charles Adams, Aluminum anodized line	Hydrofluoric Acid	NMAM 7903	<MDL (5 µg)	322 minutes
			Hydrochloric Acid	NMAM 7903	<MDL (2.5 µg)	322 minutes
			Sulfuric Acid	NMAM 7903	<MDL (5 µg)	322 minutes
			Nitric Acid	NMAM 7903	<MDL (5 µg)	322 minutes
			Phosphoric Acid	NMAM 7903	<MDL (2.0 µg)	322 minutes
11/13/1996	Personal	Charles Adams, Aluminum anodized line	Nickel	OSHA-125	<MDL (2.0 µg)	320 minutes
			Zinc	OSHA-125	<MDL (0.5 µg)	320 minutes
			Copper	OSHA-125	<MDL (2.0 µg)	320 minutes
08/23/1999			Nickel	?	<MDL	226 liters

Table 2: Historic Air Sampling Results (Collected by GSFC IHO)

Date	Type of Sample	Location of Sample	Analyte	Method	Results	Sample Time/PEL
			Nickel	?	<MDL	774.6 Liters
10/22/2008	Area	Near A-1, Non-etch soak tank and A-2 Alkaline Etch tank	Sodium (Sodium Hydroxide)	3 NMAM 7300 M	0.0066 mg/m^3	324 minutes (sodium phosphates). TLV = 2 mg/m^3
10/22/2008	Area	Near G-1 Gold Strike tank	Potassium	4 NMAM 7300	<MDL (2.5 µg)	345 minutes
			Gold	4 NMAM 7300M	<MDL (2µg)	345 minutes
10/22/2008	Area	Near B-8 Watts Nickel tank	Nickel	2 NMAM 7300	<MDL (2µg)	343 minutes
10/23/2008	Area	Near A-1, Aluminum soak cleaner (Oakite 61B) and A-2, Aluminum Etch (Oakite 160) tanks	Sodium (Sodium Hydroxide)	5 NMAM 7300M	<MDL (2.5 µg)	384 minutes
10/23/2008	Area	Near E-7 Electroless Nickel tank	Nickel	6 NMAM 7300	<MDL (2 µg)	420 minutes
10/23/2008	Area	Near G-1 tank	Gold	7 NMAM 7300	<MDL (2 µg)	425 minutes
			Potassium	7 NMAM 7300	<MDL (2.5 µg)	425 minutes
10/28/2008	Area	Near N-5C Anodized Strip tank	Hexavalent Chromium	11 OSHA 215	<MDL (0.025 µg)	371 minutes
10/28/2008	Area	Near B-3 Zincate tank	Zinc	12 NMAM 7300	<MDL (2 µg)	361 minutes
			Sodium (Sodium Hydroxide)	12 NMAM 7300M	0.004 mg/m^3	361 minutes, TLV = 2.0 mg/m^3
10/28/2008	Area	Near N-1 Electrocleaner Oakite 90 tank	Sodium (Sodium Hydroxide)	13 NMAM 7300M	<MDL (2.5 µg)	350 minutes
10/29/2008	Area	Near B-1 HCl Dip tank	Hydrochloric Acid	S-1 NMAM7903	<MDL (2.5 µg)	432 minutes
10/29/2008	Area	Near B-4A Nitric Acid and Ammonium Bifluoride dip tank	Nitric Acid	s-2 NMAM7903	<MDL (5 µg)	422 minutes
10/29/2008	Area	Near B-10 Acid Copper tank	Copper	21 NMAM 7300	<MDL (1µg)	413 minutes
10/29/2008	Area	Between B-6 Woods Nickel Strike tank and B-7 Black Nickel tank	Nickel	22 NMAM 7300	<MDL (2µg)	396 minutes
10/29/2008	Area	Near A-12 Iridite 14-2 tank	Barium	23 NMAM 7300	<MDL (2µg)	379 minutes
			Chromium	23 NMAM 7300	<MDL (2 µg)	
10/30/2008	Area	Near A-6 Anodize tank	Sulfuric Acid	s-11 NMAM7903	<MDL (5 µg)	431 minutes
10/30/2008	Area	Near N3A Stainless Steel Etching tank	Hydrochloric Acid	s-12 NMAM7903	<MDL (2.5 µg)	402 minutes

Table 2: Historic Air Sampling Results (Collected by GSFC IHO)						
Date	**Type of Sample**	**Location of Sample**	**Analyte**	**Method**	**Results**	**Sample Time/PEL**
			Hydrofluoric Acid	s-12 NMAM7903	<MDL (5 µg)	
10/30/2008	Area	Near N3A Stainless Steel Etching tank	Chromium	31 NMAM 7300	<MDL (2 µg)	412 minutes
			Nickel	31 NMAM 7300	<MDL (2µg)	
10/30/2008	Area	Near A-12 Iridite 14-2 tank	Hexavalent Chromium	32 OSHA ID 125	<MDL (0.025 µg)	345 minutes
11/10/2008	Area	Near N-7, Stainless Steel Electropolish tank	Phosphoric Acid	s-34 NIOSH 7903	<MDL (10 µg)	250 minutes
01/16/2009	Area	Spray drying station	Nickel	NMAM 7300	<MDL (2 µg)	88.7 L at 19.9 LPM
			Chromium	NMAM 7300	<MDL (2 µg)	88.7 L at 19.9 LPM
			Barium	NMAM 7300	<MDL (2 µg)	88.7 L at 19.9 LPM
			Sodium (Sodium Hydroxide)	NMAM 7300M	<MDL (2.5 µg)	88.7 L at 19.9 LPM
			Potassium	NMAM 7300	<MDL (2.5 µg)	88.7 L at 19.9 LPM
			Gold	NMAM 7300M	<MDL (2 µg)	88.7 L at 19.9 LPM
			Cyanide	calculated by using analytical results for potassium and gold and plugging into formula for potassium gold cyanide		
01/16/2009	Area	Spray drying station	Nickel	NMAM 7300	<MDL (2 µg)	89.6 L at 20.1 LPM
			Chromium	NMAM 7300	<MDL (2 µg)	89.6 L at 20.1 LPM
			Barium	NMAM 7300	<MDL (2 µg)	89.6 L at 20.1 LPM
			Sodium (Sodium Hydroxide)	NMAM 7300M	<MDL (2.5 µg)	89.6 L at 20.1 LPM
			Potassium	NMAM 7300	<MDL (2.5 µg)	89.6 L at 20.1 LPM
			Gold	NMAM 7300M	<MDL (2 µg)	89.6 L at 20.1 LPM

NMAN—NIOSH Manual of Analytical Methods

MDL—Method Detection Limit—The MDL is the lowest quantity of a substance that can be distinguished from the absence of that substance (a blank value) within a stated confidence limit. <MDL means it's less than the limit.

Note: Cells highlighted in **green** contain data reflecting detectable contaminant concentrations.

Note: The GSFC IH staff has performed several rounds of air monitoring in the Plating Lab over the past 22 years. The majority of the sampling conducted represents area samples where the collection media is allowed to remain over a contaminant source for an entire day versus a personal sample, which follows the employee throughout the day whether that employee remains within the lab or not. The area sample represents the worst case scenario, but does not necessarily represent the exposure to personnel. The personal sample accurately relates to employee exposure. For circumstances in which employees' exposures vary greatly with workload, an IH may decide to perform area sampling to represent the worst case exposure if the workload dictates an 8-hr day dedicated to plating.

The sample results from the past 22 years consistently show the majority of data points are below the detection limits the methods were capable of detecting. The remainder of the data points has consistently been found to be orders of magnitude below legal permissible exposure limits. Sample locations have been well dispersed throughout the lab, representing exposures throughout the area. Sampled contaminants also represent the most harmful materials used in the lab.

Push-pull ventilation systems, such as the ones used in the Plating Lab, are designed to operate with a minimum airflow pull velocity of 100–150 feet per minute (fpm). The pull velocity should be 1.5 to 2.0 times the push velocity. The advantage of the push-pull system is that the push portion forces a jet of air across the contaminant source into the flow field of the capture (pull) hood. This allows the airflow to travel in a much more controlled manner over a much larger area than using an exhaust hood alone could achieve.

The IA Team IH reviewed a sample of previous assessments from 1996 (Attachment 22: Copy of LEV GSFC Working Copy); 2004 (Attachment 12: Code 547 Baseline IH Survey October 2003); and 2008 (Attachment 23: Bldg. 5 Plating Lab Push-Pull Ventilation Survey 2008). While the GSFC IH and the IA Team IH noted that the pull velocity did not always meet the 1.5 to 2.0 times the push velocity, the pull velocity did always exceed the push velocity. This, coupled with previous sampling consistently showing below detection limit findings or findings at orders of magnitude below legal permissible exposure limits, suggests the exhaust is effectively removing contaminants from the worker's breathing zone even though it may not be operating as design requirements dictate.

To verify the capture of contaminants, the IA Team IH requested a smoke test be performed over a random set of hoods. During this test, smoke is blown over the top of the tank allowing the hygienist to visibly see air currents and, therefore, to determine if the smoke is captured in the "pull" side of the exhaust system intended. This provides a visible verification of successful contaminant capture.

The GSFC IH staff performed the smoke tube test on June 15, 2009. The testing was videotaped for the IA Team to view and document the results. The smoke test was performed over the following tanks:

- A–12—Iridite Bath
- B–4—50-percent Nitric Acid Dip
- B–6—Nickel Strike Tank
- G–1—Gold Strike Tank
- G–3—Gold Plating Tank

The results show the smoke being entrained into the exhaust system as intended (Figure 5). These results are consistent with what would be expected based on the minimum chemical odor found in the room and consistently low or non-detectable air sampling results.

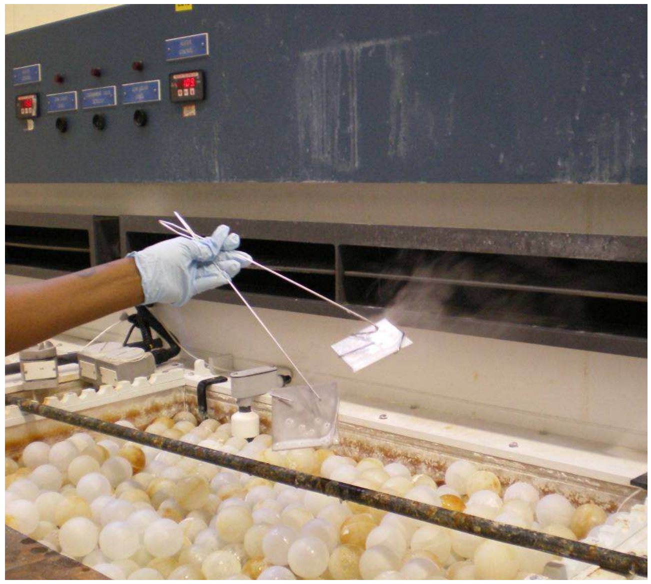

Figure 5: Vapor entrained into LEV system.

The medical staff also provided the following information:

> "This email is a response to a request for comment regarding concerns of an employee in a Plating Lab at GSFC. The employee apparently expressed concern regarding potential exposure to respirable toxic chemicals.
>
> After being informed of the concern, I spoke with the employee by phone. He suggested screening blood of employees in the Plating Lab for toxic chemicals. At that time he responded that as far as he knew, none of the employees in the shop had mentioned suffering symptoms that may be related to exposure. I informed him that screening for toxic chemicals would depend on qualitative and quantitative exposure assessment currently planned by the IH staff.
>
> Following review of results of the IH exposure assessment a few weeks later, I called the employee, Mr. Udofot, to discuss, and left a message. He never returned my call.
>
> In the months prior to, during and subsequent to this time period, no workers from any Plating Labs at GSFC were seen in the GSFC clinic complaining of symptoms which would have been attributable to respirable (gaseous) or airborne droplet toxic chemical exposure. Also, no medical documentation was forwarded to the GSFC clinic from physicians in the local community suggesting possible toxic chemical exposure in any workers."

Violation of law, rule, or regulation: None

Recommendation: Some of the employees did not recall seeing the 2003 IH Survey of Code 547 or previous air sampling results; however, they stated that they felt they would have been notified if there were an issue. It is recommended that the Plating Lab employees and managers attend a safety meeting to review the contents and recommendations within the 2003 IH assessment in addition to the air sampling results.

Concern 2: Employee exposure to acid mists, cyanides and heavy metals, specifically hexavalent chromium through inhalation during the use of shop air for parts drying

Evidence: The employees interviewed did not experience respiratory signs and symptoms relating to exposure to acids, bases, and heavy metals. The IA Team IH visited the Plating Lab and did not notice any tell-tale chemical odors one would expect in a plating lab. The IA Team IH reviewed previous air sampling data and performed additional air sampling, all showing air concentrations below the OSHA PELs and ACGIH TLVs. Figure 6 shows the parts drying operation.

Figure 6: Parts blow-drying operation.

***Violation of law, rule, or regulation*:** None

2.2.2.1.3 Exposure to Surface Contaminants in the Electroplating Room

Concern 1: Employee exposure to acid mists, cyanides and heavy metals, specifically hexavalent chromium, through skin absorption from contact with contaminated surfaces while working at the electroplating tanks

***Evidence**:* Review of chemical hygiene practices. The IA Team IH did not observe any signs of acid burns or allergic reaction to heavy metals on Plating Lab personnel's hands and arms.

The GSFC staff did not collect surface samples because there are no standards with which to compare the wipe samples to determine if a limit had been exceeded. There are hygiene practices in place and described in the lab's Chemical Hygiene Plan (CHP) that address personnel exposure relating to surface contamination from any source throughout the lab (e.g., no food or drink in lab; hand washing; etc.). The IA Team IH concurs with the decision not to conduct sampling of the rinse tanks or worktable because the results do not correlate to human exposure as air samples do.

A CHP has been developed for the Plating Lab as required by the Code of Federal Regulations 29CFR1910.1450. The plan was developed and signed by a team of employees consisting of Plating Lab employees and managers and their safety engineer. The CHP was noted as comprehensive (several binders in size) and covered topics such as employee training requirements and documentation, processing and plating procedures, safety procedures, PPE requirements, and Material Safety Data Sheets (MSDS).

The IA Team IH noted there were several procedures documented in the CHP consistent with interview answers that would minimize employee exposure to hazardous materials through dermal exposure. These procedures include the following:

- Washing hands when leaving the lab area
- No food or drink permitted in the lab area
- Use of chemical resistant gloves during plating and chemical mixing tasks (including removal of gloves when answering phone within the Plating Lab to reduce risks of phone, phone-to-face, and hand-to-face contamination)

The IA Team IH noted that some pieces of documentation stored within the CHP were not kept up to date. For example, training records and LEV survey results contained within the CHP were not the most recent versions. When the IA Team IH requested the most recent versions of this documentation, it was immediately provided. It appeared that employees were up to date on respiratory protection training, but the documentation had not been updated.

The IA Team IH confirmed with the employees that they had not been seen by the on-site physician for injury or illness related to acids or heavy metals. The IA Team IH did not see any evidence of acid burns on any of the employees' hands or arms.

Violation of law, rule, or regulation: None

Recommendation 1*:* The CHP is in need of updating. The training documentation is outdated (training requirements are maintained, but the data are not updated within the document), and there are some disagreements between the CHP and the 2003 IH Survey of Code 547 that should be remedied. The 2003 IH Survey of Code 547 should be corrected to identify gloves as required for chemical conversion coating operations.

Recommendation 2*:* Even though the employees were all aware of the hydrofluoric acid First Aid kits, they were not aware of how to use them or the reporting procedures after their use. It is recommended that an awareness training class be provided to the Plating Lab employees on the use of the kits and follow-up medical procedures for exposure to hydrofluoric acid.

Concern 2: Employee exposure to acid mists, cyanides, and heavy metals, specifically hexavalent chromium, through skin absorption from contact with contaminated surfaces that potentially result from the use of shop air for parts drying

Evidence*:* Review of chemical hygiene practices. The IA Team IH did not observe any signs of acid burns or allergic reaction to heavy metals on Plating Lab personnel's hands and arms.

Violation of law, rule, or regulation: None

In conclusion, with respect to areas of Industrial Hygiene, the IA team **did not find a violation of law, rule, or regulation.** Moreover, the investigation revealed that Mr. Udofot did not raise any concerns that would present a substantial and specific danger to public health and safety.

2.2.2.2 Quality Assurance

In the OSC letter, Mr. Udofot stated there were problems with maintenance of the plating tanks in the GSFC Plating Lab that could compromise the quality and safety of the Plating Group product. During the IA Team's interview with Mr. Udofot, he made clear his concerns relating to the final product were mainly associated with the rinse tanks problems. The concerns Mr. Udofot confirmed in the telephone interview were associated with the following:

- Rinse tank maintenance
- Rinse water quality

– Certification documentation

– Customers and GSFC Plating Lab personnel complaints

The evidence provided under each concern stated further on in this section is based on the following:

- Interviews with employees (Plating Lab employees, managers of the Plating Lab employees, planners, quality employees, facility maintenance personnel, retired lab chemist and manager, and customer named by Mr. Udofot)
- Review of laboratory procedures, industry specifications, drawing, tank logs, probes’ purchase order and quality manual, and certification logs
- Review of old (collected by GSFC) and new (collected by the IA Team) water samples

Note: The following items and documents were reviewed prior to or during the visit to GSFC:

Goddard Space Flight Center Documentation

- GSFC Work Instruction 547-WI-8072.1.22A “Quality Plan in the Electroplating Laboratory”
- GSFC Work Instruction 547-WI-8072.1.16A “Process Control for Electroplating”
- GSFC Work Instruction 547-WI-8072.1.6B “Bath Analysis for the Electroplating Solutions”
- GSFC Procedural Requirements GPR8072.1D “Process Control”
- GSFC Procedure Guidelines 547-PG-8072.1.1D “Manufacturing Process”
- GSFC Certification Log
- GSFC Plating Bath Book
- GSFC Maintenance Log

Test Reports

- Attachment 6a: IA—Water Sample Report July 23, 2008
- Attachment 6b: IA—Water Sample Report June 24, 2009
- Attachment 6c: IA—Water Sample Report July 23, 2009
- Attachment 24: Purchase Order for Probes

Company Literature

- Myron L. Company—CONTROLSTIK Rinse Tank System Model 597 Operation Manual, 21 Oct. 08
- ASTM D1193-06 “Standard Specification for Reagent Water”
- ASTM A967-05 “Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts”
- AMS 2422E “Plating, Gold”
- AMS 2700C “Passivation of Corrosion Resistant Steels”
- QQ-P-35C “ Passivation Treatments for Corrosion Resistant Steel”

Military Standards

- MIL-G-45204C “Gold Plating, Electrodeposited”
- MIL-C-26074E “Coating, Electroless Nickel”

2.2.2.2.1 Rinse Tank Maintenance

Concern 1: The sensor probes were never used or maintained by the employees, which resulted in improper rinse water pH.

***Evidence**:* Interviews held with GSFC personnel confirmed the probes were not maintained in accordance with the manufacturer’s (Myron L. Company) Operations Manual. Since GSFC’s Plating Lab work instructions contain no pH requirement for rinse tank de-ionized water, no violation could occur. Specifically, for the final hot rinse the ideal pH should be 6 to 8. This would prevent any alkaline or acidic surface reactions as a result of drag out from the prior, cold rinse operation. However, the limited time in these rinses coupled with the fact the parts are rapidly dried after removal from the hot water rinse does not allow much opportunity for surface reactions to occur.

Violation of law, rule, or regulation: None

Recommendations:

1. Maintain and use the probes or remove them from the tanks. The latter action would prevent potential contamination if the probes were not maintained.
2. Measure and record rinse tank conductivities in tank maintenance log books to demonstrate process control. This could be done in-house or it could be sent to the same commercial lab performing GSFC’s process tank analyzes.

Concern 2: The sensor probes were not properly set to sense when the rinse water needed to be replaced. It is stated in the OSC report that the probes had degraded in the tanks.

***Evidence**:* Interviews held with GSFC personnel confirmed the probes were not set in accordance with the manufacturer’s (Myron L. Company) suggested settings as specified in the Operation Manual. In addition, the maintenance team appeared to lack a level of competence regarding probe functionality. GSFC personnel conveyed to the IA Team that the probes were installed when the Plating Lab was originally opened. The intent was to utilize the latest in plating lab water monitoring technology. They stated the probes were not able to sense dust and dirt. To overcome this and other shortfalls, the lab personnel flushed the rinse tanks prior to use on new plating tasks. This method rather than the automated control was used as an obvious and completely acceptable expedient because of low plating process throughput compared with a commercial plating shop.

Note: During the IA Team Plating Lab tour, team members observed conductivity probes were turned off on several cold water rinse tanks (Figure 7).

Figure 7: Cold water rinse tank conductivity probe switch "Off."

Violation of law, rule, or regulation: None

Recommendation: Refer to Concern 1 recommendations.

Concern 3: The solenoid valves were clogged, preventing them from properly regulating rinse water quality per the OSC report.

Evidence: Interviews held with GSFC personnel confirmed the probes were not maintained properly. The rinse water tanks were emptied at the end of the week and re-filled at the beginning of the week. In addition, water conditioning included a limited daily flush of the rinse tanks. To perform this operation, the solenoid valves were overridden. During the Plating Lab tour, the senor probes and solenoid valves were demonstrated to be functional.

Violation of law, rule, or regulation: None

Recommendation: Refer to Concern 1 recommendations. Solenoid valves and sensor probes are an integral part of the same de-ionized rinse water tank supply and monitoring system.

Additional Information: The IA Team's additional comments to the OSC allegation regarding the probes and valves maintenance were as follows:

The probes and valves are still a part of the rinse water monitoring system. The Plating Lab initiated the process to replace the probes in October 2008 as a result of Mr. Udofot's suggestion. Fourteen replacement probes were ordered November 21, 2008 from Accent Controls Systems (Attachment 24: Purchase Order for Probes). The probes were received November 24, 2008. During the GSFC on-site interviews the IA Team was informed the probes were installed in 12 of the 14 tanks (cold water only) in early June 2009. According to the Plating Lab maintenance team, some of the solenoid valves had also been replaced. The Plating Lab maintenance team added that the probes were not used to control the cleanliness of the water. The only requirements associated with the rinse water are detailed in Work Instruction 547-WI-8072.1.22A Quality Plan in the Electroplating Laboratory written in 2005. This work instruction contains a maintenance log requirement to clean the probes weekly. Since the probes were installed for the original facility in the early 1990's, there is a time lapse on conformance with this requirement. Also, there is an indication that the replacement probes have not been maintained per Myron L. Company's maintenance manual instructions.

2.2.2.2.2 Rinse Water Quality

Concern 1: The rinse water was not maintained to the proper pH level.

***Evidence**:* Through interviews with Mr. Udofot and the GSFC Plating Lab personnel, the IA Team determined the de-ionized rinse water requirements had not been defined. Mr. Udofot and the Plating Lab personnel were unaware that a de-ionized water specification existed. The current method used to maintain the rinse water quality has no requirements. The method used to ensure the rinse water quality was, and still is, to drain the rinse tanks at the end of the week and to refill them at the start of the following week. In addition, there is a daily flushing of the rinse tanks for approximately 30 minutes. This is not listed as an action required per Work Instruction 547-WI-8072.1.22A Quality Plan in the Electroplating Laboratory.

Ideally, the final hot rinses' pH should be in the range of 6 to 8 to prevent alkaline and acidic surface reactions. However, the limited time in these rinses coupled with the fact the parts are rapidly dried after removal does not allow much opportunity for surface reactions to occur.

***Violation of law, rule, or regulation**:* None

***Recommendation**:* Update the Work Instruction to include an applicable water quality standard for the de-ionized water. For example, ASTM D1193 type IV for all cold rinses and type II for hot rinses and spray rinses might be considered.

Concern 2: The improper final hot rinse water pH (high acidity level) leaves the plated parts open to corrosion, leading to shortened life and possibly premature failure.

Evidence: There was no evidence found to support this conjecture and no credible proposed mechanism. Corrosion requires an electrolyte, oxygen, a susceptible material, and time. Corrosion while the part is in the de-ionized water rinse is unlikely because of short exposure time and lack of oxygen. Once the part is removed and dried, the only electrolyte source is humidity, hence the need to rapidly dry. Corrosion in climate-controlled areas is generally minimal, since heating, ventilating, and air conditioning (HVAC) systems typically maintain relative humidity at 50-percent or less. Outdoor storage requires corrosion protection for all but the most naturally resistant materials. Halides are known to accelerate corrosion (e.g., chloride). A commonly observed problem is wrapping parts in plastics or touching them with bare hands. Both acts are potential sources of chlorides; therefore, the post-processing corrosion is more likely a result of improper storage and handling rather than a less than optimal rinse pH. This could have been the source of the part's surface corrosion referred to in Mr. Hidrobo's interview. Since no analyzes were performed, the IA Team cannot state the surface contamination was, in fact, corrosion.

After reviewing the certification packages for over 520 plating jobs, there was no evidence to support Mr. Udofot's allegation that any part processed at GSFC's facility was rejected because of improper rinse pH.

***Violation of law, rule, or regulation**:* None

Concern 3: The post-final hot rinse blow dry operations generate an aerosol that corrodes the metal equipment in the Plating Lab.

Evidence: After touring the GSFC Plating Lab, the IA Team came to the conclusion that the facility, specifically, the blow-dry/air hose area (Figure 8), did not appear to have *preferential* corrosion on equipment or any facility hardware (e.g., tables, chairs, material racks) (Figure 9). There is no reason to believe the GSFC facility corrosion, referred to in the OSC letter was a result of anything other than humidity.

Note: The corrosion observed was much less than that seen in a typical electroplating facility.

Figure 8: Blow-drying booth.

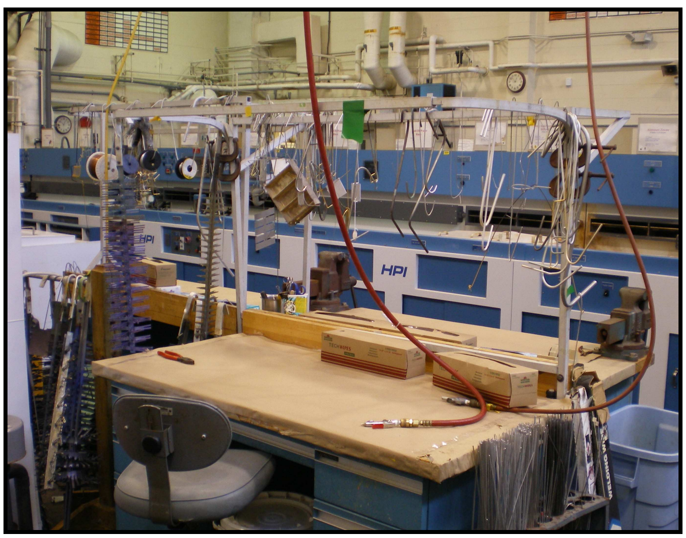

Figure 9: Facility hardware.

Violation of law, rule, or regulation: None

Concern 4: Improper rinse water pH could compromise the passivation layer thicknesses on critical parts rendering them prone to corrosion.

Evidence: No evidence was found to support this claim. The oxide layers on passivated parts are inherently stable; this is the reason for utilizing them. As a result, it takes specialized conditions to dissolve them at any appreciable rate. Typical conditions are extreme acidity, pH 1 or less, coupled with reducing agents. Given the lack of both conditions in GSFC's rinses, chemical attack on passivation layers would be very slow at best and more likely non-existent.

Violation of law, rule, or regulation: None

Concern 5: The Plating Lab used tap water in lieu of de-ionized water for the rinse tanks.

Evidence: During the June 17, 2009 IA Team teleconference with Mr. Udofot, he indicated tap water had been used because of a malfunctioning reverse osmosis (RO) system for the production of de-ionized water. No evidence was found to support or deny this claim. Analysis of final rinse water samples taken during the IA Team site visit provided conductivity data consistent with de-ionized water rather than tap water (Attachment 6C: IA–Water Sample Report July 23, 2009). Nevertheless, there were no rejected parts attributable to the use of tap water. Finally, GSFC has no documented requirement for the use of de-ionized water in final rinses or any other rinses.

Violation of law, rule, or regulation: None

Recommendation: See Concern 1.

<u>Additional information</u>: It is not uncommon for commercial surface treatment job shops to use tap water for some process rinses, especially after hot alkaline cleaners. Its use depends primarily on the tap water's hardness; that is, the concentration of low solubility inorganic compounds commonly referred to as scale.

2.2.2.2.3 Certification Documentation

Concern 1: The Plating Lab consistently plated parts with Type 1 gold (Au) instead of Type 2 without customer agreement, which is in violation of GSFC's quality system requirements.

Evidence: There was no evidence found to substantiate this allegation. The IA Team reviewed the Au plating bath specification and determined the GSFC's bath is capable of plating Au that meets Type 1 ***and*** Type 2 purity requirements. The method of providing an Au plating bath that meets both Type 1 and Type 2 is an industry practice that the IA Team confirmed with a separate vendor.

Violation of law, rule, or regulation: None.

Concern 2: The parts coating thicknesses were measured incorrectly using incorrect methods and thus, certified incorrectly.

Evidence: This allegation was substantiated. QA only measured the parts' dimensions before processing and after all plating was completed (Attachment 25: Electroplated Inspection Form (548.2.14). **GSFC responded to Mr. Udofot's concern that the coating thicknesses were improperly measured by purchasing an UPA Technologies XRF-2000 machine, which was delivered in October 2008. Mr. Udofot was trained on how to operate the machine.**
This machine is capable of measuring the thicknesses of individual layers in multi-layered coatings (e.g., a nickel underlayment of 0.0005 inches thick minimum followed by a gold coating of 0.0001 inches thick minimum). Three employees have since been trained in the operation of the machine.

Violation of law, rule, or regulation: None. The IA team noted a nonconformance to the final inspection requirement for thickness as specified on the drawing for gold plating per specification MIL-G-45204, ***Class 2*** and MIL-C-26074, ***Grade B***. GSFC QA certified the final product met the thickness drawing requirement, but there was no evidence found to support the thickness certification. The Certification Logs reviewed did not have the level of detail for thickness measurement required to assure the thickness as specified by the specification on the drawing could be validated. Per discussions with QA the reported thickness measurement indicates a comparison of the part's final dimension verses its initial dimension, not individual thickness measurements for each coating. This method is verification by similarity and is not direct verification as required. As a result, the method used by QA does not properly validate the drawing requirement resulting in the non-compliance of the process requirement and a non-compliance of an ISO 9001 requirement for documenting conformance to requirements using properly developed means for establishing objective evidence. According to NASA Policy Directive 1280.1 (NASA Management System Policy), ISO 9001 is a type of management system. The management system provides a structure whereby NASA can measure how effectively it is performing its mission and meeting its objectives; focus on where improvements are needed; and ensure that value is delivered to its customers.

The non-compliance on the thickness constitutes low risk to the form and fit of the plated part. A functional test is performed on the plated part to validate it meets the requirements.

Recommendations:

1. QA personnel need additional training to understand plating specification requirements; for example, thickness and acceptable methods to certify them.

2. GSFC's Plating Lab personnel need training on assessing plating specification measurements and QA's measuring capability constraints.

3. Purchase and train Plating Lab personnel in equipment necessary to validate plating thickness requirements stated in the specifications or seek validation through vendor analyzes.

<u>Note:</u>

There are instances where it is impossible to directly measure the part after every coating is applied. For example, to plate copper (Cu) on stainless steel, a Woods nickel (Ni) strike must be employed. To do this, the part is immersed in the Woods bath and held at an anodic potential to remove the naturally occurring oxide layer. This reduces the part's thickness. Next, without removing the part from the bath, the part's polarity is reversed making it cathodic. The part cannot be removed for measurement here because it will spontaneously oxidize in air, rendering any further surface treatment ineffective. It is held at this potential to plate a thin Ni strike. In this instance, it is impossible to get the strike thickness by difference measurement since the anodic step removes some of the parent material. Also, if the resulting Cu coating is thick enough, even X-ray measurement techniques cannot measure the thickness of the underlying strike because of attenuation. In such instances, the only option is to plate coupons and measure the thickness through metallographic cross-sectioning.

For thicker underlying coatings, this can still be an issue; for example, plating Cu on Ni. If the Ni coating has been in contact with the air momentarily, Cu can be plated directly on it with good results. If it has been exposed to the air longer, an oxide "grows" on the surface, which will either prevent Cu plating or result in poor adhesion, peeling, or blistering. If an acid etch is used to remove the oxide, the part thickness changes because some of the Ni is removed. Many times the requirements have "loose" thickness tolerances such that small variations in thickness are not important. When they are important, these problems can be overcome by using X-ray techniques or by sectioning coupons and measuring the layers optically.

Documentation Recommendations:

1. The planners should have an in-house list of plating capabilities per the specification stated on engineering drawing notes and maintained by the Plating Lab. If the requirements are not on the in-house list, then an outside vendor should be sought.

2. Plating Lab should purchase and train Plating Lab personnel in equipment necessary to validate all plating requirements stated in the specifications or seek validation through vendor analyzes. Typically, process control and verification through process bath and coupon analyzes is used for validation. Although preferred, validation on actual hardware is not possible in many instances.

3. GFC's Plating Lab documentation needs to be updated to include data supporting direct and indirect validation/verification techniques.

2.2.2.2.4 Customers and Goddard Space Flight Center Plating Lab Personnel Complaints

Concern 1: During the interview with Mr. Udofot, it was conveyed that the Plating Lab received a customer complaint from Mr. Hidrobo. It was also alleged that Mr. Hidrobo was prevented from bringing a part back to Mr. Udofot for further advice.

Evidence: During the interviews with GSFC personnel, Mr. Hidrobo was interviewed. He confirmed a part was to have an additional processing operation. He stated his conversation with Mr. Udofot was not a complaint but characterized it as more of a technical discussion. Mr. Gray corroborated that the discussion was more of a technical discussion. He stated Mr. Udofot was providing Mr. Hidrobo with a technical explanation of what could have caused the poor quality plating results. Mr. Hidrobo informed the IA Team that the Plating Lab took the part and re-plated it at no additional cost (time to the project) and the results were good. Mr. Hidrobo went on to state he was not asked by Mr. Hinkle or any other GSFC personnel to refrain from taking parts to or asking for assistance from Mr. Udofot.

Violation of law, rule, or regulation*:* None.

Concern 2: In the interview with Mr. Udofot, he stated Plating Lab personnel complained that the Plating Lab was too hot and humid.

Evidence: Mr. Adams confirmed he made the excessive heat complaint to Mr. Udofot. During the investigation of the "White Cloud Mist" issue, broken air controllers in the Plating Lab were discovered. These broken controllers were repaired as a result and the high humidity condition was resolved.

Violation of law, rule, or regulation*:* None.

Concern 3: No sensor probes were installed in the Hot Water Rinse Tanks (HWRT). This prevents quality control of the hot water rinse tank.

Evidence: This allegation was confirmed through a tour of the Plating Lab (Figure 10). Plating Group instructions do not contain requirements for the water quality as discussed earlier. Two replacement probes were purchased for the HWRT, but were never installed. As best as could be determined, the original system design did not include them in hot water rinse tanks.

Violation of law, rule, or regulation*:* None.

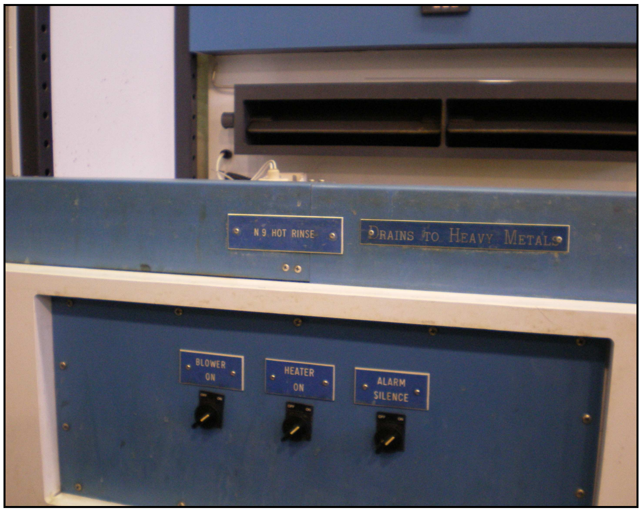

Figure 10: Missing conductivity probe switch on HWRT.

In conclusion, with respect to areas of Quality Assurance, the IA team **did not find a violation of law, rule, or regulation.** The investigation did confirm one ISO 9001 non-compliance against operational procedure as stated by Mr. Udofot in the OSC letter.

3.0 Supporting Documentation

Attachment 1: OSC Letter

05/19/2009 10:03 FAX 2026535151 OSC 002/007

U.S. OFFICE OF SPECIAL COUNSEL
1730 M Street, N.W., Suite 300
Washington, D.C. 20036-4505

May 19, 2009

The Special Counsel

Mr. Christopher Scolese
Acting Administrator
National Aeronautics and Space Administration
300 E Street, S.W.
Washington, D.C. 20546

Re: OSC File No. DI-09-1621

Dear Mr. Scolese:

Pursuant to my responsibilities as Acting Special Counsel, I am referring to you for investigation a whistleblower disclosure that officials at the National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), Greenbelt, Maryland, are engaging in conduct which may constitute a violation of a law, rule, or regulation and a substantial and specific danger to public health and safety.

Mr. Bassey Udofot, who has consented to the release of his name, was previously an Aerospace Engineer Group Leader[1] in the Advanced Manufacturing Branch Plating Group (Plating Group) at GSFC. Mr. Udofot holds a Masters Degree in electrochemical plating and has 14 years of experience in the field. He has also conducted research, presented numerous technical seminars, and holds patents in electrochemical plating. Mr. Udofot disclosed that during his tenure in this position he witnessed practices that placed employees in danger of exposure to hazardous chemicals and compromised the quality and safety of the products that the Plating Group handled.

Mr. Udofot explained that the Plating Group contracts with various internal NASA customers, such as the Jet Propulsion Laboratory and the Landsat Program, to plate critical spacecraft components for space missions and testing. The process requires several steps, including plating with an aqueous solution of simple or complex salts and several rinses using de-ionized water, with a final de-ionized hot water rinse of the parts before they are dried and completed. Mr. Udofot identified several problems with the plating process at GSFC, as well as with the maintenance of GSFC's equipment and the certification of parts for use.

First, Mr. Udofot alleged that the plating room contains three very large tanks containing cyanide and other potentially carcinogenic chemicals, such as hexavalent chromium. He contends that these tanks are not capped or covered, even when they are not in use, and are therefore releasing potentially hazardous acid mist, alkali mist, and other corrosive fume mixtures into the plating room, where employees inhale them. Employees are not required to

[1] Mr. Udofot's current address and telephone number are: 1135 Delray Road, Knoxville, Tennessee 37923; (865) 692-8683

AA/1009-M159

Attachment 1 continued

wear gloves or masks when working near or with the tank containing a hexavalent chromium compound, and Mr. Udofot indicated that the NASA Industrial Hygiene Office's 2003 Executive Summary states that such protective measures are unnecessary. Mr. Udofot noted that this instruction is in opposition to the warnings and safety instructions contained in the "materials safety data sheets" provided by the suppliers of the chemicals used in the plating lab. Furthermore, the air circulation, or "push/pull," system in the plating room was not properly circulating fresh air, as was discovered when Mr. Udofot noticed a condensation cloud forming in the room. He immediately brought this to the attention of another employee, who called emergency services to the site. Upon investigation, it was found that the system's humidity transmitter was not properly calibrated and was not intended to be used in such a manner. Additionally, the push/pull supply and exhaust fans were not connected to the system command, and were running without control from Metasys, the main control system. Thus, the entire air circulation system was compromised and was potentially unable to properly circulate the air containing the fumes from the uncapped tanks.

Mr. Udofot also explained that the final step before drying in the plating process is the "hot water rinse," which involves rinsing the plated parts in a hot water bath to slough off any chemical remnants. To achieve optimal results, the rinse water should have a neutral pH of approximately 7. Mr. Udofot stated that approximately 25 years ago, NASA installed 12 sensor probes and solenoid valves on the tanks containing the rinse water, which were meant to automatically measure and regulate the quality of the water. When the probes and valves operated properly, the probes would sense that the water in the tanks was not at the proper pH level and needed to be replaced, which would cause the solenoid valves to open, allowing fresh water in to replace the stagnant water in the tanks. Mr. Udofot discovered that the probes were never used or maintained by employees, and were neglected to the point that they had degraded in the tanks. When Mr. Udofot questioned this, management and the operator of the plating shop told Mr. Udofot that the valves were not opening because the water was never dirty enough to set off the sensor on the probe, and that when they were opened, the valves failed to automatically shut off, allowing a continuous flow of water into the tanks. Upon investigation, Mr. Udofot discovered that, in fact, the probes were never properly set to sense when the water needed replacing, and the valves were clogged due to lack of maintenance, causing them to fail to close automatically. When Mr. Udofot used the manufacturer's manual to reset the operating parameters on the system, the system worked properly. However, many of the probes were brittle and cracked, and had lost their markings due to exposure to the acidic rinse water and years of neglect.

Because the probes and valves did not operate properly, when the parts were rinsed a buildup of remnant chemicals, or "drag-out," was left in the rinse water. Mr. Udofot noticed that metal equipment in contact with the rinse water showed signs of acid degradation, and suspected that the rinse water was not at the proper pH of 7 because of the build-up of drag-out it contained. Mr. Udofot reported his concerns to his supervisor, Mr. Garcia Blount, who ordered outside laboratory tests to determine the pH of the water. The final hot rinse water was tested and found to have pH levels of 3.3, 4.1 and 4.9, which are acidic. Mr. Udofot explained that the acidity causes the cyanide on the parts to be etched off into the water, forming hydrogen cyanide, chloride, and fluoride, hexachromic acids, and other trace toxins and making the water hazardous to humans. In addition, Mr. Udofot stated that the acidity of the final hot rinse water used in the

Attachment 1 continued

rinsing process could compromise the organic inclusions in the metal deposit crystal lattices, the thickness of metal deposits on the parts, and the necessary protective oxide films deposited on them. This leaves the parts open to corrosion attacks and can shorten their life expectancies which in turn may lead to premature failure of a part during a space flight mission.

After rinsing, the plated parts are blown dry in the plating room, which has an air-circulating hood under which the parts can be dried. The use of this hood would prevent the dispersion of the water containing the drag-out, which poses a safety hazard to the plating employees in the room. Mr. Udofot reported, however, that instead of using this hood, employees simply blow the parts dry into the room, spraying the contaminated water on equipment and other employees. He noted that the long table at which employees work was showing signs of corrosion from contact with the water containing these chemicals. He also noted that the plating room contains 14 rectifiers, which power the plating process, and that 12 of the rectifiers were not covered and were badly corroded because of the water to which they were exposed. Based upon his observations, Mr. Udofot was concerned for the safety and health of employees and he recommended to staff that they employ the hood in the drying process. However, staff and management resisted this change to the process and continued to dry the parts without using the hood, exposing Mr. Udofot and other employees to potentially hazardous chemicals.[2]

Additionally, Mr. Udofot alleged that the plating shop has consistently, and without the customer's knowledge, plated parts with Type 1 gold instead of the Type 2 gold specified by the customer. Customers complete a certification log, which lays out the specifications for the part being plated, and then forward the certification log to the planner, who then sends it to the platers at GSFC. Mr. Udofot explained that NASA follows the International Organization for Standardization (ISO) 9000 series of requirements for product quality through process controls. The plating process in particular must be performed in accordance with ISO 9001/2000, or alternatively, Aerospace Standard (AS) 9100. AS 9100 is a similar standard to ISO 9001, but is tailored to aerospace manufacturers and contains additional requirements and clarifications. Mr. Udofot alleged that the substitution of Type 1 gold without the customer's knowledge is a violation of the quality requirements associated with ISO 9001 and AS 9100. Type 1 gold is more expensive than Type 2 gold, and plating shop employees told Mr. Udofot that the shop exclusively uses Type 1 gold. Customers requesting Type 2 gold were not advised of this, and therefore they were not given the opportunity to look elsewhere to have their parts plated. The parts were simply plated with Type 1 gold and returned to the customer as if no substitution was made. Mr. Udofot alleged that this practice has gone on in the plating shop for at least several years.

Mr. Udofot also alleged that employees of Northrop-Grumman Corp., the NASA contractor responsible for measuring and certifying the thickness of the plating on parts, used a faulty measuring system and therefore knowingly certified parts incorrectly. Specifically,

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[2] It is noteworthy that Mr. Udofot attempted to substitute less-hazardous trivalent chromium for hexavalent chromium, as it was in stock and would not compromise or change the plating process, but he met with resistance because it would require too many administrative approvals to effect the change.

Attachment 1 continued

Mr. Udofot explained that plating on parts with a single layer coating can be measured by taking the difference between the thickness of the unplated part, or the substrate, and the thickness of the part after plating. However, this method is not reliable when measuring parts that are coated in multiple layers, such as those plated by the Plating Group at GSFC. Nevertheless, Mr. Udofot discovered that this was the method being used by Northrop Grumman employees when he attempted to measure compliance within the Plating Group. Mr. Udofot immediately ordered X-ray equipment capable of providing a more accurate measurement. He alleged, however, that improperly measured and certified parts were returned to customers during a minimum of nine months prior to the arrival of the new equipment. He contended that an improper thickness certification could result in plating on spacecraft parts that fails to provide necessary dry lubrication, corrosion protection, or shielding, leading to parts seizing while in use. This could possibly shorten the life expectancy of such parts and/or lead to an accident.

The U.S. Office of Special Counsel (OSC) is authorized by law to receive disclosures of information from federal employees alleging violations of law, rule, or regulation, gross mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety. 5 U.S.C. § 1213(a) and (b). As Acting Special Counsel, if I find, on the basis of the information disclosed, that there is a substantial likelihood that one of these conditions exists, I am required to advise the appropriate agency head of my findings, and the agency head is required to conduct an investigation of the allegations and prepare a report. 5 U.S.C. § 1213(c) and (g).

I have concluded that there is a substantial likelihood that the information the whistleblower provided to OSC discloses a violation of law, rule, or regulation and a substantial and specific danger to public health and safety. As previously stated, I am referring this information to you for an investigation of the whistleblower's allegations and a report of your findings within 60 days of your receipt of this letter. By law, the report must be reviewed and signed by you personally. Should you nevertheless delegate your authority to review and sign the report to the Inspector General, or any other official, the delegation must be specifically stated and must include the authority to take the actions necessary under 5 U.S.C. § 1213(d)(5). Without this information, the report may be found deficient. The requirements of the report are set forth at 5 U.S.C. § 1213(c) and (d). A summary of § 1213(d) is enclosed. As a matter of policy, OSC also requires that your investigators interview the whistleblower as part of the agency investigation whenever the whistleblower consents to disclosure of his or her name.

In the event it is not possible to report on the matter within the 60-day time limit under the statute, you may request in writing an extension of time not to exceed 60 days. Please be advised that an extension of time is normally not granted automatically, but only upon a showing of good cause. Accordingly, in the written request for an extension of time, please state specifically the reasons the additional time is needed.

After making the determinations required by 5 U.S.C. § 1213(e)(2), copies of the report, along with any comments on the report from the person making the disclosure and any comments or recommendations by this office, will be sent to the President and the appropriate oversight committees in the Senate and House of Representatives. 5 U.S.C. § 1213(e)(3). Unless classified or prohibited from release by law or by Executive Order requiring that

Attachment 1 concluded

information be kept secret in the interest of the national defense or the conduct of foreign affairs, a copy of the report and any comments will be placed in a public file in accordance with 5 U.S.C. § 1219(a).

Please refer to our file number in any correspondence on this matter. If you need further information, please contact Catherine A. McMullen, Chief, Disclosure Unit, at (202) 254-3604. I am also available for any questions you may have.

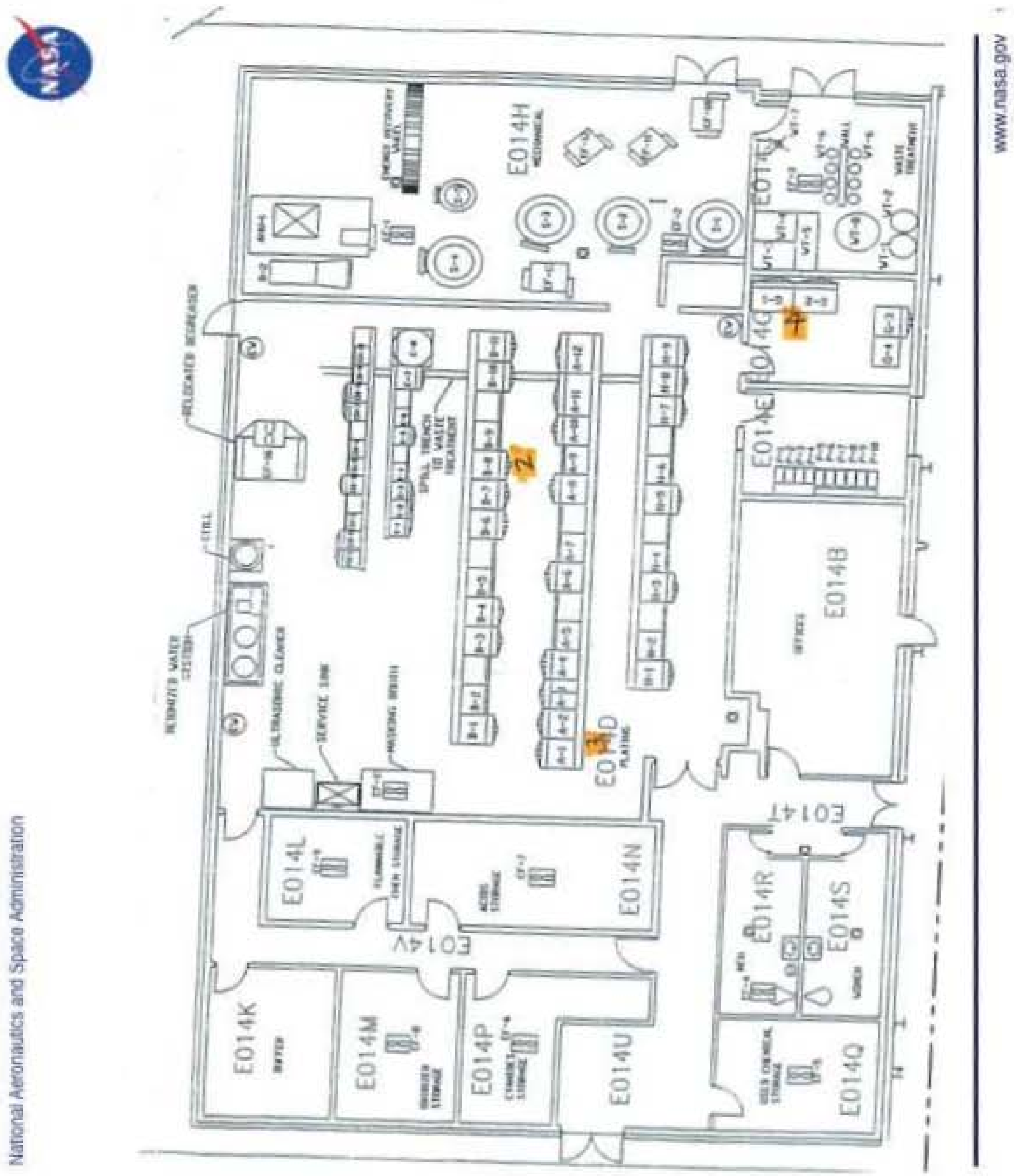
Sincerely,

William E. Reukauf

William E. Reukauf
Acting Special Counsel

Enclosure

Attachment 2: Facility Drawing



Attachment 3: 2008 Follow-Up Survey of the Plating Group

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

November 17, 2008

Reply to Attn of 250

TO: 547/ Chief, Advanced Manufacturing Branch

FROM: 250/ Safety, Health and Environmental Division

SUBJECT: 2008 Follow Up Survey Of The Plating Group (Code 547.5)

1. **BACKGROUND**: The Industrial Hygiene Office (IHO) received a request for a follow-up industrial hygiene survey on the Plating Group (Code 547.5) of the Advanced Manufacturing Branch. Mr. Ching-tsen Bien, CIH, of the IHO conducted an air sampling program to evaluate the potential exposures to the air contaminants that exist in the Plating Shop. The air sampling was conducted between October 22 and November 10, 2008. The purpose of this evaluation was to determine the exposure of the GSFC employees to these potential health hazards. Since the activities of the GSFC employees at the Plating Shop were low at this time period, only area samples were collected. Personal sampling will resume when more orders are received.

2. **THE PLATING PROCESS**

The Plating Group provides services such as electroplating, surface finishing, and electroforming for the components of spacecraft, flight hardware, or ground support equipment. In addition, to electroplating of gold, silver, nickel, or copper, the shop also has the capability of anodizing and iriditing aluminum parts. A plating process consists of the following steps:

1) Degreasing
2) Removing Soiling
3) Removing oxide film on the metal surface.
4) Adding a thin metal "Strike" to improve adhesion, and
5) Plating.

The GSFC Plating Shop has several lines for different types of plating. There are A, B, CN, E, G, and N lines. Each line has tanks for solvents, chemicals, and water rinse. Typical gold plating on an aluminum part involves the following steps, chemicals, and operating parameters:

Step	Process	Tank #	Main chemicals	pH	Temp., °F
1	Aluminum soak cleaner	A-1	Phosphates	11.97 – 12.0	150 – 160
2	Counter-flow rinse	A-3	Water		

Attachment 3 continued

3	Aluminum deoxidizer	A-4	Nitric and hydrofluoric acids	0.56 - 0.6	70 – 80
4	Cold water rinse	A-5	Water		
5	Aluminum etch cleaner	A-2	Sodium hydroxide	12.4 -12.8	150 - 160
6	Cold water rinse	A-3	Water		
7	Aluminum deoxidizer rinse	A-4	Nitric and hydrofluoric acids	0.56 -0.6	70 – 80
8	Cold water rinse	A-3	Water		
9	Nitric acid rinse	B-4A	Nitric acid	-0.2 - -0.3	75 – 80
10	Counter-flow rinse	B-5	Water		
11	Aluminum zincate activation	B-3	Sodium hydroxide, Zinc oxide	12.4 - 13.4	Room
12	Nitric acid drip	B-4B	Nitric acid	-0.025 - - 0.034	75 – 80
13	Cold water rinse	B-5	Water		
14	Aluminum zincate activation	B-3	Sodium hydroxide, Zinc oxide	12.4 – 13.4	Room
15	Counter-flow rinse	B-2	Water		
16	Electroless nickel	E-7	Nickel, Sodium hydroxide	4.5 – 5.2	180 – 195
17	Cold water rinse	E -6	Water		
18	Cold water rinse	B-5	Water		
19	Woods nickel strike	B-6	Hydrochloric acid	-0.15 - -0.20	75 – 85
20	Hot water rinse	B-5	Water		130
21	Gold strike	G-1	Potassium gold cyanide	3.3 – 4.0	120 – 140
22	Water spray rinse	G-2	Water		
23	Gold plating	G-3	Gold	8.5 – 9.5	120 – 130
24	Cold water rinse	G-4	Water		
25	Hot water rinse	B-11	Water		130
26	Blow dry with compressed air				

Plating of other metal may involve different steps using different types of chemicals. The immersion time for the metal piece in each tank is brief in general, except for the plating operation which may take 15 to 30 minutes. After immersion the metal piece in the tank, the operator can stay outside the process area to avoid exposure to the air contaminants. In general, the operator's exposure is minimal as observed at the gold plating process.

3. **Air Sampling**

Area sampling was performed for the following chemicals:

Acid: Hydrochloric, Hydrofluoric, Nitric, Phosphoric, and Sulfuric.
Base: Sodium hydroxide.
Metal: Barium, Copper, Hexavalent chromium (chromic acid), and Nickel.
Other chemical: Cyanide.

Samples were analyzed by an American Industrial Hygiene Association accredited laboratory. The acids samples except for the phosphoric acid were collected on a silica gel

Attachment 3 continued

tube and analyzed by the NIOSH 7903 method. The phosphoric acid sample was collected on a membrane filter and analyzed by the OSHA 111 method. Metals samples (except chromium), such as barium and nickel were collected on membrane filters and analyzed by the NIOSH 7300 method. Hexavalent chromium samples were collected on a PVC membrane filter and analyzed by the OSHA ID 215 method. The sampling time varied between 290 and 430 minutes.

Potassium cyanide and silver cyanide are used for silver plating at the CN line. No samples were collected on the CN line since the line is not in operation. In general, the metal analytical method is more sensitive than the wet chemical method for analyzing sodium hydroxide or hydrogen cyanide. Instead of analyzing cyanide at the G-1 tank, gold or potassium was determined from the potassium or gold concentration on the filter. The cyanide concentration can be calculated from the chemical formula of potassium gold cyanide ($KAu(CN)_2$). The concentration of sodium hydroxide is also determined by same approach.

4. Summary of Toxicity of Chemicals Used in the Plating Shop

Many chemicals used in the Plating Shop are very corrosive or irritating. A summary of exposure limit and acute health effects for these chemicals is listed in the following table:

Chemical	Exposure Limit, mg/m^3	Acute Health Effects	
		Inhalation	**Dermal and eye**
Hydrochloric Acid	7.0	Severe irritation and chemical burns to the respiratory tract	Corrosive and causes severe skin burns and eye ulceration
Hydrofluoric acid	2.5	Severe irritation of the upper respiratory tract with pain, burns, and inflammation. May cause pulmonary edema	Severe skin burns and delayed tissue destruction and irreversible eye damage
Nitric Acid	5	Chemical burns to the respiratory tract, chemical pneumonitis and pulmonary edema.	Skins burns and irreversible eye damage
Phosphoric Acid	1.0	Severe irritation and chemical burns to the respiratory tract	Severe skin burns., chemical conjunctivitis and corneal damage of eyes
Sulfuric Acid	1.0	Severe irritation to mucous membranes	Severe skin burns and irreversible eye damage
Sodium hydroxide	2.0	Extreme pulmonary irritation	Severe full thickness skin burns and irreversible eye damage
Barium chloride	0.5	Irritation of respiratory tract	Skin irritation, necrosis
Chromic acid	0.0025	Irritation to respiratory tract and mucous membranes, potential carcinogen	Irritation or itching to skin
Chromium (II or III)	0.5	Irritation to respiratory tract and mucous membranes	Irritation to skin
Copper compounds	1.0	Upper respiratory tract irritation	Itching, erythema and conjunctivitis on eyes
Nickel compounds	1.0	Irritating upper respiratory tract	Skin sensitization and conjunctivitis on eyes

3

Attachment 3 continued

Sodium phosphates	N/A	Irritation	Irritation to skin and eyes
Zinc oxide	5	Respiratory tract irritation	Dermatitis and eye irritation
Cyanide (potassium gold cyanide)	5	Irritation to gastro-intestinal or respiratory tract	Inflammation and blistering on skin and corneal damage on eyes

5. Sampling Results

The results of air sampling are shown on Table 1. Almost all samples reported less than the detection limit of the analytical method, which means they were less than the exposure limit for these air contaminants for a minimum sampling time of five hours. Since the time the operator spends at each tank is very brief, further personal sampling may not yield meaningful results. Personal sampling for such short duration will not allow detection limits as low as those reported here.

6. Other Observations

a. There is a wall chart posted at the Plating Shop that indicates the required personal protective equipment (PPE) for various types of operations. For example, safety toe boots are required for most operations. The street clothes are worn by operators. Disposable nitrile rubber gloves are used for most operations.
b. An eye wash and an emergency shower are available in the Plating Shop.
c. There are several storage rooms for chemicals. Some rooms have shelves for container storage. Containers stacked as high as three were observed in a few storage rooms. Large containers (55-gallon size) are scattered in one room, blocking the access to other containers in the room.
d. A compressed air jet was used to dry the finished plating parts after final water rinse. The Group Leader has expressed concerns that the chemical-containing water droplets may present as an inhalation hazard. He preferred to perform this procedure inside an chemical exhaust hood in the Plating Shop.
e. Large or heavy metal pieces are immersed into and removed from the tanks using an overhead hoist.
f. Some tanks are covered after the end of the work shift and others are left open.
g. The GSFC does not have a fire department or an emergency response team to handle emergencies. It relies on the Greenbelt Fire Department. The Group Leader indicated that he was informed that the Hazmat Team of the Greenbelt Fire Department would not perform emergency service in an event of spills of materials containing any quantities of cyanides.

Conclusions

The sampling results indicate that there was minimal release of hazardous air contaminants to the environment. This is an indication of effective ventilation controls at the Plating Shop. The previous 1996 personal sampling results also confirmed that employees at the Plating Shop had minimal exposure to these hazardous chemicals. Since highly toxic or corrosive chemicals such as sodium hydroxide, hydrogen fluoride, nitric acid or chromic

Attachment 3 concluded

acid are routinely used in the Plating Shop at elevated temperatures, prevention of accidental skin or eye exposure to these hazardous chemicals should be emphasized.

Recommendations

1. The effectiveness of the ventilation system is the key for low contaminant emission in the Plating Shop. In addition to the annual IHO LEV (local exhaust ventilation) evaluations, consider installing flow rate monitors at tanks containing most hazardous chemicals such as sodium hydroxide, nitric acid, or chromic acid to ensure the continuing effective ventilation at these locations.
2. It appears that leather hard toe safety boots are listed as the required foot protection for the operators. Leather shoes do not protect against the permeation of acids and caustic compounds. Chemical resistant boots with hard toe should be used.
3. A chemical resistant apron is required at the plating shop. It should be sufficient for handling small metal pieces. For handling large or heavy parts or transferring acids or sodium hydroxide, consider requiring the use of clothing that provides full body chemical protection in case of spill or splash of these liquids. Long gauntlet chemical resistant gloves that provide hand and arm protection should also be used for these operations. The IHO can provide selection recommendations for the appropriate PPE.
4. Consider requiring the wearing of long-sleeved shirt and long pants in the plating area to reduce accidental chemical burns to the bare skin.
5. If it is practical, consider covering the tanks at the end of the workday to minimize the emission of air contaminants.
6. Consider installing additional shelves in the storage room so that all small containers are stored on the shelves. Also rearrange the location of the large storage drums to provide easy access to other containers.
7. Perform periodic inspection of the eye wash fountain and emergency shower to maintain continuing operation.
8. As a good hygiene practice, consider performing the final compressed air drying of the finished part inside the chemical fume hood. The compressed air nozzle should be relocated for convenient reach.
9. Since most chemicals used in the tanks are highly corrosive, a periodic inspection program of these tanks should be considered to prevent catastrophic failures.
10. Consider the formation of an emergency response team to handle spills of cyanides if the Greenbelt Fire Department does not provide assistance.

We appreciate the assistance provided by Mr. B. Udofot, Mr. C. Adams, Ms. K. Harvey, Mr. B. White, Mr. L. White, and Mr. J. Wolfe.

Ching-tsen Bien

Ching-tsen Bien, CIH
Industrial Hygienist
Industrial Hygiene Office (250.9)

Attachment 4: IA Team Interview List

Note: Charlie Adams was on vacation during the GSFC site visit; the IA team had a telecom with him on July 1, 2009.

Time	June 22 Bldg 5, CR C026	Time	June 23 Bldg 5, CR C026	Time	June 24 Bldg 5, CR C026
				8:00	Armando Lopez (Chief, Safety & Environ Div)
				8:15	X 6-2281
8:30		8:30	Steve Simond (Retired Supervisor)	8:30	Marvin Kaufman (Mech Group Lead Contractor)
8:45		8:45	(H) 301-290-0667 (Telecon)	8:45	x6-6271
9:00		9:00	Katrina Harvey (CS Acting Team Lead)	9:00	
9:15		9:15	x6-0930 Electroplater)	9:15	Pilar Joy (Retired SME)
9:30		9:30	Melonie Scofield x6-1035 (CS Safety Mgr)	9:30	(H) 410 349-8203 / (C) 301-602-0208
9:45		9:45	Roy Deza x6-6795 (CIH Contractor)	9:45	
10:00		10:00	Ching-tsen Bien x6-6918 (CIH Contractor)	10:00	Ken Hinkle (CS Chief Mech Syst)
10:15		10:15		10:15	X6-7101
10:30		10:30	Overrun	10:30	James Baker (CS Planning) Jeff Dalhoff (CS CIH Group Lead) X62498 off-schedule -
10:45		10:45		10:45	Todd Purser (CS COTR / HST Fab Mgr)
11:00		11:00	Overrun	11:00	x6-4265
11:15		11:15		11:15	
11:30		11:30	Overrun	11:30	Trieu Thai (Qual Inspector Contractor)
11:45		11:45		11:45	x6-4437
12:00		12:00	Armando Lopez	12:00	
12:15		12:15		12:15	
12:30		12:30		12:30	
12:45		12:45		12:45	
1:00	Opening Mtg (Bldg 5, Rm C026)	1:00	Larry White (Electroplater Contractor /	1:00	**Group Meeting:** Todd Purser,
1:15	(Armando Lopez)	1:15	x6-8344 Can't make Maintenance)	1:15	Katrina Harvey; Garcia Blount; Jim Loughlin
1:30		1:30		1:30	Donneise Briscoe; Tim Hamilton (CS Planner)
1:45	Plating Shop Visit	1:45	Ben White (Electroplater Contractor /	1:45	Mike Adams x 6 2010 (HST Project Engineer)
2:00	(Ken Hinkle)	2:00	x6-6464 Maintenance)	2:00	Ken Hinkle Bob Vernier (CS COTR; Analyx)
2:15		2:15		2:15	Jill Mcguire X62504 (HST Project Engineer)
2:30	Art Turner (Quality Lead Contractor)	2:30	John Wolfe (CS Electroplater)	2:30	Emrold Gray - x 6-6911 - confirmed
2:45	x6-6015	2:45	x6-5708	2:45	(Electrician - Jackson & Tull Contractor)
3:00	Garcia Blount (CS Former Supervisor)	3:00		3:00	Dr. Peter Blake (informal mentor)
3:15	x6-8374	3:15	Greg Hidrobo (CS Mech Designer)	3:15	x 6-4211 -Confirmed
3:30		3:30	x6-6794 or x6-6508 / (C) 301-266-0090)	3:30	Barry Greenberg; Manager Analyx Contract
3:45		3:45		3:45	
4:00		4:00	Donneise Briscoe (CS Planning Office)	4:00	Outbrief
4:15		4:15	x6-8364 - -James Baker - Can't Make	4:15	
4:30		4:30		4:30	
		5:00	Jim Loughlin (CS Manager)		
			x6-6208		
					Update on Wednesday @ 4:00pm

Attachment 5: "White Cloud Mist" Incident Report

Incident report - # 2008-04-08-007

On April 8, 2008 at approximately 1700 hours, Donneise BRISCOE, Bldg. 5 Rm. E004 Code 547.0 X 68364, contacted Ofc. Marsha HENDERSON, Communications, reporting a chemical emergency at Bldg. 5 Rm. E14D, Plating Lab. BRISCOE stated there was a vapor cloud forming over two cylinders and it appeared to be growing in size. Sgt. Jeremy BROWN, sierra 5, Sgt. Todd VANWHY, sierra 6, Ofc. EMT. Jason GALLO, 35 Patrol, Ofc. EMT. Brandon WRIGHT, 34 Patrol, and Ofc. Willie MOTON, 32 Patrol were dispatched and arrived on scene at 1706 hours. At 1707 hours Sgt. VANWHY activated the fire alarm in Bldg. . 5 by direction of Mr. Charles LOMBARD, Emergency Prep. Officer, Bldg. 8 Rm. 100F Code 240.0 X 61109 and the Building was evacuated. At approximately 1711 hours it was learned that 2 employees were unaccounted for. Benjamine WHITE, Lab Tech. Bldg. 5 Rm. E014B, Code 250.0 X 66464 and Katrina HARVEY, Engr. Tech. Bldg. 5 Rm. E014C Code 247.0 X 60930. At 1714 hours a safety perimeter was set and incident command **DETAILS: continued...**
was placed at the intersection on Tiros and Minitrack Roads. At 1712 hours P.G. Dispatcher # 146 was notified and rescue, fire and HAZMAT apparatus were dispatched and began arriving on scene at 1720 hours. Unit 18, Unit 14, Amb. 419, Amb. 199, Amb. 137, Eng. 28, Eng. 14, Eng. 18, Eng. 484, Eng. 487, Eng. 411, Eng. 35, Eng. 181, Eng. 302, Tanker 45, HMSU 41 & 45, Medic 11, Medic 48 and HAZMAT 830. Arriving on the scene at 1717 hours is as follows. Harry STEIN, Hazardous Waste MNGR. Bldg. 27 Rm. 140 Code 250.0 X 68874. Phillip NESSLER, Environmental Engr. Bldg. 28 Rm. N150 Code 250.0 X 64693. Anthony NICOLETTI, Safety Engr. Bldg. 28 Rm. N150 Code 250.0 X 62015. Raymond RUBILOTTA, Assoc. Director Bldg. 8 Rm. 140 Code 200.0 X 68214 and Capt. Kenneth FULTON, Security Operations MNGR. Bldg. 9 Rm. 005 Code 240.0 X 60784. At 1727 Hours all appropriate paging and notifications were completed. At 1815 hours both WHITE and HARVEY were located off Center via telephone. At 2004 hours the scene was declared safe by P.G. County Fire and Rescue, Chief MILLER and Chief EBEY, P.G. HAZMAT. Through their investigation it was determined the suspected vapor cloud was steam. At 2048 hours all Units were clear and no further action was taken.

Attachment 6a: IA—Water Sample Report July 23, 2008

al TECHNICAL DATA

FAX COVER PAGE

Company NASA-GSFC

Fax number: 1-301-286-1693

Pages to follow: 3

Original copies of any official reports will be sent via mail or parcel.

URGENT DATED MATERIAL
PLEASE GIVE TO:
JOHN WOLFE OR BASSEY

AS SOON AS POSSIBLE

ANY INFORMATION IN THIS SPACE PERTAINS TO FAXED ITEMS

Thank you,

JANE HALL

NOTE: This facsimile contains confidential information intended only for the addressee. Any other disclosure is prohibited. Should it be received in error, or incomplete, please notify Ashley Laboratories immediately.

ASHLEY LABORATORIES, LTD. • 10030 HARFORD ROAD • BALTIMORE, MARYLAND 21234
Phone (410) 668-1270 • Fax (410) 668-0668 • www.ashleylabs.com • techservices@ashleylabs.com
METAL FINISHING SPECIFICATION TESTING ANALYSTS & CONSULTANTS

Attachment 6a continued

al TECHNICAL DATA

REPORT: #D-0792 ***Amended***

DATE: N.A.S.A. / Goddard Space Flight Center
Code 547
Greenbelt Road
Greenbelt, MD 20770

Attn: Mr. John Wolfe

DATE: ***September 25, 2008***

SCOPE: Analysis of Water Sample

RESULTS:

Sample marked 7/23/08 - B

pH 4.9

chromium (total) < 0.5 mg/l

cyanide (total) 0.006 mg/l

chloride < 1 mg/l

OFFICIAL ONLY WITH EMBOSSED SEAL

Jane Hall, CEF

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Phone (410) 668-1270 • Fax (410) 668-0668 • www.ashleylabs.com • techservices@ashleylabs.com

METAL FINISHING SPECIFICATION TESTING ANALYSTS & CONSULTANTS

Printed on Recycled Paper

Attachment 6a continued

al TECHNICAL DATA

REPORT: #D-0793 ***Amended***

DATE: N.A.S.A. / Goddard Space Flight Center
Code 547
Greenbelt Road
Greenbelt, MD 20770

Attn: Mr. John Wolfe

DATE: ***September 25, 2008***

SCOPE: Analysis of Water Sample

RESULTS:

Sample marked 7/23/08 - N

pH 3.3

chromium (total) < 0.5 mg/l

cyanide (total) 0.006 mg/l

chloride < 1 mg/l

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Phone (410) 668-1270 • Fax (410) 668-0668 • www.ashleylabs.com • techservices@ashleylabs.com

METAL FINISHING *SPECIFICATION TESTING* *ANALYSTS & CONSULTANTS*

Attachment 6a concluded

al TECHNICAL DATA

REPORT: #D-0792 ***Amended***

DATE: N.A.S.A. / Goddard Space Flight Center
Code 547
Greenbelt Road
Greenbelt, MD 20770

Attn: Mr. John Wolfe

DATE: ***September 25, 2008***

SCOPE: Analysis of Water Sample

RESULTS:

Sample marked 7/23/08 - B

pH 4.9

chromium (total) < 0.5 mg/l

cyanide (total) 0.006 mg/l

chloride < 1 mg/l

OFFICIAL ONLY WITH EMBOSSED SEAL

Jane Hall, CEF

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Phone (410) 668-1270 • Fax (410) 668-0668 • www.ashleylabs.com • techservices@ashleylabs.com

METAL FINISHING SPECIFICATION TESTING ANALYSTS & CONSULTANTS

Attachment 6b: IA—Water Sample Report June 24, 2009

Water Testing Laboratories of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 6/25/2009
Report #: K5332A

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank A5
Date / Time Collected: 6/24/2009 11:20 AM
Sampler/Company: A. Arnold 8892aa, Wtl Of Md
Field Record: Chlorine residual: Absent Clear when drawn

Analytical Results

Parameter	**Result**	Units	Detection Level	MCL	Analytical Method
pH	**3.1**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**290**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Christina Rodgers

C. Rodgers, Customer Service Representative

Attachment 6b continued

Water Testing Laboratories

of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 6/25/2009
Report #: K5332B

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank N9
Date / Time Collected: 6/24/2009 11:25 AM
Sampler/Company: A. Arnold 8892aa, Wtl Of Md
Field Record: Chlorine residual: Absent Clear when drawn

Analytical Results

Parameter	Result	Units	Detection Level	MCL	Analytical Method
pH	**4.6**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**ND**	µmhos/cm	10	—	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Christen Rodgers

C. Rodgers, Customer Service Representative

Reviewed by: AB

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Attachment 6b continued

Water Testing Laboratories

of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 6/25/2009
Report #: K5332C

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank B11
Date / Time Collected: 6/24/2009 11:30 AM
Sampler/Company: A. Arnold 8892aa, Wtl Of Md
Field Record: Chlorine residual: Absent Clear when drawn

Analytical Results

Parameter	**Result**	Units	Detection Level	MCL	Analytical Method
pH	**4.9**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**ND**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Christina Rodgers

C. Rodgers, Customer Service Representative

Reviewed by:

Water Quality Laboratories certified by the Maryland, Delaware, and Virginia State Health Departments
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Attachment 6b concluded

Water Testing Laboratories

of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 6/25/2009
Report #: K5332D

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14G Tank G4
Date / Time Collected: 6/24/2009 11:35 AM
Sampler/Company: A. Arnold 8892aa, Wtl Of Md
Field Record: Chlorine residual: Absent Clear when drawn

Analytical Results

Parameter	**Result**	Units	Detection Level	MCL	Analytical Method
pH	**4.8**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**ND**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20[th] Ed.

Reported by,

Christine Rodgers

C. Rodgers, Customer Service Representative

Reviewed by: LB

Attachment 6c: IA—Water Sample Report July 23, 2009

Water Testing Laboratories
of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 7/28/09
Report #: K5419A

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank G4
Date / Time Collected: 7/23/2009 11:30 AM
Sampler/Company: C. McAdam 8644CM, WTL of MD

Analytical Results

Parameter	Result	Units	Detection Level	MCL	Analytical Method
pH	**6.05**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**10**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

S. Besterfeldt, Quality Assurance Manager

Reviewed by: SMB

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Attachment 6c continued

Water Testing
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of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 7/28/09
Report #: K5419B

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank N9
Date / Time Collected: 7/23/2009 11:25 AM
Sampler/Company: C. McAdam 8644CM, WTL of MD

Analytical Results

Parameter	**Result**	Units	Detection Level	MCL	Analytical Method
pH	**7.17**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**10**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Sheri Besterfeldt

S. Besterfeldt, Quality Assurance Manager

Reviewed by: SMS

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Attachment 6c continued

Water Testing Laboratories
of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 7/28/09
Report #: K5419C

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank A5
Date / Time Collected: 7/23/2009 11:36 AM
Sampler/Company: C. McAdam 8644CM, WTL of MD

Analytical Results

Parameter	Result	Units	Detection Level	MCL	Analytical Method
pH	**4.52**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**30**	umhos/cm	10	---	SM2510B

Notes:
1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Sheila Besterfeld
S. Besterfeldt, Quality Assurance Manager

Reviewed by: SMB

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Attachment 6c concluded

Water Testing Laboratories
of Maryland, Inc.

P.O. Box 712
Stevensville, MD 21666
410-643-7711

Marshal Space Flight Center
Steven Hudson
Building 4612, Room 1309
MSFC, Alabama 35812

Reporting Date: 7/28/09
Report #: K5419D

Submitted Sample Address: Nasa Goddard Space Center
8800 Greenbelt Road
Greenbelt, Md 20771
Submitted Sample Source: Building 5 E14D Tank B11
Date / Time Collected: 7/23/2009 11:40 AM
Sampler/Company: C. McAdam 8644CM, WTL of MD

Analytical Results

Parameter	**Result**	Units	Detection Level	MCL	Analytical Method
pH	**6.59**	SU	0.1	6.5-8.5 (SMCL)	EPA 150.1
Conductivity	**10**	umhos/cm	10	---	SM2510B

Notes:

1. MCL is EPA's maximum contaminant level under primary drinking water regulations. SMCL is secondary maximum contaminant level and is the aesthetic quality only. If your result is above any MCL or SMCL, you may want to consider a water treatment system or a new well. Please check your local regulations for any restrictions or additional limits.
2. ND – Not Detected.
3. Sample received and examined within EPA's recommended holding time
4. Analyzed by Lab 214.
5. SM – Greenberg, Clesceri and Eaton, *Standard Methods for the Examination of Water and Wastewater*, 20th Ed.

Reported by,

Sheila Besterfeld

S. Besterfeldt, Quality Assurance Manager

Reviewed by: SNB

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Attachment 7: Close Call Report—De-Ionization Tank Burst Incident

Close Call Report: De-Ionization Tank Burst Incident

Background:

Incident report -- Tuesday, September 16, 2008:

> "Two employees went over to the RO (reverse osmosis) system in the Electroplating Shop [Plating Lab] and turned the RO system from automatic mode to manual mode. About one minute later pressure released around the cylinder heads. Shortly thereafter one cylinder burst and another cracked. The system was then immediately turned off. There was about a 4-inch hole in the one that burst, and a small amount of resin came out. Siemen's who takes care of the RO system was called immediately."
>
> Sieman's came in the net day to repair the system. The tech explained that when switching the RO into manual mode, a relief valve should have opened to release pressure building up from the system still making water."

Figure 1. Electroplating Shop Reverse Osmosis/De-Ionization water treatment system.

Attachment 7 continued

History:

Potable water feeding the Electroplating Shop is treated prior to feeding shop process equipment, Figure 1. The original system incorporated a series of filters operating at the water line feed pressure. The system fed a storage tank with automatic level control using a solenoid valve at the outlet of the treatment system to regulate flow. The system included a manual by-pass for the solenoid valve. Approximately two years ago the treatment system was modified, replacing the original system with pretreatment (water softener/carbon filters), reverse osmosis (RO) and de-ionization. Figure 2 presents the system schematic. Most of the piping associated with the original system remained in place, including valves. The upgraded system includes a high pressure pump to drive the RO process. The normal operating pressure at the inlet of the RO filters is ~130 psi. For low flow conditions the RO pump generates a maximum pumping pressure of ~225 psi. As part of the upgrade the storage tank level control was modified to operate the RO pumping system, eliminating the need for the solenoid valve. The mechanism in the solenoid valve was reported removed to disable the valve, allowing open flow. However, system inspection after the incident proved the valve remained operational. The RO control panel is equipped with a "Automatic/Manual" mode switch. "Manual" mode overrides the level control switch for the RO pump, providing operator flexibility to read water quality gauges, or to override failure of "automatic" mode control. The "manual" mode switch does not override the level control switch operating the solenoid valve. Following the upgrade the system continued to function without incident. The original system and the RO system upgrade were installed by HydroMax, Emmitsburg, MD.

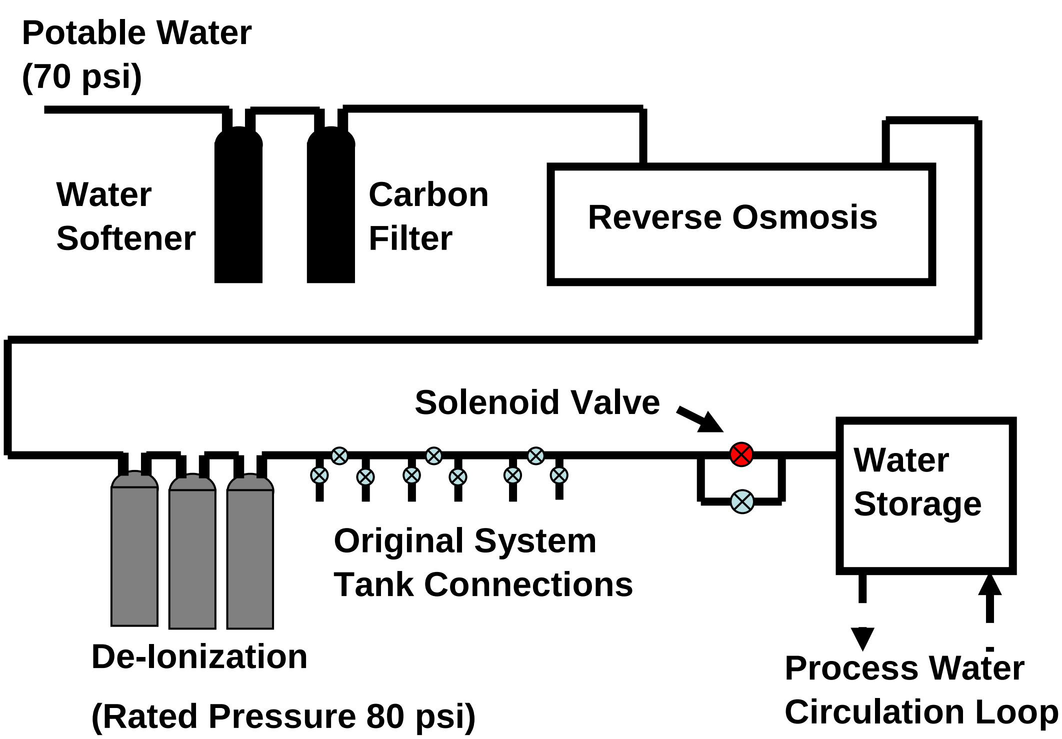

Figure 2. Electroplating Shop Reverse Osmosis/De-Ionization System Flow Diagram

Attachment 7 continued

A few months ago, the new lab manager noted that the water quality gauge indicated a need to replace the DI tank filters. Due to concerns with the responsiveness of HydroMax, a new maintenance contract was established with Siemens Corp. Siemens installed a new set of DI tank filters with a maximum operating pressure of 80 psi.

Failure of the DI tank occurred within minutes after the system was placed in “manual” mode. The most probable cause is over pressurized by the RO system pump due to flow restriction between the DI system and the storage tank. The solenoid valve by-pass was closed, and all other valves along the normal flow path were open. The flow restriction is attributed to a closed condition of the solenoid valve. As noted above, the RO system pump is capable of generating pressures almost three times the rated pressure of the DI system.

Causal Factor: Lack of engineering/safety review for system modifications

While switching the system to “manual” mode triggered the DI tank rupture, the failure is attributed to a poorly engineered treatment system. Selection of the replacement DI system installed by Siemens failed to consider potential operating pressures within the existing system. There were no installed safety devices to prevent over pressurization of the DI system by the RO system pump.

Static pressure of the Center’s potable water distribution system defined the maximum operating pressure of the original system. The design appears to incorporate proper engineering. Installation of the RO/DI system re-utilized a substantial portion of the plumbing associated with the original system, including unnecessary valves. Closed valves in the piping between the DI system and the storage tank generated the flow restriction associated with the DI tank failure. The system retrofit should have included removal and replacement of the entire piping segment with piping appropriate for the modified system. The vendor, HydoMax, has records of the system maintenance, including modifications. It is unclear if the changes were subject to engineering/safety review/approval by government personnel.

The DI tank installation/configuration reflects poor engineering and a lack of safety oversight. Over pressurization of the DI system depends on free flow though the DI tank filters and piping to the open atmosphere pressure of the storage tank. Any flow restriction in a tank or system valve would have elevated the pressure in the DI system, potentially triggering a similar tank failure. The installation clearly lacks proper safety devices, normally identified in an engineering and safety design review.

Causal Factor: Lack of knowledge on system design/operation by lab personnel

Interviews with several members of the Electroplating Shop staff reflected limited understanding of the RO/DI water treatment system operation. System operation and maintenance are delegated to an offsite service contractor. Documentation and training on the system is lacking. Generally the system functions in a “hands-off” mode. While poor engineering is the root cause for the tank failure, operating the system in “manual” mode triggered over pressurization of the system. Based on interviews, the operator lacked full understanding of the system design and impact of the mode change.

Causal Factor: Inadequate safety inspections

Conditions for the tank failure incident have existed since installation of the RO system. Safety inspectors knowledgeable of the RO/DI system design and operation should have identified the risk of system over pressurization, and recommended corrective action. As a minimum safety inspectors should have identified the lack of documentation and training for the RO/DI treatment system.

Attachment 7 concluded

Suggested Corrective Actions:

1. Perform an engineering and safety review of the RO/DI system to identify appropriate modifications. Include consideration of the following options:
   a. Installation of safety devices to prevent over pressurization of DI tanks, i.e. pressure relief valve, pressure control switch to deactivate RO pump.
   b. Move DI tanks to circulation loop that feeds plating shop equipment from water storage tank. This option suggested by Siemens technical representative.
2. Ensure system modifications are installed by qualified personnel and properly inspected.
3. Provide operation manual for water treatment system. Identify and train system operators.

Additional Findings:

The investigation revealed informal procedures for modifying or retrofitting installed equipment, specifically for the RO/DI water treatment process. Extrapolating, the finding potentially reflects a culture of informality.

Recommendation: Assess AETD shop culture

a. Ensure engineering and safety factors are formally incorporated into lab equipment installation or modification.
b. Ensure operators are provided proper documentation and training

Incident Review Team

Son Ngo	6-5504	son.n.ngo@nasa.gov -- Chair
Rich Luquette	6-5881	rich.luquette@nasa.gov
Mollie Powell	6-8145	Mollie.M.Powell-1@nasa.gov

Attachment 8a: Possible Employee Exposure Plan (e-mail)

From: Scofield, Melonie E. (GSFC-500.0)
Sent: Thursday, September 25, 2008 1:09 PM
To: Dalhoff, Jeffrey J. (GSFC-250.0); Joy, Pilar T. (GSFC-541.0); Blount, Garcia J. (GSFC-547.0); Bolt, Richard B. (GSFC-321.0); Cody, Regina J. (GSFC-691.0); Deza, Romulo B. (GSFC-250.0)[PEC]
Cc: Niemeyer, William L. (GSFC-540.0); Hinkle, Raymond K. (GSFC-540.0); Flynn, Karen E. (GSFC-500.0)
Subject: Employee Possible Exposure Issue

The following are my draft notes. Please review and let me know where I need to make changes. If you have additional comments, please add them. Thanks.

Wednesday 9/24/08, the following personnel assembled at the Plating Lab (B5/E14) to investigate a safety issue raised by Bassey Udofot. The hazard Mr. Udofot expressed was the breathing exposure of personnel to heavy metals and cyanide when air drying parts after the final hot rinse.

Attendees:
Garcia Blount/547
Richard Bolt/321
Pilar Joy/541
Jeffery Dalhoff/250
Roy Deza/250
Regina Cody/691
Melonie Scofield/500

The team asked Mr. Udofot to explain his concern. He started by explaining his background was electrochemistry. He felt that the way parts were being blow dried after the final rinse in the hot water rinse tank was putting hazardous materials in the air for employees to breath. He indicated he expressed the concern to his boss, Mr. Garcia Blount which resulted in his taking three samples of the rinse water and sending them to a lab for analysis. The lab results came back showing ph levels of 3.3 and 4.1 and trace amounts of chromium and cyanide.

Basically, there are two plating lines that are of concern (line N and B). The silver line that contains the most cyanide is shut down and the rinse tanks are drained. Mr. Udofot explained that the procedure for maintenance of the rinse tanks was to overflow the rinse tanks each day, sometimes every other day to remove any dust or contaminates from the surface of the water, but personnel in the lab had only been adding water into the tanks. By just topping off the tanks, the heavy metals did not get mixed up enough and would remain in the tank and this would create an issue with conductivity of the liquid. When asked how the conductivity relates to the safety issue raised, Mr. Udofot explained that the more conductive the water was the more contaminated the water was. He was also concerned the conductivity meters in the tanks did not work. Conductivity meters are used to automatically fill the tanks to overflow. The meters in the Plating Lab tanks have been bypassed. The action that would

Attachment 8a concluded

have occurred by activation of the meters is done manually, because the original meters were not sensitive enough and water was never automatically added to the tank as need to maintain cleanliness. The final hot water rinse tank does not have a conductivity probe/meter. Mr. Blount reports they are in the process of buying new conductivity meters which will be more sensitive.

The rinse tanks in question get drained each Friday, cleaned with a nylon brush and refilled each Monday. The tank cleaning is only done by Ben White or Larry White. To plate parts, items are placed in the cleaning tank, then rinse tank, specific coating tank, rinsed using a spray method and then placed in the hot water rinse tank. After that they are taken to a work bench where they are dried with shop air, especially the holes and cervices. If parts are not dried fast enough they leave water marks on the product. Since the parts are not dried in a hood, contaminates in the rinse water are being blown into the room and toward other personnel per Mr. Udofot. Two other employees that actually do the operations were interviewed (Ben White and Katrina Harvey). When asked how they dried the parts they indicated they either blew them off down toward the floor or away from other people, but never toward anyone. When asked if they could do the drying under hood, they indicated they could for the smaller parts, but not the larger ones.

Plan for determining exposure. The group discussed the best way to determine if there was exposure of employees and how much. It was decided to:

1. Industrial Hygiene will take all the samples. For the water samples it may be taken by Code 547 personnel, but IH will witness how the sample is drawn to ensure not contamination of the samples.
2. Sample the hot water rinse tank on several different Monday's and Friday's. This would be done two or three times with a couple of weeks separating the sampling to ensure a better cross section of results since the work load in the area is very irregular. Additionally, if there is a known heavy week, IH will be called in to sample again.
3. Samples will be analyzed for ph, cyanide, and chromium 6.
4. Sample pumps will be placed on the civil servants that perform plating work and an area sample pump will be placed in the area the parts are blown off.

Melonie E. Scofield
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Attachment 8b: Final AETD Investigation Report on Potential Employee Exposure

Possible Employee Exposure to Chemicals in the Plating Lab

June 12, 2009

On approximately September 17, 2008, Melonie Scofield, AETD Safety Manager, was contacted by Bassey Udofot about a possible exposure of Plating Lab personnel to chemicals while blow drying parts in the Lab. Mr. Udofot expressed concern that personnel could be breathing heavy metals and cyanide when air drying parts after the final hot rinse.

A team consisting of the following personnel met on September 24, 2008 to investigate the compliant.
Garcia Blount/547
Richard Bolt/321
Pilar Joy/541
Jeffery Dalhoff/250
Roy Deza/250
Regina Cody/691
Melonie Scofield/500

The team interviewed the following Plating Lab personnel to determine what operations were done and how they were done.

Bassey Udofot
Ben White
Katrina Harvey

The following is a summary of the investigation and the results of the sampling.

The team asked Mr. Udofot to explain his concern. He started by explaining his background was electrochemistry. He felt blow-drying parts after the final rinse in the hot water rinse tank was putting hazardous materials in the air for employees to breath. He indicated he took three samples of the rinse water and sent them for analysis. The lab results came back showing ph levels of 3.3 and 4.1 and trace amounts of chromium and cyanide. There was no information available as to how the samples were taken (date, time, tools used, method for obtaining sample, etc.) Mr. Udofot's analysis only looked at pH levels, not specific chemicals.

Basically, there are two plating lines that are of concern (line N and B) which are presently in use. The silver-plating line (CN line), which contain the most cyanide is shut down (not used for at least the past 1.5 years, but chemicals are still present). All rinse tanks are drained to the waste treatment facility, where the material is neutralized and then release to sewage. Mr. Udofot explained that the procedure for maintenance of the rinse tanks is to overflow the rinse tanks each day, sometimes every other day to remove any dust or contaminates from the surface of the water. He felt that by just topping off the tanks, the heavy metals did not get mixed up enough and would remain in the tank

Attachment 8b continued

and this would create an issue with conductivity of the liquid. When asked how the conductivity relates to the safety issue raised, Mr. Udofot explained that he felt the more conductive the water was indicated increased level of contamination. He was also concerned the conductivity probes in the tanks did not work. Conductivity probes can be used to automatically fill the tanks to overflow, but the probes in the Plating lab rinse tanks had been bypassed. The action that would have occurred by activation of the probes was being done manually each day. The original automatic probes were not sensitive enough to activate, so water was never automatically added to the tank to maintain cleanliness. The final hot water rinse tank does not have a conductivity probe. Mr. Blount reported they were in the process of buying new conductivity probes, which will be more sensitive.

The rinse tanks in question are drained each Friday, cleaned with a nylon brush and refilled each Monday. Tank cleaning is only performed by Ben White or Larry White. To plate parts, items are placed in the cleaning tank, then a rinse tank, the specific coating tank, rinsed using a spray method and then placed in the hot water rinse tank in question. From there the parts are taken to a workbench where they are dried using shop air to blow dry them, especially the holes and cervices. If parts are not dried fast enough watermarks may be left on the product. Since the parts are not dried in a hood, possible contaminants in the rinse water may be blown into the room and toward other personnel per Mr. Udofot. Two employees that actually do the operations were interviewed (Ben White and Katrina Harvey). When asked how they dried parts they indicated they either blew them off down toward the floor or away from other people, but never toward anyone. When asked if they could do the drying under hood, they indicated they possibly could for the smaller parts, but not the larger ones.

A plan was developed for determining possible exposure. The group discussed the best way to determine if there was exposure of employees and how much. The preliminary plan discussed was to:

1. Industrial Hygiene will take all the samples. For the water samples it may be taken by Code 547 personnel, but IH will witness how the sample is drawn to ensure no contamination of the samples.
2. Sample the hot water rinse tank on several different Mondays and Fridays. This would be done two or three times with a couple of weeks separating the sampling to ensure a better cross section of results since the work load in the area is very irregular. Additionally, if there is a known heavy week, IH will be called in to sample again.
3. Samples will be analyzed for ph, cyanide, and chromium 6.
4. Sample pumps will be placed on the civil servants that perform plating work and an area sample pump will be placed in the area the parts are blown off.

After further investigation, Code 250 Safety decided that sampling the rinse tank would not provide relevant information. The rational follows.

Per Phil Nessler, "Environmental can not perform water sampling without an understanding of what needs to be analyzed and what purpose the results will serve. The extreme breadth of sampling and analytical protocol that exist make it difficult at best and

Attachment 8b continued

closer to impossible to end up with useful results when performing analysis without adequate planning and understanding of the needs."

Per Jeff Dalhoff, Industrial Hygeine, "In developing a sampling strategy for measuring exposure to plating shop chemicals, we will collect area and personal air samples as previously discussed this month and later this Winter when the work load in the plating shop increases. We have decided not to collect liquid bath samples because the results would not provide information about exposure levels to personnel."

According to Ted Mooney of the Electroplating Association, "the acceptable concentrations in final rinse tanks is unfortunately empirical, but a general rule of thumb as a starting point is that the concentration in the plating tank should be diluted 1000:1 for chrome and cyanide and 500:1 for other processes". This acceptable concentration concerns the quality control of the plating operations, but would not necessarily translate to unacceptable breathing air concentrations if chromium and cyanide were not diluted to these levels.

Correlating contaminant concentrations in the plating baths to air concentrations is not useful since the air monitoring serves this purpose and eliminates the questionable nature of making correlations to assess potential worker exposure. If liquid samples of the plating baths were collected, there would be no acceptable concentration level of contaminants to compare the results. You could only compare them to the above concentrations put forth by Mr. Mooney, and these would not concern occupational health exposure, rather quality of plating operations. Questions about quality control would need to be handled by the Plating Shop and not this team.

The report of air samples taken provided by Ching-tsen Bien, CIH, dated May 12, 2009 indicate that almost all results for nickel salts, sodium phosphates, potassium gold cyanide, sodium hydroxide, chromic acid, zinc oxide, copper salts, chromium, nickel, hydrofluoric acid, hydrochloric acid, nitric acid, sulfuric acid, phosphoric acid, and bariumnitrate were less than the detection limit of the analytical method, which means they are less than the exposure limit for these air contaminants for a minimum sampling time of five hours. Conclusions indicate that the general ventilation system should be sufficient for controlling air contaminants released during blow-drying operations.

Conclusion: Based on the sampling results, levels of selected contaminants appear to be well below occupational exposure limits. Moreover, concentrations of most of the sampled contaminants of concern were not detectable. This may be due in part to limited workload in the plating shop, the existence of push-pull local exhaust and general room exhaust ventilation systems, and tendency of contaminants of concern to remain in the liquid or solid phase. Covers for the plating baths were discussed to limit potential exposures even further, although it would be difficult to demonstrate a measurable benefit. Activity levels never increased enough for personal sampling – so area sampling was the most protective sampling that could be performed.

Attachment 8b concluded

The processes currently in place for blow-drying parts appear to provide adequate protection for employees since the air sampling results are well below exposure limits and indicate personnel are not placed at risk from inhalation hazards. Employees must continue to wear required PPE, perform blow-drying at specified locations, and not aim drying operations toward other employees.

Original Signature on File

Melonie Scofield
AETD Safety Manager

Attachment 9: IA—Air Sample Report

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. N176-B07
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

**** FINAL REPORT ****

Date Received: 06/25/09
Sample Type: 7 - Air Sample(s)
Project: BLDG 5 PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	CB-09-06-24 1	Samp Date:	06/24/09	5um PVC filter with quartz support pa		
-	CRVI	547 L	0.033 ug	.025 ug	0.06 ug/M3	06/29/09
-002	CB-09-06-24 2	Samp Date:	06/24/09	BLANK 5um PVC filter with quartz support pa		
-	CRVI	0 L	0.029 ug	.025 ug	--	06/29/09
Cr6 found in client blank. Samples are not corrected.						
-003	CB-09-06-24 3	Samp Date:	06/24/09	Soda Lime-200/600		
-	HCN-Front		< 2.6 ug	2.6 ug		06/30/09
-	HCN-Rear		ND	2.6 ug		06/30/09
-	HCN-Total	70.7 L	< 2.6 ug	2.6 ug	< 0.033 ppm	06/30/09
-004	CB-09-06-24 4	Samp Date:	06/24/09	BLANK Soda Lime-200/600		
-	HCN-Front		< 2.6 ug	2.6 ug		06/30/09
-	HCN-Rear		ND	2.6 ug		06/30/09
-	HCN-Total	0 L	< 2.6 ug	2.6 ug	--	06/30/09
-005	CB-09-06-24 5	Samp Date:	06/24/09	Silica Gel 200/400 (Specially Cleaned		
-	H2SO4 Front		< 5 ug	5 ug		06/29/09
-	H2SO4 Rear		ND	5 ug		06/29/09
-	H2SO4 Total	154 L	< 5 ug	5 ug	< 0.032 mg/M3	06/29/09
-006	CB-09-06-24 6	Samp Date:	06/24/09	Silica Gel 200/400 (Specially Cleaned		
-	H2SO4 Front		< 5 ug	5 ug		06/29/09
-	H2SO4 Rear		ND	5 ug		06/29/09
-	H2SO4 Total	169 L	< 5 ug	5 ug	< 0.03 mg/M3	06/29/09

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

ANALYTICS

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Group No. N176-007
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

Final Report

Date Received: 06/25/09
Sample Type: 7 - Air Sample(s)
Project: BLDG 5 PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-007	CH-09-06-24 7	Samp Date: 06/24/09		BLANK		
				Silica Gel 200/400 (Specially Cleaned		
-	H2SO4 Front		< 5 ug	5 ug		06/29/09
-	H2SO4 Rear		ND	5 ug		06/29/09
-	H2SO4 Total	0 L	< 5 ug	5 ug	--	06/29/09

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

ANALYTICS

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Ashland, Virginia 23005
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www.analyticscorp.com

Group No. N176-007
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Hexavalent Chromium	OSHA ID 215	CRVI
Sulfuric Acid Total	NIOSH 7903	H2SO4 Total
Hydrogen Cyanide	NIOSH 6010M	HCN

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James N. Calpin, CIH
Laboratory Director

End of Report
Page 3

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

LABORATORY TEST REQUEST ACCOUNT PENDING

ANALYTICS

ACCOUNT NUMBER, NAME AND ADDRESS

~~PROJECT ENHANCEMENT CORPORATION~~
~~NASA GODDARD SPACE FLIGHT CENTER~~
~~MAILSTOP 250.9, BUILDING 97~~
~~GREENBELT, MD 20771~~
~~Phone: 301-286-6795~~
~~Fax: 301-286-1618~~
~~PROJ#: 19602030~~

10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3500
TOLL FREE (800) 888-8061
FAX (804) 365-3002

PROJECT NAME OR NUMBER: GSFC BLDG 5 PLATING SHOP

CONTACT: ANGELA WINDAU

TELEPHONE NUMBER: (216) 433-3073

EMAIL RESULTS TO: angela.d.windau@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOL.	ANALYSES REQUESTED
	CB-09-06-24-1	06-24-2009		Chromic acid
	CB-09-06-24-2	06-24-2009	Blank	Chromic acid
	CB-09-06-24-3	06-24-2009		HCN
	CB-09-06-24-4	06-24-2009	Blank	HCN
	CB-09-06-24-5	06-24-2009		H_2SO_4
	CB-09-06-24-6	06-24-2009		H_2SO_4
	CB-09-06-24-7	06-24-2009	Blank	H_2SO_4

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

SIGN HERE TO INITIATE CHAIN OF CUSTODY

DATE

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
6/25/09 955	int	SIGNATURE/SAMPLE RECEIVING: M Childress	SIGNATURE/SAMPLE RECEIVING
		SIGNATURE/SAMPLE ADMINISTRATION	SIGNATURE/SAMPLE ADMINISTRATION
		SIGNATURE/LAB	SIGNATURE/LAB
		SIGNATURE/LAB	SIGNATURE/LAB

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 9 continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No: N176-008
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAD
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

**** FINAL REPORT ****

Date Received: 06/25/09
Sample Type: S - Air Sample(s)
Project: BLDG 5 PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	CB-09-06-24 8	Samp Date:	06/24/09	PTFE		
-	NaOH	1098 L	< 40 ug	40 ug	< 0.036 mg/M3	06/30/09
-002	CB-09-06-24 9	Samp Date:	06/24/09	PTFE		
-	NaOH	1129 L	< 40 ug	40 ug	< 0.035 mg/M3	06/30/09
-003	CB-09-06-24 10	Samp Date:	06/24/09	PTFE		
-	NaOH	1123 L	< 40 ug	40 ug	< 0.036 mg/M3	06/30/09
-004	CB-09-06-24 11	Samp Date:	06/24/09	BLANK PTFE		
-	NaOH	0 L	< 40 ug	40 ug	--	06/30/09
-005	CB-09-06-24 14	Samp Date:	06/24/09	5um PVC filter with quartz support p		
-	CRVI	464 L	0.045 ug	.025 ug	0.097 ug/M3	06/29/09

Alkaline dust as Sodium Hydroxide.

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

ANALYTICS

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Group No. N176-008
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
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21000 BROOKPARK RD
CLEVELAND, OH 44135

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Sodium Hydroxide	NIOSH 7401	NaOH
Hexavalent Chromium	OSHA ID 215	CRVI

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

LABORATORY TEST REQUEST ACCOUNT PENDING

ANALYTICS

ACCOUNT NUMBER, NAME AND ADDRESS
Do you want to print a test (Y/N)? N
~~PROJECT ENHANCEMENT CORPORATION~~
~~NASA GODDARD SPACE FLIGHT CENTER~~
~~MAILSTOP 250.5, BUILDING 97~~
~~GREENBELT, MD 20771~~
~~Phone: 301-286-6795~~
~~Fax: 1-301-286-1610~~

1025 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

PROJECT NAME OR NUMBER: GSFC BLDG 5 PLATING SHOP

CONTACT: ANGELA WINDAH

TELEPHONE NUMBER: (301) 433-3073

E-MAIL RESULTS: angela.d.windam@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE I.D./SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME	ANALYSIS REQUESTED
	CB-07-06-24-8	06-24-2009		NaOH
	CB-07-06-24-9	06-24-2009		NaOH
	CB-09-06-24-10	06-24-2009		NaOH
	CB-07-06-24-11	06-24-2009	Blank	NaOH
	CB-07-06-24-12	06-24-2009		
	CB-07-06-24-14	06-24-2009		Chromic acid

CHAIN OF CUSTODY RECORD

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
6/25/09 952	int	MChildress	

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 9 continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
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www.analyticscorp.com

Group No. M180-014
Account No. 14119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

**** FINAL REPORT ****

Date Received: 06/29/09
Sample Type: 6 - Air Sample(s)
Project: GSFC BLDG 5 PLATING PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	CB-09-06-25-21	Samp Date: 06/25/09		Soda Lime-200/600		
-	HCN-Front		< 2.6 ug	2.6 ug		06/30/09
-	HCN-Rear		ND	2.6 ug		06/30/09
-	HCN-Total	73.4 L	< 2.6 ug	2.6 ug	< 0.032 ppm	06/30/09
-002	CB-09-06-25-22	Samp Date: 06/25/09		Soda Lime-200/600		
-	HCN-Front		< 2.6 ug	2.6 ug		06/30/09
-	HCN-Rear		ND	2.6 ug		06/30/09
-	HCN-Total	72.8 L	< 2.6 ug	2.6 ug	< 0.032 ppm	06/30/09
-003	CB-09-06-25-23	Samp Date: 06/25/09		BLANK Soda Lime-200/600		
-	HCN-Front		< 2.6 ug	2.6 ug		06/30/09
-	HCN-Rear		ND	2.6 ug		06/30/09
-	HCN-Total	0 L	< 2.6 ug	2.6 ug	--	06/30/09
-004	CB-09-06-25-24	Samp Date: 06/25/09		Silica Gel 200/400 (Specially Cleane		
-	H2SO4 Front		< 5 ug	5 ug		06/30/09
-	H2SO4 Rear		ND	5 ug		06/30/09
-	H2SO4 Total	68.7 L	< 5 ug	5 ug	< 0.073 mg/M3	06/30/09
-	HCl-Front		< 2.5 ug	2.5 ug		06/30/09
-	HCl-Rear		ND	2.5 ug		06/30/09
-	HCl-Total	68.7 L	< 2.5 ug	2.5 ug	< 0.036 mg/M3	06/30/09
-	HF Front		< 5 ug	5 ug		06/30/09
-	HF Rear		ND	5 ug		06/30/09
-	HF Total	68.7 L	< 5 ug	5 ug	< 0.073 mg/M3	06/30/09
-005	CB-09-06-25-25	Samp Date: 06/25/09		Silica Gel 200/400 (Specially Cleane		
-	HF Front		< 5 ug	5 ug		06/30/09
-	HF Rear		ND	5 ug		06/30/09

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M180-014
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

Final Report

Date Received: 06/29/09
Sample Type: 6 - Air Sample(s)
Project: GSFC BLDG 5 PLATING PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-	HF Total	165 L	< 5 ug	5 ug	< 0.03 mg/M3	06/30/09
-006	CB-09-06-25-26	Samp Date: 06/25/09		BLANK Silica Gel 200/400 (Specially Cleane		
-	H2SO4 Front		< 5 ug	5 ug		06/30/09
-	H2SO4 Rear		ND	5 ug		06/30/09
-	H2SO4 Total	0 L	< 5 ug	5 ug	---	06/30/09
-	HCl-Front		< 2.5 ug	2.5 ug		06/30/09
-	HCl-Rear		ND	2.5 ug		06/30/09
-	HCl-Total	0 L	< 2.5 ug	2.5 ug	---	06/30/09
-	HF Front		< 5 ug	5 ug		06/30/09
-	HF Rear		ND	5 ug		06/30/09
-	HF Total	0 L	< 5 ug	5 ug	---	06/30/09

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion. Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given, NAG = No Area Given, LOQ = Limit of Quantitation.

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Attachment 9 continued

ANALYTICS

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CLEVELAND, OH 44135

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Sulfuric Acid Total	NIOSH 7903	H2SO4 Total
	NIOSH 7903	HCl
Hydrofluoric Acid Total	NIOSH 7903	HF Total
Hydrogen Cyanide	NIOSH 6010M	HCN

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James R. Colgin, CIH
Laboratory Director

End of Report
Page 3

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

LABORATORY TEST REQUEST ACCOUNT PENDING

ACCOUNT NUMBER, NAME AND ADDRESS

~~PROJECT ENHANCEMENT CORPORATION~~
~~NASA GODDARD SPACE FLIGHT CENTER~~
~~MAILSTOP 250, 5, BUILDING 97~~
~~GREENBELT, MD 20771~~
~~Phone: 301-286-5795~~
~~Fax: 1-301-286-1618~~
~~PROJ#: 13680636~~

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SAMPLED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
6/26/09	6	VARIOUS	GSFC BLDG 5 PLATING SHOP

CONTACT: ANGELA WINDAU — TELEPHONE NUMBER: (216) 433-3073

FAX RESULTS/FAX NUMBER: 216-433-3362
EMAIL RESULTS: EMAIL: angela.d.windau@nasa.gov

TURNAROUND TIME: ☐ RUSH ☑ STANDARD ☐ CALL FOR AVAILABILITY ☐ EXTRA CHARGE

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE ID	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYTE/METHOD REQUESTED FOR EACH SAMPLE TYPE
	CB-09-06-25-21	09-06-25	73.4	HCN
	CB-09-06-25-22	"	72.8	HCN
	CB-09-06-25-23	"	Blank	HCN
	CB-09-06-25-24	"	68.7	HF, H_2SO_4, HCL
	CB-09-06-25-25	"	163	HF
	CB-09-06-25-26	"	Blank	HF, H_2SO_4, HCL

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

SIGNATURE TO INITIATE CHAIN OF CUSTODY

DATE: 6-25-2009

CARRIER — IF "ANALYTICS COURIER" SIGN HERE

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
6-29-09 0845	MAG	SIGNATURE/SAMPLE RECEIVING: JAMES ALTIERI	SIGNATURE/SAMPLE RECEIVING
		SIGNATURE/SAMPLE ADMINISTRATION: JAMES ALTIERI	SIGNATURE/SAMPLE ADMINISTRATION
		SIGNATURE/LAB	SIGNATURE/LAB
		SIGNATURE/LAB	SIGNATURE/LAB

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 9 continued

ANALYTICS

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10329 Stony Run Lane
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www.analyticscorp.com

Group No. N180-007
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

**** FINAL REPORT ****

Date Received: 06/29/09
Sample Type: 2 - Air Sample(s)
Project: GSFC BLDG 5 PLATING PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	CB-09-06-26-31	Samp Date: 06/26/09		Silica Gel 200/400 (Specially Cleans		
-	HF Front		< 5 ug	5 ug		06/30/09
-	HF Rear		ND	5 ug		06/30/09
-	HF Total	106.2 L	< 5 ug	5 ug	< 0.047 mg/M3	06/30/09
-002	CB-09-06-26-33	Samp Date: 06/26/09		BLANK Silica Gel 200/400 (Specially Cleans		
-	HF Front		< 5 ug	5 ug		06/30/09
-	HF Rear		ND	5 ug		06/30/09
-	HF Total	0 L	< 5 ug	5 ug	--	06/30/09

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 1

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 continued

ANALYTICS

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804-365-3002 Fax
www.analyticscorp.com

Group No. N180-087
Account No. 34119020
Report Date: 06/30/09

ANGELA WINDAU
NASA GLENN RESEARCH CENTER
MS 50-1
21000 BROOKPARK RD
CLEVELAND, OH 44135

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Hydrofluoric Acid Total	NIOSH 7903	HF Total

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

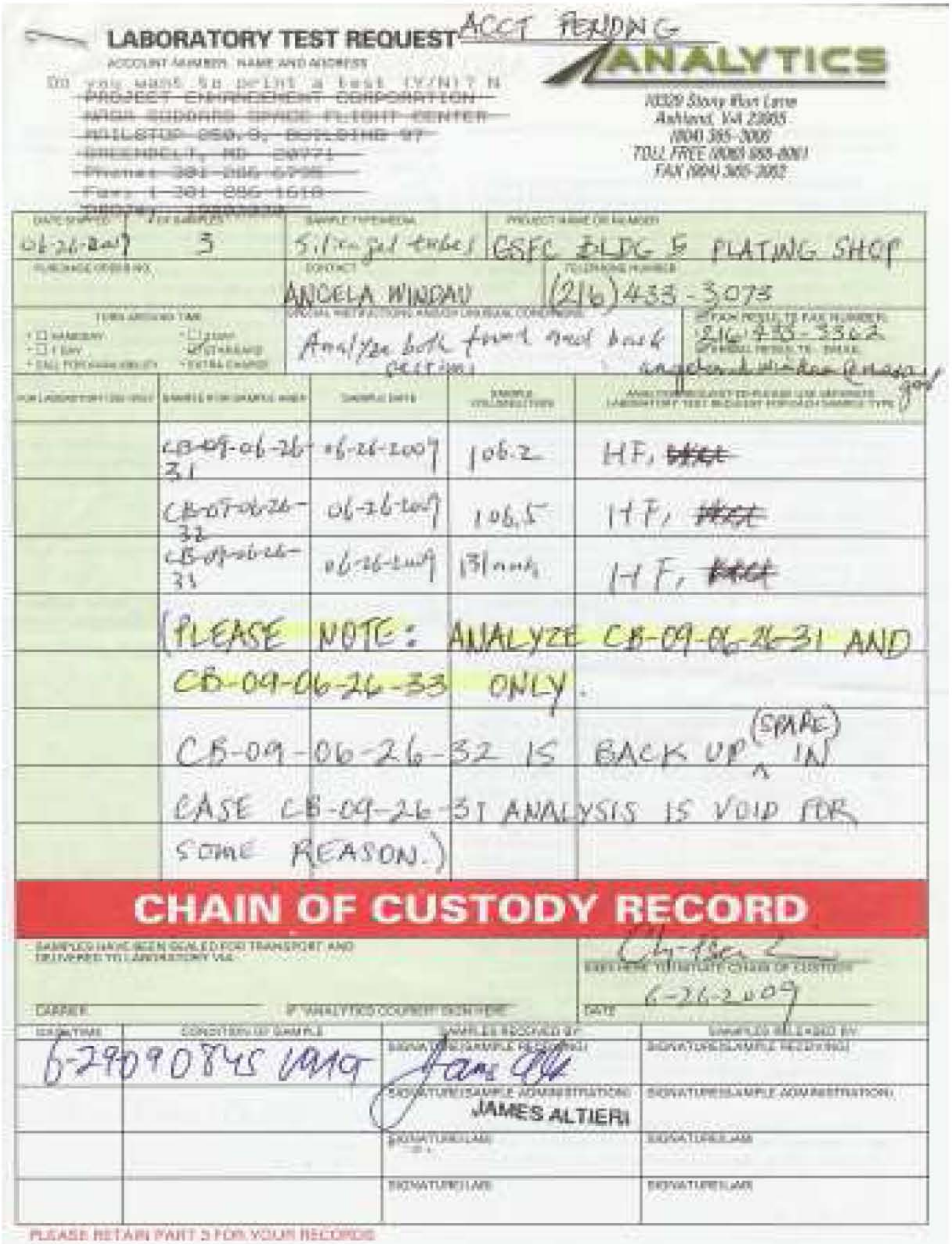
We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 9 concluded


LABORATORY TEST REQUEST ACCT PENDING

ANALYTICS

10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

ACCOUNT NUMBER, NAME AND ADDRESS

Do you want to print a test (Y/N)? N

~~PROJECT ENHANCEMENT CORPORATION~~
~~NASA GODDARD SPACE FLIGHT CENTER~~
~~MAILSTOP 250.9, BUILDING 97~~
~~GREENBELT, MD 20771~~
~~Phone: 301-286-6798~~
~~Fax: 1-301-286-1610~~

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
06-26-2009	3	Silica gel tubes	GSFC BLDG 5 PLATING SHOP

CONTACT: ANGELA WINDAU
TELEPHONE NUMBER: (216) 433-3073

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS: Analyze both front and back sections

FAX RESULTS TO FAX NUMBER: 216-433-3362

E-MAIL RESULTS TO: angela.windau@nasa.gov

TURN AROUND TIME: STANDARD

FOR LABORATORY USE ONLY	SAMPLE FOR SAMPLE NUMBER	SAMPLE DATE	SAMPLE VOLUME	ANALYTE(S)
	CB-09-06-26-31	06-26-2009	106.2	HF, ~~BACK~~
	CB-09-06-26-32	06-26-2009	106.5	HF, ~~BACK~~
	CB-09-06-26-33	06-26-2009	131 nmL	HF, ~~BACK~~

(PLEASE NOTE: ANALYZE CB-09-06-26-31 AND CB-09-06-26-33 ONLY.
CB-09-06-26-32 IS BACK UP (SPARE) IN CASE CB-09-26-31 ANALYSIS IS VOID FOR SOME REASON.)

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

IF ANALYTICS COURIER SIGN HERE

SIGN HERE TO INITIATE CHAIN OF CUSTODY

DATE 6-26-2009

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY	SAMPLES RELEASED BY
6-29-09 0845	intact	SIGNATURE (SAMPLE RECEIVING)	SIGNATURE (SAMPLE RECEIVING)
		SIGNATURE (SAMPLE ADMINISTRATION) JAMES ALTIERI	SIGNATURE (SAMPLE ADMINISTRATION)
		SIGNATURE (LAB)	SIGNATURE (LAB)
		SIGNATURE (LAB)	SIGNATURE (LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 10: Ted Mooney E-mail on Final Rinse Tank Composition

From: Dalhoff, Jeffrey J. (GSFC-250.0)
Sent: Thursday, October 23, 2008 5:13 PM
To: Scofield, Melonie E. (GSFC-500.0)
Cc: Deza, Romulo B. (GSFC-250.0)[PEC]; Bien, Ching-Tsen (GSFC-250.0)[PEC]
Subject: Plating Shop Sampling

Melonie,

In developing a sampling strategy for measuring exposure to plating shop chemicals, we will collect area and personal air samples as previously discussed this month and later this Winter when the work load in the plating shop increases. We have decided not to collect liquid bath samples because the results would not provide information about exposure levels to personnel.

According to Ted Mooney of the Electroplating Association, "the acceptable concentrations in final rinse tanks is unfortunately empirical, but a general rule of thumb as a starting point is that the concentration in the plating tank should be diluted 1000:1 for chrome and cyanide and 500:1 for other processes". This acceptable concentration concerns the quality control of the plating operations, but would not necessarily translate to unacceptable breathing air concentrations if chromium and cyanide were not diluted to these levels.

Correlating contaminant concentrations in the plating baths to air concentrations is not useful since the air monitoring serves this purpose and eliminates the questionable nature of making correlations to assess potential worker exposure. If liquid samples of the plating baths were collected, there would be no acceptable concentration level of contaminants to compare the results. You could only compare them to the above concentrations put forth by Mr. Mooney, and these would not concern occupational health exposure, rather quality of plating operations. Questions about quality control would need to be handled by the Plating Shop.

Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009

Memorandum

TO: 547/ Garcia Blount

CC: 549/ Melonie Scofield
250/ Terrence Bidnick
250/ Pat Hancock
250/ Jeff Dalhoff
250/ Roy Deza

FROM: 250/ Ching-tsen Bien

DATE: May 12, 2009

Re: Health Hazard Evaluation of the Plating Group (Code 547)

BACKGROUND

In response to concerns of plating shop personnel exposure to toxic plating chemicals during operations, an exposure assessment/health hazard evaluation was conducted at the Plating Group of Advanced Manufacturing Branch (Code 547). Ching-tsen Bien, CIH, of the Industrial Hygiene Office (IHO) conducted an air sampling program to evaluate the potential exposures to the air contaminants that exist in the Plating Shop. The air sampling was conducted between October 22, 2008 and November 10, 2008; also on January 16, 2009. The previous air sampling conducted in 1996 indicated that results of personal sampling were much lowered than the established exposure limits and the time spent at each plating tank is brief. Since there is no change in the process or operations, long term area sampling was performed during this survey to determine the potential emission of toxic contaminant at the plating tanks.

THE PLATING PROCESS

The Plating Group provides services such as electroplating, surface finishing, and electroforming for the components of spacecraft, flight hardware, or ground support equipment. In addition, to electroplating of gold, silver, nickel, or copper, the shop also has the capability of anodizing and iriditing aluminum parts. A plating process consists of the following steps:

1) Degreasing
2) Removing Soiling
3) Removing oxide film on the metal surface.
4) Adding a thin metal "Strike" to improve adhesion and
5) Plating.

Attachment 11a continued

The GSFC Plating Shop has several lines for different types of plating. There are A, B, CN, E, G, and N lines. Each line has tanks for solvents, chemicals, and water rinse. Steps involved in typical gold plating on an aluminum part consist of the following steps, chemicals, and operating parameters. This information is shown in **Table 1** in the **Appendices**.

Plating of other metal may involve different steps using different types of chemicals. The immersion time for the metal piece in each tank is brief in general, except for the plating operation which may take 15 to 30 minutes. After immersion the metal piece in the tank, the operator can stay outside the process area to avoid exposure to the air contaminants. In general, the operator's exposure is minimal as observed at the gold plating process.

Air Sampling

Area sampling was performed for the following chemicals:

Acid: Hydrochloric, Hydrofluoric, Nitric, Phosphoric, and Sulfuric.
Base: Sodium hydroxide.
Metal: Barium, Copper, Hexavalent chromium (chromic acid), and Nickel.
Other chemical: Cyanide.

Samples were analyzed by Analytics Corporation of Ashland, VA, an American Industrial Hygiene Association accredited laboratory. The acids samples except for the phosphoric acid were collected on a silica gel tube and analyzed by the NIOSH 7903 method. The phosphoric acid sample was collected on a membrane filter and analyzed by the OSHA 111 method. Metals samples (except chromium), such as barium and nickel were collected on membrane filters and analyzed by the NIOSH 7300 method. Hexavalent chromium samples were collected on a PVC membrane filter and analyzed by the OSHA ID 215 method. The sampling time varied between 290 and 430 minutes.

Potassium cyanide and silver cyanide are used for silver plating at the CN line. No samples were collected on the CN line since the line is not in operation. In general, the metal analytical method is more sensitive than the wet chemical method for analyzing sodium hydroxide or hydrogen cyanide. Instead of analyzing cyanide at the G-1 tank, gold or potassium was determined from the potassium or gold concentration on the filter. The cyanide concentration can be calculated from the chemical formula of potassium gold cyanide [$KAu(CN)_2$]. The concentration of sodium hydroxide is also determined by same approach. Many chemicals used in the Plating Shop are very corrosive or irritating. A summary of exposure limit and acute health effects for these chemicals is listed in **Table 2**.

Sampling Results

The results of air sampling are shown on **Table 3**. Almost all results were reported as less than the detection limit of the analytical method, which means they were less than the exposure limit for these air contaminants for a minimum sampling time of five hours. Since the time the operator spends at each tank is very brief, further personal sampling is likely to yield similar results. Personal sampling for such short duration will not allow detection limits as low as those reported here.

Attachment 11a continued

Compressed Air Drying of Finished Products

The finished plating parts are dried by hanging them from a work station rack and using a compressed air line. This has the function of removing any liquid droplets from the metal parts following hot and cold water rinses. The former Plating Group leader had expressed concerns that using compressed air to dry parts in this manner may present an inhalation hazard to other personnel in the vicinity of the operation, alleging that the operation releases undue toxic chemicals used in the plating process. Air sampling was performed on January 16, 2009, during the compressed air drying operation to determine the concentration of any air contaminants. Two high volume sampling pumps were set at both sides of the compressed air spray drying station at 12 liters per minute air flow rate. The samples were analyzed for barium, chromium, nickel, sodium (sodium hydroxide) and potassium (cyanide). All samples showed less than detection limit for these air contaminants (**Table 3**). No additional air sampling was performed at the drying station since the activity at the Plating Shop was low during the winter months.

Conclusions

The air sampling results indicated that concentrations of hazardous air contaminants at the work station were very low and usually non-detectable. This indicates that the general ventilation system should be sufficient for controlling any contaminants released during this operation. Additionally, it appeared that the local exhaust ventilation system nearby was neither designed for this operation nor suitable for drying off larger parts.

Since highly toxic or corrosive chemicals such as sodium hydroxide, hydrogen fluoride, nitric acid or chromic acid are routinely used in the Plating Shop at elevated temperatures, prevention of accidental skin or eye exposure to these hazardous chemicals should be emphasized.

Recommendations

1. Ensure that personnel are not positioned directly across from the compressed air drying of parts.
2. Ensure that face shields, rubber gloves (verify glove material), aprons, and chemical resistant clothing are worn when there is potential for splashes or contact with corrosive plating shop liquids. Refer to the PPE Assessment conducted by the IHO as part of the Code 547 Baseline Survey Report.
3. Ensure that personal protective equipment worn during the mixing of plating baths is increased to that indicated in PPE Hazard Assessment. For example, chemical resistant boots are recommended during mixing of chemicals for plating baths since leather boots do not protect against permeation of acids and caustic liquids.

We appreciate the assistance provided by Mr. C. Adams, Ms. K. Harvey, Mr. B. White, Mr. L. White, and Mr. J. Wolfe.

Yours truly,

Attachment 11a continued

// Original Signed //

Ching-tsen Bien, CIH
Industrial Hygienist
Industrial Hygiene Office (250.9)

Attachment 11a continued

Appendices

Table 1: Procedures of a Typical Gold Plating Process

Step	Process	Tank #	Main chemicals	pH	Temp., °F
1	Aluminum soak cleaner	A-1	Phosphates	11.97 – 12.0	150 – 160
2	Counter-flow rinse	A-3	Water		
3	Aluminum deoxidizer	A-4	Nitric and hydrofluoric acids	0.56 - 0.6	70 – 80
4	Cold water rinse	A-5	Water		
5	Aluminum etch cleaner	A-2	Sodium hydroxide	12.4 -12.8	150 - 160
6	Cold water rinse	A-3	Water		
7	Aluminum deoxidizer rinse	A-4	Nitric and hydrofluoric acids	0.56 -0.6	70 80
8	Cold water rinse	A-3	Water		
9	Nitric acid rinse	B-4A	Nitric acid	-0.2 - -0.3	75 – 80
10	Counter-flow rinse	B-5	Water		
11	Aluminum zincate activation	B-3	Sodium hydroxide, Zinc oxide	12.4 - 13.4	Room
12	Nitric acid drip	B-4B	Nitric acid	-0.025 - -0.034	75 – 80
13	Cold water rinse	B-5	Water		
14	Aluminum zincate activation	B-3	Sodium hydroxide, Zinc oxide	12.4 – 13.4	Room
15	Counter-flow rinse	B-2	Water		
16	Electroless nickel	E-7	Nickel, Sodium hydroxide	4.5 – 5.2	180 – 195
17	Cold water rinse	E -6	Water		
18	Cold water rinse	B-5	Water		
19	Woods nickel strike	B-6	Hydrochloric acid	-0.15 - -0.20	75 – 85
20	Hot water rinse	B-5	Water		130
21	Gold strike	G-1	Potassium gold cyanide	3.3 – 4.0	120 – 140
22	Water spray rinse	G-2	Water		
23	Gold plating	G-3	Gold	8.5 – 9.5	120 – 130
24	Cold water rinse	G-4	Water		
25	Hot water rinse	B-11	Water		130
26	Blow dry with compressed air				

Table 2: Summary of Toxicity of Chemicals Used in the Plating Shop

Chemical	Exposure Limit, mg/m^3	Acute Health Effects	
		Inhalation	Dermal and eye
Hydrochloric Acid	7.0	Severe irritation and chemical burns to the respiratory tract	Corrosive and causes severe skin burns and eye ulceration
Hydrofluoric acid	2.5	Severe irritation of the upper respiratory tract with pain, burns, and inflammation. May cause pulmonary edema	Severe skin burns and delayed tissue destruction and irreversible eye damage
Nitric Acid	5	Chemical burns to the respiratory tract, chemical pneumonitis and pulmonary edema.	Skins burns and irreversible eye damage
Phosphoric Acid	1.0	Severe irritation and chemical burns to the respiratory tract	Severe skin burns., chemical conjunctivitis and corneal damage of eyes
Sulfuric Acid	1.0	Severe irritation to mucous membranes	Severe skin burns and irreversible eye damage
Sodium hydroxide	2.0	Extreme pulmonary irritation	Severe full thickness skin burns and irreversible eye damage

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Attachment 11a continued

Barium chloride	0.5	Irritation of respiratory tract	Skin irritation, necrosis
Chromic acid	0.0025	Irritation to respiratory tract and mucous membranes, potential carcinogen	Irritation or itching to skin
Chromium (II or III)	0.5	Irritation to respiratory tract and mucous membranes	Irritation to skin
Copper compounds	1.0	Upper respiratory tract irritation	Itching, erythema and conjunctivitis on eyes
Nickel compounds	1.0	Irritating upper respiratory tract	Skin sensitization and conjunctivitis on eyes
Sodium phosphates	N/A	Irritation	Irritation to skin and eyes
Zinc oxide	5	Respiratory tract irritation	Dermatitis and eye irritation
Cyanide (potassium gold cyanide)	5	Irritation to gastro-intestinal or respiratory tract	Inflammation and blistering on skin and corneal damage on eyes

Table 3: Results of Area Sampling

Sample #	Location	Contaminant	Exposure Limit, mg/m^3	Mass reported, µg	Concentration mg/m^3	Detection limit µg/filter	Analyzed as
2	Near B-8 Watts Nickel tank	Nickel salts	1 mg/m^3	<2 µg	<0.0019	2	Ni
3	Near A-1 non-etch Soak and A-2 Alkaline Etch tanks	Sodium phosphates	2 mg/m^3	9.69	0.0066	2.5	Na
4	Near G-1 Gold Strike Tank	Potassium gold cyanide	5 mg/m^3 (as cyanide)	<2	<0.012	2	Au
5	Near A-1 non-etch Soak and A-2 Alkaline Etch tanks	Sodium Hydroxide	2 mg/m^3	<2.5	<0.0015	2.5	Na
6	Near E-7 Electroless Nickel tank	Nickel salts	1 mg/m^3	<2	<0.0010	2	Ni
7	Near G-1 Gold Strike Tank	Potassium gold cyanide	5 mg/m^3 (as cyanide)	<2	<0.0016	2	Au
7	Near G-1 Gold Strike Tank	Potassium gold cyanide	10 ppm as hydrogen cyanide	<2.5	<0.0019	2.5	K
11	Near N5-c Anodized Strip tank	Chromic acid	0.0025 mg/m^3	<0.025	<0.033 $\mu g/m^3$	0.025	Cr(VI)
12	Near B-3 Zincate tank	Sodium hydroxide	2 mg/m^3	3.03	0.0044	2.5	Na
12	Near B-3 Zincate tank	Zinc oxide	15 mg/m^3 (as Zinc oxide)	<2.0	<0.003	2	Zn
13	Near N-1 Electrocleaner Oakite 90 tank	Sodium hydroxide	2 mg/m^3	<2.5	<0.0024	2.5	Na
21	Near B-10 Acid Copper tank	Copper salt	1	<1.0	<0.001	1	Cu
22	Between B-6 Woods Nickel Strike and B-7 Black Nickel tanks	Nickel salts	1 (as metal)	<2.0	<0.002	2	Ni

Attachment 11a continued

Sample #	Location	Contaminant	Exposure Limit, mg/m^3	Mass reported, µg	Concentration mg/m^3	Detection limit µg/filter	Analyzed as
23	Near A-12 Iridite 14-2 tank	Bariumnitrate	0.5 (as barium chloride)	<2.0	<0.002	2	Ba
23	Near A-12 Iridite 14-2 tank	Chromium	0.5	<2.0	<0.002	2	Cr
31	Near N3A Stainless Steel Etching tank	Chromium	0.5	<2.0	<0.002	2	Cr
31	Near N3A Stainless Steel Etching tank	Nickel	1	<2.0	<0.002	2	Ni
32	Near A-12 Iridite 14-2 tank	Chromic acid	0.0025	<0.025	<0.024 µg/m³	0.025	Cr(VI)
S-1	Near B-1 Hydrochloric Acid Etch tank	Hydrochloric Acid	7	<2.5	<0.028	2.5	HCl
S-2	Near B-4 Nitric Acid and Ammonium Bifluoride Dip tank	Nitric acid	5	<5.0	<0.062	5	HNO_3
S-11	Near A-6 Anodized tank	Sulfuric acid	1	<5.0	<0.061	5	H_2SO_4
S-12	Near N-3A Stainless Steel Etch tank	Hydrochloric Acid	7	<2.5	<0.030	2.5	HCl
S-12	Near N-3A Stainless Steel Etch tank	Hydrofluoric acid	3	<5.0	<0.060	5	HF
S-34	Near N-3A Stainless Steel Etch tank	Phosphoric acid	1	<10.0	<0.098	10	H_3PO_4
S-41	Compressed air drying station	Nickelsalts	1 mg/m³	< 2 µg	<0.0019	2	Ni
S-41	Compressed air drying station	Chromium	0.5	< 2 µg	<0.002	2	Cr
S-41	Compressed air drying station	Bariumnitrate	0.5 (as barium chloride)	< 2 µg	<0.002	2	Ba
S-41	Compressed air drying station	Sodium hydroxide	2 mg/m³	< 2 µg	<0.0022	2	Na
S-41	Compressed air drying station	Potassium gold cyanide	5 mg/m³ (as cyanide)	< 2 µg	<0.0022	2	Au
S-42	Compressed air drying station	Nickelsalts	1 mg/m³	< 2 µg	<0.0019	2	Ni
S-42	Compressed air drying station	Chromium	0.5	< 2 µg	<0.002	2	Cr

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Attachment 11a concluded

A. Survey Report Cover Letter

TO: 250/IH TAM
Safety and Environmental Health Division

FROM: 250/Senior Industrial Hygienist
Consolidated Safety Services, Inc.

SUBJECT: 2003 Industrial Hygiene Survey of Code 547.0

The NASA Goddard Space Flight Center Industrial Hygiene Office has completed the Baseline Industrial Hygiene Survey of Code 547.0, Advanced Manufacturing Branch, located in Buildings 5, 5A, 10 and 21. The purpose of the survey was to identify and evaluate potential health hazards in the workplace and to determine the need for engineering controls, administrative controls, and personal protective equipment, as well as requirements for medical surveillance.

This survey report is organized to include an executive summary, exposure measurements criteria, and sections for each process area.

The cooperation of all work activity personnel is gratefully acknowledged. Comments regarding the conduct of the survey or contents of this report are welcomed in order to identify areas that require greater attention. Points of contact are Scott Robbins, CIH, CSP Industrial Hygiene Project Manager and Jeff Dalhoff, CIH both at extension 6-6669.

Enclosure: NASA Goddard Space Flight Center 2003 Baseline Industrial Hygiene Survey of Code 547.0

Attachment 11b: Reconciliation between the Goddard Space Flight Center Industrial Hygiene Report Draft Recommendations and Final Report Recommendations

Mr. Bien made ten recommendations in his November 2008 draft report (Attachment 3: 2008 Follow-Up Survey of the Plating Group), which were then decreased to three in the final May 2009 version (Attachment 11a: Bldg. 5 Plating Lab Air Sampling Report May 2009). The background and/or rationale for the differences in the two reports are stated as follows:

1. Ensure personnel are not positioned directly across from compressed air drying of parts.

   "This was a new recommendation that directly addresses Mr. Udofot's concerns about drying off parts directly across from employees. Although interviews with all other Plating Lab personnel revealed that drying off parts is not conducted directly across from another employee, this recommendation was made to illustrate the point that this should not be done. Exposure from any droplets containing hazardous chemicals during the blow drying of parts would most likely occur if someone were directly across from the blow drying of parts. The final May 12, 2009 report was submitted after it had been determined that activity level in the Plating Lab would not increase between November 2008 and April, 2009. That is, possible higher exposure levels during November 2008 and April, 2009 did not occur."

2. Ensure face shields, rubber gloves (verify glove with material), aprons, and chemical resistant clothing are worn when there is a potential for splashes or contact with corrosive Plating Lab liquids. Refer to PPE Assessment conducted by the IHO as part of the Code 547 Baseline Survey Report (Attachment 12: Code 547 Baseline IH Survey October 2003).

3. Ensure that PPE worn during the mixing of plating baths is increased to that indicated in PPE Hazard assessment. For example, chemical resistant boots are recommended during mixing of chemicals for plating baths since leather boots do not protect against permeation of acids and caustic liquids.

   "Recommendations in the May 12, 2009 report address possible exposure concerns directly and are in line with the "Conclusions" paragraph of both reports, that "Since highly toxic or corrosive chemicals…are routinely used…, prevention of accidental skin or eye exposure to these hazardous chemicals should be emphasized." The recommendations consolidate recommendations #2 through #4 of the Nov 17, 2008 report and bring it better in line with previous PPE Assessment and the 2003 Baseline Survey. They do this by recommending the PPE required for specific operations with potential for splashes and contact with Plating Lab chemicals. When there is no anticipated contact with chemicals, such as when employees merely walk through the Plating Lab, such PPE as face shields would not be required. By referencing the previous 2003 Baseline Survey and PPE Assessment conducted during this survey, the May 12, 2009 report recommendation gives guidance as to which specific operations require which specific level of PPE. Interviews indicate personnel wear PPE recommended in the IH PPE Assessment, although this has not been verified due to the infrequent nature of some operations. One past discrepancy between an IH recommendation to wear face shields or goggles during plating operations differs from shop PPE procedure to wear safety glasses with side shields."

4. This recommendation was removed in the May report: Consider installing flow rate monitors at tanks containing most hazardous chemicals such as sodium hydroxide, nitric acid, and chromic acid to ensure the continuing effective ventilation at these locations.

   "Since exposure levels were well below occupational exposure limits and the exhaust ventilation appeared to be effective, this statement about flow rate monitors was not included in the May 12, 2009 report. At the time of the Nov 17, 2008 report, the recommendation was made to "consider" installing

flow rate monitors. Flow rate monitors are still an option, but their feasibility and practicality have not yet been fully determined. Since the ventilation system for the tanks is a push-pull system, and not an ordinary laboratory hood, the placement of the monitors so that they actually capture an accurate picture of flow rate data and so that they do not impede operations is problematic and might make it infeasible or impractical."

5. This recommendation was removed in the May report: Consider wearing long sleeve shirts and long pants in plating area to reduce accidental chemical burns to bare skin.

   "This recommendation was included in Recommendations #2 and #3 of the May 12, 2009 report. The recommendations stated in the May 12, 2009 are in line with the previous PPE Assessment and the 2003 Baseline Survey. The recommendation as written in the Nov. 17, 2008 report did not delineate PPE required for specific operations with potential for splashes and contact with Plating Lab chemicals. When there is no anticipated contact with chemicals, such as when employees merely walk through the Plating Lab, such PPE as chemical resistant boots and face shields would not be required. By referencing the previous 2003 Baseline Survey and PPE Assessment conducted during this survey, the May 12, 2009 report recommendation gives guidance as to which specific operations require which specific level of PPE."

6. This recommendation was removed in the May report: Consider covering the tanks at the end of the work day to minimize the emission of air contaminants.

   "This recommendation was not retained because it does not appear to be standard practice in Plating Labs to cover the tanks. In addition, the ventilation system would prevent build up of airborne vapors and mists, and there are no employees in the Plating Lab at the end of the work day. A verbal recommendation and a written recommendation were made in a Dec. 3, 2008 email to the Code 500 team evaluating Plating Lab issues to further research the issue and benchmark the Plating Lab against other Plating Labs."

7. This recommendation was removed in the May report: Consider installing additional shelves in the storage room so that all small containers are stored on the shelves. Re-arrange storage of large drums to provide easy access to other containers.

   - *"Upon review, it did not appear that it was necessary to make this recommendation since the storage rooms are normally orderly. In addition, it did not relate to the complaint.*
   - *The IA Team IH visited the storage areas and did not see any storage concerns."*

8. This recommendation was removed in the May report: Perform periodic inspection of the eyewash and emergency shower to maintain continued effectiveness.

   - *"This is a good general reminder and we often preface this recommendation with "Continue to …." Upon review, it appeared that inspections were being performed and that it was not necessary to include this in this report.*
   - *The IA Team IH noted that the emergency eyewashes and showers were being inspected as required."*

9. This recommendation was removed in the May report: Consider developing a periodic inspection program of the tanks (considering corrosive nature of materials used) to prevent catastrophic failures.

   "At the time of this writing we were not sure if this practice was taking place. A certain of level of inspection may already be taking place. A periodic inspection program is a good general

recommendation. For the May 12 report, it did not directly relate to the exposure issue we were trying to address."

10. This recommendation was removed in the May report: Consider the formation of an emergency response team to handle cyanide spills to which the local Fire Department will not respond. Greenbelt HazMat team from Fire Department will come, but Fire Department will not.

    "Prince George County Fire and Rescue is expected to provide emergency response to the Center, to include cyanide spills."

Attachment 12: Code 547 Baseline IH Survey October 2003

A. Survey Report Cover Letter

TO: 250/IH TAM
Safety and Environmental Health Division

FROM: 250/Senior Industrial Hygienist
Consolidated Safety Services, Inc.

SUBJECT: 2003 Industrial Hygiene Survey of Code 547.0

The NASA Goddard Space Flight Center Industrial Hygiene Office has completed the Baseline Industrial Hygiene Survey of Code 547.0, Advanced Manufacturing Branch, located in Buildings 5, 5A, 10 and 21. The purpose of the survey was to identify and evaluate potential health hazards in the workplace and to determine the need for engineering controls, administrative controls, and personal protective equipment, as well as requirements for medical surveillance.

This survey report is organized to include an executive summary, exposure measurements criteria, and sections for each process area.

The cooperation of all work activity personnel is gratefully acknowledged. Comments regarding the conduct of the survey or contents of this report are welcomed in order to identify areas that require greater attention. Points of contact are Scott Robbins, CIH, CSP Industrial Hygiene Project Manager and Jeff Dalhoff, CIH both at extension 6-6669.

Enclosure: NASA Goddard Space Flight Center 2003 Baseline Industrial Hygiene Survey of Code 547.0

Attachment 12 continued

B. Survey Report Cover Page

NASA
Goddard Space Flight Center

Industrial Hygiene Survey
Of
Code 547.0
Buildings 5, 5A, 10, 21 Advanced Manufacturing Branch

2003

Survey Performed by:
Industrial Hygiene Office
Code 250

Technical Support:
Chris Bunyea
Code 547.0

Reviewed by:
Richard Koster, CIH
Scott Robbins, CIH, CSP
Code 250

Attachment 12 continued

C. Table of Contents

Attachment 12 continued

D. Executive Summary

An industrial hygiene survey of Code 547 was conducted on October 28, November 4,10, 19, December 2, 4, 10, 12, 15, 22, and January 6, 2003 per the NASA Goddard Space Flight Center (GSFC) Safety and Environmental Health Division initiative to conduct comprehensive baseline industrial hygiene surveys for all areas on Center. The purpose of the survey was to identify and evaluate potential occupational health hazards, provide recommendations to mitigate these hazards, and review any previous evaluations and changes in work processes that may have occurred since previous industrial hygiene surveys were conducted. Particular areas of concern or management interest follow:

1. Past relevant full-shift noise monitoring indicated that machinists in the Machining Technology Group were exposed to noise levels in excess of the NASA Instruction limit during the operation of DeVlieg milling machines. Other past relevant monitoring results indicated that personal noise exposures were less than this limit. Personal noise dosimetry conducted during this survey showed that employee exposure to noise approaches the limit during certain milling and other machining operations if these machines are operated for a full eight-hour shift. Based on these results, personnel are not required to be enrolled in a hearing conservation program, but it is recommended that employees already enrolled in the Hearing Conservation Program remain in the program. Additional monitoring is recommended in order to make a final determination to de-register employees from this program. Additionally, it was determined through instantaneous sound level measurements that personnel would be required to wear hearing protection during the operation of certain machines, regardless of duration.

2. Past area air monitoring in the Machine Shop indicated that certain milling machines generated levels of oil mist great enough that personnel may be exposed to levels above the Occupational Safety and Health Administration (OSHA) and American Conference of Governmental Industrial Hygienists (ACGIH) limits. Follow-up area air monitoring conducted during this survey indicated that although the relocation of certain machines since the previous monitoring appears to have reduced the concentrations of oil mist in the air, overexposures to personnel are still possible. Since contract personnel typically operate the machines in question, the contracting officer should be made aware of these results. In addition to the recommendation of local exhaust ventilation for these machines, it is recommended that other employees in the area reduce their time spent in the vicinity of these machines. In the interim, National Institute of Occupational Safety and Health (NIOSH) approved P95 respirators are recommended for civil servants operating adjacent machines. Mineral oils are receiving increasing attention for their human carcinogenicity, while "natural" or "organic" oils have not fallen under this scrutiny. Personnel required to wear respirators must be enrolled in the Respiratory Protection Program and receive a medical evaluation, training and fit testing prior to wearing respirators.

3. Plating Group personnel presently enrolled in the Respiratory Protection Program received annual training and fit-testing in 2003. Personnel stated they wear respirators during operations such as mixing chemicals, although plating tank baths are usually mixed by a contract employee. One Model Shop employee enrolled in the Respiratory Protection

Attachment 12 continued

Program has not received an annual medical evaluation, training and fit-testing. During the survey, it was observed that personnel wearing disposable respirators in other groups did not follow manufacturer's instructions regarding storage in a sanitary location and maintenance. Although the respirators were being worn on a voluntary basis (i.e. they were not required based on exposure levels or shop procedures), manufacturer's instructions, including those regarding storage, must be followed.

4. Push-pull exhaust ventilation systems in the Plating Shop were evaluated and compared to design requirements in the ACGIH *Industrial Ventilation Manual*, 21st ed. Many of the push-pull exhaust systems were not operating at required ventilation rates. A review of 1987-1988 personal and area air monitoring results indicated that airborne concentrations of solvent vapors, acid mist, and alkali mist were well below occupational exposure limits. However, additional area monitoring for select tanks is recommended to ensure that current processes are controlled.

5. Employees expressed concern regarding aluminum dust generated during the de-burring and filing of aluminum parts in the Precision Assembly Area. Personnel regarded this operation as creating undue amounts of aluminum dust that could harm employee health and compromise the quality of the hardware being processed. Past area air monitoring for airborne concentrations of aluminum indicated levels to be below the limit of quantitation for the laboratory analysis method, and well below applicable exposure limits. The frequency, duration and nature of operations have not changed significantly since the previous survey. From a housekeeping and quality control standpoint, however, it may be advisable to install a local exhaust ventilation system for the comfort of personnel and to prevent undue accumulations of aluminum dust.

6. The review and evaluation of operations and past relevant air monitoring results in the plating shop, machine shop, composites lab, and other areas as part of this survey indicated that no worker overexposures to chemical hazards would be expected. Past monitoring results indicated that airborne concentrations of plating shop chemicals in the plating shop, beryllium in the EDM Room and carbon fiber in the Composites Lab were well below applicable limits. While the survey did identify and address most of the work tasks performed, not all of them could be evaluated because of the infrequency with which they were performed. No further exposure monitoring is currently recommended, but any increase in the operations involving the aforementioned materials should be carefully monitored. Beryllium, nickel compounds and inorganic sulfuric acid mists warrant attention due to their carcinogenic or probable carcinogenic properties.

7. Elements of a Hazard Communication Program such as requirements for MSDSs and labeling were implemented, but it was not documented that training was provided upon initial assignment to this work area. Ensure that training is provided upon initial assignment or whenever a new hazard is introduced through a change in procedures or processes. Ensure that all group leaders are aware that MSDSs are accessible through the MSDS Pro database. Because a few MSDSs for this code were not available through MSDS Pro as of December 2003, ensure that all MSDSs are properly entered into the system.

Attachment 12 continued

8. When used properly, the PPE currently available should be adequate in further decreasing the risk of exposure to materials used in the shops. However, in the case of the Plating Shop, the previous workplace hazard assessments did not determine that chemical splash goggles or face shields were needed during plating operations. Although acid burns or other injuries have reportedly not been experienced in this shop, the U.S. judicial system has upheld the requirement for goggles or face shields for similar plating operations (manual dipping parts into tanks) in private industry. It is prudent in this case to err on the side of safety in making the recommendation to require goggles or face shields when manually placing racks or individual parts in tanks of corrosive chemicals. For groups other than the Plating Group, a workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented. Maintain or post the PPE hazard assessment checklists as Attachments H-1.1-9.1 contained in this report and ensure that employee training regarding PPE is documented. As mentioned, personnel operating machines generating noise levels above 85 dBA, regardless of duration, must wear hearing protection.

9. Local exhaust ventilation (LEV) systems were evaluated during this survey or earlier in 2003. The LEV systems other than those in the Plating Shop met recommended applicable ACGIH guidelines for controlling airborne concentrations of welding fumes, dusts and acid or alkali mists. Contact the IHO if new LEV systems are installed or if current systems have not been evaluated annually as required.

10. As recommended in the October, 2003 LEV and carbon fiber assessment performed by the IHO in Bldg 5A Composites Lab, reconfigure and adjust the LEV system in the Router Room to maximize the effectiveness of the LEV and minimize carbon dust and fiber exposure to employees.

11. Conditions did not warrant programs for lead exposure control, asbestos exposure control, cadmium exposure control, and confined spaces.

12. The survey is organized into individual sections for each process area so that information may be readily detached and forwarded to the appropriate supervisor for action. Each section includes a summary table of work tasks and health hazards, observations, sampling results if any, and recommendations. Observations include the key workplace assessment elements such as the operation, number of individuals exposed to the operation, potential hazardous physical or chemical agents, personal protective equipment (PPE) utilized, and evaluation of existing engineering controls. Recommendations may include PPE requirements for specific work tasks, identification of populations that need to be included in the Medical Surveillance Program and implementation of engineering/administrative controls.

13. PPE checklists are provided as attachments to the individual process area report sections. These checklists show the PPE required for each specific work task and serve as the OSHA-required PPE hazard assessment. The PPE checklists should be posted at the work site to help ensure that employees at the shop level are informed of PPE requirements.

Attachment 12 continued

14. Authorized hazardous material use lists should be updated continuously and entered into the MSDS Pro database. Copies of these lists should be maintained at each work activity to help provide on-going information about health hazards.

15. This report reflects conditions and operations during the survey period. Based on negative exposure assessments, many areas will not be surveyed annually. Where changes in procedures or processes significantly alter personnel exposure, more frequent evaluations are required. Shop supervisors are encouraged to notify the Industrial Hygiene Office when this occurs or when processes require follow-up evaluation.

16. In conducting this survey, a two step process was used for assessing hazards in the workplace: Basic characterization of work activities involved observing operations, cataloging equipment and associated hazards, and reviewing existing data; Risk assessment involved quantitatively monitoring exposures during operations and establishing recommendations for further evaluations. This survey will establish the groundwork for implementing an effective monitoring strategy that will efficiently utilize resources. Survey findings and recommendations can be used to conduct further qualitative and quantitative evaluations on a routine (annual) basis.

17. Code 547 is comprised of the following groups: Plating Group, Manufacturing Engineering Planning Group, Precision Assembly Group, Machining Technology Group, Mechanical Inspection Group, Design Group, Composites and Rapid Prototyping Group and Maintenance Repair Group. Operations take place primarily in Building 5 while Composites and Rapid Prototyping Group operations are performed primarily in Building 5A. An employee of the Machining Technology Group works in Building 10 and another in Building 21.

18. Of special concern to Code 547 Management was the presence of water leaks, which could drip down on electrical equipment creating potential safety hazards. During this survey, Room E019 outside the plating shop was noted as a location where a water leak was present. The Safety Office can be reached at extension 6-6905 for assistance in evaluating the risk posed by water leaks.

Attachment 12 continued

E. Exposure Measurements Criteria and Rationale

Reported Units and Standards
The data and results of this survey express the concentrations of chemical contaminants as milligrams per cubic meter of air (mg/m^3), micrograms per cubic meter of air (ug/m^3), parts per million in air by volume (ppm), or parts per billion in air by volume (ppb). The average chemical airborne concentrations, as well as the measured levels of physical agents, are compared to exposure standards established by the following: appropriate NASA Instructions or Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL). If there are no applicable NASA Instruction or OSHA PEL, a nationally recognized consensus standard promulgated by such organizations as the American Conference of Governmental Industrial Hygienists (ACGIH), the American National Standards Institute (ANSI), or the Institute of Electrical and Electronics Engineers (IEEE) is used. The average chemical airborne concentrations are compared to the appropriate standards without regard to the use of personal protective equipment (PPE). Occupational exposure limits, i.e. 8-hour time-weighted averages (TWA), 15-minute short-term exposure limits (STEL), or ceiling limits (C), established by NASA Instructions or OSHA standards must not be exceeded.

Integrated Air Sampling Methods
Air sampling and analyses performed in support of surveys follow protocols of established National Institute for Occupational Safety and Health (NIOSH) Methods, OSHA Analytical Methods, or NASA Instructions. When these methods are not available or applicable, other consensus or recognized methods are used. In all cases, established professional industrial hygiene practices are followed. The Industrial Hygiene Office (IHO) maintains proper documentation concerning sampling instruments/media and data as well as all instrument calibration certifications.

Direct Reading Methods
As a first cut screening tool of various work tasks or where integrated air sampling is not appropriate due to the brevity of activities, a direct reading instrument can be used to collect real-time measurements. An instrument such as a Photovac photoionization detector Model 2020 measures peak concentrations of chemicals in the air. For measuring the exhaust capabilities of a local exhaust ventilation system, a TSI® VelociCalc® Air Velocity Meter Model 8357 or 8345 is used. A Quest® Sound Level Meter Model 2700 is used to measure peak sound pressure levels in decibels.

Radiation Evaluation
Ionizing (x-ray) and non-ionizing (radiofrequency) radiation exposure sources are referred to the Radiation Protection Office.

Ventilation Evaluation
Local exhaust ventilation (LEV) controls are evaluated by measuring the face velocity or exhaust flow rate. Where appropriate laminar air currents are identified, a TSI® VelociCalc® Air Velocity Meter Model 8357 or 8345 using constant-temperature anemometry is used to measure the velocity of the air at the face of the LEV hood. The results are compared to

Attachment 12 continued

ACGIH Guidelines for specific operations in cubic feet per minute (cfm) or general guidelines of >100 feet per minute (fpm).

Noise Evaluation

Sound pressure level (SPL) readings are taken using a Quest® Model 2700 Sound Level Meter. The meter parameters are set to A frequency weighting, slow response time, and a range of 60-120 decibels (dBA). Results are compared to the NASA Policy Guideline on Hearing Conservation (NPG 1820.1) Action Limit of 80 dBA as an 8-hour time-weighted average (TWA) for 30 days or more per year or 85 dBA as an 8-hour TWA for one day per year, requiring inclusion in the Hearing Conservation Program. Additiona lly, all personnel who enter designated hazardous noise areas or who perform tasks where exposures to continuous noise exceed 85 dBA, regardless of the duration of the exposure, will be required to wear hearing protection. If sources or work activities are identified as a potential risk for overexposure, personal noise dosimetry is performed using a Quest® Q-100 or Ametek A-1 Audio Dosimeters to capture an integrated 8-hour exposure.

Ergonomic Evaluation

Ergonomic hazards are not identified in process areas due to limited frequency and duration of operations involving tools. In addition, automated equipment appeared correctly designed to keep the operator in a proper position while working, and thus did not promote prolonged static postures, reaches, or lifts. Design and office personnel interviewed reported no cumulative trauma disorders (CTDs), although computer workstations may be poorly designed. Personnel did not always have wrist and mouse rests for their computers, and keyboards were usually located on top of desks not designed for this use. The video display terminal (VDT) was not always supported so that the top of the screen is at eye level with the screen tilted slightly downward. Repetitive motions associated with key entry at computer workstations were observed.

Attachment 12 continued

F. Program Summaries

Medical Surveillance Program Summary (Chemical/Physical Hazards)

Based on the results of, and observations made during the industrial hygiene survey, the following work activities warrant the implementation of an on-going medical surveillance program.

Table F-1
Medical Surveillance Program Summary

Report Section	Location	Operation	Health Hazard	Recommended Medical Surveillance	# of Workers
1	E014, E014D, E014L, E014M, E014N, E014P, E014Q	Mixing chemicals/mixing a bath/adding chemicals	Acids, caustics, nitric acid, hydrochloric acid, phosphoric acid, chromic chloride, ammounium bifluoride, ammonium hydroxide, Oakites, acetone.	Respiratory Protection	4 (3 GS)
1	E014	Mixing chemicals, masking	Methyl ethyl ketone, toluene, acetone, lead chromate, ammonium hydroxide, potassium carbonate, hydrochloric acid.	Respiratory Protection	1 GS
8	E052	Painting, cleaning, bonding	Epoxies, isopropyl alcohol, paint solvents	Respiratory Protection	1 GS
4	E019	Operating milling machines	Noise	Hearing Conservation	1 GS
8	E052, E048, E048A	Operating milling, rough cutting and portable equipment	Noise	Hearing Conservation	2 GS

Hearing Conservation Program Summary

Attachment 12 continued

Based on the results of full-shift noise dosimetry, sound pressure level readings, observations during the industrial hygiene survey, and a review of past exposure monitoring records, there are no work activities or sources of noise requiring the participation of individuals in a hearing conservation program at this time. However, personnel records list two personnel as being already enrolled in the GSFC Hearing Conservation Program although they may not have received their annual training and audiogram. Since monitoring results show that these personnel have exposures approaching the NASA Policy Guideline of 80 dBA measured as an 8-hour TWA, personnel are recommended to remain enrolled in the Hearing Conservation Program. Additional monitoring is recommended to obtain a sufficient number of samples to make a final determination on their enrollment status.

Respiratory Protection Program Summary

Plating Group personnel performing operations such as mixing tank baths and chemicals were enrolled in the GSFC Respiratory Protection Program. A review of past air monitoring results indicated that personnel exposure to airborne concentrations of solvent vapors, acid mist, and alkali mist were below occupational exposure limits during routine plating operations. However, it is recommended and is shop policy that Plating Group personnel remain enrolled in the Respiratory Protection Program since they wear respirators during non-routine mixing operations.

Air monitoring results indicated that a civil servant operating machines in the vicinity of other machines known to generate significant airborne concentrations of oil mist was not exposed to oil mist at levels above the occupational exposure limit. This employee is not required to be enrolled in the Respiratory Protection Program, but he should be given the opportunity to participate in the Respiratory Protection Program and his exposure to oil mist should be monitored in the future. No other operations were identified which would necessitate the use of respiratory protection. A review of past air monitoring results as well as air monitoring conducted during this survey indicated that personnel exposure to airborne concentrations of solvent vapors, carbon fiber, beryllium, and aluminum dust were below occupational exposure limits.

Employees may use respirators when not required if the respirator is certified for use to protect against the contaminant of concern; if instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirator's limitations are followed; and if respirators are not mistakenly used by someone else.

Approved disposable respirators for protection against particulates were observed, although other forms of respiratory protection such as half- and full-face air purifying respirators (APR) and self-contained breathing apparatus (SCBA) were not available.

Attachment 12 continued

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Table F-2

Summary of Work Tasks that Respiratory Protection Equipment

Report Section	Location	Operation	Health Hazard	Minimum Respirator Type	# of Workers
1	E014	Mixing chemicals/mixing a bath/adding chemicals	Acids, caustics, nitric acid, hydrochloric acid, phosphoric acid, chromic chloride, ammounium bifluoride, ammonium hydroxide, Oakites, cyanide, nitric prep alloy, zinc, electroless Ni, Ni strike, gold strike, copper, black Ni, potassium carbonate, acetone, pH buffers	Half-face Respirator with cartridges for acid mists and organic vapors	4 (3 GS)

Personal Protective Equipment Program Summary

For each Group, a workplace hazard assessment is attached at the end of each Section as Attachments H-1.1-9.1. These assessments are a summary of work tasks by process area for which PPE (non-respiratory) is recommended. Regarding the Plating Group, which had already conducted a workplace hazard assessment to determine operations necessitating the use of PPE, the recommendations attached with this report are more stringent. The IHO determined that proper PPE would dictate chemical splash goggles or face shields when manually placing racks or individual parts in plating tanks containing corrosive chemicals.

As part of the implementation of this program, employees must receive information and training as to the hazards identified and the corresponding PPE to be worn for protection. The IHO should be consulted when implementing this program. Individuals are responsible for the care and storage of their own PPE, which was often observed to be stored in various unsanitary locations in the work area. This practice may increase the risk of using PPE that has been contaminated by conditions of the location or by other employees.

Engineering Controls Program Summary (Ventilation)

Table F-3 is a summary all local exhaust ventilation (LEV) systems by process area where an annual maintenance and evaluation schedule should be in place. With respect to the ventilation measurements collected in the Plating Shop, it was determined that many of the push-pull type exhaust systems were not operating at the ventilation rates required by the ACGIH Industrial Ventilation Manual 21st ed. A review of 1987-1988 personal and area air monitoring results indicated that airborne concentrations of solvent vapors, acid mist, and alkali mist were well below occupational exposure limits. However, additional area monitoring for select tanks is recommended to ensure that current processes are controlled. These recommendations are based on results of, and observations during, the industrial hygiene survey. Consult with the IHO while maintaining this schedule.

Attachment 12 continued

Table F-3
Summary of LEV Systems that Require Routine Inspections

Report Section	Process Area	LEV Description	Rec. Exhaust Capabilities	Date of Last Evaluation
1	Bldg 5, Rm E014	Fume hood for mixing chemicals and masking	50-100 cfm/sq. ft. or 80-120 fpm at face	3 Jun 2003 130 fpm at 24"
1	Bldg 5, Rm E014D	Fume hood for mixing chemicals	50-100 cfm/sq. ft. or 80-120 fpm at face	4 Nov 2003 113 fpm at 17"
1	Bldg 5, Rm E014F or E	Push/Pull Hood	50-100 cfm/sq. ft. or 80-120 fpm at face	13 Oct 2002 100 fpm w/ 26" sash height
1	Bldg 5, Rm E014K	Flexible duct/flanged hood for buffing/polishing wheel	400 cfm	129 cfm
1	Bldg 5, Rm E014K	Flexible duct/flanged hood for buffing/polishing wheel	400 cfm	198 cfm
1	Bldg 5, Rm E014K	Flexible duct/flanged hood for buffing/polishing wheel	400 cfm	250 cfm
1	Bldg 5, Rm E014K	Flexible duct/flanged hood for buffing/polishing wheel	400 cfm	322 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-1	Pull – 632 cfm; Push – 43 cfm	5 Jan 2004 Pull – 701 cfm; Push – 17 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-2	Pull – 632 cfm; Push – 43 cfm	5 Jan 2004 Pull – 907 cfm; Push – 17 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-4	Pull – 600 cfm; Push – 43 cfm	5 Jan 2004 Pull – 1007 cfm; Push – 18 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-6	Pull – 600 cfm; Push – 43 cfm	5 Jan 2004 Pull – 959 cfm; Push – 20 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-9	Pull – 325 cfm; Push – 30 cfm	5 Jan 2004 Pull – 729 cfm; Push – 10 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-10	Pull – 412 cfm; Push – 32 cfm	5 Jan 2004 Pull – 860 cfm; Push – 9 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-11	Pull – 600 cfm; Push – 43 cfm	5 Jan 2004 Pull – 942 cfm; Push – 13 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank A-12	Pull – 600 cfm; Push – 43 cfm	5 Jan 2004 Pull – 1359 cfm; Push – 8 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-1	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 476 cfm; Push – 12 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-3	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 370 cfm; Push – 11 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-4	Pull – 450 cfm;	5 Jan 2004

Attachment 12 continued

			Push – 32 cfm	Pull – 531 cfm; Push – 8 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-6	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 443 cfm; Push – 10 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-7	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 666 cfm; Push – 11 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-8	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 677 cfm; Push – 8 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-10	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 760 cfm; Push – 9 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank B-11	Pull – 474 cfm; Push – 32 cfm	5 Jan 2004 Pull – 820 cfm; Push – 17 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-1	Pull – 300 cfm; Push 21 cfm	5 Jan 2004 Pull 220 cfm; Push – 13 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-2	Pull – 300 cfm; Push – 21 cfm	5 Jan 2004 Pull – 321 cfm; Push – 11 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-3	Pull – 300 cfm; Push – 21 cfm	5 Jan 2004 Pull – 325 cfm; Push – 8 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-5	Pull – 300 cfm; Push – 21 cfm	5 Jan 2004 Pull – 402 cfm; Push – 17 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-7	Pull – 285 cfm; Push – 18 cfm	5 Jan 2004 Pull – 532 cfm; Push – 8 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank E-8	Pull – 760 cfm; Push – 19 cfm	5 Jan 2004 Pull – 432 cfm; Push – 12 cfm
1	Bldg 5, Rm E014G	Push/Pull Hood Tank G-1 (no push)	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 499 cfm; Push – None
1	Bldg 5, Rm E014G	Push/Pull Hood Tank G-3 (no push)	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 524 cfm; Push – None
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-1	Pull – 474 cfm; Push – 32 cfm	5 Jan 2004 Pull – 685 cfm; Push – 7 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-3 (a,b,c) (c has no push/pull)	Pull – 675 cfm; Push – 48 cfm	5 Jan 2004 Pull – 597 cfm; Push – 14 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-5 (a,b,c) (c has no push/pull)	Pull – 675 cfm; Push – 48 cfm	5 Jan 2004 Pull – 602 cfm; Push – 15 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-7	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 740 cfm; Push – 9 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-8	Pull – 300 cfm; Push – 21 cfm	5 Jan 2004 Pull – 357 cfm;

Attachment 12 continued

				Push – 11 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank N-9	Pull – 450 cfm; Push – 32 cfm	5 Jan 2004 Pull – 655 cfm; Push – 10 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-1	Pull – 300 cfm; Push – 30 cfm	5 Jan 2004 Pull – 194 cfm; Push – 42 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-2	Pull – 300 cfm; Push – 30 cfm	5 Jan 2004 Pull – 197 cfm; Push – 22 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-4	Pull – 450 cfm; Push – 12 cfm	5 Jan 2004 Pull – 239 cfm; Push – 21 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-5	Pull – 600 cfm; Push – 34 cfm	5 Jan 2004 Pull – 199 cfm; Push – 21 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-6	Pull – 375 cfm; Push – 34 cfm	5 Jan 2004 Pull – 406 cfm; Push – 20 cfm
1	Bldg 5, Rm E014D	Push/Pull Hood Tank CN-8	Pull – 375 cfm; Push – 34 cfm	5 Jan 2004 Pull – 443 cfm; Push – 23 cfm
8	Bldg 5, Rm E052	Flexible duct close capture #1	100 fpm capture velocity	6 Jun 2003 100 fpm @ 12"
8	Bldg 5, Rm E052	Flexible duct close capture #2	100 fpm capture velocity	6 Jun 2003 108 fpm @ 12"
8	Bldg 5, Rm E052	Floor exhaust	100 fpm capture velocity	
8	Bldg 5, Rm E052	Chemical cabinet	100 fpm capture velocity	6 Jun 2003 150 fpm @ 22"
8	Bldg 5, Rm E052	Slot hood	100 fpm capture velocity	
8	Bldg 5, Rm E048	Floor exhaust	100 fpm capture velocity	
8	Bldg 5, Rm E048	Flexible duct close capture #1	100 fpm capture velocity	6 Jun 2003 100 fpm @ 10"
8	Bldg 5, Rm E048	Flexible duct close capture #2	100 fpm capture velocity	6 Jun 2003 177 fpm @ 10"
8	Bldg 5, Rm E048	Flexible duct close capture #3	100 fpm capture velocity	6 Jun 2003 100 fpm @ 6"
8	Bldg 5, Rm E048	Flexible duct close capture #5 Saw	100 fpm capture velocity	6 Jun 2003 1200 fpm @ base of saw
8	Bldg 5, Rm E048	Flexible duct close capture #6	100 fpm capture velocity	6 Jun 2003 180 fpm @ on table
8	Bldg 5, Rm E048	Flexible duct close capture #7	100 fpm capture velocity	6 Jun 2003 420 fpm @ on top of table
8	Bldg 5, Rm E048	Flexible duct close capture #8	100 fpm capture velocity	6 Jun 2003 695 fpm @
8	Bldg 5, Rm E048	Flexible duct close capture #9	100 fpm capture velocity	6 Jun 2003 280 fpm @ base of saw
8	Bldg 5, Rm E048A	Flexible duct close capture #10	100 fpm capture	6 Jun 2003

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			velocity	128 fpm @ saw
8	Bldg 5, Rm E048A	Flexible duct close capture #11	100 fpm capture velocity	6 Jun 2003 9999 fpm @ hole
8	Bldg 5, Rm E048A	Flexible duct close capture #12	100 fpm capture velocity	6 Jun 2003 457 fpm @ 8"
8	Bldg 5, Rm E048A	Flexible duct close capture #13	100 fpm capture velocity	6 Jun 2003 108 fpm @ 14"
8	Bldg 5, Rm E048A	Flexible duct close capture #14	100 fpm capture velocity	6 Jun 2003 146 fpm @ 14"
			100 fpm capture velocity	
3	Bldg 5, Rm E038	Flexible duct/flanged hood for welding	250 cfm/sq. ft. or 80	4 Jun 2003 95 fpm at 6"
3	Bldg 5, Rm E038	Flexible duct/flanged hood for welding	250 cfm/sq. ft. or 80	4 Jun 2003 99 fpm at 10"
3	Bldg 5, Rm E038	Flexible duct/flanged hood for welding	250 cfm/sq. ft. or 80	4 Jun 2003 96 fpm at 6"
3	Bldg 5, Rm E038	Flexible duct/flanged hood for welding	250 cfm/sq. ft. or 80	4 Jun 2003 104 fpm at 8"
3	Bldg 5, Rm E038	Flexible duct/flanged hood for welding	250 cfm/sq. ft. or 80	4 Jun 2003 98 fpm at 7"
	Bldg 5, Rm W21	Fume hood	50-100 cfm/sq. ft. or 80-120 fpm at face	
8	Bldg 5A, Rm 020	Flexible duct/flanged hood for router		Sep 2003
8	Bldg 5A, Rm	Flexible duct/flanged hood for milling machines	250 cfm/sq. ft. or 80-120 fpm at face	

non-compliance with manufacturer's specifications

Exposure Monitoring Program Summary

Based on observations and the nature and frequency of operations reviewed during the industrial hygiene survey, there were no conditions identified warranting the implementation of an exposure monitoring program.

Attachment 12 continued

G. Index of Survey Report Section

Attachment 12 continued

H. Process Area Survey Report Sections

Industrial Hygiene Survey

Of Code 547.0

Section 1

Process Area: Plating Group

Location: Building 5, Rooms E014, E014A-E014Q

Date of Survey: October 28, November 4, December 12, 2003 & January 6, 2004

Attachment: (H-1.1) PPE Checklist

Process Area Description:
The Plating Group provides practical consulting and new process development services in the fields of electroplating, chemical processing, mechanical product finishing, adhesive bonding, and composite H/W development for state-of-the-art instrument and spacecraft components as well as micro-electromechanical and optical structures. Up to 5 civil servant and 2 contract employees may be working in any of the Plating Group areas. Major activities take place in the E014 Plating Lab where masking of parts and mixing chemicals is conducted, in the E014D Plating Shop where cleaning, mixing, etching and plating processes are conducted, and in E014B/C where administrative duties are performed.

Work Tasks:
Table H-1.1 presents the major operations that are associated with the Plating Group and the hazards that are of concern to the Industrial Hygiene Office. A list of tanks, their contents, and processes is provided as Appendix 1.

Table H-1.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	E014 Plating Lab	Masking/Masking stripping	Toluol, tetrachloroethylene, toluene, naphtha, lead chromate	7	Daily-Monthly/ 1-8 hrs	84
5	E014	Mixing chemicals	Potassium	7 (5 GS)	3x/wk/15 min	16

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.

0-50 = Review if process changes.
50-99 = Review process every 24-36 months.
100-199 = Collect air samples and review process every 12 months.
200-299 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

	E014D	for testing, related activities	carbonate, hydrochloric acid, ammonium hydroxide, acetone, pH buffers			
5	E014A X-ray Room	X-ray operation	X-rays	7 (5 GS)	Monthly-Yearly	N/A
5	E014B E014C	Administrative duties	Static positions, improper angles, repetitive motion	7 (5 GS)	20 hrs/wk	N/A
5	E014D Plating Shop	Chromate conversion coating	Iridite (sodium silicofluoride, chromic acid, barium nitrate), nitric acid	7 (5 GS)	Daily-Monthly/1hr	49
5	E014D	Cleaning/etching aluminum	Nitric acid, cyanide, Oakite 61B (disodium phosphate, tetrasodium pyrophosphate), Oakite 160 (sodium hydroxide, sodium carbonate)	7 (5 GS)	Daily-Weekly/1-2 hrs	98
5	E014D	Etching steel and titanium	Acids and caustics, CrCl, FeCl, FeNO3, HCl, NiCl, nitric acid, ammonium bifluoride	7 (5 GS)	Daily-Weekly/1-2 hrs	98
5	E014D E014E E014F E014G	Metal plating	Acids, caustics, nitric acid, hydrochloric acid, phosphoric acid, chromic chloride, sulfuric acid, ammounium bifluoride, ammonium hydroxide, sodium hydroxide, zinc oxide, Oakites, cyanide, nitric prep alloy, zinc, electroless Ni (nitric acid, NiSO4, NaOH), Ni strike (HCl, NiCl), gold strike, copper, black Ni (NiSO4, ZnSO4, NiNHO4, NaSCn4), silver strike (AgCn, KCN, KCO3), black anodize (sulfuric acid, aluminum oxide)	7 (5 GS)	Daily/1-4 hrs	147
5	E014D E014L	Mixing a bath/adding	Acids, caustics, nitric acid,	4 (3 GS)	Daily-Monthly/15	28

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	E014M E014N E014P E014Q	chemicals	hydrochloric acid, phosphoric acid, chromic chloride, ammounium bifluoride, ammonium hydroxide, Oakites, cyanide, nitric prep alloy, zinc, electroless Ni, Ni strike, gold strike, copper, black Ni, potassium carbonate, acetone, pH buffers		min.	
5	E014D	Utrasonic cleaning	Acetone, toluene, blue gold, methanol, ethyl alcohol, isopropyl alcohol, other solvents	7 (5 GS)	1 hrs/day	56
5	E014K Buffing and Polishing Room	Buffing and polishing	Flying particles, noise	7 (5 GS)	Daily-Monthly/15 min.	N/A

1. Masking

a) Observations:

1) Toluol- or tetrachloroethanol-containing masking (AC Products AC-818-T-250) and Miccro Super XP2000 Mask containing naphtha, toluene, and lead chromate is applied to iridited parts to preserve their conductivity. Masking is performed daily or monthly one to eight hours as needed, usually by two civil servants, but potentially five. Masking is applied as a liquid and dries to give a rubber-like appearance. Stripping or cleaning up masking with a reducer occurs at a similar frequency as that of masking. Miccro Super XP-2000 Miccrostrip Reducer contains methyl ethyl ketone, acetone, methyl isobutyl ketone and toluene. The lab hood in which this operation is conducted was found to be in compliance with its annual inspection. The results of the 3 June 2003 LEV evaluation indicated the provision of adequate exhaust, 108 feet per minute (fpm) at a sash height of 18.5". Personnel reportedly wear safety glasses, safety shoes, and some wear gloves. Signs indicating PPE were posted in all Plating Group rooms. In addition, eyewashes and safety showers were accessible.

2) MSDSs were available as hard copies in the MSDS book and in the MSDS Pro database with the exception of some products. The XP-2000 Miccrostrip Reducer (Pyramid Plastics) and AC – 818-T-250 Masking were not found in the MSDS Pro system, but other masking agents and reducers by other manufacturers were present in the database. The MSDS for Miccrostrip Reducer was also not readily located as a hard copy. Hazard communication training was provided in the past by Baker Co. This training or related chemical hygiene training has reportedly not been provided for some time.

b) Recommendations:

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1) Because masking contains chemicals which may cause serious effects and may occasionally be performed for several hours during a given day, this process should be reviewed and air monitoring conducted at a time in which the process is conducted for an extended duration. Inform the Industrial Hygiene Office (IHO) in advance when it is known that masking and/or stripping will be performed for several hours. Continue to ensure that the lab hood is evaluated according to its annually scheduled inspection.

2) Further analysis should be performed regarding the use of safety glasses in lieu of chemical splash goggles. Generally, chemical splash goggles or face shields are required where splash hazards are present. Provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-1.1. Nitrile gloves offer an excellent degradation rating for the solvents mentioned except for acetone, for which nitrile is not recommended.

3) Ensure that MSDSs for all potentially hazardous materials are entered into the MSDS Pro database. Continue to ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure all employees receive chemical hygiene plan training or training on the hazardous chemicals in their work area as applicable at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Document all training.

c) *Exposure Monitoring:* Monitoring is recommended based on the duration of the operation and the nature of the chemicals used.

2. Mixing Chemicals for Testing and Related Activities

a) *Observations:* The chemist stated that she mixes chemicals for testing three times per week for approximately 10 minutes. This operation is conducted either under the lab hood in the E014 Plating Lab or under the lab hood in the E014D Plating Shop. The chemist works with chemicals such as potassium carbonate, hydrochloric acid, acetone, ammonium hydroxide and buffers under the lab hood. MSDSs for these chemicals were accessible through the MSDS Pro database. The lab hoods in which this operation is conducted were found to be in compliance with their annual inspection. The results of the 4 November 2003 LEV evaluation indicated the provision of adequate exhaust, 113 feet per minute (fpm) at a sash height of 17" in the Plating Lab and 130 fpm at a sash height of 24" in the Plating Shop. The Chemist wears safety glasses, safety shoes, and N-Dex nitrile gloves and uses a pipette. The Plating Group Safety Committee performed a workplace hazard assessment and informed employees of operations necessitating the use of personal protective equipment (PPE). A chemical hygiene plan was maintained in the office, but there was no documentation of training that could be reviewed.

b) *Recommendations:* Due to the intermittent frequency and short duration of chemical mixing, and because chemicals are mixed in a fully functioning lab hood, air monitoring for these chemicals was not warranted. Continue to ensure that the lab hood is evaluated according to its annually scheduled inspection. Chemical splash goggles are recommended where splash hazards are present. For the limited frequency and duration in which chemicals are handled, nitrile, neoprene or butyl rubber gloves should all afford protection before breakthrough occurs, but nitrile gloves are normally not recommended for heavy acetone use. See the workplace hazard

Attachment 12 continued

assessment, identifying operations requiring the use of PPE and the type of PPE required. Maintain PPE that is in good condition and store it in a sanitary manner. Complete the Chemical Hazard Process Analysis Checklist for Laboratories attached as Attachment H-1.2. Ensure the provision of chemical hygiene training for laboratory personnel.

c) *Exposure Monitoring:* Routine monitoring is not required based on the frequency and duration of the operation.

3. X-ray Operation

a) *Observations:* X-ray equipment is used very infrequently by two employees to check the thickness of plating applications. A "Caution" sign was observed at this room warning of x-rays. Printers and computers were also stored in this room.

b) *Recommendations:* Use equipment only for its intended purpose and follow manufacturer's recommendations regarding inspection of equipment for proper function. This item was referred to the Radiation Protection Office. According to the Radiation Protection Office, ionizing radiation training is required for the operation of this x-ray equipment and radiation badges to detect leakage will be placed at the equipment and reviewed quarterly.

4. Administrative Duties

a) *Observations*: Personnel perform administrative functions approximately 20 hours per week. Workstations were not always ergonomically designed and personnel may work for extended periods at their desks with improper wrist/body angles. However, no complaints were noted and personnel reported no cumulative trauma disorders (CTDs).

b) *Recommendations*: Provide, where feasible, articulated keyboard trays that accommodate the keyboard and mouse. Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Position the keyboard so that it is between 28-30 inches above the floor. To allow sufficient knee space if an adjustable keyboard tray is installed to the underside of the desk, the height from the floor to the adjustable keyboard tray should range from 23-28 inches. Use adjustable chairs that allow personnel to sit at comfortable height, angle, and distance from the screen. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Ensure a minimum viewing distance of 12 inches and support the monitor so that the top of the screen is at eye level with the screen tilted slightly downward. The entire viewing plane should be between 0 and 40 degrees below the horizontal viewing plane. When viewing screens with dark backgrounds, use lower lighting. Dark characters on a light screen are generally more readable. Ensure high contrast between the screen background and the screen characters. Minimize glare and choose screens that tilt and have contrast and brightness controls.

5. Chromate Conversion Coating

a) *Observations:* Aluminum parts undergo chromate conversion coating for corrosion protection by being placed in iridite baths. This coating also preserves the conductivity of aluminum and serves as a primer before painting. This process is not considered a plating process. Plating processes are summarized in paragraph 6 of this section. There is less exposure to chemical baths

Attachment 12 continued

in chromate conversion coating than would be present in plating, etching or cleaning. The Safety Committee does not require the use of gloves for this process. Signs indicating PPE were posted in all Plating Group rooms. In addition, eyewashes and safety showers were accessible. Past monitoring results indicated that airborne concentrations of plating shop chemicals in the plating shop were well below applicable limits. MSDSs were accessible through the MSDS Pro database. According to records, hazard communication training was provided in the past by Baker Company. This training or related chemical hygiene training has reportedly not been provided for some time.

b) Recommendations: Based on past air sampling results, no further air monitoring for this operation was warranted. Ensure personnel are aware of the hazard communication program describing MSDSs, labeling and information and training requirements. Maintain PPE that is in good condition ad store it in a sanitary manner.

6. Cleaning, Etching and Plating

a) Observations:

1) Five civil servant and two contract employees are involved in cleaning, etching and plating processes in the Plating Shop E014D. Similar operations are performed in the E014G Electroplating Gold Room and E014E Prototype Room. Base metals to be plated include aluminum, brass, steel, stainless steel, Invar (Ni-Fe), aluminum alloy, titanium, and inconel (Ni-brass alloy). Cleaning, etching, and plating processes usually consist of several stages beginning with ultrasonic cleaning, which employs Blue-gold for 15 sec.-15 min. to remove oils and dirt from parts. The process of cleaning, etching and plating aluminum was described as a series of rinse baths of deionized water, deoxidizing baths of nitric acid, and an etch bath of caustic Oakite 61B. The main difference between cleaning and etching is that the parts etched remain in the baths for longer time periods while parts cleaned remain in the baths for 20-30 seconds. If aluminum is to be plated, it undergoes a nitric prep alloy bath, rinsing, zincating which puts a zinc coating on the part, rinsing, a nitric acid bath that strips off the zinc, rinsing, another zincate step to reapply a zinc coating, rinsing, an electroless nickel bath that replaces zinc with nickel, rinsing, nickel strike, rinsing, gold strike, gold, rinsing, hot water rinsing and blow drying. Stainless steel, steel, copper, brass and invar parts normally undergo an electrocleaning step and a hydrochloric acid bath. Only aluminum undergoes the deoxidizing step. Base metals may be plated with nickel, gold, copper, black nickel, but there is no cadmium or chromium plating processes.

2) Personnel perform plating and related operations approximately four hours per day and wear safety glasses, safety shoes, and rubber or nitrile gloves according to the workplace hazard assessment performed by the Safety Committee. Personnel also received PPE training on the required PPE. According to the written SOP for plating, aprons are to be worn, but personnel stated their PPE assessment did not require aprons. It was reported that safety glasses were used instead of chemical splash goggles because parts are normally small and dipped slowly so that no splashing occurs; a crane would be used for large parts.

3) Each bath or tank in the Plating Shop has a push-pull hood that has been evaluated according to annually scheduled inspection. It was determined that many of the push-pull type exhaust systems were not operating at the ventilation rates required by the ACGIH Industrial Ventilation Manual 21st ed as shown in Table F-3. A review of 1987-1988 personal and area air monitoring results indicated that airborne concentrations of solvent vapors, acid mist, and alkali mist were well below

Attachment 12 continued

occupational exposure limits. Past air monitoring results are kept with this survey report in the IHO.

4) Plating processes as described above involve the use of various chemical mixtures, not all of which were mentioned. Hazard Communication training had been provided in the past by Baker Co, but training has not been offered this year and for some time previously. Other elements of a Hazard Communication Program including MSDSs and labeling were in effect. MSDSs were usually readily accessible through the MSDS Pro database. Blue-Gold appeared not to have been entered into the MSDS Pro System. In addition a Chemical Hygiene Plan was reviewed in the office, but training had not been provided to employees.

5) The Plating Shop contains five eyewashes and a safety shower that were inspected monthly. Other items such as a spill control kit, an emergency evaluation plan and fire extinguishers were observed. Eyewashes were compliant with the ANSI requirements for primary eyewash units.

6) Sound level measurements taken at the noisiest points of Room E014D indicated levels of 79-81 dBA. Personnel would likely work in these locations for a short duration.

b) Recommendations:

1) Because many of the push-pull exhaust systems for the plating tanks do not meet design requirements and since the tanks contain chemicals that may cause serious health effects and are used in large quantities on a frequent basis, additional air monitoring for select tanks is recommended to ensure that processes are controlled. Thus, the process should be reviewed every 12 months and air monitoring will be conducted by the IHO again in the future. Continue to ensure that the push-pull hoods are evaluated according to their annually scheduled inspection.

2) Upon further analysis regarding the use of safety glasses in lieu of chemical splash goggles, it is still recommended that face shields or chemical splash goggles be used when dipping parts into tanks though the probability of a splash is slight. A review of the case history of judicial decisions involving OSHA and the plating industry shows outcomes ruling against employers who allowed the use of safety glasses as protection during plating operations. Continue to inspect eyewashes and safety showers monthly and activate them weekly in accordance with ANSI Z358.1- 1998 Standard for Emergency Eyewashes and Showers.

3) Provide hazard communication and chemical hygiene plan training for employees who have not had this training on initial assignment. Document all training.

4) Because of the limited duration that employees would remain in the area with the potential to exceed sound levels in excess of 80-dBA, exposure to noise as an 8-hour TWA would not be expected to exceed the NASA Action Level of 80 dBA. Therefore, participation in GSFC's Hearing Conservation Program was not warranted. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection in areas where sound levels exceed 80 dBA.

7. Mixing Chemicals, Mixing a Bath, Adding Chemicals

a) Observations: Mixing plating tank baths is usually performed by one contractor, but up to three other civil servants could also perform this operation. Plating Shop personnel mix an entirely

Attachment 12 continued

new bath once per year and otherwise add chemicals to existing baths as needed. Mixing an entirely new bath involves cleaning the empty bath, transferring the drum and mixing fresh chemicals. This operation could be performed in chemical storage rooms E014L-E014Q and in the Plating Shop E014D. Other operations involving mixing of chemicals take place in the Plating Shop E014D as well. Chemicals are transferred from the different chemical storage rooms E014L-E014Q. Up to six employees may be involved in other activities involving mixing and adding of chemicals. The contractor who usually mixes chemicals reportedly wears an apron, face shield, gloves and possibly a respirator with cartridges for acid mists or organic vapors. Other persons may wear North half-face or other respirators while making an acid bath or similar operation.

b) Recommendations: Due to the frequency and duration of these operations, further air monitoring was not warranted. Continue to select and provide the types of PPE that will protect the affected employee from the hazards identified. See the workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required. Maintain PPE that is in good condition ad store it in a sanitary manner. Continue to inspect eyewashes and safety showers monthly and activate them weekly in reference to ANSI Z358.1- 1998 Guidance. Provide hazard communication and chemical hygiene plan training for employees who have not had this training on initial assignment. Document all training. Continue to evaluate LEV systems according to their annual inspection schedule.

8. Ultrasonic Cleaning

a) Observations: Five civil servants and two contractors perform ultrasonic cleaning in two ultrasonic tanks with Blue-gold degreaser approximately daily for 15 seconds to 15 minutes each time for a total of one hour. Parts are normally cleaned before being plated. Signs indicating PPE were posted based on the Safety Committee hazard assessment, in this case safety glasses, safety shoes and metal beakers in which to place parts.

b) Recommendations:

Due to the relatively short duration of this operation and because the process is enclosed, further air monitoring was not warranted. Continue to use the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment. Maintain PPE that is in good condition and store it in a sanitary manner. Continue to inspect eyewashes and safety showers monthly and activate them weekly in accordance with ANSI Z358.1- 1998 Standard for Emergency Eyewashes and Showers. Provide hazard communication or chemical hygiene plan training as appropriate for employees who have not had this training upon initial assignment. Document all training.

9. Buffing and Polishing

a) Observations: The Buffing and Polishing Room E014K contains a L'Hommedieu buffing lathe and a Baldor grinder/buffer. These machines are equipped with local exhaust ventilation (LEV) for each of their two wheels and were used daily to monthly as needed by up to seven employees. Sound level measurements taken during the operation of the buffing lathe with the LEV indicated sound levels at or near 82 dBA. No annual evaluation records were available for the LEV for each of the four buffing wheels, but as part of this survey, an airflow evaluation was performed on 6 Jan 2004. Personnel stated they wear PPE in the form of safety glasses, cotton gloves, a face shield and occasionally voluntarily wear disposable half-face 3M 9511 N95 respirators. Hearing

Attachment 12 continued

protection was reportedly not worn. There was no sign observed stating eye and hearing protection was required.

b) Recommendations:

1) Because buffing and polishing operations are normally conducted for only one hour per day, exposure to noise would not be expected to exceed the NASA Action Level of 80 dBA as an 8-hour TWA. Therefore, participation in GSFC's Hearing Conservation Program was not warranted. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection when operating the buffing lathe and wheels.

2) Ensure that all LEV hoods continue to be evaluated according to their annually scheduled inspection. Contact the IHO if hoods that have not been evaluated within the past year are identified.

3) Continue to select and have each employee use the types of PPE that offer protection from the hazards identified. Use and maintain PPE in a sanitary and reliable condition. Each employee shall be trained to know at least the following: when PPE is necessary; what PPE is necessary; how to properly don, doff, adjust, and wear PPE; the limitations of the PPE; and, the proper care, maintenance, useful life and disposal of the PPE.

Cancer/Mutation/Reproduction Hazards:
Lead chromate is listed by ACGIH as a suspected carcinogen and reproductive hazard. Sulfuric acid is listed by ACGIH as a suspected larynx carcinogen. The IARC lists hexavalent chromium compounds as carcinogenic to humans. 2-ethoxyethanol is listed by ACGIH as a chemical causing reproductive effects and is among chemical substances contained in a Department of Navy Occupational Chemical Reproductive and Developmental Hazard List along with toluene as substances known to cause reproductive or developmental toxicity in humans, or known to cause reproductive or developmental toxicity in animals by mechanisms of action directly applicable to humans.

Personal Protective Equipment:
A PPE Checklist recommended by the IHO is presented as Attachment H-1.

Medical Surveillance Recommendations:
Medical surveillance is required for personnel enrolled in the Respiratory Protection Program. Based on chemical and physical hazard assessments and regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include hearing conservation, radiation monitoring, or biological monitoring.

Sound Level Survey:
A sound level survey performed in Building 5, Rooms E014D Plating Shop and E014K Buffing and Polishing Room showed sound levels to be less than 85 decibels as measured on an A-weighted scale (dBA) at the operator's hearing zone during the operation of certain equipment. The NASA Hearing Conservation Policy (NPG 1820.1) requires that personnel wear hearing protection when exposure to noise is above 85 dBA, regardless of duration, or when personal exposure to noise is equal or greater than 80 dBA as an 8-hour Time-Weighted-Average (TWA) for more than 30 days per year. Sound level readings are summarized in Table H-1.2 below.

Attachment 12 continued

Table H-1.2
Summary of Sound Pressure Level Results

Equipment Type/Area	Sound Levels (dBA)*	Hazard Radius (ft)	Comments
Buffing wheel and LEV/ Bldg 5, E014K	82	--	Daily-monthly/15 minutes
E1 nitric strip tank / Bldg 5, E014D	77.5-79.1	--	1-2 hrs/day in this area
A2 alkaline etch tank / Bldg 5, E014D	79.5-81	--	1-2 hrs/day in this area

* at the operator's hearing zone
ER – entire room

Attachment 12 continued

Attachment H-1.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5 **Process Area:** Plating Shop Group **Date:** 11/04/03	**Supervisor:** Charles Adams **Telephone:** 6-2620 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f. Powered APR respirator g. Supplied-air respirator h. SCBA** i. Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Masking and Stripping	5	E014	a, b or d, i	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone) Safety shoes required.
Mixing Chemicals for Testing and Related Activities	5	E014, E014D	b or d, i	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone) Safety shoes required.
Chromate Conversion Coating	5	E014D	a, i	None	None	Safety glasses, safety shoes required
Cleaning, Etching, Plating	5	E014D, E014E, E014F,	b or d, i	g, i	None	Face shield or goggles required when dipping parts.

Attachment 12 continued

		E014G				Nitrile/rubber/neoprene gloves required. Safety shoes required Apron recommended
Mixing a Bath, Mixing Chemicals, Adding Chemicals	5	E014D, E014L-Q	b or d, i	g, i	c	Face shield or goggles required. Nitrile/rubber/neoprene gloves required. Safety shoes required Apron required for mixing a bath and transporting. Respirators recommended for mixing a bath.
Ultrasonic Cleaning	5	E014D	a, i	i	None	Safety glasses, gloves and safety shoes required
Buffing and Polishing	5	E014K	a, i	k	None	Safety glasses, canvas gloves and safety shoes required

Attachment 12 continued

Attachment H-1.2
Chemical Process Hazard Analysis
Moderate Hazard Review Checklist
(See attached instructions)

Introduction

Every laboratory performing chemical processes should have a current hazard analysis. The Process Hazard Analysis (PHA) is mandatory for chemical processing laboratories to assess the hazards associated with new or modified chemical processes or operations. The Moderate Hazard Review Checklist is used in evaluating the safety of new, modified, or relocated experiments or tests which present a moderate potential hazard to employees, equipment and facilities, or the environment. Laboratory Managers are responsible for completing the analysis. Participation by a representative of the Safety and Environmental Branch (S&EB), Code 205.2, is recommended.

Instructions at the end of this template provide information on the hazard review process, and aid the Laboratory Manager in determining which level of Process Hazard Review is appropriate: Low, Moderate, or High. The Moderate Hazard Review Checklist is used for those processes or experiments that present a moderate potential hazard, but do not require a full High Hazard Review (HHR).

This is a multi-page checklist that requires laboratory managers and workers to work together to ensure that all potential problem areas are analyzed, documentation is generated where necessary, and personnel are made aware of the hazards and safety review findings that affect their work. This checklist, when complete, becomes part of a safety documentation package that will be controlled in accordance with GPG 1410.2. This package should be available in a prominent location in the laboratory while the work is in progress.

Laboratory Identification

Laboratory Name/Description		
Laboratory Location		
Laboratory Manager	Code	Ext.
Product/Experiment Description		

Moderate Hazard Review Checklist

BRIEF DESCRIPTION OF PROCESS:

To check a checkbox, double -click on the box, and select Checked or Not Checked.

A. Have the following been defined by appropriate documentation? Check if done.

- ☐ 1. Process description
- ☐ 2. Process flow diagram/equipment
- ☐ 3. Material Safety Data Sheets (MSDS)
- ☐ 4. Laboratory Safety Procedures, including (as applicable)
- ☐ a. Emergency Procedures
  - Shut-down
  - Spills
- ☐ b. Specialized Operating Procedures:

GSFC 23-57 (May 2003)
Previous versions are obsolete

Attachment 12 continued

- Normal Start-Up
- Normal Operation
- Normal Shutdown

☐ c. Lockout Procedure
☐ d. Operating Hazards (including chemical, mechanical, etc.)
☐ e. Line Break Procedure
☐ f. Personal Protective Equipment
☐ g. Procedure for Modifications
☐ h. Waste Disposal Procedures

ATTACH all of the above documentation to this checklist

B. Evaluate and describe the following potential hazards, and the necessary precautions taken for each. Attach supplemental sheets as necessary. Check when completed.

☐ 1. Toxicity of solids, liquids, and gases associated with the process (Consult MSDS)

☐ 2. Reactivity and explosion hazards of solids, liquids, and gases associated with the experiment or process (Consult MSDS)

☐ 3. Corrosiveness of solids, liquids, and gases associated with the process (Consult MSDS)

☐ 4. Ignition sources such as sparking motors, switches, alarms, exposed heaters, etc.

☐ 5. Fuel sources such as feedstock, products, solvents, gaseous reaction products, insulation, etc., in the area that could be ignited (Consult MSDS)

☐ 6. Sound level exposure

☐ 7. Nuclear radiation

☐ 8. Radiations such as ultraviolet, infrared, microwaves, lasers, X-rays, etc.

☐ 9. Pressure system failure (projectiles, shrapnel, sprays from leaks, etc.)

☐ 10. Electrical (e.g., bonding, grounding, sources identified/labeled)

☐ 11. Pressure and temperature transients

☐ 12. Ergonomics (spacing, access to equipment, physical requirements of job)

☐ 13. Other (describe)

C. Consider and evaluate the effect of your work in the following environmental areas. Attach supplemental sheets as necessary. Check when completed.

☐ 1. Identification and resolution of potential air, water and soil pollution

☐ 2. Identification and development of written disposal methods for all wastes

Attachment 12 continued

☐ 3. Air emissions and air emission rates calculated and reported to the Safety and Environmental Branch

D. Confirm that the following have been provided in the design and construction of the equipment/apparatus. Check left column if OK.

1. Piping and Instrumentation

☐ a. Pressure relief valves and/or rupture disks where necessary (vessels, positive displacement pumps, blocked-in lines, blocked-in heat exchangers, compressors, etc.) with no valves or restrictions of any kind in the lines between the equipment and the protective devices

(1) Properly sized ☐ Yes ☐ N/A

(2) Proper set pressure ☐ Yes ☐ N/A

☐ b. Proper relief and blow-down system with no valves or restrictions of any kind in the lines between the protective devices and the point of discharge

☐ c. Emergency overflow lines ☐ Yes ☐ N/A

☐ d. Emergency shutdown system ☐ Yes ☐ N/A

☐ d. Emergency shutdown system

☐ e. Suitable alarms, shutdowns, interlocks, purges, etc., to bring unit to a safe automatic shutdown in the event of an emergency such as:

(1) Loss of instrument air ☐ Yes ☐ N/A

(2) Loss of steam ☐ Yes ☐ N/A

(3) Loss of cooling water ☐ Yes ☐ N/A

(4) Loss of electric power ☐ Yes ☐ N/A

(5) Loss of fuel ☐ Yes ☐ N/A

(6) Severe leakage by rupture of piping or equipment, by leakage from stuffing boxes or mechanical seals, or due to corrosion ☐ Yes ☐ N/A

(7) Fire in the area of the unit ☐ Yes ☐ N/A

(8) Other (Explain if Yes) ☐ Yes ☐ No

☐ f. Alarms for all other critical variables (high/low temperature, high/low pressure, high/low flow, high/low level, etc.)

☐ g. Automatic shutdown of certain pieces of equipment if certain critical variables are exceeded (high/low temperature, high/low pressure, high/low flow, high/low level, etc.)

☐ h. Fail-safe positioning of control valves and solenoid valves in the event of instrument air loss or electrical failure

☐ i. Pressure, temperature, flow, and level measurement devices installed at all critical points

☐ j. Suitable devices to prevent the flow or backup of materials into undesirable areas

☐ k. Suitable interconnect methods to utility systems such as water, gas, electricity, etc. (e.g., use of Back Flow Preventer Valve in a potable water system)

☐ l. Backup pumps, compressors, etc., where required for safety

☐ m. Automatic detection devices, as applicable, for:

(1) Toxic materials ☐ Yes ☐ N/A

(2) Combustible mixtures ☐ Yes ☐ N/A

(3) Radiation ☐ Yes ☐ N/A

(4) Oxygen detection ☐ Yes ☐ N/A

(5) Fire ☐ Yes ☐ N/A

If Yes for any of above, describe:

Attachment 12 continued

2. Pressure vessels, pumps, compressors, heat exchangers, etc.
   - ☐ a. Proper materials of construction with consideration for corrosion, fatigue, stress cracking, embrittlement, strength, toughness, etc. Special care should be taken when using glass.
   - ☐ b. Proper design and material for seals and gaskets
   - ☐ c. Proper design pressures and temperatures
   - ☐ d. Guards on all rotating, reciprocating, and conveying equipment

☐ 3.Vessel identification, tagging, and record keeping in accordance with Center's procedures? If not, explain.

E. Chemical Description. Check left column if OK.

OK

☐ 1. What ***Chemicals*** are used in your process?

☐ 2. Are any of the Chemicals: (check all that apply)

☐ Carcinogen	☐ Developmental Toxin
☐ Flammable	☐ Light Sensitive
☐ Mutagen	☐ Peroxidizable
☐ Pyrophoric	☐ Radioisotope
☐ Reactive With Air	☐ Reproductive Toxin
☐ Shock Sensitive	☐ Temperature Sensitive
☐ Toxic/Poison	

☐ 3. If your Chemicals display any of the above listed characteristics, is the ductwork certified as leakproof? ☐ Yes ☐ N/A

☐ 4. If your Chemicals display any of the above listed characteristics, will access to the roof be prohibited while you are running your experiment or equipment? ☐ Yes ☐ N/A

☐ 5. How will these Chemicals be stored?

☐ 6. If refrigeration is required, is the refrigerator or freezer alarmed, approved, and properly marked for chemical storage? ☐ Yes ☐ N/A

F. Transportation and Storage. Check left column if OK.

OK

☐ 1. How will you transport chemicals in the building or across the site?

☐ 2. Will chemicals be shipped off site? ☐ Yes ☐ No
If Yes, do you have the necessary information for the 20-4 Shipping Request?
☐ Yes ☐ N/A

G. Area: Evaluate the following safety items and describe the reason or location for each.

OK **Check left column if OK.**

☐ 1. Are there limits on personnel in attendance while operating?

☐ 2. Are there special area requirements, e.g., High Noise?

☐ 3. Are barricades required?

☐ 4. Are special signs or alarms needed?

☐ 5. Are exits from laboratory or area adequate (standard and emergency)?

☐ 6. Where are the nearest fire and/or evacuation alarms?

Attachment 12 continued

- ☐ 7. Where are the nearest fire extinguishers?
- ☐ 8. Have extinguishers been inspected within a year? When?
- ☐ 9. Where is the nearest Safety Shower and/or Eye Wash?
- ☐ 10. Has the eyewash been inspected weekly?
- ☐ 11. What is the location of the nearest telephone?
- ☐ 12. Does the nearest telephone have a 911 emergency sticker?
- ☐ 13. Will there be any unattended operation of this process? If so, what special procedures will be implemented?
- ☐ 14. Will this process be operated by a lone worker? If yes, explain.
- ☐ 15. Will this process be operated after normal working hours? If yes, what special procedures will be implemented?
- ☐ 16. Are the Emergency Contact names and phone numbers posted on the door?

H. Training: describe or attach list of any special training required, and identify for whom.

I. Are there any corrections that must be made before startup?

At this time, print this document and obtain the appropriate signatures. The following are required:

CERTIFICATION AND APPROVAL:

Certification by the Laboratory Manager that all required corrections have been completed, the laboratory process is safe (subject to completion of required training), and procedures are properly implemented and understood.

______________________________ *Date* ____________
Laboratory Manager Signature/Code

Certification by laboratory personnel that they have read and understood this Hazard Review and associated laboratory procedures: (use additional sheets if necessary)

______________________________ *Date* ____________
Laboratory User Signature/Code

______________________________ *Date* ____________
Laboratory User Signature/Code

______________________________ *Date* ____________
Laboratory User Signature/Code

Attachment 12 continued

_______________________ Date _______________

C. Laboratory User Signature/Code

_______________________ Date _______________

Laboratory User Signature/Code

Branch Head Approval:

_______________________ Date _______________

Signature/Code

Concurrence by Code 205.2, if they participated in the review:

_______________________ Date _______________

205 Concurrence Signature

Following all approvals, a copy of this document and its attachments, including a copy of the Hazard Analysis Selection Matrix, shall be posted in the laboratory area and placed under configuration control per GPG 1410.2. A dated copy shall be sent to Code 250.

Attachment 12 continued

General Instructions for Laboratory Process Hazard Analysis

Introduction

The identification and control of hazards in the laboratory is the responsibility of the owning organization. The Laboratory Process Hazard Analysis is designed to aid management in meeting this responsibility.

The Process Hazard Analysis (PHA) is mandatory for laboratories and other areas that use chemicals for other than normal housekeeping purposes. These analyses are used to assess the hazards associated with new or modified processes or operations in a laboratory environment. There are three levels of reviews for three anticipated levels of hazards: Low, Moderate, and High.

The Hazard Analysis Selection Matrix provides the Laboratory Manager a quick way to assess the level of process hazard analysis required. The matrix has three vertical columns that correspond to the three levels of review. Horizontal lines describe various potential hazards. By checking those that apply in the appropriate columns, the necessary review level becomes easier to define.

Approach

The first step in determining the level of review required is to fill out the **HAZARD ANALYSIS SELECTION MATRIX** on the last page of these instructions. There are four major sections to the matrix: Material Hazards, Processing Hazards, Equipment Hazards, and Environmental Hazards. Various criteria within these categories determine the level of hazard analysis required.

These guidelines are the MINIMUM suggested methods, and are not meant to be a substitute for good judgment. Combinations of lower level hazards may indicate a need for a higher level of review. Conversely, if in your judgment you can use a lower level of hazard review than that indicated by these guidelines, you may do so with the approval of the Laboratory Manager and Division Chief.

Levels of Process Hazard Analysis

1. **Low Hazard Review (LHR):** Low Hazard Review (LHR) is conducted when the hazard is deemed "low". Low hazard is defined as having little potential to create injury or property damage, and no potential for environmental release. A LHR requires completion of a brief description of the process, the potential hazards, and what steps will be taken to mitigate those hazards. A set of operating procedures, the personal protective equipment required, special training required, and the signature of those involved with the review must be included. The Laboratory Manager and users conduct this level of review. The review is performed using GSFC Form 23-56.

2. **Moderate Hazard Review (MHR)**: Moderate Hazard Review (MHR) is conducted when the hazards involved are deemed "moderate". Moderate hazard is defined as having the potential to cause injury, equipment damage, or environmental release. Laboratory Managers and users conduct an MHR. The involvement of a safety representative can be requested and is encouraged. A MHR requires the completion of a comprehensive checklist, and must be accompanied by a complete set of standard operating procedures. Among the information evaluated are process technology, potential hazards and mitigation, environmental issues, and adherence to specific engineering/design standards. The review is performed using GSFC Form 23-57.

3. **High Hazard Review (HHR)**: High Hazard Review (HHR) is conducted for experiments, equipment installations, or processes which are deemed "high hazard". High Hazard is defined as having the potential to cause serious injury, severe equipment or facility damage, or negative environmental impact.

A HHR Committee shall be established for each Laboratory that meets the criteria for High Hazard Review. The HHR Committee will consist of a chairperson, a representative from the Safety and Environmental

Attachment 12 continued

Branch, researcher, technician, member of the Chemical Safety Committee (CSC), and any other resources deemed necessary. A comprehensive review by the HHR Committee of all potential hazards involved in processes and equipment is required. A member of the CSC or an S&EB representative can help determine what type of HHR method will be used based on the nature of the hazard(s) presented. The HHR requires that a number of documents be assembled and made available to the review committee. Piping and instrument diagrams, chemical reaction characteristics, relevant incident reports, process chemistry, and operation procedures are all required.

The review is performed using GSFC Form 23-58 and must be documented completely. The HHR Committee must approve significant changes.

Required Participation for Process Hazard Analysis

Position	LHR	MHR	HHR
Laboratory Manager and users	X	X	X
Branch Head	X	X	X
Safety Representative			X
Additional Technical Sources			X

Documentation Requirements

- The Hazard Analysis Selection matrix, a copy of the most recent Hazard Review, and operating procedures/attachments must be available in a prominent location in the laboratory while the work is going on.
- A dated copy of all safety documentation packages, including hazard reviews, Hazard Analysis Selection Matrices, and operating procedures, shall be sent to the Safety and Environmental Branch, Code 205.2.

Attachment 12 continued

Hazard Analysis Selection Matrix

For new, modified or relocated processes, equipment or experiments, or scale-up of previous work, characterize your process according to the criteria below. Then use the most detailed analysis method called for by any single criterion.

	No Review Required	LHR*	MHR*	HHR*
1. Material Hazard – Acute Toxicity				
HMIS Health Rating: circle the Hazardous Material Identification System rating, found in the Material Safety Data Sheet (MSDS)	0	1-2	3	4
Cylinder DOT Label: if a cylinder, circle Yes if the DOT label on the cylinder indicates Poison Gas, Corrosive Gas, or Flammable Gas			Yes	
2. Material Hazard – Chronic Toxicity. Circle Yes if the MSDS indicates the material exhibits Chronic Toxicity.			Yes	
3. Material Hazard – Flammability. Choose applicable line and circle the MHIS rating from the MSDS				
<1 Liter & MHIS Flammability Rating	0-1	2-4		
>1 Liter & MHIS Flammability Rating	0	1-2	3-4	
≥ Liter and under Pressure or above Flash Point & MHIS Flammability Rating	0		1	2-4
4. Material Hazard – Reactivity. Circle one.				
HMIS Reactivity Rating from MSDS	0-1	2	3-4	
5. Processing Hazard – Radiation. Circle all that apply.				
Laser		Class I-IIIA	Class IIIB – IV	
X-Ray Source		<20kv	>20kv	
Radioisotopes in use	None		Yes	
UV, Infra-red, Microwave, Radio wave		<TLV	>TLV	
6. Processing Hazard – Pressure. Circle any one that applies.				
Non-glass	= 0 psig	<0 psig or >0 psig & <90 psig	>90 psig	
Glassware			<0 or >0 psig	
7. Processing Hazard – Chemical Reaction Energy				
Will adiabatic reaction lead to temperature change? Circle the one that applies. (Check MSDS).	<60° F		>60° F	
Will this cause solvent to boil? Circle yes, if applicable.			Yes	
8. Processing Hazard – New Technology				
New chemistry or technology. Circle correct answer, if applicable.	None		Outside of Experience	Unknown Reactions
9. Equipment Hazard – Electrical. Circle one if applicable.	Protected <120V	Exposed or >120V		
10. Equipment Hazard – Mechanical. Circle yes or no.				
Exposed pinch points, belts, chains, rotating parts, knives, suspended loads, stored energy, etc.	No	Yes		
11. Equipment Hazard – Thermal. Circle one if applicable.				
Unprotected heated or chilled surfaces	> -20° F & < 140° F	< -20° F & >140° F		
12. Environmental Hazards.				
Noise. Circle one. Call x6-6669 if you need assistance.	<80 dBA	>80 dBA		
Hood/Ventilation Testing. Circle one if applicable.		Exemption	Permit	

Contact the Safety and Environmental Branch for assistance if ratings are not available, or if any other assistance is needed in completing the matrix for the forms.

*ACRONYMS

Attachment 12 continued

DBA	decibels, A-scale
DOT	Department of Transportation
HHR	High Hazard Review
HMIS	Hazardous Material Identification System

Branch Head Date

LHR	Low Hazard Review
MHR	Moderate Hazard Review
OT	Odor Threshold
TLV	Threshold Limit Value

Laboratory Manager Date

Attachment 12 continued

Section 2

Process Area: Manufacturing Engineering Group

Location: Building 5, Room E004, E056, E056A

Date of Survey: October 28, November 10, 2003

Attachment: (H-2.1) PPE Checklist

Process Area Description:
The Manufacturing Engineering Group is comprised of the Planning Office and the Shipping and Receiving Area. Approximately six civil servants and four contract employees are engaged in planning and administrative functions in the E004 Planning Office. This includes oversight of all hardware fabricated by the code or assigned to a vendor. The drawing dimensions and material are verified before fabrication or procurement. Parts ranging in size from those barely visible to stainless steel parts moveable only with mechanical devices are stored in the E056 Shipping and Receiving Area until moved to the Inspection Area. Two contract employees work mainly in the E056A Shipping/Receiving Office.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-2.1:

Table H-2.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	E004, E056A	Planning, administration and checking drawings, tracking, inventory	Repetitive motions	12 (6 GS, 6 contract)	25 hrs/wk	N/A
5	E056	Shipping/Receiving	Falling objects, Strikes by mechanical equipment	1 contractor	10-20 hrs/wk	N/A
5	E056	Ink stamping and other chemical use (gluing and cleaning)	Mineral spirits, alcohol, acetone, epoxies	1 contractor	5-10 hrs/wk	32

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.

0-50 = Review if process changes.
50-100 = Review process every 24-36 months.
100-200 = Collect air samples and review process every 12 months.
200-300 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

1. Planning and Administrating

a) Observations: Six civil servants and four contract employees in the E004 Planning Office were primarily engaged in planning and administrative activities. Two contract employees in the Shipping/Receiving Office inventoried and tracked parts. Personnel work 3-6 hours per day at computer workstations. No complaints were noted.

b) Recommendations: Provide, where feasible, articulated keyboard trays that accommodate the keyboard and mouse. Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Position the keyboard so that it is between 28-30 inches above the floor. To allow sufficient knee space if an adjustable keyboard tray is installed to the underside of the desk, the height from the floor to the adjustable keyboard tray should range from 23-28 inches. Use adjustable chairs that allow personnel to sit at comfortable height, angle, and distance from the screen. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Ensure a minimum viewing distance of 12 inches and support the monitor so that the top of the screen is at eye level with the screen tilted slightly downward. The entire viewing plane should be between 0 and 40 degrees below the horizontal viewing plane. When viewing screens with dark backgrounds, use lower lighting. Dark characters on a light screen are generally more readable. Ensure high contrast between the screen background and the screen characters. Minimize glare and choose screens that tilt and have contrast and brightness controls.

2. Shipping and Receiving

a) Observations: One contractor performs shipping and receiving operations utilizing an electric lift truck, forklift or crane. High levels of carbon monoxide are not expected with electric lift trucks and forklifts. It could not be determined whether the employee had received forklift training and crane inspection documentation was not available. It was stated that the employee wears a hard hat, safety glasses, steel-toed shoes, and gloves, available from the tool crib.

b) Recommendations: Ensure that employees operating forklifts have received proper training and that cranes are inspected regularly. Continue to maintain and wear PPE meeting ANSI requirements. See the PPE checklist included as Attachment H-2.1 of this report section, which identifies operations requiring the use of PPE and the type of PPE required.

c) Exposure Monitoring: Routine monitoring is not required based on the frequency and duration of the operation.

3. Ink Stamping, Bonding, Cleaning

Attachment 12 continued

a) Observations: One contract employee uses stamping ink, epoxies for bonding, and alcohol and acetone for cleaning parts on an intermittent basis. These chemicals contain chemicals considered hazardous, mainly as skin irritants. Inks normally contain mineral spirits and kerosene. Epoxy systems generally include epoxy resins, hardeners and catalysts containing epoxy resins, acrylated epoxies and polyamines. Gloves and safety glasses among other PPE were reportedly provided for use. A documented workplace hazard assessment of operations necessitating the use of personal protective equipment (PPE) had been performed. A book containing MSDS was available to employees.

b) Recommendations: Due to the nature of the chemicals used and the frequency and duration of use, air monitoring was not warranted. Continue to wear the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment. Chemical impervious gloves are recommended for protection against skin irritants. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except acetone. Chemical splash goggles are recommended where splash hazards are present. For the limited frequency and duration in which epoxies are handled, nitrile, neoprene or butyl rubber gloves should all afford protection before breakthrough occurs. Butyl rubber gloves are recommended when using hardeners. See the workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required. Maintain PPE that is in good condition and store it in a sanitary manner.

c) Exposure Monitoring: Routine monitoring is not required based on the frequency and duration of the operation.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected or probable carcinogens were identified as being used in this code.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-2.1. A copy is to be reviewed with workers who perform each work task and posted in the work area.

Medical Surveillance Recommendations:
Based on chemical and physical hazard assessments and regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Attachment 12 continued

Attachment H-2.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5 **Process Area:** Manufacturing Engineering Group **Date:** 11/10/03	**Supervisor:** Donneise Briscoe **Telephone:** 6-8364 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	**Clothing and Hand Protection**	**Respiratory Protection**
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f Powered APR respirator g Supplied-air respirator h SCBA** i Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	**Bldg**	**Room**	**Eye & Hearing Protection**	**Clothing & Hand Protection**	**Minimum Respiratory Protection**	**Comments**
Shipping and Receiving	5	E056	a, i	j	None	Safety glasses, hard hat, canvas gloves and steel-toed shoes required. Hard hat and canvas gloves recommended.
Ink Stamping, Bonding, Cleaning	5	E056	b or d, i	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone) Safety shoes required.

Attachment 12 continued

Section 3

Process Area: Precision Assembly Group

Location: Building 5, Rooms E035, E005, E335, E038, E010

Date of Survey: October 28, November 19, December 2, 4, 12, 2003

Attachment: (H-3.1) PPE Checklist

Process Area Description:
The Precision Assembly Group provides assembly and machining support to other groups and is responsible for fabricating, sanding, cleaning and assembling cut sheet metal components. Principal fabrication work takes place in the northwest half of Room E035, Room E005 and E335, while welding, soldering and heat-treating are performed in Room E038. Laser welding and cutting is performed in Room E010. Ninety percent of material fabricated is one-sixteenth inch aluminum, with the remainder being steel, titanium, and copper. In addition, ninety percent of all material is fabricated using a CNC punch press. Other equipment used includes a metal shears, band saw, grinder, sandblaster, roller, drill press, surface finisher, corner notcher, sheet metal press brakes, and smaller hand equipment such as the hand shears, hand brake and portable pneumatic equipment.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-3.1:

Table H-3.1

Building	Room/ Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency / Duration	Risk Assessment[1]
5	E035	Operating larger equipment (CNC punch press, press brake, etc.)	Noise, metal particles, oil mist	4 (2 GS)	2-3 hrs/day	N/A
5	E035	Operating hand and portable pneumatic equipment (hand shears,	Flying particles	4 (2 GS)	2-3 hrs/day	N/A

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.

0-50 = Review if process changes.
50-101 = Review process every 24-36 months.
100-201 = Collect air samples and review process every 12 months.
200-301 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

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		hand brake)				
5	E035	Parts cleaning	Propanol, ethyl alcohol, acetone	4 (2 GS)	Daily/1 hr	24
5	E035	Stamping with Ink	Ink solvents	4 (2 GS)	Monthly/1 hr	16
5	E035, E005	Compressed air blowing	Noise, flying particles	4 (2 GS)	Daily 5-10x/30 sec	N/A
5	E335	Operating equipment/storage	Flying particles	4 (2 GS)	Weekly/10 minutes	N/A
5	E005	Assembling components	Noise, flying partices	4 (2 GS)	8-10 hrs/wk	N/A
5	E005	Parts cleaning, Hand layout	Propanol, ethyl alcohol, acetone, other solvents	4 (2 GS)	Weekly/15 min	12
5	E038	Welding (tig)	Welding fumes, UV/visible rays, noise	1 GS	Daily/1 hr	24
5	E038	Brazing	Metal fumes, UV/visible rays	1 GS	Weekly/ 1 hr	16
5	E038	Soldering (Ag-Sn)	Silver fumes	1 GS	Weekly/1 hr	16
5	E038	Heat treating	Hot surfaces	1 GS	Monthly/2 hrs	N/A
5	E038	Parts cleaning	Propanol, acetone	1 GS	Monthly/15 min.	16
5	E038	Grinding, operating machines	Noise, Flying particles	1 GS	Weekly/1 hr	N/A
5	E010	Laser cutting/welding	IR radiation	1 GS	Monthly/4hrs	N/A

1. Operating CNC Punch Press/Larger Equipment

a) Observations:

1) Two civil servant employees and two contractors operate larger computer numerically controlled (CNC) equipment as follows in Table H-3.2:

Table H-3.2

Equipment	Serial Number	Guarding	Comments
Punch Press – Trumpf Trumatic 240	9070	Distance to point of operation	To be excessed

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Press Brake – Darley EHP10	121269	Concurrent safety tripping device	Requiring two hands and a foot to operate and normally two persons
Press Brake – Diacro JB1038	N/A	None	Foot-operated device with hands holding the part at a safe distance
Press Brake - Furnas 14-48-2	6820678377	None	Foot-operated device with hands holding the part at a safe distance
Ann Yang DY-880X1000CN	HR-3-201C	None	–
Surface Finisher - AEM 40237	MO6591	Tripping device	Emergency stop bar
Corner Notcher (Tennsmith)	N/A	Point of operation	Barrier guard
Punch Press - Strippit Super AG	2305082991	None	Foot-operated device with hands holding the part at a safe distance
Sandblaster - Trinco 48x48	25365-3	Enclosure	No points needing guarding
Sandblaster - Silverado	ECN 352962	Enclosure	No points needing guarding
Metal shear (Wysong 1072)	P119-143	Point of operation	Barrier guard
Belt sander - Leeson 120477	N/A	Nip point	Spindle guard
Band saw DoAll Contour DBW-15M	290-8211916	Point of operation	Barrier guard
Baldor grinder 1215W	F685	Spindle guard, Work rest and tongue guard	Not properly anchored to the floor
Roller (Wysong D-48)	PR22-121	None	No nip point guarding
Roller (Tennsmith SR48P)	16872	Tripping device	emergency stop cords at the machine perimeter that would not guard the nip point
Roller Montgomery 4R4812	041285	Tripping device	emergency stop cords at the machine perimeter that would not guard the nip point
Manual milling machine Deckel FP4M	17396	None	Requires the use of at least one hand
Manual milling machine DoAll	N/A	None	Requires the use of at least one hand
Press Societe Sip Genovoise Hydroptic 7	N/A	Distance	Distance to point of operation

Personnel stated that some machines could not be guarded without impeding operations. Jon Ohman, Safety Office, accompanied the Industrial Hygienist (IH) upon referral to review machine guarding. It was determined that the foot-operated punch presses, press brakes and the punch press without point of operation guarding and rollers without nip point guarding were in compliance with OSHA requirements. This determination was based on OSHA-issued interpretations of *the Machine Guarding Standard,* 29 CFR 1910.212, which indicate that acceptable controls include a combination of foot-operated

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or CNC controls and/or distance from the point of operation, adequately trained personnel, and work practices. Personnel normally operate various machines 2-3 hours per day for durations up to 2-3 hours. The Trumatic 240 is operated on a weekly basis.

2) A sound level survey conducted as a part of this Baseline Survey indicated that instantaneous sound levels during the operation of equipment exceeded 85 dBA, the level at which hearing protection must be worn. Noise dosimetry conducted in Precision Assembly and the adjacent Machine Shop as well as past results, however, indicated employee exposure to noise as an 8-hour time-weighted average (TWA) was less than NASA's 80 dBA Action Level for full-shift exposures. The results of the current sound level survey and noise dosimetry are presented below in Tables H-3.3 and H-3.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection, nitrile gloves, canvas gloves, and comfort dust masks were provided. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were sometimes observed not wearing hearing protection during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented, although signs indicating the requirement to wear steel-toed shoes and safety glasses were posted.

4) Area air monitoring for oil mist in the adjacent Machine Shop indicated that exposure to airborne oil mist was expected to be well below applicable occupational health limits. The frequency and duration of oil-mist producing operations in Precision Assembly is less than those in the Machine Shop. Exposure to airborne metal particulates is expected to be well below applicable limits based on the nature of the operation.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1) requiring hearing protection when employee noise exposure exceeds 85 dBA, regardless of duration, personnel must wear hearing protection during the operation of the punch presses, surface finisher, and other equipment producing sound levels in excess of 85 dBA. Ensure these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry results of similar operations in the adjacent Machine Shop and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

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2) Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-3.1 and ensure employee training regarding PPE is documented.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

2. Operating Hand Equipment/Portable Pneumatic Equipment

a) Observations:

1) Two civil servant employees and two contractors operate hand equipment such as a hand shears, hand brake or an air grinder or air dynafile 2-3 hours per day for a similar duration. Some pneumatic hand equipment including the air grinder generates sound levels exceeding 85 dBA as shown in Table H-3.2 and as indicated by past sound level measurements. Limited noise dosimetry in this area and the adjacent Machine Shop conducted in the past and as part of this survey, Table H-3.3, indicated that employee exposure to noise as an 8-hour time-weighted average (TWA) was less than NASA's 80 dBA Action Level for full-shift exposures. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that are required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years. Hearing protection was available, but it was observed that it was not always worn when operating hand equipment generating high sound levels.

2) Personnel use a portable pneumatic grinder or dyna-file to debur or clean out edges of parts on a daily basis for approximately 30 minutes. Ninety-five percent of the parts are aluminum, but beryllium and other metal parts are also involved. To protect both employee health and the quality of the parts finished, personnel requested a grinding booth at the time of the survey. Past monitoring results revealed that airborne concentrations of aluminum and beryllium were less than the limit of quantitation. The results of air monitoring are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). Personnel were observed wearing safety glasses at all times during the operation of hand and portable pneumatic equipment.

3) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection, nitrile gloves, canvas gloves, and comfort dust masks were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented, although signs indicating required steel-toed shoes and safety glasses were posted.

4) Compressed air hoses that were equipped with nozzles with pressure relief to maintain a maximum pressure of 30 p.s.i. were observed throughout the area. Some nozzles,

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however, did not appear to have pressure relief and were not marked as to their maximum pressure. Safety glasses were worn at all times.

b) Recommendations:

1) Personnel are required to wear hearing protection when operating hand equipment such as air grinders that produce sound levels in excess of 85 dBA, regardless of duration, in accordance with the NASA Hearing Conservation Policy (NPG 1820.1). Ensure that this equipment is labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on full-shift noise dosimetry results of similar operations in the adjacent Machine Shop and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) The installation of a grinding booth is recommended to minimize personnel exposure to aluminum and beryllium particles. Although airborne exposure to aluminum and beryllium is not expected to approach applicable occupational exposure limits, the installation of a grinding booth is recommended as a feasible control measure to further minimize employee exposure to metal particulates as well as to safeguard hardware and promote housekeeping.

3) Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-3.1 and ensure employee training regarding PPE is documented.

4) Ensure that compressed air used for cleaning purposes is reduced to less than 30 p.s.i and that safety glasses continue to be worn.

c) Exposure Monitoring: No further noise monitoring is warranted unless changes in processes or operations increase the exposure of noise to personnel.

3. Parts Cleaning

a) Observations:

1) Two civil servant employees and two contractors reportedly clean parts on a daily basis up to one hour by applying ethyl alcohol, propanol or acetone to a Techwipe tissue and wiping. Nitrile gloves were available for use. Exposure to airborne concentrations of these chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. An eyewash meeting the ANSI Standard Z358.1- 1998 requirements for a primary eyewash with procedures for inspection, testing, and documentation was observed. Personnel did not recall receiving training on the hazards of the chemicals they work with, but MSDS were accessible and containers and storage cabinets were properly labeled.

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2) A Royson vibratory finisher utilizing ethyl alcohol and diethanolamine was observed whereby parts are placed inside the tank and the lid is closed. Exposure to airborne concentrations of chemicals is expected to be minimal since it is enclosed. Proper PPE in the form of nitrile gloves was available.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-3.1. Chemical impervious gloves are recommended when cleaning parts. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Chemical splash goggles are recommended where splash hazards are present.

2) Ensure that personnel are aware of the written hazard communication program which describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure that all employees receive hazard communication training on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

4. Stamping with Ink

a) Observations: Two civil servant employees and two contractors reportedly stamp parts with ink on a monthly basis up to one hour. Nitrile gloves were available for use. Exposure to airborne concentrations of chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. An eyewash meeting the ANSI Standard Z358.1- 1998 requirements for a primary eyewash with procedures for inspection, testing, and documentation was observed. Personnel did not recall receiving training on the hazards of the chemicals they work with, but MSDS were accessible and containers and storage cabinets were properly labeled.

b) Recommendations: Continue to provide the types of PPE that will protect the affected employees from ink solvents as identified in the hazard assessment shown in Attachment H-3.1. Chemical impervious gloves are recommended if inks are used in significant quantities. Ensure that personnel are aware of the written hazard communication program and the MSDS Pro database. Ensure that all employees receive training upon

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initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) *Exposure Monitoring:* Monitoring is not required based on the nature, frequency and duration of the operation.

5. Compressed Air Blowing

a) *Observations:* The majority, but not all, compressed air hoses were equipped with nozzles with pressure relief holes to maintain a maximum pressure of 30 p.s.i.. Compressed air is used an estimated 15 minutes per day for blowing off parts. Proper PPE including safety glasses was worn at all times.

b) *Recommendations:* Ensure that compressed air used for cleaning purposes is reduced to less than 30 p.s.i. and that safety glasses continue to be worn.

6. Operating Equipment/Storage

a) *Observations:* Two civil servant employees and two contractors may operate some small machinery on the 3rd floor mezzanine, but the area is primarily used for storage at this time. An eyewash adaptor for the sink was observed.

b) *Recommendations:* Notify the IHO should the area again be used for routine operations. Personnel are required to wear hearing protection when operating equipment that produces sound levels in excess of 85 dBA, regardless of duration, in accordance with the NASA Hearing Conservation Policy (NPG 1820.1).

c) *Exposure Monitoring:* No further noise monitoring is warranted unless changes in processes or operations increase the exposure of noise to personnel.

7. Assembling Components

a) *Observations:* Two civil servant employees and two contractors assemble larger components in the Rm. E005 Assembly Area. In doing this, personnel operate hand drills, use wedge locks for temporary set-up, and use compressed air to blow off parts. Personnel spend an estimated 40 hours/month in assembling components. Some equipment, including the compressed air and the air grinder, generates sound levels exceeding 85 dBA, as shown in Table H-3.2 and as indicated by past sound level measurements. Hearing protection was available, but not worn during this operation.

b) *Recommendations:* Personnel are required to wear hearing protection when using compressed air or operating equipment that produces sound levels in excess of 85 dBA, regardless of duration. Ensure that this equipment is labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*.

Attachment 12 continued

c) Exposure Monitoring: No further monitoring was warranted due to the nature of the operation.

8. Parts Cleaning/Hand Layout

a) Observations: Two civil servant employees and two contractors reportedly clean parts on a daily basis for 15 minutes by applying ethyl alcohol, propanol or acetone to a Techwipe tissue before wiping. Personnel also use layout paint for hand layouts Exposure to airborne concentrations of these chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. Personnel did not recall receiving training on the hazards of the chemicals they work with, but MSDS were accessible and containers and storage cabinets were properly labeled. Nitrile gloves were available for use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-3.1. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Chemical splash goggles are recommended where splash hazards are present.

2) Ensure all personnel have received Hazard Communication training. Ensure that personnel are aware of the written hazard communication program which describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

9. Welding

a) Observations: The E038 Welding Area is occupied by one civil servant employee. TIG welding on aluminum and steel using one of the two Miller Syncrowave 300 welders is conducted approximately one hour per day. In addition, the room contains an Airco 300 welder and a welding chamber for welding titanium. This welding chamber is purged with argon gas, but presents no health hazard other than that previously mentioned. Exposure to airborne concentrations of welding fumes is expected to be well below permissible levels. The five local exhaust ventilation hoods were evaluated by the IHO on 06/04/03 and their measured capture velocities as shown in Table F-2 were

Attachment 12 continued

adequate. PPE used for this operation consists of a welding face shield (shade #9-11) and leather gloves. Hearing protection is also reportedly worn when changing the frequency of the welder to greater than 120 Hz. An apron was not observed to be present. Helium, argon, acetylene, and oxygen cylinders were properly secured although some cylinders were not capped and a small argon cylinder was too short for the chains securing it. Cranes were reportedly inspected every six months and recorded in a log book.

b) Recommendations: Exposures should be minimal as long as operators adhere to proper work practices. A welding apron should be provided for all welding operations. Select and provide the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment as shown in Attachment H-3.1. Attempt to better secure smaller cylinders.

c) Exposure Monitoring: Monitoring is not required based on the frequency and duration of the operation

10. Brazing

a) Observations: Brazing stainless steel, brass and copper is conducted approximately one hour per week. Acetylene and oxygen cylinders were properly secured when stored. Brazing is conducted at 1100 °F with a face shield and shade #4 and gloves as PPE.

b) Recommendations: Exposure to metal fumes is expected to be minimal during brazing. Inform the IHO regarding changes in procedures and processes that would increase employee exposure. Continue to wear proper PPE as shown in Attachment H-3.1.

c) Exposure Monitoring: Air monitoring for metal fumes is not warranted based on the frequency and duration of the operation.

11. Soldering

a) Observations: Soldering with silver- and tin-containing solder on stainless steel, brass and copper is performed one hour per week. Exposure to silver fumes and solder flux gases is expected to be minimal.

b) Recommendations: Due to the nature of soldering and the limited frequency and duration in which it is conducted, air monitoring for metal fumes and solder flux gases was not warranted. Inform the IHO regarding changes in procedures and processes that would increase employee exposure.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

12. Heat Treating

Attachment 12 continued

a) Observations: Heat treating parts of any type of metal may be conducted in any of five ovens at approximately 1500 °F prior to assembly. This operation is performed to harden or soften the part according to specification. One of these ovens uses argon gas. Personnel stated welding gloves and a face shield are used as PPE against the radiant heat and hot surfaces. The operation is performed approximately monthly for two hours.

b) Recommendations: Continue to wear the proper PPE as shown in Attachment H-3.1.

13. Parts Cleaning

a) Observations: One civil servant employee in the welding area reportedly cleans parts on a monthly basis for approximately 15 minutes. This is performed using propanol and acetone applied to Techwipe tissues before wiping. N-Dex nitrile exam gloves, Fisher polyethylene gloves, and Ansell rubber gloves were all available for use. Exposure to airborne concentrations of these chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. Personnel did not recall receiving training on the hazards of the chemicals they work with, but MSDS were accessible and containers and storage cabinets were properly labeled.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-3.1. Chemical impervious gloves are recommended when cleaning parts. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Chemical splash goggles are recommended where splash hazards are present.

2) Ensure personnel have received hazard communication training. Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

14. Grinding

Attachment 12 continued

a) Observations: Grinding on metal parts to smooth rough edges is conducted approximately weekly for 1 hour. The Welding Area contains bench grinding wheels and hand-held grinders for smoothing rough edges of metal parts as well as buffers, drills and other hand tools. Grinding is conducted approximately weekly for one hour. One bench grinder did not appear as though it was anchored to the floor but was properly guarded in other respects. Grinding is expected to produce sound levels above 85 dBA, but full-shift exposure is expected to be below the Action Level of 80-dBA as an 8-hour TWA. The employee stated that proper PPE to include hearing protection and safety glasses was worn. In addition, the employee stated that he might wear a disposable respirator during grinding. This 3M 8710 disposable respirator was observed to be stored in the general shop area in the open and the employee currently has a beard, which would interfere with the face to face-piece seal.

b) Recommendations: Because of the limited frequency and duration with which equipment that generates sound levels in excess of 80-dBA is operated, participation in GSFC's Hearing Conservation Program was not warranted. Continue to wear hearing protection as required, though, during operations such as grinding in which the employee is exposed to sound levels in excess of 85 dBA, regardless of duration. Personnel may voluntarily wear disposable respirators without being in the Respiratory Protection Program, but respirators must be properly stored in a sanitary location and otherwise used according to manufacturer's recommendations. Generally, it is not recommended to wear a respirator with a beard since the beard compromises the face to face-piece seal. Employees should be informed of the hazard assessment as shown in Attachment H-3.1.

c) Exposure Monitoring: No further air or noise monitoring was warranted due to the nature, frequency and duration of the aforementioned hazards.

15. Laser Cutting/Welding

a) Observations: A Lasag Nd-Yg (Yag) laser was located in Room E010 for microscopic welding and cutting on stainless steel parts. One civil servant, Mr. Mark Mann, stated that he operates the Yag laser monthly for four hours and would wear laser safety glasses with an optical density of 6.5. This Class IV laser is operated at a wavelength of 1060 nm, requiring eye protection against infrared radiation and a warning sign that was posted on the machine. The door to this room is interlocked so that the laser shuts off if the door is opened. At the time of the survey however, the door was kept unlocked to allow project personnel to enter. Personnel stated that the key was not at the machine so that it could not be operated anyway, and if the laser were to be operated, the door would be locked. The Radiation Office reviewed this operation within the last year and was consulted about its current condition.

b) Recommendations: The Lasag Yag laser should continue to be screened at least annually to ensure that it is in keeping with laser safety requirements (The Radiation Protection Office maintains this schedule). All operators of Class IV lasers must have received laser safety training, have current certification cards, and continue to wear PPE in the form of laser safety glasses with the correct optical density as shown in Attachment H-3.1.

Attachment 12 continued

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected carcinogens and by the IARC as carcinogens, probable carcinogens or possible carcinogens (with the exception of mixed mineral oil) were identified as being used in this code. Untreated and mildly treated mineral oil is listed by the IARC as a carcinogen. Ethyl alcohol is among chemical substances contained in a Department of Navy Occupational Chemical Reproductive and Developmental Hazard List as substances known to cause reproductive or developmental toxicity in humans, or known to cause reproductive or developmental toxicity in animals by mechanisms of action directly applicable to humans.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-3.1. This checklist is to be reviewed with personnel and posted in the work area. Documentation that personnel received this information must be kept on file.

Medical Surveillance Recommendations:
Based on anticipated exposures and corresponding regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Sound Level Survey:
A sound level survey performed during the operation of equipment in Building 5, Room E035 showed sound levels to be at or greater than 85 decibels as measured on an A-weighted scale (dBA) at the operator's hearing zone. The NASA Hearing Conservation Policy (NPG 1820.1) requires that personnel wear hearing protection when exposure to noise is above 85 dBA, regardless of duration, or when personal exposure to noise is equal or greater than 80 dBA as an 8-hour Time-Weighted-Average (TWA) for more than 30 days per year. Sound level measurements are summarized in Table H-3.3 below.

Table H-3.3
Summary of Sound Pressure Level Results in the Machine Shop Room E035

Equipment Type/Area	Sound Levels (dBA)*	Hazard Radius (ft)	Comments
AEM Surface Finisher/E035	89-97	25	Weekly, 1 hour
Trumatic 240 Punch Press/E035	91-94	25	Weekly, 2-3 hrs
Compressed air hose/E005	90-96	25	Daily, 15 min
Sander	97	25	10 min./day
Pneumatic Dynafile/E035	86-88	10	
Pneumatic Grinder/E035	89-90	15	
Pneumatic Drill	83-85	5	
Lathe	61	--	10 min/day
Band Saw	90	12	10 min./day
CNC Haas Milling Machine	74	--	4hrs/day
Bridgeport Milling Machine	75	--	4 hrs/day

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* at the operator's hearing zone
ER – entire room

Table H-3.4
Noise Dosimetry Results

Employee/ Dosimeter/ Date	Location/ Operation	Average (dBA)*	8-Hour Time-weighted average (TWA)	Dose (%)	Time Period (minutes)
Francis Rondeau/ QAB060055/ 4 Dec 03	Bldg 5, Rm E035/ Precision Assembly – operating machine and bench work	72.2	72.2	8.48	480

Attachment 12 continued

Attachment H-3.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5 **Process Area:** Precision Assembly Group **Date:** 11/19/03	**Supervisor:** Chris Bunyea **Telephone:** 6-3956 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f Powered APR respirator g Supplied-air respirator h. SCBA** i. Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Operating CNC punch press, larger machines	5	E035	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required.
Operating hand equipment, portable pneumatic equipment	5	E035	a, i, g	j	None	Safety glasses, hearing protection, canvas gloves, and steel-toed shoes required.
Parts cleaning, Stamping with ink	5	E035, E005	b or d, i	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone) Safety glasses and steel-toed shoes

Attachment 12 continued

						required.
Using compressed air	5	E035, E005, E038, E335	a, i, g	None	None	Safety glasses, hearing protection, steel-toed shoes required
Operating equipment	5	E335	a, i, g	None	None	Safety glasses, hearing protection and steel-toed shoes required by shop
Assembling components	5	E005	a, i	None	None	Safety glasses and steel-toed shoes required by shop
Parts cleaning and hand layout	5	E035, E005	b or d, i	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone). Safety glasses and steel-toed shoes required by shop.
Welding (tig)	5	E038	a, f, i	j, apron	None	Welding shield with shade #9-#11, leather gloves, apron, safety glasses, steel-toed shoes required
Brazing	5	E038	a, f or g, i	j,apron	None	Welding shield with shade #4, leather gloves, apron, safety glasses, steel-toed shoes required
Soldering, Heat-treating	5	E038	a, i	None	None	Safety glasses and steel-toed shoes required by shop
Parts cleaning	5	E038	b or d	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone) Safety glasses and steel-toed shoes required by shop.
Grinding	5	E038	a, i	None	None	Safety glasses and steel-toed shoes required by shop
Operating class IV laser	5	E010	a, i	None	None	Laser safety glasses with O.D. 6.5. Safety glasses and steel-toed shoes required by shop

Attachment 12 continued

Section 4

Process Area: **Machining Technology Group**

Location: Building 5, Rooms E035, E019, E026, E026A, E092, E235, E020; Building 21, Room 081; Building 10, Room 004

Date of Survey: October 28, December 2, 4, 10, 12, and 15, 2003

Attachment: (H-4.1) PPE Checklist

Process Area Description:
The Machining Technology Group consists of the Building 5 Machine Shop (comprised of the northeast half of Room E035 and Room E019), the E235 Mezzanine, E026 to be renovated, the E092 and E026A Offices, and the E020 EDM Room. The Machining Technology Group also includes machine shops in Building 21, Room 081 and Building 10, Room 004. This Group uses computer-aided manufacturing systems and provides automated manufacturing capability. In addition, it advises on the practical design application of current and advanced CAM technology. The Building 5 Machine Shop contains primarily CNC milling machines, with aluminum being the predominant material fabricated along with steel, titanium, and copper. The Machine Shop and Mezzanine also contain other equipment such as lathes, band saws, grinders, sander, and smaller hand equipment while the EDM Room contains wire EDM (electrical discharge machining) machines. Two civil servants and eleven contractors carry out operations in Building 5. One civil servant is employed in the Building 21, Room 081 machine shop and one civil servant occupies Building 10, Room 004. This Group was formerly under Codes 751 and 752.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-4.1:

Table H-4.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	E035, E019,	Operating	Flying metal	13 (2 GS)	Daily/6 hrs	80

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.
- 0-50 = Review if process changes.
- 50-102 = Review process every 24-36 months.
- 100-202 = Collect air samples and review process every 12 months.
- 200-302 = Collect air samples and review process every 6 months.
- 300 + = Collect air samples and review process every 3 months.

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	E235 Machine Shop	milling machines and lathes	particles, noise, oil mist			
5	E019, E235, E026	Sawing, grinding, sanding	Flying metal particles, noise	13 (2 GS)	Daily/30 minutes	N/A
5	E035, E235	Operating portable equipment	Flying metal particles, noise	13 (2 GS)	Daily/30 minutes	N/A
5	E035, E019, E235	Parts cleaning and chemical use	Ethanol, acetone, ethylene glycol, other solvents and oils	13 (2 GS)	Weekly/15 min.	8
5	E235	Using compressed air	Flying metal partices	13 (2 GS)	Weekly/5 min.	N/A
5	E020	Operating EDM machines	None observed	5 (2 GS)	Daily	N/A
21	081	Operating milling machines, lathes	Flying metal particles, noise, oil mist	1 GS	Daily/6 hrs	80
21	081	Sawing, grinding, sanding	Flying metal particles, noise	1GS	Daily/30 minutes	N/A
21	081	Parts cleaning and chemical use	Ethanol, acetone, ethylene glycol, other solvents and oils	1 GS	2xWeekly/20 min.	16
10	004	Operating milling machines, lathes	Flying metal particles, noise, oil mist	1 GS	Daily/6 hrs	80
10	004	Sawing, grinding, sanding	Flying metal particles, noise	1GS	Daily/30 minutes	N/A
5	E092, E026A	Administrative activities	Repetitive motion, improper angles	13 (2 GS)	Daily/1-8 hrs	N/A

1. Operating CNC Milling Machines and Lathes

a) Observations:

1) Two civil servant employees and eleven contractors operate computer numerically controlled (CNC) equipment in the main Machine Shop and the 2nd floor Mezzanine. Some personnel in the Machine Shop operate one or various machines on a daily basis for up to 6 hours. Machines observed in the Machine Shop E035/E019 include the

Attachment 12 continued

following in Table H-4.2. The Bridgeport milling machine was reportedly operated by contractors 100 days /yr. 7 hrs/day. Machines appeared to be properly guarded.

Table H-4.2

Equipment	Serial Number	Comments
Vertical Milling Machine – Burgmaster VTC-150	214036	Guarded to the extent possible without interfering with work piece
Jig Milling Machine – DeVlieg 2203 3B-48	N/A	Guarded to the extent possible without interfering with work piece
Milling Machine – Chevalier FM-33H CV1	HC-88B302	Guarded to the extent possible without interfering with work piece
Milling Machine – Chevalier FM-33H CV2	HC-88B801	Guarded to the extent possible without interfering with work piece
Milling Machine – Chevalier FM-33H CV3	HC-87B801	Guarded to the extent possible without interfering with work piece
Milling Machine – Chevalier FM-33H CV4	HC-878301	Guarded to the extent possible without interfering with work piece May not be in use
Milling Machine - Deckel FP4NC: DL1	2810-3262	Guarded to the extent possible without interfering with work piece
Milling Machine - Deckel FP4NC: DL2	2810-3198	Guarded to the extent possible without interfering with work piece
Milling Machine - Hovdaille	N/A	Guarded to the extent possible without interfering with work piece
Lathe HH Robert RB1	HR-3-201C	Minimal guarding
Lathe Clausing Colchester 22V1	505338	Minimal guarding
Milling Machine - Deckel	4383	Guarded to the extent possible without interfering with work piece
Milling Machine - Bridgeport	146415	Guarded to the extent possible without interfering with work piece
Milling Machine - SuperMax	409588	Guarded to the extent possible without interfering with work piece
Milling Machine – Haas VF-3	24554	Enclosed – large machine
Milling Machine – Haas VF-3	24632	Enclosed – large machine
Milling Machine -Cincinnati Milacron	182014	Distance to point of operation, acceptable guarding
Milling Machine Devlieg	10165	Distance to point of operation, acceptable guarding
Contour Machine - DoAll	457-88758	Guarded to the extent reasonable – Barrier guard
Milling Machine/Cutter - Fadal: 88HS, FL1	9901278	Guarded to the extent reasonable
Milling Machine/Cutter - Fadal: VMC15XT, FL2	9701147	Guarded to the extent reasonable
Milling Machine - Cincinnati Milacron 10V-1250 5520B01-77-7	N/A	Large – distance to point of operation – guarded to extent reasonable
Lathe - Wasino LJ-10	ECN 1183616	Enclosed
Sander - Delta C19391	N/A	Spindle guard

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2) In the E235 Mezzanine, three lathes were operated daily for 1-8 hours and three other lathes were not used. Lathes included Monarch (sn# 352465, unknown, sn# 44409) and Hardinge (ECN 1755743 and two HLVHs). Five milling machines were also present, of which the Bridgeport was usually used, and operated on a daily basis for one-half hour. The other milling machines included a Clausing CSG 2A618 and Deckels ECN 215159, 279911, 279909 and 585278. Machines appeared to be properly guarded.

3) Noise.

a) A sound level survey conducted as a part of this Baseline Survey indicated that instantaneous sound levels during the operation of equipment exceeded 85 dBA, the level at which hearing protection must be worn.

b) Personal noise dosimetry conducted in 1984 indicated that one civil servant operating a DeVlieg milling machine was exposed to a noise level of 84.1 dBA as an average for the 349-minute duration. This level exceeded NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). One person currently could have a similar exposure. Other limited noise dosimetry conducted in the past revealed average noise levels below 80 dBA.

c) Although one noise dosimetry result as part of this survey showed that the employee was exposed to noise at an average level of 80.2 dBA for 202 minutes during the operation of a Deckel milling machine, employee exposure to noise was likely to be less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA) because as in this instance, the employee operates a Deckel for approximately five hours and spends the three hours prior to this setting up and performing miscellaneous activities. Hearing protection was not worn and the employee does not receive annual audiometric testing although he is listed as being included in the Hearing Conservation Program. The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4.

d) The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

4) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection, nitrile gloves, canvas gloves and comfort dust masks were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were observed not always wearing hearing protection during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not available, although signs indicating that steel-toed shoes and safety glasses are required were posted.

5) Oil Mist

Attachment 12 continued

a) Past area air monitoring results in the 2nd floor mezzanine Rm E235 revealed oil mist concentrations of 10.5 mg/m^3, 7.66 mg/m^3 and 22.9 mg/m^3 during the operation of milling machines (reportedly Chevalier) and lathes using Blaser Swisslube Blasocut 2000 CF, containing 40-70% severely hydrotreated mineral oil. The resulting concentrations were in excess of acceptable limits. Based on these results, local exhaust ventilation, administrative controls and/or respirators were recommended in a report dated 24 October 2002. A copy of past monitoring results is kept with this Baseline Survey in the IHO.

b) The American Conference of Governmental Hygienists (ACGIH) threshold limit value (TLV) for mineral oils is 5 mg/m^3 for an 8-hour TWA, and 10 mg/m^3 for a 15-minute short-term exposure limit (STEL). The ACGIH TLV for insoluble particulates not otherwise specified is 10 mg/m^3. Currently two OSHA air contaminant permissible exposure limits apply to metal working fluids. They are 5 mg/m^3 for an 8 hour time weighted average (TWA) for mineral oil mist, and 15 mg/m^3 (8-hour TWA) for Particulates Not Otherwise Classified (PNOC) [applicable to all other metalworking fluids], 29 CFR 1910.1000. In 1998, the National Institute for Occupational Safety and Health (NIOSH) published a criteria document which recommended an exposure limit (REL) for metal working fluid aerosols of 0.5 mg/m^3 for total particulate mass as a time-weighted average (TWA) concentration for up to 10 hours per day during a 40-hour work week. The NIOSH REL is intended to prevent or greatly reduce respiratory disorders causally associated with metal working fluid exposure. It is NIOSH's belief, that in most metal removal operations, it is technologically feasible to limit metal working fluid aerosol exposures to 0.4 mg/m^3 or less.

c) During this survey, it was observed that the Chevalier milling machines had been relocated to the main shop area Room E019. Air flow is better in Room E019 and it is less likely that the oil mist would be confined to a certain area. No other controls had been implemented. However, the metal working fluid currently used for the Chevalier milling machines was ITW Accu-lube LB 5000, which contains 0.0% mineral oil according to the technical data sheet. The MSDS for this product lists the 10 mg/m^3 ACGIH limit for organic/natural oils as the applicable exposure limit. The metal working fluid for the Deckel milling machines was stated to be Blasocut BC35NF, which contains 50-70% severely hydrotreated mineral oil.

d) As part of this survey, two area air samples in the vicinity of the Chevalier milling machines and one personal air sample for Mr. Richard Freburger operating a Deckel milling machine positioned behind the Chevalier milling machines were collected. The results are presented in Table H-4.5. The results indicate that Mr. Freburger's exposure to metal working fluids as mineral oil mist was less than the most stringent standard, the NIOSH REL of 0.5 mg/m^3. Results of the area samples around the Chevalier milling machines which had generated the most mist in the past and now utilize an oil referenced as "organic/natural" resulted in levels below OSHA and ACGIH limits, but greater than the NIOSH REL of 0.5 mg/m^3. This limit does not

Attachment 12 continued

appear to distinguish between mineral oil and "organic/natural oil" but applies to a personal rather than an area sample.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of machines and other equipment producing sound levels in excess of 85 dBA, regardless of duration, as listed in Table H-4.2. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry results and the limited duration (usually 5-6 hours) in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. However, based on past results and averages over 5-6 hours, persons are advised to remain enrolled in the Hearing Conservation Program until follow-up monitoring shows conclusively that personnel are not exposed to noise greater than 80 dBA as an 8-hour TWA for 30 or more days per year. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

3) Since personnel operating or in the vicinity of the Chevalier milling machines may be exposed to airborne concentrations of metal working fluids in excess of the NIOSH REL of 0.5 mg/m^3, it is recommended to institute engineering or administrative controls as explained in OSHA's *Metalworking Fluids: Safety and Health Best Practices Manual,* http://www.osha.gov/SLTC/metalworkingfluids/metalworkingfluids_manual.html. Controls include: (1) proper design and operation of the metal working fluid delivery system/decreased flow; (2) isolation/splash guards; (3) effective local exhaust ventilation; (4) effective general or dilution ventilation; (5) good work practices on the part of the machinists, including the proper use of controls; and (6) proper maintenance of equipment;

c) Exposure Monitoring: Follow-up air and noise monitoring is warranted to ensure that full-shift noise exposure is less than the permissible limit and to determine the effectiveness of engineering and administrative controls in the case of metal working fluids.

2. Sawing, Grinding, and Sanding

a) Observations:

1) Rough cutting operations such as sawing, grinding and sanding are conducted by two civil servants and up to eleven contractors. Room E019 contains a vertical band saw (DoAll Contour) and a belt sander (Delta) used daily for 15-30 minutes. The Mezzanine E235 contains three bench grinders that were either not properly guarded or not properly

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anchored. The Rockwell-Delta 438-02-314-0087, sn# xc56C34124AW and Baldor sn# F186 were not anchored and had neither tongue guards nor spindle guards. The Rockwell 438-02—014-0021, sn# WM103A06WCCWW was not anchored. The machines were reportedly in this area temporarily and used 2-3 times per day for 15 minutes or 10 hours per month. Room E026 is a room to be remodeled and temporarily contains a grinder (Hammond 12-A sn# 6548), a lathe (Cincinnati), a jig mill (Moore sn# 7442), a milling machine (Jones & Shipman 1300X), and a buffer (Baldor sn# P0104) equipped with grinding wheels without tongue guards, work rests or spindle guards. A compressed nitrogen fire extinguisher was observed in this room however, it was not mounted, as required. Machine guarding concerns were referred to the Safety Office.

2) Sound level measurements indicated that instantaneous sound levels exceeded 85 dBA during these operations. Limited noise dosimetry conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) In room E026, personnel use the Baldor Buffer equipped with two 8" grinding or Scotchbrite wheels several times per week for approximately 30 minutes. Ninety-five percent of the parts are aluminum, but beryllium and other metal parts are also involved. To protect both employee health and the quality of the parts finished, personnel requested a grinding booth at the time of the survey. Past monitoring results revealed that airborne concentrations of aluminum and beryllium during this operation were less than the limit of quantitation, and also lower than applicable exposure limits. The results of air monitoring are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). Personnel were observed wearing safety glasses at all times.

4) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection, nitrile gloves, canvas gloves, and comfort dust masks were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were observed not always wearing hearing protection during operations producing high noise levels. A disposable 3M 8511 N95 respirator was observed improperly stored in E235. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not available, although signs indicating that steel-toed shoes and safety glasses are required were posted

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection in areas where sound levels are in excess of 85 dBA, regardless of duration. Ensure that high noise generating machines such as saws,

Attachment 12 continued

grinders, certain milling machines, etc. are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry results and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) The installation of a grinding booth is recommended to minimize personnel exposure to aluminum and beryllium particles. Although airborne exposure to aluminum and beryllium is not expected to approach applicable occupational exposure limits, the installation of a grinding booth is recommended as a feasible control measure to further minimize employee exposure to metal particulates as well as to safeguard hardware and promote housekeeping.

3) Respirators may be worn on a voluntary basis without implementing a respiratory protection program, but they must be stored in a sanitary location and manufacturer's recommendations concerning usage must be followed. Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

3. Operating Portable Equipment

a) Observations:

1) Two civil servant employees and eleven contractors operate portable equipment such as pneumatic grinders up to a few hours per day for a similar duration. Some portable equipment including the air grinder generates sound levels exceeding 85 dBA as shown in Table H-4.3 and as indicated by past sound level measurements. Limited noise dosimetry in the Machine Shop conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that were required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years. Hearing protection was available, but not always worn when operating hand equipment generating high sound levels.

2) Compressed air hoses equipped with nozzles without effective chip guarding were observed throughout the area. Safety glasses were worn at all times.

b) Recommendations:

Attachment 12 continued

1) Personnel are required to wear hearing protection when operating portable equipment such as air grinders that produce sound levels in excess of 85 dBA, regardless of duration, in accordance with the NASA Hearing Conservation Policy (NPG 1820.1). Ensure that this equipment is labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on full-shift noise dosimetry results and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Ensure that compressed air used for cleaning purposes is reduced to less than 30 p.s.i., nozzles are equipped with effective chip guarding and safety glasses are worn.

c) Exposure Monitoring: No further noise monitoring is warranted unless changes in processes or operations increase the exposure of noise to personnel.

4. Parts Cleaning/Hand Layout

a) Observations: Two civil servant employees and eleven contractors reportedly clean parts on a daily basis for 15 minutes by applying ethyl alcohol, propanol, spray solvents or acetone to a Techwipe tissue before wiping. Personnel also use layout paint for hand layouts. Exposure to airborne concentrations of these chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. Personnel did not recall receiving training on the hazards of the chemicals they work with and were not aware of the MSDS Pro system. In addition, ethyl alcohol and propanol were not entered in the MSDS Pro database for Code 547. Hard copies of MSDS were accessible and containers and storage cabinets were properly labeled. Nitrile gloves were available for use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-4.1. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Chemical splash goggles are recommended where splash hazards are present.

2) Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings.

Attachment 12 continued

Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) *Exposure Monitoring:* Monitoring is not required based on the nature, frequency and duration of the operation.

5. Compressed Air Blowing

a) *Observations:* A compressed air hose in Room E235 was equipped with a nozzle without effective chip guarding and possibly not limited to the permissible maximum of 30 p.s.i. It could also present a flying object hazard if someone turned on the valve without securing the hose. Compressed air is used an estimated 15 minutes per day for blowing off parts. Proper PPE including safety glasses was worn at all times.

b) *Recommendations:* Ensure that compressed air used for cleaning purposes is reduced to less than 30 p.s.i., that nozzles are equipped with effective chip guarding and that safety glasses are worn. Ensure that hoses are secured before the valve is turned on.

6. Operating EDM Machines

a) *Observations:* Two civil servants and three contractors operate wire electrical discharge machining (EDM) machines in Room E020 on a daily basis for extremely hard materials such as titanium or materials that are difficult to machine cleanly using conventional methods. Wire EDM machines employ an electrostatically charged wire, cooled by water jets, to cut the work-piece. These machines are normally enclosed and are left unattended for hours while operating. The machines include the Charmilles Obofil 300, Robofom 20 and Robofil 600. Employee exposure to beryllium was monitored in August, 2001 in this room since a beryllium-copper wire was being used for a three-week period to cut metal. Results, kept with this Baseline Survey at the IHO, indicated that the airborne concentration of beryllium was below the limit of detection limit.

b) *Recommendations:* Ensure that personnel continue to receive training for working with EDM machines.

c) *Exposure Monitoring:* Further monitoring is not required based on past sampling results and the nature and duration of the operation.

7. Operating Milling Machines and Lathes

a) *Observations:*

Attachment 12 continued

1) One civil servant employee of Code 547, co-located with two contractors of Code 680 and 685, operates milling machines and lathes in the Building 21, Room 081 machine shop. Two Bridgeport milling machines (sn#146159 and sn#171491), a Deckel milling machine (sn#27163), and a Hardinge lathe (model HLV), Monarch lathe (sn# EE44527) and Jet lathe (440-3PGH sn#JW036) were used for machining aluminum, copper, steel, and Delrin. The employee operates these machines for six hours per day. Machines appeared to be properly guarded. Compressed air nozzles had pressure relief holes and were limited to 30 p.s.i.

2) A sound level survey conducted for similar operations in other areas of Code 547 indicated that instantaneous sound levels during the operation of milling machines and lathes normally do not exceed 85 dBA, the level at which hearing protection must be worn. Limited noise dosimetry conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that were required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) PPE required by the shop includes safety glasses. Other PPE such as hearing protection, nitrile gloves, canvas gloves, and comfort dust masks were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were observed not always wearing hearing protection during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

4) Due to the nature of the operation and past monitoring results of similar operations in the 2nd floor mezzanine of Building 5, personnel exposure to airborne oil mist and metal particles was expected to be well below applicable occupational health limits. A copy of past monitoring results is kept with this Baseline Survey in the IHO.

b) Recommendations:

1) Based on sound level measurements and noise dosimetry results of similar operations, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Continue to wear safety glasses as proper PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

Attachment 12 continued

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

8. Sawing, Grinding, and Sanding

a) Observations:

1) Rough cutting operations such as sawing, grinding and sanding are conducted by one civil servant employee of Code 547 who is co-located with two contractors of Code 680 and 685. Room 081 contains a vertical band saw (Rockwell sn#1627933), sander (Kalamazoo/Baldor sn#F1298), and bench grinder (Baldor, sn#P1098) that are used daily for approximately 30 minutes. There existed a one-half inch gap between the tongue guard/wheel periphery at the top of the bench grinder and the grinding wheel periphery. Machine guarding concerns were referred to the Safety Office.

2) Sound level measurements of similar operations indicated that instantaneous sound levels exceeded 85 dBA during these operations. Based on the limited frequency and duration of use and noise dosimetry, personnel are not expected to be exposed to noise at levels greater than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) Required PPE in this shop includes safety glasses. Other PPE such as hearing protection, nitrile gloves, canvas gloves, and comfort dust masks were available for personnel use. Hearing protection devices were reportedly available, but personnel stated they did not always wear hearing protection during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented, although signs indicating required PPE were posted.

b) Recommendations:

1) OSHA regulations require that the distance between the wheel periphery of the bench grinder and the adjustable tongue or the end of the peripheral member at the top never exceeds one-fourth inch. Adjust the tongues to meet this requirement.

2) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of saws, grinders, sanders, and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry results and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are

Attachment 12 continued

not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

3) Continue to wear safety glasses as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

9. Parts Cleaning/Chemical Use

a) Observations: One civil servant employee of Code 547 employed in Building 21, Room 081 reportedly cleans parts approximately twice per week for twenty minutes. Parts would be placed in a plastic bowl of solvents. Solvents stored in a flammable storage cabinet included denatured alcohol, methanol, propanol and mineral spirits. Personnel also use tapping fluid, lubricating oil and WD-40 for cleaning and lubrication during machining. Exposure to airborne concentrations of these chemicals is expected to be well below applicable limits due to the nature, frequency and duration of the operation. Personnel did not recall receiving training on the hazards of the chemicals they work with, but MSDS were accessible and containers and storage cabinets were properly labeled. Nitrile gloves were available for use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Table F-1 and Attachment H-4.1. Neoprene, nitrile or rubber gloves offer an excellent degradation rating for the solvents mentioned. Chemical splash goggles are recommended where splash hazards are present.

2) Ensure all personnel receive Hazard Communication Training. Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

Attachment 12 continued

10. Operating Milling Machines and Lathes

a) Observations:

1) One civil servant employee of Code 547 operates milling machines and lathes in a Building 10, Room 004 machine shop. Two Bridgeport milling machines (sn#168374 and sn#152638) and two Monarch lathes (sn# 37709 and ECN 585380) were used for machining aluminum, copper, and steel. The employee operates these machines for six hours per day. Machines appeared to be properly guarded. Compressed air nozzles with pressure relief and limited to 30 p.s.i were observed along with nozzles without pressure relief holes and not limited to 30 p.s.i. Two secondary personal eyewash bottles (Eyesaline 32 oz) containing water not beyond their expiration dates were observed. Only chemical-containing products such as cutting oil and varsol for lubrication when machining were stated to be used in this shop.

2) A sound level survey conducted in this area during a simulation of work without work-pieces and a sound level survey for similar operations in other areas of Code 547 indicated that instantaneous sound levels during the operation of milling machines and lathes normally do not exceed 85 dBA, the level at which hearing protection must be worn. Limited noise dosimetry conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that were required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) PPE such as safety glasses, hearing protection, and nitrile gloves were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were observed not always wearing hearing protection during operations producing high noise levels. Regular prescription glasses were worn in place of safety glasses. The operator stated he would wear safety glasses and hearing protection if he really needed them. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

4) Due to the nature of the operation and monitoring results of similar operations in other areas of Code 547, personnel exposure to airborne oil mist and metal particles was expected to be well below applicable occupational health limits. A copy of past monitoring results is kept with this Baseline Survey in the IHO.

b) Recommendations:

Attachment 12 continued

1) Based on sound level measurements and noise dosimetry results of similar operations, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Ensure that safety glasses are worn as proper PPE during the operation of machines. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

3) Use compressed air nozzles with effective chip guarding and limited to 30 p.s.i.

4) Dispose of the expired eyewash bottles. Procure and install an eyewash that meets the ANSI requirements for primary emergency eyewash stations. The requirements include, but are not limited to, the capability of providing a 15 minutes supply of water at 0.4 gallons per minute. Inspect and flush the eyewashes weekly and document these inspections.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

11. Sawing, Grinding, and Sanding

a) Observations:

1) Rough cutting operations such as sawing, grinding, buffing and sandblasting are conducted by one civil servant employee in Building 10, Room 004. The room contains a vertical band saw (Do Alll sn#6122670), grinder (Hammond sn# VA), buffer (Baldor sn#W0101), and a sandblaster (Cyclone sn#10681) that are used daily for approximately 30 minutes. All machines appeared to be correctly guarded

2) Sound level measurements obtained during a simulation of operations and sound level measurements of similar operations in Code 547 indicated that instantaneous sound levels exceeded 85 dBA during some operations. Based on noise dosimetry conducted in the shop and the limited frequency and duration of use, personnel are not expected to be exposed to noise at levels greater than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). The results of the current sound level survey and noise dosimetry are presented below in Tables H-4.3 and H-4.4. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) PPE such as safety glasses, hearing protection, and nitrile gloves were available for use. Hearing protection devices in the form of ear muffs and ear plugs were available, but personnel were observed not always wearing hearing protection during operations

Attachment 12 continued

producing high noise levels. Regular prescription glasses were worn in place of safety glasses. The operator stated he would wear safety glasses and hearing protection if he really needed them. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of saws, sandblasters and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry results and the limited duration in which equipment generating sound levels in excess of 80 dBA is operated, personnel are not required to participate in the GSFC Hearing Conservation Program. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Ensure that safety glasses are worn as proper PPE during the operation of machines. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-4.1 and ensure that employee training regarding PPE is documented.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected carcinogens and by the IARC as carcinogens, probable carcinogens or possible carcinogens (with the exception of mixed mineral oil) were identified as being used in this code. Untreated and mildly treated mineral oil is listed by the IARC as a carcinogen. Ethyl alcohol is among chemical substances contained in a Department of Navy Occupational Chemical Reproductive and Developmental Hazard List as substances known to cause reproductive or developmental toxicity in humans, or known to cause reproductive or developmental toxicity in animals by mechanisms of action directly applicable to humans.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-4.1. This checklist is to be reviewed with personnel and posted in the work area. Documentation that personnel received this information must be kept on file.

Medical Surveillance Recommendations:
Based on anticipated exposures and corresponding regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological

Attachment 12 continued

monitoring. Mr. Freburger is recommended to remain in the Hearing Conservation Program pending further monitoring.

Sound Level Survey and Noise Dosimetry:
A sound level survey performed in Building 5, Rooms E035 and E019, and Building 10, Room 004 showed sound levels to be at or greater than 85 decibels as measured on an A-weighted scale (dBA) at the operator's hearing zone during the operation of some machines. The NASA Hearing Conservation Policy (NPG 1820.1) requires that personnel wear hearing protection when exposure to noise is above 85 dBA, regardless of duration, or when personal exposure to noise is equal or greater than 80 dBA as an 8-hour Time-Weighted-Average (TWA) for more than 30 days per year. Noise dosimetry was performed in Buildings 5, 10, and 21 to measure average exposure to noise for an 8-hour shift. No persons with exposure at or above 80 dBA as an 8-hour TWA were identified.

Table H-4.3
Summary of Sound Pressure Level Results

Equipment Type/Area	Sound Levels (dBA)*	Hazard Radius (ft)	Comments
Bridgeport Milling Machine/ Bldg 5, E035	85-94	25	1-7 hrs/day, 100 days/year
DeVlieg Milling Machine/ Bldg 5, E019	88	10	1-7 hrs/day, 100 days/year
Cincinnati Millacron Milling Machine/ Bldg 5, E019	87-89	10	1-7 hrs/day, 100 days/year
Chevalier Milling Machine/ Bldg 5, E019	82-84	--	1-7 hrs/day, 100 days/year
Haas Milling Machine/ Bldg 5, E019	75-77	--	2 wks/mo, 4-5 hrs/day
Fadal Cutter/Milling Machine/ Bldg 5, E019	71-76	--	3 days/wk, 8 hrs/day
Bridgeport Milling Machine/ Bldg 5, E235	77-82	--	1-7 hrs/day, 100 days/year
Monarch Lathe/ Bldg 5, E235	77	--	1-7 hrs/day, 100 days/year
DoAll Band Saw/ Bldg 10, 004	88	10	Daily/15-30 min
Hammond Grinder/ Bldg 10, 004	77	--	Daily/15 min
Cyclone Sandblaster/ Bldg 10, 004	87	10	Weekly/30 min
Baldor Buffer/ Bldg 10, 004	65	--	Daily/15 min
Monarch Lathe/ Bldg 10, 004	73	--	Daily/ 3 hrs
Monarch Lathe/ Bldg 10, 004	78	--	Daily/3 hrs
Bridgeport Milling Machine/ Bldg 10, 004	75	--	Daily/3 hrs
Bridgeport Milling Machine/ Bldg 10, 004	77	--	Daily/3 hrs

* at the operator's hearing zone

Attachment 12 continued

ER – entire room

Table H-4.4
Noise Dosimetry Results

Employee/ Dosimeter/ Date	Location/ Operation	Average (dBA)*	8-Hour Time-weighted average (TWA)	Dose (%)	Time Period (minutes)
Chris Kolos/ QAB060055/ 2 Dec 03	Bldg 5, Rm E019/ Machine Shop – operating Fadal milling machine	74.1	69.0	5.46	233
Mark Saulino/ QAB060055/ 10 Dec 03	Bldg 21, Rm 081/ Machine Shop – operating lathe&milling machine	72.8	69.9	6.13%	319
Ron Moxley/ ECN 1520681/ 10 Dec 03	Bldg 10, Rm 004/ Machine Shop – operating lathe and milling machine	74.8	70.2	12.8%	253
Richard Freburger/ QAB060055/ 16 Dec 03	Bldg 5, Rm E019/ Machine Shop – operating Deckel milling machine	80.2	74.0	10.9%	202
Richard Freburger/ QAB060055/ 22 Dec 03	Bldg 5, Rm E019/ Machine Shop – operating lathe and Deckel milling machine	74.7	72.4	8.67%	347

* average exposure in decibels, A-weighted, for the time period

Table H-4.5
Air Monitoring Results for Oil Mist

Employee/ Sample/ Pump	Location/ Operation	Result*	8-Hour Time-weighted average (TWA)	Time Period	Exposure Limits
Area/ JD121503-01/ 23252	Bldg 5, Rm E019/ Machine Shop – bench across from Chevalier milling machines CV2 and CV3 – both Chevaliers operating	0.708 mg/m^3	0.170 mg/m^3	115 min.	0.500 mg/m^3# 10.0 mg/m^3?
Area/ JD121503-02/ 23236	Bldg 5, Rm E019/ Machine Shop – bench behind Chevalier milling	4.041 mg/m^3	0.934 mg/m^3	111 min.	0.500 mg/m^3 10.0 mg/m^3

Attachment 12 continued

	machine CV2				
Richard Freburger/ JD121503-03/ 23246	Bldg 5, Rm E019/ Machine Shop – operating Deckel milling machine	0.171 mg/m^3	0.046 mg/m^3	129 min.	0.500 mg/m^3 5.00 mg/m^{3§}

* average exposure over the time period sampled
# NIOSH REL for metal working fluids
? ACGIH TLV for insoluble particulates not otherwise specified/natural oils
§ ACGIH TLV for mineral oil mist

Attachment 12 continued

Attachment H-4.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5, 21, 10 **Process Area:** Machining Technology Group **Date:** 12/04/03	**Supervisor:** Rick Fedorchak **Telephone:** 6-7093 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f Powered APR respirator g. Supplied-air respirator h. SCBA** i. Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Operating CNC milling machines and lathes	5	E038, E019, E235	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required.
Rough cutting (sawing, grinding, sanding)	5	E019, E235	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required
Operating portable equipment	5	E038, E235	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required
Parts cleaning	5	E038, E019, E235	b or d	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene

Attachment 12 continued

						gloves (neoprene for acetone)
Using compressed air	5	E235	a, i, g	None	None	Safety glasses, hearing protection required
Operating EDM Machines	5	E020	a, i	None	None	Safety glasses and steel-toed shoes required by shop
Operating milling machines and lathes	21	081	a	None	None	Safety glasses
Sawing, grinding, sanding	21	081	a, g	None	None	Safety glasses, hearing protection required
Parts cleaning, chemical use	21	081	b or d	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone)
Operating milling machines and lathes	10	004	a	None	None	Safety glasses
Sawing, grinding, sanding	10	004	a, g	None	None	Safety glasses, hearing protection required

Attachment 12 continued

Section 5

Process Area: **Mechanical Inspection Group**

Location: Building 5, Rooms E054, E054A, E014F

Date of Survey: October 28, December 15, 2003

Attachment: (H-5.1) PPE Checklist

Process Area Description:
The Mechanical Inspection Group is engaged in the inspection, critical alignment, measurement and reverse engineering of finished parts. Parts could also include pre-machined parts and parts from outside vendors. The Group conducts its main operations using coordinate measuring machines, an optical comparator, a shadow graph, and other measurement devices in Room E054. Room E054A is a staging area for parts and an administrative area with computer workstations. Non-destructive testing is performed in Room E014F. All four individuals of this group are employed by Swales, Inc. and work a normal 8-hour shift.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-5.1:

Table H-5.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	E054	Inspecting and measuring parts	None observed	4 (0 GS)	Daily/8 hrs	N/A
5	E054	Parts cleaning	Isopropyl alcohol, ammonia, acetic acid	4 (0 GS)	Daily/15 minutes	16
5	E054A	Staging and administrative functions	Repetitive motion, improper angles	4 (0GS)	Daily/4 hours	N/A
5	E014F	Non-destructive	Penetrant	1 (0 GS)	Monthly/1hr	16

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.

0-50 = Review if process changes.
50-103 = Review process every 24-36 months.
100-203 = Collect air samples and review process every 12 months.
200-303 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

		testing	(isodecyl diphenyl phosphate, mineral oil, solvents), emulsifier (ethoxylated nonylphenol, hexylene glycol), developer (pentacrythritol, Ca phosphate, Mg phosphate)			

1. Inspecting and Measuring Parts

a) Observations: Four contractors inspect and verify parts to ensure they are of the proper measurements and specifications. Personnel use two coordinate measuring machines (Mitutoyo BH305 CNC and Brown & Sharp Gamma manual), an optical comparator (Starrett Sigma HB400) and smaller tools including pipe gauges, measurement devices, surface plates and computers in performing this operation. Room E054 is a temperature and humidity controlled room. No health hazards related to this operation were observed. PPE was not required, but N-Dex nitrile exam gloves were available and used for handling gold-plated instruments or other instruments with sensitive finishes.

b) Recommendations: Based on the nature of the operation, no recommendations are warranted for this operation at this time.

2. Parts Cleaning

a) Observations:

1) Four contractors reportedly clean parts on a daily basis for 15 minutes by applying isopropyl alcohol or glass cleaner to a Techwipe tissue before wiping. Skin contact and airborne exposure to these chemicals is expected to be minimal. N-Dex nitrile exam gloves were available for use but generally PPE was not worn during this operation. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

2) MSDSs are kept at stations in the main shop area and in the plating shop, as well as in the MSDS Pro database, but personnel were unaware if they included the chemicals used by this group. The Group Leader stated that he would access them on-line. Isopropyl alcohol was listed in the plating shop section of the MSDS Pro database for Code 547, but glass cleaner was not entered. Documentation concerning training on the hazards of the chemicals they work with was not available. One small plastic bottle was not properly labeled as to its identity and contents.

Attachment 12 continued

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-4.1. Nitrile, neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Attachement H-5.1 serves as the OSHA-required workplace hazard assessment. Ensure that personnel receive documented information and training regarding operations necessitating the use of PPE.

2) Ensure all personnel in this shop have received hazard communication training. Ensure that personnel are aware of the company's written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure that all employees receive training on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) Exposure Monitoring: Monitoring is not required based on the nature, frequency and duration of the operation.

3. Staging and Administrative Functions

a) Observations: Four contract employees used Room E054A as a staging and office area. Personnel normally work in the adjacent inspection room but some personnel may spend 1-4 hours at computer workstations. No complaints were noted.

b) Recommendations: Provide, where feasible, articulated keyboard trays that accommodate the keyboard and mouse. Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Position the keyboard so that it is between 28-30 inches above the floor. To allow sufficient knee space if an adjustable keyboard tray is installed to the underside of the desk, the height from the floor to the adjustable keyboard tray should range from 23-28 inches. Use adjustable chairs that allow personnel to sit at comfortable height, angle, and distance from the screen. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Ensure a minimum viewing distance of 12 inches and support the monitor so that the top of the screen is at eye level with the screen tilted slightly downward. The entire viewing plane should be between 0 and 40 degrees below the horizontal viewing plane. When viewing screens with dark backgrounds, use lower lighting. Dark characters on a light screen are generally more readable. Ensure high contrast between the screen background and the screen characters. Minimize glare and choose screens that tilt and have contrast and brightness controls.

Attachment 12 continued

4. Non-destructive Testing

a) Observations:

1) The group leader performs non-destructive testing on parts approximately 12 times per year for an hour in Rm E014F whereby a fluorescent penetrant, an emulsifier/remover, and a developer are used. First, Zyglo ZL-27A Fluorescent Penetrant containing isodecyl diphenyl phosphate, white mineral oil, castor oil and solvent is brushed onto metallic parts. Then, the parts are rinsed and placed in an emulsifier tank of Zyglo ZR-10-B containing ethoxylated nonylphenol and hexylene glycol. This emulsifier/remover takes the penetrant off the surface but not out of any potential crack. Next, Zyglo 2P-4-B developer containing pentacrythritol, calcium phosphate and magnesium phosphate is utilized to develop the image of cracks in the parts. Gloves and goggles are reportedly worn for protection during this operation. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

2) MSDSs are kept at stations in the plating shop and in the MSDS Pro database, but personnel were unaware if they included the chemicals used by this group. The Group Leader stated that he would access MSDSs on-line. The Zyglo products were not listed in the plating shop section of the MSDS Pro database for Code 547. Documentation concerning training on the hazards of the chemicals personnel work with was not available. An eyewash meeting ANSI Z358.1- 1998 guidance with procedures for inspection, testing, and documentation was observed.

b) Recommendations:

1) Continue to provide the types of PPE that will protect the affected employee from the chemicals as identified in the hazard assessment shown in Table F-1 and Attachment H-4.1. Nitrile, neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Rubber gloves, however, afford poor degradation ratings for oils. Table F-1 or Attachment H-5.1 serves as the OSHA-required workplace hazard assessment. Ensure that personnel receive documented information and training regarding operations necessitating the use of PPE.

2) Ensure all personnel have received Hazard Communication Training. Ensure that personnel are aware of the company's written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Ensure that all chemical products are entered into the MSDS Pro database and that personnel are aware that MSDSs are readily accessible through this database. Ensure that all employees receive training on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

Attachment 12 continued

c) *Exposure Monitoring:* Monitoring is not required based on the frequency and duration of the operation.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected carcinogens and by the IARC as carcinogens, probable carcinogens or possible carcinogens (with the exception of mixed mineral oil) were identified as being used in this code. Untreated and mildly treated mineral oil is listed by the IARC as a carcinogen.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-5.1. This checklist is to be reviewed with personnel and posted in the work area. Documentation that personnel received this information must be kept on file.

Medical Surveillance Recommendations:
Based on anticipated exposures and corresponding regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Attachment 12 continued

Attachment H-5.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5 **Process Area:** Mechanical Inspection Group **Date:** 12/15/03	**Supervisor:** George Berholdt **Telephone:** 6-3064 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f Powered APR respirator g. Supplied-air respirator h SCBA** i Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Cleaning parts	5	E054	None	i	None	Nitrile/rubber/neoprene gloves
Non-destructive testing	5	E014F	b or d	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone)

Attachment 12 continued

Section 6

Process Area: **Design Group**

Location: Building 5, Room C235

Date of Survey: October 28, December 15, 2003

Process Area Description:
Seven civil servants and one contract employee perform engineering and administrative functions at computer workstations. Personnel provide conceptual and detailed mechanical design support for the development of flight systems and ground support equipment. Personnel develop designs using computer assisted designing software for designing in both 2-D and 3-D formats, which have concurrent engineering links to computer-aided manufacturing and engineering applications. All eight individuals of this group work a normal 8-hour shift. The room had been designed as a mainframe room but was renovated as an office area, so that the lights are controlled by motion sensors.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-6.1:

Table H-6.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	C235	Using computer assisted designing programs	Repetitive motions, static postures, illumination	8 (7 GS)	40 hrs/wk	N/A

1. Designing Programs and Testing

a) Observations: Seven civil servants and one contractor were engaged in designing parts or instruments and other engineering or administrative duties at computer workstations for 40 hours per week. No ergonomic hazards were observed in relation to

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.
- 0-50 = Review if process changes.
- 50-104 = Review process every 24-36 months.
- 100-204 = Collect air samples and review process every 12 months.
- 200-304 = Collect air samples and review process every 6 months.
- 300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

the office furniture and no complaints were noted. Overhead light were not within the occupants control leading to glare on computer screens.

b) Recommendations: Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Minimize glare by adjusting the lighting and positioning lights in front of the computer screens instead of behind them. Purchase glare screens and choose screens that tilt and have contrast and brightness controls.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected carcinogens and by the IARC as carcinogens, probable carcinogens or possible carcinogens were identified as being used by this group.

Personal Protective Equipment:
No operations requiring the use of PPE were identified.

Medical Surveillance Recommendations:
Based on anticipated exposures and corresponding regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Attachment 12 continued

Section 7

Process Area: Maintenance and Repair Group (includes Maintenance and Repair, Cutting Area, and Tool Crib)

Location: Repair and Maintenance - Building 5, Room N032 + all areas with Code 547 activities;
Cutting Area – Building 5, Room N050;
Tool Crib – Building 5, Room E032

Date of Survey: October 28, December 22, 2003

Attachment: (H-7.1) PPE Checklist

Process Area Description:
The Maintenance and Repair Group Leader is responsible for Mantech personnel throughout Code 547 in all of the groups. This section includes exclusively Mantech operations in the Maintenance and Repair Group, Cutting Area, and Tool Crib. Maintenance and Repair operations are performed in all areas throughout Code 547 by four Mantech employees who have their base shop in Bldg 5, Rm N032. Employees are primarily engaged in the repair, installation, maintenance and excess of machines. The Cutting Area is occupied by two Mantech employees and the Tool Crib is operated by one Mantech employee.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-7.1:

Table H-7.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	Throughout Code 547 Shops	Installing, repairing, maintaining, excessing machines	Oils, noise, flying particles, heavy objects, falling objects	4 (0 GS)	Daily/6 hrs	210

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.
0-50 = Review if process changes.
50-105 = Review process every 24-36 months.
100-205 = Collect air samples and review process every 12 months.
200-305 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

5	N032	Operating machines, grinding, sanding	Flying metal particles, noise	4 (0 GS)	Daily/30 minutes	N/A
5	N032	Parts cleaning and chemical use	Varsol, IPA, solvents and oils	4(0 GS)	Weekly/15 min.	8
5	N050	Operating shear, saws	Flying metal particles, noise	2 (0 GS)	Daily/30 minutes	N/A
5	E032	Distributing supplies, equipment, fluids	Heavy objects	1 (0 GS)	Daily/8 hrs	N/A

1. Installing Repairing, Maintaining, Excessing Machines

a) Observations:

1) Four contractors install, repair, maintain and excess machines and equipment throughout Code 547 areas on a daily basis for up to 6 hours. Machines include those listed in other group sections such as milling machines, lathes, press brakes, presses, saws, grinders, etc. and maintenance includes adding and changing fluids. Personnel may be exposed to instantaneous sound levels exceeding 85 dBA, the level at which hearing protection must be worn, during the installation and maintenance of equipment. Sound levels of various machines are referenced in sound level surveys of other shop sections. Personnel stated that hearing protection is worn near machines.

2) Contracting personnel exposed to hazardous chemicals including oils, lubricants, and cleaners received hazard communication training and PPE training by Mantech upon initial employment and every three years thereafter. Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection and nitrile gloves was available for personnel use. A Big Joe Deka PDC 25-130 sn# 90311 lift truck and a Ruger crane model 55 were available to assist in receiving, transporting and installing equipment.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of machines and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that machines producing sound levels in excess of 85 dBA are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Sound level survey results are shown in Table H-3.3 and H-4.3.

2) Continue to wear proper PPE and provide training on hazardous chemicals and PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-7.1. Ensure that personnel use proper lifting techniques when manually lifting heavy

Attachment 12 continued

equipment. Ensure that cranes are inspected regularly and that personnel receive lift truck training.

c) Exposure Monitoring: No further air or noise monitoring is warranted based on the nature and duration of operations. Similar exposure group monitoring is covered under other group sections.

2. Operating Machines

a) Observations:

1) Four contractors operate various machines in their shop in Room N032 on an as needed basis up to 1 hour per day, but usually much less. Machines observed in the shop included milling machines (Leblond ECN 585343; Deckel FP1 sn# 36434 ECN 181859; Jet sn# 188153B; Emco Maximat Super II 0098667HUH), punch press (Hill Acme), lathe (Eaton Dyn-Torq sn# 2738), grinders (Hammond sn# 64D; Delta sn# CK9783), buffer (Baldor sn# G8-165-60), and sander (MSD sn# 006). Machines appeared to be properly guarded with the exception of the punch press. This machine is operated rarely, an estimated once per year.

2) A sound level survey conducted for similar equipment in other group areas as a part of this survey indicated that instantaneous sound levels during the operation of equipment exceeded 85 dBA, the level at which hearing protection must be worn. Employees stated they would wear hearing protection around machines. The results of the current sound level survey are presented in Tables H-3.3 and H-4.3. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified.

3) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection and nitrile gloves were available for personnel use. Documentation of training on the proper use of PPE was maintained through a Mantech database system.

b) Recommendations: In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of machines and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that these machines are labeled "Hazardous Noise – Wear Hearing Protection When Operating Machinery". Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-7.1. and continue to ensure that documented hazard communication and PPE training is provided. Consider taking the Hill Acme punch press out of service since it is rarely operated.

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c) *Exposure Monitoring:* No further air or noise monitoring is warranted based on the nature and duration of operations. Similar exposure group monitoring is covered under other group sections.

3. Parts Cleaning

a) *Observations:*

1) Four contractors reportedly clean parts on a weekly basis for 15 minutes using a Clam Cleaner enc losed parts washing tank in conjunction with a water-based soap. Skin contact and airborne exposure to these chemicals is expected to be minimal. N-Dex nitrile exam gloves were available for use but generally PPE was not worn during this operation. Mantech maintained training records concerning PPE and hazard communication in a database system. MSDSs are maintained in the work area as well as in the MSDS Pro database, but personnel were unaware if MSDS Pro database included the chemicals used by this group. Goggles were reportedly not worn when handling the bowl cleaner containing acids.

2) Hazardous chemical-containing products were properly stored in flammable liquid storage cabinets with an inventory list posted on the door. Chemicals included Benzomatic propane, Benzomatic MAPP gas, Kluber Lube isoflex NBU15 grease, Precision EP2 grease, aerohydraulic HBF Mobil, Mobil Vactra #2, #4, #6, Dextron Hydraulic Fluid, Mobil 80W-90W DTE #24, #25, #26, Hydraulic Jack Oil, Air Lube 10W/NR, Super Duty SAE 10W, 704 Diffusion Pump Oil Aber Ipsen, Mobil Super Cylinder Oil, Sprizon Belt Dressing, Drummond Remedy Coil and Fan Cleaner, Coastline Cutting and Tapping Oil, Zep Drill Chill Cutting Oil, CRC 2-26 Lubricant, Oatey PVC Cement, Marsh Plastic Pipe Cleaner, Marsh PVC Primer. Other chemicals in the area included Li'l Brother Sam Bowl Cleaner containing hydrofluoric and phosphoric acid, Blaser Swisslube 2000CF containing mineral oil, Cool Tool, Toolmates Safety Solvent HD containing trichloroethylene, and a water-based powder soap for use with the Clam Cleaner parts washer. The Mantech Group Leader provided documentation that hazard communication and PPE training were provided.

b) *Recommendations:*

1) Wear chemical splash goggles when handling bowl cleaner containing hydrofluoric and phosphoric acid. Continue to ensure that documented training hazard communication and PPE is provided and that the types of PPE that will protect the affected employees from cleaning solvents as identified in the hazard assessment shown in Attachment H-7.1 are provided. Nitrile, neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned.

2) Ensure that personnel are aware of the company's written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard

Attachment 12 continued

warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure that all employees receive training on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) *Exposure Monitoring:* Monitoring is not required based on the nature, frequency and duration of the operation.

4. Operating Shear, Saws

a) *Observations:*

1) Two contractors operate the shear, saws and crane in Room N050 on an as needed basis up to 1 hour per day. Machines observed in this room included a Cincinnati 2508 sn# 31583 shear, DoAll 2613-3 vertical saw sn# 128-61223, Marvel series 81 sn# E470011 ECN 1519972 vertical saw, Marvel series 25 sn# F-18325-W ECN 214162 saw, and a crane model S2TR-S10. Machines appeared to be properly guarded.

2) A sound level survey conducted for similar equipment in other group areas as a part of this survey indicated that instantaneous sound levels during the operation of equipment exceeded 85 dBA, the level at which hearing protection must be worn. Employees stated they would wear hearing protection around machines. The results of the current sound level survey are presented in Tables H-3.2 and H-4.2. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified.

3) Required PPE includes safety glasses and steel-toed shoes. Other PPE such as hearing protection and nitrile gloves were available for personnel use. Documentation of training on the proper use of PPE was maintained through a Mantech database system.

b) *Recommendations:* In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of machines and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-7.1. Continue to ensure that documented hazard communication and PPE training is provided.

c) *Exposure Monitoring:* No further air or noise monitoring is warranted based on the nature of operations.

5. Distributing Supplies and Equipment

a) *Observations:* One Mantech employee operates the Tool Crib as Room E032 for Code 547 operations approximately eight hours per day. The employee controls tooling.

Attachment 12 continued

distributes drills, taps and other equipment. He distributes some light chemicals including acetone and cutting fluids. The Tool Crib also contains PPE such as hearing protection, glasses, and dust masks. An MSDS book is maintained at the Tool Crib for Repair and Maintenance Group chemicals. Contracting personnel exposed to hazardous chemicals including oils, lubricants, and cleaners received hazard communication training and PPE training by Mantech upon initial employment and every three years thereafter.

b) Recommendations: Continue to provide PPE to personnel and continue to maintain a hard copy of all MSDSs for hazardous chemicals used by Code 547 Mantech personnel. No PPE is required for the employee at the Tool Crib. Follow proper lifting technique when manually lifting heavy equipment.

c) Exposure Monitoring: No air or noise monitoring is warranted based on the nature of the operation.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected carcinogens and by the IARC as carcinogens, probable carcinogens or possible carcinogens (with the exception of products containing mineral oil) were identified as being used in this code. Untreated and mildly treated mineral oil is listed by the IARC as a carcinogen. Ethyl alcohol is among chemical substances contained in a Department of Navy Occupational Chemical Reproductive and Developmental Hazard List as substances known to cause reproductive or developmental toxicity in humans, or known to cause reproductive or developmental toxicity in animals by mechanisms of action directly applicable to humans.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-7.1. This checklist is to be reviewed with personnel and posted in the work area. Documentation that personnel received this information must be kept on file.

Medical Surveillance Recommendations:
Based on anticipated exposures and corresponding regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Attachment 12 continued

Attachment H-7.1

Personal Protective Equipment Checklist

Code: 547 **Building:** 5 **Process Area:** Maintenance and Repair Group **Date:** 12/22/03	**Supervisor:** Marvin Kaufman **Telephone:** 6-6271 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f. Powered APR respirator g. Supplied-air respirator h. SCBA** i. Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Installing, repairing, maintaining machines	5	Throughout Code 547	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required.
Operating machines	5	N032	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required.
Parts cleaning	5	N032	b or d	i	None	Face shield or goggles where splashing may occur Nitrile/rubber/neoprene gloves (neoprene for acetone)

Attachment 12 continued

Operating shear and saws	5	N050	a, i, g	None	None	Safety glasses, hearing protection, and steel-toed shoes required.

Attachment 12 continued

Section 8

Process Area: **Composites Lab and Rapid Prototyping Group**

Location: Building 5A, Rooms 020, 020A-D, 010
Building 5, Rooms E052, E048, E048A

Date of Survey: October 28, December 22, 2003

Attachment: (H-8.1) PPE Checklist

Process Area Description:
The Composites Lab and Rapid Prototyping Group consists of the Building 5A, Rm 020 Main Room, Rm 020A Composites Lab, Rm 020B Lay-up Room, Rm 020C Autoclave Room and 010 Offices, employing two civil servants and four contractors. This group is primarily engaged in the production of prototypes from composite materials including carbon fiber board. It performs and direct studies, develops component hardware, and provides a base of expertise in advanced composite materials processing techniques. Room 005 of Building 5A formerly contained operations, but now contains activities of Code 442. The Composites Lab and Rapid Prototyping Group also includes the Model Shop located in Building 5, Rms E052, E048 and E048A. The Model Shop plans and constructs models by request from all sources, utilizing various machines for fabricating aluminum, plexiglass, acrylic and wooden material. Two civil servants carry out operations in the Model Shop.

Work Tasks:
A summary of major operations of concern to Industrial Hygiene and their potential hazards is presented below as Table H-8.1:

Table H-8.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5A	020 Main Shop	Disassembling tools, storing, inspecting parts, preparing surface	Flying metal particles, noise	6 (2 GS)	Daily/1 hr	N/A
5A	020	Using mold	Isopropyl	6 (2 GS)	2x/week/1	16

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.
0-50 = Review if process changes.
50-106 = Review process every 24-36 months.
100-206 = Collect air samples and review process every 12 months.
200-306 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

		release	alcohol, n-butanol vapor		hour	
5A	020	Priming	Strontium chromate, MEK	6 (2 GS)	3x/month/5-30 minutes	40
5A	020	Bonding and Adhesive mixing	Epoxy resin, acrylated epoxies, toluene diisocyanate, 2-ethyl-1,3-hexanediol, bisphenol diglycidylether resin, silicates	6 (2 GS)	Weekly/15 min.	16
5A	020	Using chemicals in cleaning, stamping,etc.	Acetone, propanol, glycol ether	6 (2 GS)	Daily/15 min.	16
5A	020A Composites Lab/Router Room	Cutting carbon fiber board	Carbon fiber, noise	1 (0 GS)	Daily/2-6 hours	140
5A	020B Lay-up Room	Laying up materials	Sharp objects, epoxies, acetone, IPA	6 (2 GS)	2x/week/6 hrs	32
5A	020C Autoclave Room	Operating autoclave	Nitrogen gas	6 (2 GS)	1-2x/wk/4-5 hrs	80
5A	010 Office	Planning, administrative	Improper body positioning	2 GS	Daily/6 hours	N/A
5	E052 Model Shop	Planning and Assembling Models	Improper body angles, positioning	2 (2 GS)	Daily/4 hrs	N/A
5	E052	Bonding	Epoxy resins, acrylated epoxies, solvents	2 (2 GS)	Weekly/1 hr	16
5	E052, E048 Model Shop	Operating milling machines, lathes	Flying particles, noise	2 (2 GS)	Monthly/8 hrs	28
5	E052, E048, E048A	Rough cutting, sawing, sanding, grinding	Flying particles, noise	2 (2 GS)	Weekly/8 hr	56
5	E052	Operating pneumatic portable equipment	Flying particles, noise	2 (2 GS)	Daily/30 minutes	56
5	E052	Painting	Solvent vapors	2 (2 GS)	Weekly/2 hrs	28
5	E052	Parts cleaning	Isopropyl alcohol	2 (2 GS)	Daily/15 minutes	16

1. Disassembling Tools, Storing, Inspecting, Preparing Surfaces

Attachment 12 continued

a) Observations: Two civil servant employees and up to four contractors are involved in various operations in the Main Room of Building 5A. As the main room, it serves as a staging and storage area where parts are inspected, stored, assembled, disassembled and prepared for cutting, fabrication and painting. Preparation in this paragraph is limited to roughing up/scotch briting composite laminate surfaces once per week for 5-10 minutes in preparation for priming or an epoxy coating. Personnel perform these various functions on a daily basis for up to 6 hours. Small to large assemblies formerly conducted by Code 547 in the High Bay Room 005 may also now be performed in the Main Room 020. Required PPE includes safety glasses. Other PPE such as hearing protection, nitrile gloves, full-face respirators, half-face respirators, and disposable respirators were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented, although signs indicating required safety glasses were posted. A primary eyewash meeting ANSI standards was present.

b) Recommendations: Continue to wear safety glasses and steel-toed shoes as PPE. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented. Continue to inspect and flush the eyewash weekly and document the inspections.

c) Exposure Monitoring: Based on the nature of operations, air and noise monitoring was not warranted.

2. Using Mold Release

a) Observations: Two civil servant employees apply spray mold releasing agent to tools so that tools and parts are released from tools and do not stick together. Personnel apply 4 or 5 coats. lasting fifteen minutes each. Mold releasing products include Frekote 44-NC containing dibutyl ether, Airtech Release-All 18 containing isopropyl alcohol and n-butanol, Airtech Release-All 19 and Airtech Safelease 20L. The MSDS for the latter was not accessible through the MSDS Pro System. Generally, Mantech maintained records of hazard communication and PPE training for its employees, but such records were not available for civil servants. Personnel wore required safety glasses and other forms of PPE such as hearing protection, nitrile gloves, full-face respirators, half-face respirators, and disposable respirators were available for personnel use. Personnel stated they would wear respirators if needed. Personnel use mold release approximately two times per week for one hour. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented, although signs indicating required safety glasses were posted. Air monitoring results obtained in April, 2001 for dibutyl ether contained in Frekote 44-NC indicated concentrations below the limit of quantitation and well below applicable exposure limits. These results are kept with this Baseline Survey Report in the IHO.

b) Recommendations:

Attachment 12 continued

1) Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented. Continue to provide the types of PPE that will protect the affected employees from the chemicals identified in the hazard assessment shown in Attachment H-8.1. Neoprene or rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Chemical splash goggles are recommended where spray hazards are present.

2) Ensure that all MSDSs are entered into the MSDS Pro database. Ensure all personnel receive Hazard Communication Training. Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group. Ensure all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced.

c) Exposure Monitoring: Further monitoring is not required based on the nature, frequency and duration of the operation.

3. Priming

a) Observations:

1) Two civil servant employees and potentially up to four contractors apply Cytec BR 127 Corrosion Inhibiting Primer to composite parts approximately 3 times per month for 5-30 minutes each time. This product contains 59.1-73.0% methyl ethyl ketone, 1.2-1.8% strontium chromate, 17.6-18.4% 2-ethoxyethanol and less than 1% of methanol and formaldehyde. This product is a Class I flammable liquid. Due to the very low ACGIH ceiling limit of 0.1 mg/m^3 and TLV of 0.5 $\mu g/m^3$ of strontium chromate, air sampling was conducted 8 October 2002. The duration of the operation was short so that the sampling performed was conducted for only 18 minutes. The sampling results were less than the quantitation limit of 0.054 mg/m^3. A copy of past monitoring results is kept with this Baseline Survey in the IHO. Although the sampling results were less than the ceiling limit, follow-up sampling was recommended in the previous report when spraying for a longer duration. With regard to other chemicals in the paint, MEK has an ACGIH short-term exposure limit (STEL) of 300 ppm and TLV of 200 ppm. 2-ethoxyethanol has an ACGIH TLV of 5 ppm and a skin designation. This primer presents risk as a carcinogenic and reproductive hazard. Air monitoring results obtained in April, 2001 for methyl ethyl ketone indicated concentrations well below the TLV. These results are kept with this Baseline Survey Report in the IHO.

Attachment 12 continued

2) Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants. Personnel wore required safety glasses and other forms of PPE such as hearing protection, nitrile gloves, full-face 3M 7381 respirators, half-face North 76008A respirators, and disposable respirators were available for personnel use. Personnel stated that they wear respirators during priming, but are not enrolled in a respiratory protection program. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available.

3) The exhaust hood in which this operation is conducted was found to be in compliance with its annual inspection and appeared to be adequate for this operation. The velocity of the air at a point 12" from the face of the hood measured 87 feet per minute (fpm) during the June 2003 LEV evaluation.

4) An 85% naphtha-based silicone primer was also observed listed in MSDS Pro.

b) Recommendations:

1) Though past air sampling yielded a result for strontium chromate less than the quantitation limit, follow-up monitoring during priming for a longer duration is recommended to gather sufficient information about employee exposure. In addition to strontium chromate as a lung carcinogen with a very low allowable exposure limit, 2-ethoxyethanol is a reproductive toxin with a low allowable limit and should also be sampled. Please contact the IHO at extension 6-6669 a few days before operations involving the use of strontium chromate for more than 30 minutes are planned.

2) Continue to ensure that the exhaust hood is evaluated according to its annually scheduled inspection.

3) Ensure that this primer as a Class I flammable liquid is properly stored in the flammable liquid storage cabinet and that there are no spark-producing equipment present during spraying operations. Ensure spraying equipment is properly bonded and grounded.

4) Ensure that appropriate precautions are taken to limit skin contact to this material. 2-ethoxyethanol is designated with a skin notation by ACGIH because absorption through the skin, mucous membranes and eyes, either by contact with vapors or direct skin contact can present a significant contribution to the overall exposure. Hexavalent chromium and methyl ethyl ketone are also known for their irritant effects. Formaldehyde carries the designation as a sensitizer.

5) Provide the types of PPE that will protect the affected employees from the chemicals identified in the hazard assessment shown in Attachment H-8.1. Appropriate PPE in the form of gloves, aprons, long sleeves and pants must be worn. Chemical splash goggles are recommended where overspray could come into contact with the eyes. . Laminated film gloves offer an excellent degradation rating and natural rubber and PVA gloves offer

Attachment 12 continued

a fair degradation rating for methyl ethyl ketone. PVA gloves are not recommended for 2-ethoxyethanol or formaldehyde. Natural rubber gloves offer an excellent degradation rating for the solvents mentioned. Nitrile gloves offer an excellent degradation rating for all of the solvents mentioned except for acetone, for which nitrile is not recommended. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented

6) Respiratory protection is not recommended at levels below allowable limits, but may be worn for added protection. Personnel wearing respirators must be enrolled in the Respiratory Protection Program. Prior to using respirators, personnel must receive medical clearance, respiratory protection training and fit-testing, and cartridges must be appropriately selected to protect against the hazards presented by this product.

7) Food, beverages, tobacco or cosmetics should not be used or consumed when primer is in use. Wash hands and face before eating, drinking and smoking and shower following the workshift. Work clothes should be kept separately from street clothes and should not be taken home where they could expose family members to chemicals suspected of causing cancer. Work clothes should be laundered following the workshift.

8) Ensure all personnel receive hazard communication training. Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group.

c) *Exposure Monitoring:* Follow-up air monitoring is warranted to ensure that exposures to strontium chromate and 2-ethoxyethanol are less than the allowable limits.

4. Bonding and Adhesive Mixing

a) *Observations:*

1) Epoxy systems for bonding aluminum honeycomb core to carbon composite face sheets or board are mixed, used and stored in a freezer in Building 5A, Room 020. Normally two civil servants and up to four contractors may use epoxy systems on an intermittent, weekly basis. Epoxy systems generally include epoxy resins, hardeners and catalysts containing epoxy resins, acrylated epoxies and polyamines. Some bonding agents actually observed include Conap Conathane EN-11 containing 2-ethyl-1,3 hexanediol, Miller Stephenson Epon Resin 815 containing epoxy resin and n-butyl glycidyl ether, MS Epi-Cure 3140 Curing Agent containing polyamides and triethylenetetramine, and Hysol 9309 containing bisphenol, epoxy resins. Other bonding

Attachment 12 continued

agents listed in MSDS Pro included Epibond 1210 containing fatty acids, silicates and bisphenol diglycidylether resin, Epocast containing antimony oxide and phenol, 3M 77 Spray Adhesive containing n-hexane and cyclohexane, and Conap EN-4 containing 2,4 toluene diisocyanate. Not all epoxy systems observed in the storage cabinets, for example Miller Stephenson Epon Resin 815 and Epi-Cure 3140, had corresponding MSDSs entered into MSDS Pro. Air monitoring results obtained in 2001 for epichlorohydrin and acrylonitrile indicated concentrations below the limit of quantitation. These results are kept with this Baseline Survey Report in the IHO.

2) Personnel wore required safety glasses and other forms of PPE such as hearing protection, nitrile gloves, full-face respirators, half-face respirators, and disposable respirators were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available. Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants.

b) Recommendations:

1) Epoxy resins and hardeners present a hazard primarily as skin irritants. Airborne exposures to epoxy resins, acrylated epoxies, and polyamines are expected to be well below permissible exposure limits. To protect skin, chemical impermeable gloves should be provided. For the limited frequency and duration in which epoxies are handled, the nitrile gloves should afford protection before breakthrough occurs. Butyl rubber gloves are recommended for hardeners. The workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required is provided as Attachment H-8.1. Maintain PPE that is in good condition and store it in a sanitary manner.

2) Ensure that MSDSs for all chemical-containing products are entered into MSDS Pro. Ensure all personnel have received hazard communication training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided.

c) Exposure Monitoring: Due to the nature of epoxies and the frequency and duration in which epoxies are mixed or used, air monitoring for epoxy resins, acrylated epoxies, and polyamines was not warranted.

5. Miscellaneous Use of Chemicals, Cleaning, Stamping

a) Observations: Acetone, 2-propanol, denatured alcohol, ethyl alcohol, hexane, toluene and Ideal RS-1 black ink were observed stored in the chemical safety cabinets. These chemicals are used for cleaning parts and stamping parts. The black ink contains glycol ether. These operations are performed on an estimated daily basis for 15 minutes. Air monitoring results obtained in 2001 for stoddard solvent and 1,2,4-trimethyl benzene contained in Varsol indicated concentrations below the 8-hour exposure limit and limit of

Attachment 12 continued

quantitation respectively. These results are kept with this Baseline Survey Report in the IHO. Personnel wore required safety glasses and other forms of PPE such as nitrile gloves, full-face respirators, half-face respirators, and disposable respirators were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available. Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants.

b) Recommendations: Airborne exposures to acetone, 2-propanol and glycol ether are expected to be well below permissible exposure limits. To protect skin, chemical impermeable gloves should be provided. Nitrile gloves are not recommended for acetone, but may be worn for the other two chemicals. Neoprene or rubber gloves are recommended for protection against acetone. The workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required is provided as Attachment H-8.1. Maintain PPE that is in good condition and store it in a sanitary manner. Ensure that MSDSs for all chemical-containing products are entered into MSDS Pro. Ensure all personnel have received hazard communication training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided.

c) Exposure Monitoring: Based on the frequency and duration of use, air monitoring for these chemicals was not warranted.

6. Operating Router to Cut Carbon Fiber Board

a) Observations:

1) One contractor in the Bldg 5A, Rm 020A Router Room operates the Thermwood Router Model 40 equipped with a HSD ES919 spindle and a Dust Technology, Inc. DT-50 LEV system including two collection bags. The router is operated to machine carbon composite materials to given specifications for up to four hours per day. A typical material machined is Hexcel 954-3/3A, carbon fiber impregnated with cyanate resin. A request-based survey of the Router Room initiated on 17 September 2003 revealed the presence of visible carbon dust and the return air grill appeared to be dirty. According to air velocity measurements taken at this time, the air flow was less than that recommended by the manufacturer of the exhaust system. As a result, recommendations were made to improve the local exhaust system for the router room. Area air monitoring for carbon dust and carbon fiber indicated that levels were well below applicable exposure limits. The air monitoring results and report for the request-based survey are kept with this Baseline Survey at the IHO.

2) A sound level survey was performed as part of the request-based survey initiated on 17 September 2003. Sound levels in the entire Router Room 020A were found to exceed 85 dBA during the operation of the Thermwood Router. Sound levels outside Room 020A were below 85 dBA when the door was kept closed. The NASA Hearing

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Conservation Policy (NPG 1820.1) requires that personnel wear hearing protection when employee noise exposure is above 85 dBA, regardless of duration. The employee wore hearing protection. The results of past sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO).

3) Ear plugs, safety glasses and respirators were available for personnel use. A disposable respirator was not stored in a sanitary location at the time of the request-based survey in September, 2003. In addition, the operator maintained a beard, which would compromise the face to face-piece seal. Documentation of training on the proper use of PPE was maintained through a Mantech database system.

b) Recommendations:

1) Numerous recommendations were made concerning the reconfiguration of the exhaust system as a result of the request-based survey. These included: 1) Configuring the system to minimize the number of elbows, right angles in particular, in the ductwork; 2) Minimizing total linear footage of ductwork; 3) Incorporating smooth metal ducts into the system in place of flexible tubing; 4) Utilizing ducts with larger diameters such as the original 10" ducts near the collectors; 5) Eliminating the 10" to 4" reducer near the bag collectors; 6) Constructing the ductwork so that the section run above and parallel with the ceiling tiles extends to the middle of the work area instead of to the far end; 7) Locating the exhaust hood to within 3" of the spindle tool; 8) Investigating the possibility of fitting the spindle head with a dust shroud which would enclose the spindle head; 9) Adjusting the general ventilation system so that it operates under negative pressure with respect to adjacent areas to minimize carbon dust in other rooms; 10) Checking to see that the motor of the LEV system was correctly installed so that the fan blades are running counter-clockwise; 11) Investigating the possibility of placing the bag collectors outdoors; 12) Limiting the amount of carbon dust that enters the return air grill and the general exhaust system to other rooms, possibly by using filters; 13) Procuring N100 respirators to purify the air of 99.97% of particulates; 14) Ensuring respirators are stored in a sanitary location such as their original sealed bags away from chemical storage areas; 15) Ensuring personnel wearing respirators are included in their company's respiratory protection program.

2) Ensure that personnel continue to wear hearing protection during the operation of the router producing sound levels in excess of 85 dBA, regardless of duration. Continue to wear safety glasses. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1. Continue to ensure that documented hazard communication and PPE training is provided.

c) Exposure Monitoring: No further air or noise monitoring is recommended at this time.

7. Laying-up Materials

a) Observations:

Attachment 12 continued

1) Room 020B is a former clean room now used as a lay-up room. Two civil servants and up to four contractors perform cutting, bonding and cleaning operations similar to those already discussed approximately two times per week for 8 hours in this room. Personnel use razor blades and knives to cut the carbon composite face sheets and use a heat gun to compress the uncured composite material. An operation performed less frequently on the order of 2-3 times per month bonding carbon composite face sheets to both sides of the aluminum honeycomb core panels. In performing these steps, epoxy systems and spray adhesives are used as bonding agents and chemicals such as acetone and isopropyl alcohol are used to clean. Cuts were reported as the greatest injury or illness risk.

2) Personnel wore required safety glasses and other forms of PPE such as hearing protection, nitrile gloves, full-face respirators, half-face respirators, and disposable respirators were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available. Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants.

b) Recommendations:

1) Epoxy resins and hardeners present a hazard primarily as skin irritants. Airborne exposures to epoxy resins, acrylated epoxies, and polyamines, as well as to acetone and IPA are expected to be well below permissible exposure limits. To protect skin, chemical impermeable gloves should be provided. For the limited frequency and duration in which epoxies are handled, the nitrile gloves should afford protection before breakthrough occurs. Butyl rubber gloves are recommended for hardeners. Neoprene gloves are recommended for acetone. The workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required is provided as Attachment H-8.1. Maintain PPE that is in good condition and store it in a sanitary manner.

2) Ensure that MSDSs for all chemical-containing products are entered into MSDS Pro. Ensure all personnel have received hazard communication training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided.

c) Exposure Monitoring: No further air monitoring was warranted for this operation based on the results of past monitoring and the nature and frequency of operations.

8. Using Autoclave to Cure Composite Materials

a) Observations:

1) The Autoclave Room 020C in Bldg. 5A is a small room containing the autoclave and is open to the Main Room 020. Composite materials are cured under heat at 350°F and

Attachment 12 continued

pressure at 100 p.s.i in the autoclave. Compressed nitrogen gas is stored in two 183 ft^3 cylinders and liquid nitrogen is stored in two 160 L containers, both located outside of Building 5A and introduced into the autoclave via a closed stainless steel piping system. Two civil servants and one contractor operate the autoclave 1-2 times per week for 4-5 hours.

2) It is unlikely that a catastrophic release or major leak would produce concentrations great enough to generate an oxygen-deficient atmosphere. However, given that the conservative estimate of the combined volumes of Rooms 020 and 020C is 18,000 ft^3, a 183 ft^3 cylinder of gas could displace enough oxygen to reduce the percentage of oxygen in the air to 19.1%. Levels lower than 19.5% are considered oxygen deficient and require evacuation. This calculation assumes a worst-case scenario of instantaneous release of the full contents of the cylinder with complete mixing, preferential displacement of oxygen instead of other gases in air and no exhaust or air changes. In actuality, this room may be larger than 18000 ft^3, especially if doors to other rooms are open. Also, any potential gas leak would be diluted by air supplied through the supply air grills. This reduces the likelihood of an oxygen deficient atmosphere being produced in the event of a major or catastrophic release. A catastrophic release of liquid nitrogen would translate into a negligible volume of nitrogen gas and thusly would not significantly affect oxygen concentration.

b) Recommendations: In the event of a major gas cylinder leak, the room should be evacuated according to the emergency evacuation plan. The emergency console should be reached at 911 and efforts such as operating the general exhaust ventilation system with 100% outside air should be made to bring oxygen levels to the minimum of 19.5%. If changes require the use of more toxic gases, contact the IHO so that appropriate precautions to protect employees from catastrophic leaks may be taken.

c) Exposure Monitoring: No further air or noise monitoring was warranted due to the nature of the aforementioned hazards.

9. Planning and Assembling Models

a) Observations: Two civil servants in the E052 Model Shop perform planning and administrative activities approximately four hours per day. These personnel also perform assembly activities in addition to those discussed in the following paragraphs. This paragraph generally includes activities that play a major role in building models from the planning stage to finished product without being classified as having particular hazards. Personnel requested additional lighting on the northwest walls in E052 and E048.

b) Recommendations: Provide, where feasible, articulated keyboard trays that accommodate the keyboard and mouse. Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Position the keyboard so that it is between 28-30 inches above the floor. To allow sufficient knee space if an adjustable keyboard tray is installed

Attachment 12 continued

to the underside of the desk, the height from the floor to the adjustable keyboard tray should range from 23-28 inches. Use adjustable chairs that allow personnel to sit at comfortable height, angle, and distance from the screen. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Ensure a minimum viewing distance of 12 inches and support the monitor so that the top of the screen is at eye level with the screen tilted slightly downward. The entire viewing plane should be between 0 and 40 degrees below the horizontal viewing plane. When viewing screens with dark backgrounds, use lower lighting. Dark characters on a light screen are generally more readable. Ensure high contrast between the screen background and the screen characters. Minimize glare and choose screens that tilt and have contrast and brightness controls.

10. Bonding

a) Observations:

1) Two civil servants perform bonding activities on a weekly basis for one hour. Bonding may include epoxy systems, spray adhesives, solvent cement or wood glue. Epoxy systems generally include epoxy resins, hardeners and catalysts containing epoxy resins, acrylated epoxies and polyamines. A number of different epoxies were discussed in process 4 (Bonding and Adhesive Mixing) of this section, along with the spray adhesive. Solvent cement is used primarily for acrylics. Not all epoxy systems observed in the storage cabinets in Building 5A, for example Miller Stephenson Epon Resin 815 and Epi-Cure 3140, had corresponding MSDSs entered into MSDS Pro. Air monitoring results obtained in 2001 for epichlorohydrin and acrylonitrile indicated concentrations below the limit of quantitation and below applicable exposure limits. These results are kept with this Baseline Survey Report in the IHO.

2) Personnel wore required safety glasses and other forms of PPE such as hearing protection, nitrile gloves, and full-face respirators and disposable respirators were available for personnel use. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available. Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants.

b) Recommendations:

1) Epoxy resins and hardeners present a hazard primarily as skin irritants. Airborne exposures to epoxy resins, acrylated epoxies, and polyamines are expected to be well below permissible exposure limits. To protect skin, chemical impermeable gloves should be provided. For the limited frequency and duration in which epoxies are handled, the nitrile gloves should afford protection before breakthrough occurs. Butyl rubber gloves are recommended for hardeners. The workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required is provided as Attachment H-8.1. Maintain PPE that is in good condition and store it in a sanitary manner.

Attachment 12 continued

2) Ensure that MSDSs for all chemical-containing products are entered into MSDS Pro. Ensure all personnel have received hazard communication training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided.

c) Exposure Monitoring: Due to the nature of epoxies and the frequency and duration in which epoxies are mixed or used, air monitoring for epoxy resins, acrylated epoxies, and polyamines was not warranted.

11. Cleaning

a) Observations: Isopropyl alcohol and other chemicals are used for cleaning parts. These operations are performed on an estimated daily basis for 15 minutes. Air monitoring results for similar operations in the past indicated concentrations below the 8-hour exposure limit. Personnel wore safety glasses as required, and wore other forms of PPE such as nitrile gloves, full-face respirators, half-face respirators, and disposable respirators. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available. Although Mantech maintained records of hazard communication and PPE training for its employees, no such records were available for civil servants.

b) Recommendations: Airborne exposures to isopropyl alcohol is expected to be well below permissible exposure limits. To protect skin, chemical impermeable gloves such as the nitrile type provided are adequate. The workplace hazard assessment, identifying operations requiring the use of PPE and the type of PPE required is provided as Attachment II-8.1. Maintain PPE that is in good condition and store it in a sanitary manner. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided.

c) Exposure Monitoring: Based on the frequency and duration of use, air monitoring for these chemicals was not warranted.

12. Painting

a) Observations:

1) Two civil servant employees apply acrylic spray paint and other paint to models and model components approximately weekly for two hours. Personnel stated that they would not wear PPE with the exception one employee who would wear a full-face respirators on occasion. Painting is also performed at a local exhaust hood. Mr. Moffatt is enrolled in the Respiratory Protection Program, but has not received training, fit-testing

Attachment 12 continued

or a medical evaluation this year. Although Mantech maintained records of hazard communication and PPE training, no such records exist for civil servants.

2) The exhaust hood in which this operation is conducted was found to be in compliance with its annual inspection and appeared to be adequate for this operation. The velocity of the air at a point 22" from the face of the hood measured 150 feet per minute (fpm) during the 6 June 2003 LEV evaluation.

b) Recommendations:

1) Ensure that this primer as a Class I flammable liquid is properly stored in the flammable liquid storage cabinet and that there are no spark-producing equipment present during spraying operations. Continue to ensure that the exhaust hood is evaluated according to its annually scheduled inspection.

2) Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented. Respirators may be worn for added protection, but personnel wearing respirators must be enrolled in the Respiratory Protection Program. Prior to using respirators, personnel must receive medical clearance, respiratory protection training and fit-testing, and cartridges must be appropriately selected to protect against the hazards presented by this product.

3) Ensure that personnel are aware of the written hazard communication program which at least describes labeling and other forms of warning, material safety data sheets, and employee information and training. Ensure all personnel have received hazard communication training. Ensure that all employees receive training upon initial assignment on the hazardous chemicals in their work area at the time of their initial assignment, and whenever a change in chemicals or processes is introduced. Maintain documentation that this training was provided. Continue to ensure that each container of hazardous chemicals in the workplace is labeled with its identity and appropriate hazard warnings. Ensure that personnel are aware that all MSDSs are readily accessible through the MSDS Pro database, primarily administered by the Plating Group.

c) Exposure Monitoring: Follow-up air monitoring is not warranted due to the short duration of the operation.

13. Operating Milling Machines, Lathes, Drills, Planer, Shaper

a) Observations:

1) Two civil servant employees operate milling machines, lathes and other CNC or precision machines in the Building 5, Rooms E052, E048 and E048A Model Shop. A Pratt & Whitney M100A 4108 drill, Deckel drill FP1 (sn# 36503), Monarch Pointfinder 50 lathe (sn# 9503639), Bridgeport milling machine PT600 (sn# 002597), Clausing drill (sn# VL3480; ECN 19811), Delta RC51 planer (sn# 3522), Delta DJ20, and Delta shaper (ECN 261989) were used for machining sheets of aluminum, plexiglass, wood and other

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materials. The employees operate these machines on a monthly basis for eight hours. Machines appeared to be properly guarded. Local exhaust ventilation hoods appeared to have been evaluated according to their annually scheduled inspection. The results of the 6 June 2003 LEV evaluation indicated the provision of adequate exhaust for these operations as indicated in Table F-3. Compressed air nozzles with pressure relief and limited to 30 p.s.i were observed along with other nozzles, of which the pressure could not be determined. A primary eyewash was located outside the room within 100' or 10 seconds, but the secondary eyewash was out of service.

2) A sound level survey conducted in this area during a simulation of work with and without work-pieces and a sound level survey for similar operations in other areas of Code 547 indicated that instantaneous sound levels during the operation of certain machines exceeded 85 dBA, the level at which hearing protection must be worn. Limited noise dosimetry conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). However, the monitoring result as part of this survey showed that the employee was exposed to noise at an average level of 80.7 dBA for 355 minutes during the operation various machines. The results of the current sound level survey and noise dosimetry are presented below in Tables H-8.2 and H-8.3. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that were required to be enrolled in a Hearing Conservation Program were identified, although the one monitoring result this year indicates the need for further monitoring. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) PPE such as safety glasses, hearing protection, and nitrile gloves were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were worn during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

4) Due to the nature of the operation and monitoring results of similar operations in other areas of Code 547, personal exposure to airborne oil mist and metal particles was expected to be well below applicable occupational health limits. A copy of past monitoring results is kept with this Baseline Survey in the IHO.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of equipment producing sound levels in excess of 85 dBA, regardless of duration. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on previous noise dosimetry results, personnel are not required to participate in the GSFC Hearing Conservation Program. However, based on noise dosimetry performed during this survey, persons are recommended for enrollment in the Hearing Conservation Program until follow-up monitoring shows conclusively that personnel are not exposed to

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noise greater than 80 dBA as an 8-hour TWA for 30 or more days per year. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Ensure that safety glasses are worn as proper PPE during the operation of machines. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented.

3) Use compressed air nozzles with effective chip guarding and limited to 30 p.s.i.

c) Exposure Monitoring: Further noise monitoring is warranted to determine appropriateness of enrollment in the Hearing Conservation Program. The IHO will contact the shop supervisor to schedule noise dosimetery.

14. Operating Saws, Grinders, and Sanders

a) Observations:

1) Rough cutting operations such as sawing, grinding and sanding are conducted by two civil servants in Rooms E052, E048, and E048A Model Shop on a weekly basis for eight hours. Room E048 contains a Burr King Model 562 sander, and a Baldor scroll saw (sn# 8640 5260). Room E048 contains a Reuland sander (sn# 91217 3A-1; ECN 1100834), Two Inca saws (ECN 1193839), Hammond grinder (sn# 64D), Dewalt table saw (ECN 308256), Clayton drum saw, and Milwaukee mitre saw. Room 048A contains a Jet belt sander/grinder model JSG-6, Delta Unisaw (sn# 92A01025), and Black & Decker Sawcat panel saw. Machines appeared to be properly guarded. Local exhaust ventilation hoods appeared to have been evaluated according to their annually scheduled inspection. The results of the 6 June 2003 LEV evaluation indicated the provision of adequate exhaust for these operations as indicated in Table F-3. Personnel requested, however, more LEV hoods in Room 048A for the table saw.

2) Sound level measurements indicated that instantaneous sound levels exceeded 85 dBA during these operations. Limited noise dosimetry conducted in the past and as part of this survey indicated employee exposure to noise was less than NASA's 80 dBA Action Level as an 8-hour time-weighted average (TWA). One monitoring result showed that the employee was exposed to noise at an average level of 80.7 dBA for 355 minutes during the operation various machines. The results of the current sound level survey and noise dosimetry are presented below in Tables H-8.2 and H-8.3. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years.

3) PPE such as safety glasses, hearing protection, and nitrile gloves were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were worn during operations producing high noise levels. A workplace hazard assessment

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documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) In accordance with the NASA Hearing Conservation Policy (NPG 1820.1), personnel must wear hearing protection during the operation of saws, grinders, sanders, and other equipment producing sound levels in excess of 85 dBA, regardless of duration. Double hearing protection is recommended for use while operating the Black & Decker Sawcat panel saw and other equipment generating sound levels of 103 dBA or greater. Ensure that these machines are labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. Based on noise dosimetry performed during this survey, persons are recommended for enrollment in the Hearing Conservation Program until follow-up monitoring shows conclusively that personnel are not exposed to noise greater than 80 dBA as an 8-hour TWA for 30 or more days per year. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Ensure that safety glasses are worn as proper PPE during the operation of machines. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure that employee training regarding PPE is documented.

c) Exposure Monitoring: No further air or noise monitoring is warranted unless changes in processes or operations increase noise exposure to personnel

15. Operating Hand Equipment/Portable Pneumatic Equipment

a) Observations:

1) Two civil servant employees operate hand equipment such as a Shil drill, air grinder, Bosch jigsaw 1587 and Milwaukee circular saw on a weekly basis for up to hours per day. Some pneumatic hand equipment including the air grinder generates sound levels exceeding 85 dBA as shown in Table H-8.2 and as indicated by past sound level measurements. Limited noise dosimetry in this area and the adjacent Machine Shop conducted in the past and as part of this survey indicated that exposure was less than 80 dBA as an 8-hour TWA. One monitoring result showed that the employee was exposed to noise at an average level of 80.7 dBA for 355 minutes during the operation various machines. The results of past dosimetry and sound level measurements are kept with this Baseline Survey Report in the Industrial Hygiene Office (IHO). No personnel that are required to be enrolled in a Hearing Conservation Program were identified. Personnel stated they had not received hearing conservation training or audiometric testing for a few years. Hearing protection was worn when operating hand equipment generating high sound levels.

2) PPE such as safety glasses, hearing protection, and nitrile gloves were available for personnel use. Hearing protection devices in the form of ear muffs and ear plugs were

Attachment 12 continued

worn during operations producing high noise levels. A workplace hazard assessment documenting the operations necessitating the use of PPE was not available and any training for affected personnel was not documented.

b) Recommendations:

1) Personnel are required to wear hearing protection when operating hand equipment such as air grinders that produce sound levels in excess of 85 dBA, regardless of duration, in accordance with the NASA Hearing Conservation Policy (NPG 1820.1). Double hearing protection is required when operating equipment such as the Milwaukee hand-held circular saw and Sawcat panel saw that generates noise in excess of 104 dBA. Ensure that this equipment is labeled *"Hazardous Noise – Wear Hearing Protection When Operating Machinery"*. However, based on noise dosimetry performed during this survey, persons are recommended for enrollment in the Hearing Conservation Program until follow-up monitoring shows conclusively that personnel are not exposed to noise greater than 80 dBA as an 8-hour TWA for 30 or more days per year. Since it is prudent practice to minimize exposures to "high" noise levels, it is recommended that employees wear hearing protection whenever exposure levels are in excess of 80 dBA.

2) Continue to wear safety glasses. Maintain or post the PPE Hazard Assessment Checklist provided as Attachment H-8.1 and ensure employee training regarding PPE is documented.

c) Exposure Monitoring: No further noise monitoring is warranted unless changes in processes or operations increase the exposure of noise to personnel.

Cancer/Mutation/Reproduction Hazards:
Strontium chromate is listed by ACGIH as a suspected lung carcinogen. Formaldehyde is listed by ACGIH as a suspected carcinogen with sensitizing characteristics. The IARC lists hexavalent chromium compounds as carcinogenic to humans, formaldehyde as a probable carcinogen, and toluene diisocyanate as possibly carcinogenic. 2-ethoxyethanol is listed by ACGIH as a chemical causing reproductive effects and is among chemical substances contained in a Department of Navy Occupational Chemical Reproductive and Developmental Hazard List along with toluene as substances known to cause reproductive or developmental toxicity in humans, or known to cause reproductive or developmental toxicity in animals by mechanisms of action directly applicable to humans.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-8.1. This checklist is to be reviewed with personnel and posted in the work area. Documentation that personnel received this information must be kept on file.

Medical Surveillance Recommendations:
Personnel in the Model Shop are recommended for enrollment in the Hearing Conservation Program. Based on anticipated exposures and corresponding regulatory requirements, there

Attachment 12 continued

are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, radiation monitoring, or biological monitoring.

Sound Level Survey:
A sound level survey performed during the operation of equipment in Building 5, Rooms E052, E048 and E048A showed sound levels to be at or greater than 85 decibels as measured on an A-weighted scale (dBA) at the operator's hearing zone during the operation of certain equipment. The NASA Hearing Conservation Policy (NPG 1820.1) requires that personnel wear hearing protection when exposure to noise is above 85 dBA, regardless of duration, or when personal exposure to noise is equal or greater than 80 dBA as an 8-hour Time-Weighted-Average (TWA) for more than 30 days per year.

Table H-8.2
Summary of Sound Pressure Level Results in the Model Shop Rooms E052, E048, E048A

Equipment Type/Area	Sound Levels (dBA)*	Hazard Radius (ft)	Comments
Burr King Sander Model 562/E052	82-83	--	
Baldor Scroll Saw/E052	85	2	
Compressed Air/E052	90-99	20	
Pneumatic Grinder/E052	90-99	20	
Pneumatic Jigsaw Bosch 1587/E052	94-95	20	
Milwaukee Circular Saw/E052	102-106	ER	
Reuland Sander/E048	85-90	5	
Inca Saw/E048	78-79	--	
Inca Saw 1193839/E048	79-80	--	
Hammond Grinder/E048	82-92	15	
Deckel Drill/E048			
DeWalt Table Saw/E048	91-92	10	
Clayton Drum Saw/E048	87-88	5	
Bridgeport Milling Machine PT600/E048	70-72	--	With no work piece
Milwaukee Mitre Saw/E048	95-97	ER	
Clausing Drill/E048	80	--	With no work piece
Delta RC51 Planer/E048	90-91	10	
Delta DJ20/ E048A	81-83	--	
Delta Shaper/E048A	90-93	10	
Jet Belt Sander/Grinder JSG-6/E048A	73-75	--	
Delta Unisaw Arbor Saw/E048A	89-90	7	
Black&Decker Sawcat Panel Saw/E048A	103-106	ER	

* at the operator's hearing zone
ER – entire room

Table H-8.3
Noise Dosimetry Results

Attachment 12 continued

Employee/ Dosimeter/ Date	Location/ Operation	Average (dBA)*	8-Hour Time-weighted average (TWA)	Dose (%)	Time Period (minutes)
Gary Moffatt/ QAB060055/ 6 Jan 04	Bldg 5, Rm E052/ Model Shop – operating various machines	80.7	78.5	20.35	355

* average exposure in decibels, A-weighted, for the time period

Attachment 12 continued

Attachment H-8.1

<table>
<tr><td colspan="3">Personal Protective Equipment Checklist</td></tr>
<tr><td colspan="2">Code: 547
Building: 5 & 5A
Process Area: Composites and Rapid Prototyping Group
Date: 12/22/03</td><td>Supervisor: Mike Schoolman
Telephone: 6-5217
Industrial Hygiene: IHO
Telephone: 6-6669</td></tr>
<tr><td colspan="3">PPE Key</td></tr>
<tr><td>Eye and Hearing Protection</td><td>Clothing and Hand Protection</td><td>Respiratory Protection</td></tr>
<tr><td>a. Safety glasses or goggles
b. Chemical splash goggles
c. Non-ventilated goggles
d. Face shield
e. Welding goggles
f. Welding helmet
g. Single hearing protection (plugs or muffs)
h. Double hearing protection (both)
i. Other</td><td>a. Type coveralls
b. Cloth coveralls
c. Long sleeve shirt
d. Type hood
e. Cloth hood
f. Leather jacket or vest
g. Chemical resistant apron
h. Chemical resistant boots
i Chemical resistant gloves (specify)
j. Temperature resistant gloves
k. Barrier creams</td><td>a. Disposable face mask
b. Half-face APR* respirator
c. Full-face APR respirator
d. Hood
e. Helmet
f. Powered APR respirator
g. Supplied-air respirator
h. SCBA**
i. Cartridge type (specify)
j. Other

* Air Purifying Respirator
** Self Contained Breathing Apparatus</td></tr>
</table>

PPE Recommendations						
Operation	**Bldg**	**Room**	**Eye & Hearing Protection**	**Clothing & Hand Protection**	**Minimum Respiratory Protection**	**Comments**
Disassembling tools, storing, preparing surfaces	5A	020	a, i	None	None	Safety glasses and safety shoes required.
Using mold release	5A	020	a, i	i	None	Safety glasses and shoes required and neoprene gloves recommended.
Priming	5A	020	a, i	i	None	Safety glasses and shoes required and neoprene gloves recommended.

Attachment 12 continued

Bonding and adhesive mixing	5A	020	a	i	None	Safety glasses and shoes required and neoprene gloves recommended.
Miscellaneous use of chemicals, cleaning, stamping	5A	020	b or d	i	None	Safety glasses required and neoprene gloves recommended. Chemical splash goggles where splashing may occur
Operating router	5A	020A	a, g, i	None	None	Safety glasses, shoes and hearing protection required. Abrasion-resistant gloves recommended.
Laying-up materials	5A	020B	a, i	None	None	Safety glasses, shoes. Abrasion-resistant gloves recommended.
Using autoclave to cure composite materials	5A	020C	a, i	None	None	Safety glasses and shoes required in shop
Bonding	5	E052	b or d, a, i	i	None	Safety glasses and shoes required and neoprene gloves recommended. Chemical splash goggles where splashing may occur
Cleaning	5	E052	b or d, a, i	i	None	Safety glasses and shoes required and neoprene gloves recommended. Chemical splash goggles where splashing may occur
Painting	5	E052	a, i	None	None	Safety glasses and shoes required. Neoprene gloves recommended. Chemical splash goggles where splashing may occur
Operating milling machines, lather, drills, planer, shaper	5	E052, E048, E048A	a, g, i	None	None	Safety glasses, shoes, hearing protection required.
Sawing, grinding, sanding	5	E052, E048, E048A	a, g, i	None	None	Safety glasses, shoes, hearing protection required.

Attachment 12 continued

Operating portable equipment	5	E052, E048, E048A	a, g, i	None	None	Safety glasses, shoes, hearing protection required.

Attachment 12 continued

Section 9

Process Area: Clean Room

Location: Building 5, Room E005A

Date of Survey: October 28, December 22, 2003

Attachment: (H-9.1) PPE Checklist

Process Area Description:
The Clean Room, which is used and controlled by Code 547, but not the responsibility of any single group, includes the clean room and a small area for staging and processing parts. Three civil servants may occupy the staging and office area where parts are received and verified before they are passed transferred to the actual clean room. The function of the Class 1000 clean room is for building core 1 flight instruments at the Class 100 bench. The bench and clean room are operated under positive pressure and the bench is equipped with a HEPA filter.

Work Tasks:
Table H-9.1 presents the major operations that are associated with the Clean Room and the hazards that are of concern to the Industrial Hygiene Office.

Table H-9.1

Building	Room/Name	Work Task (Equipment)	Potential Health Hazards	# of Workers Exposed	Frequency/ Duration	Risk Assessment[1]
5	E005A	Receiving, staging and processing parts	Repetitive motions, heavy objects	3 (3 GS)	3-5x weekly/1 min.-6 hrs	N/A
5	E005A	Assembly, alignment, cleaning	Isopropyl alcohol	5 (3 GS)	Daily/5 min - hours	16

1. Receiving, Staging and Processing

[1] The Risk Assessment Ranking provides a numerical index of the potential hazard and allows prioritization of further monitoring or evaluation. See Appendix 1 for instructions on calculating the Risk Assessment rankings.

0-50 = Review if process changes.
50-107 = Review process every 24-36 months.
100-207 = Collect air samples and review process every 12 months.
200-307 = Collect air samples and review process every 6 months.
300 + = Collect air samples and review process every 3 months.

Attachment 12 continued

a) Observations: Up to three civil servants, but usually one, occupy an area separated from the actual clean room. Parts are super cleaned in Bldg 29 before they are baked-out in other areas. Following this, they are received, staged and processed in this staging area. The parts are verified so that there are no silicones present, a substance that would interfere with mechanism function, and given to personnel in the actual clean room so that clean room personnel do not have to exit the clean room in order to get the parts. Personnel in the staging and processing area do not wear PPE and are not exposed to hazardous chemicals. Employees in this area stated they would work up to 11 hours per day, presenting a repetitive motion injury risk if work primarily involves entering data. No complaints were noted.

b) Recommendations: Use proper lifting techniques when transferring heavy objects. Provide, where feasible, articulated keyboard trays that accommodate the keyboard and mouse. Adopt a 70-90° angle between the upper arm and forearm, with an upper maximum angle of 135° putting wrists in alignment with forearms. Work surfaces should be located so that the arms and shoulders do not have to be lifted to perform the work. Position the keyboard so that it is between 28-30 inches above the floor. To allow sufficient knee space if an adjustable keyboard tray is installed to the underside of the desk, the height from the floor to the adjustable keyboard tray should range from 23-28 inches. Use adjustable chairs that allow personnel to sit at comfortable height, angle, and distance from the screen. Stretch and perform hand exercises at regular intervals, or change the pattern of work if possible. Ensure a minimum viewing distance of 12 inches and support the monitor so that the top of the screen is at eye level with the screen tilted slightly downward. The entire viewing plane should be between 0 and 40 degrees below the horizontal viewing plane. When viewing screens with dark backgrounds, use lower lighting. Dark characters on a light screen are generally more readable. Ensure high contrast between the screen background and the screen characters. Minimize glare and choose screens that tilt and have contrast and brightness controls.

2. Assembly, Alignment and Cleaning

a) Observations: Up to two contract employees and three civil servants perform clean room operations including assembly, alignment and cleaning with isopropyl alcohol. In the clean room and more specifically at the bench, parts are assembled and aligned with telescopes. Personnel wore full body suits, face masks and gloves in the clean room. A documented workplace hazard assessment of operations necessitating the use of personal protective equipment (PPE) was not available. A book containing MSDS was available to employees. It was not determined if hazard communication or PPE training was provided or if employees were aware of MSDS Pro.

b) Recommendations: Due to the nature of the chemicals used and the frequency and duration of use, air monitoring was not warranted. Continue to wear the types of PPE suitable for a clean room. Maintain the workplace hazard assessment attached as Attachment H-9.1. Chemical impervious gloves including nitrile gloves are recommended for protection against skin irritants. Chemical splash goggles are recommended where splash hazards are present.

Attachment 12 continued

c) *Exposure Monitoring:* Routine monitoring is not required based on the frequency and duration of the operation.

Cancer/Mutation/Reproduction Hazards:
No substances listed by the ACGIH as suspected or probable carcinogens were identified as being used in this code.

Personal Protective Equipment:
A PPE Checklist is presented as Attachment H-9.1. A copy is to be reviewed with appropriate workers for each work task and posted in the work area.

Medical Surveillance Recommendations:
Based on chemical and physical hazard assessments and regulatory requirements, there are no workers or work activities that warrant participation in medical surveillance programs that include respiratory protection, hearing conservation, radiation monitoring, or biological monitoring.

Attachment 12 continued

Attachment H-9.1

Personal Protective Equipment Checklist	
Code: 547 **Building:** 5 **Process Area:** Clean Room **Date:** 12/22/03	**Supervisor:** David Clark **Telephone:** 6-0710 **Industrial Hygiene:** IHO **Telephone:** 6-6669

PPE Key

Eye and Hearing Protection	Clothing and Hand Protection	Respiratory Protection
a. Safety glasses or goggles b. Chemical splash goggles c. Non-ventilated goggles d. Face shield e. Welding goggles f. Welding helmet g. Single hearing protection (plugs or muffs) h. Double hearing protection (both) i. Other	a. Type coveralls b. Cloth coveralls c. Long sleeve shirt d. Type hood e. Cloth hood f. Leather jacket or vest g. Chemical resistant apron h. Chemical resistant boots i Chemical resistant gloves (specify) j. Temperature resistant gloves k. Barrier creams	a. Disposable face mask b. Half-face APR* respirator c. Full-face APR respirator d. Hood e. Helmet f Powered APR respirator g. Supplied-air respirator h. SCBA** i Cartridge type (specify) j. Other * Air Purifying Respirator ** Self Contained Breathing Apparatus

PPE Recommendations

Operation	Bldg	Room	Eye & Hearing Protection	Clothing & Hand Protection	Minimum Respiratory Protection	Comments
Assembly, alignment Parts cleaning	5	E005A	b or d, i	i	None	Clean room full body suits, masks, gloves, booties, hats. Face shield or goggles where splashing may occur. Nitrile gloves for chemicals

Attachment 12 concluded

Attachment 13a: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-029

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-029
Account No. 19802030
Report Date: 11/11/08

CHING
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 11/05/08
Sample Type: 5 - Air Sample(s)
Project: BLDG 5 PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	11 Samp Date: 10/28/08		5um PVC filter with quartz support pad			
-	CRVI	769 L	< 0.025 ug	.025 ug	< 0.033 ug/M3	11/10/08
-002	12 Samp Date: 10/28/08		0.8 micron MCE filter			
-	Sodium	686 L	3.03 ug	2.5 ug	0.004 mg/M3	11/07/08
-	Zinc	686 L	< 2.00 ug	2 ug	< 0.003 mg/M3	11/07/08
-003	13 Samp Date: 10/28/08		0.8 micron MCE filter			
-	Sodium	1.059 L	< 2.50 ug	2.5 ug	< 2.361 mg/M3	11/07/08
-004	10CRB Samp Date: 10/28/08		5um PVC filter with quartz support pad			
-	CRVI	0 L	< 0.025 ug	.025 ug	--	11/10/08
-005	10B Samp Date: 10/28/08		0.8 micron MCE filter			
-	Sodium	0 L	2.62 ug	2.5 ug	--	11/07/08
-	Zinc	0 L	< 2.00 ug	2 ug	--	11/07/08

Sodium present in client blank. Samples are not corrected.

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 1

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13a continued

ANALYTICS CORPORATION
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www.analyticscorp.com

Group No. M309-029
Account No. 19802030
Report Date: 11/11/08

CHING
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Hexavalent Chromium	OSHA ID 215	CRVI
Sodium	NIOSH 7300M	----
Zinc	NIOSH 7300	----

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13a continued

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED: 10-31-08
OF SAMPLES: 5
SAMPLE TYPE/MEDIA: Filter
PROJECT NAME OR NUMBER: Bldg 5, Plating Shop
PURCHASE ORDER NO.:
CONTACT: Ching-tser Bien
TELEPHONE NUMBER: 301-286-6918

TURN AROUND TIME: ☐ SAMEDAY ☐ 1 DAY * CALL FOR AVAILABILITY ☐ 2 DAY ☒ STANDARD * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:

☐ FAX RESULTS FAX NUMBER: ( )
☐ EMAIL RESULTS - EMAIL: Ching-tser.bien-1@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	11	10-28-08	769	Chromic acid Phosphoric acid
	12		686	Sodium and Zinc
	13		1,059	Sodium*
	10 CRB		0	for Chromic acid
	10 B		0	Sodium and Zinc

Sample Contains sodium hydroxide, Sodium Carbonate, tetrasodium pyrophosphate, Sodium metasilicate

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

SIGN HERE TO INITIATE CHAIN OF CUSTODY: Ch-tz C

CARRIER: IF "ANALYTICS COURIER" SIGN HERE: DATE: 10-31-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
11/4/08 1000	Intact	SIGNATURE(SAMPLE RECEIVING) [signature]	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 13a concluded

TERMS AND CONDITIONS

Except as otherwise provided on this document or other related documents, the parties agree to the following provisions:

1. Acceptance and Modification: This document contains all terms of the parties' agreement concerning the services described on this document or other related documents (to include, but not limited to, environmental analysis policies listed in the Analytics Environmental Laboratory services brochure), can be accepted only upon the provisions expressed herein, and may not be modified, added to, amended, superseded or waived except in writing by Analytics Corporation, duly authorized representative. Client may accept this document by acknowledging or confirming it or by accepting any performance, partial or complete, by Analytics Corporation. Reference by Analytics Corporation to any purchase or work order number supplied by Client shall be for accounting identification purposes only. This document shall be binding upon the successors and assigns of the parties.

2. Independent Contractor: In performing its services, Analytics Corporation shall be deemed to be acting solely as an independent contractor, and only to the extent and for the specific purpose expressly set forth on this document or other related documents.

3. Force Majeure: Delay in performance or failure to perform by Analytics Corporation shall be excused to the extent caused by any act of God, labor trouble, fire, inclement weather, act of governmental authority, failure of transportation, accident or any other limitation. Client's failure to furnish information or to approve or disapprove Analytics Corporations' work. In the event of any of these circumstances, Analytics Corporations' time for completion of its services shall be extended accordingly.

4. Limited Warranty and Limitation of Liability: ANALYTICS CORPORATION MAKES NO EXPRESS OR IMPLIED REPRESENTATION, WARRANTY OR CONDITION AS TO ITS SERVICES, FINDINGS, RECOMMENDATIONS OR PROFESSIONAL ADVICE EXCEPT THAT THEY ARE PREPARED, PERFORMED AND RENDERED IN ACCORDANCE WITH PROCEDURES, PROTOCOLS AND PRACTICES GENERALLY ACCEPTED IN ANALYTICS CORPORATIONS' PROFESSION FOR USE IN SIMILAR ASSIGNMENTS. ANALYTICS CORPORATION SHALL NOT BE LIABLE TO CLIENT IF SUCH NON-COMPLIANCE IS CAUSED BY NEGLIGENCE OR WILLFUL MISCONDUCT OF CLIENT. NOTWITHSTANDING ANY OTHER PROVISION OF THIS AGREEMENT, THE LIABILITY OF ANALYTICS CORPORATION TO CLIENT, OR TO ANY OTHER PERSON OR ENTITY, ARISING OUT OF, RESULTING FROM OR IN CONNECTION WITH THIS AGREEMENT OR THIS SERVICES PROVIDED BY ANALYTICS CORPORATION, INCLUDING BUT NOT LIMITED TO ANALYTICS CORPORATIONS' NEGLIGENT PROFESSIONAL ACTS. ERRORS OR OMISSIONS, WHETHER ACTIVE OR PASSIVE AND WHETHER OR NOT RELATED TO HAZARDOUS WASTES OR SUBSTANCES, SHALL NOT CONSTITUTE A FUNDAMENTAL BREACH, INCLUDING LIABILITY FOR CONSEQUENTIAL, INDIRECT, SPECIAL INCIDENTAL OR EXEMPLARY DAMAGES, OR EXCEED THE COMPENSATION PAID TO ANALYTICS CORPORATION. NO ACTION, SUIT OR PROCEEDING SHALL BE INSTITUTED IN CONNECTION WITH THIS AGREEMENT MORE THAN TWO YEARS AFTER ANALYTICS CORPORATION CEASES ITS PERFORMANCE HEREUNDER.

5. Information from Client: Client shall provide Analytics Corporation with all information and samples required to enable Analytics Corporation to perform its services. Analytics Corporation shall not be liable for any incorrect advice, judgment, recommendation, finding, decision or conduct based upon any inaccurate or incomplete information or samples supplied by Client, or the failure of any such samples to be representative.

6. Indemnification: Client shall indemnify and hold harmless Analytics Corporation and its affiliated corporations from and against any and all claims, causes of action, demands, losses, costs, expenses, liabilities, damages, settlements or judgments of any nature, including without limitation those related to the defense or investigation thereof and all attorney's fees incurred, which are attributable to the negligence or wrongful conduct of Client or its employees or agents, which arise from or are related to any matter or circumstances as to which Analytics Corporation does not expressly assume responsibility or disclaims responsibility, which exceed the maximum amount for which Analytics Corporation is liable as set forth herein, or which are attributable to the acts, errors, or omissions of others and arise from or are related to this agreement or the work to be performed hereunder.

7. Waiver: One or more waivers of any term, condition or covenant by Analytics Corporation shall not be construed by Client as a waiver of a subsequent breach of the same or of any other term, condition or covenant.

8. Severability: In the event any provision of this agreement shall be held to be invalid and unenforceable, the other provisions shall be valid and binding on the parties hereto.

9. Retention of Samples: All samples received by Analytics Corporation may be disposed of 30 days after submission of Analytics Corporation report to Client unless otherwise mutually agreed.

Attachment 13b: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-018

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

G..oup No. M309-018
Account No. 19802030
Report Date: 11/21/08

CHING BIEU
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 11/04/08
Sample Type: 8 - Air Sample(s)
Project: BLDG PLATING SHP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001 2	Samp Date: 10/22/08		0.8 micron MCE filter			
-	Nickel	1035 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/06/08
-002 3	Samp Date: 10/22/08		0.8 micron MCE filter			
-	Sodium	1464 L	9.69 ug	2.5 ug	0.01 mg/M3	11/07/08
-003 4	Samp Date: 10/22/08		0.8 micron MCE filter			
	Gold	1620 L	< 2.00 ug	2 ug	< 0.001 mg/M3	11/13/08
-	Potassium	1620 L	< 2.50 ug	2.5 ug	< 0.002 mg/M3	11/13/08
-004 00B	Samp Date: 10/22/08		BLANK 0.8 micron MCE filter			
-	Gold	0 L	< 2.00 ug	2 ug	--	11/13/08
-	Potassium	0 L	< 2.50 ug	2.5 ug	--	11/13/08
-	Sodium	0 L	11.6 ug	2.5 ug	--	11/13/08
-	Nickel	0 L	< 2.00 ug	2 ug	--	11/13/08
-005 5	Samp Date: 10/23/08		0.8 micron MCE filter			
-	Sodium	1731 L	< 2.50 ug	2.5 ug	< 0.001 mg/M3	11/07/08
-006 6	Samp Date: 10/23/08		0.8 micron MCE filter			
-	Nickel	1966 L	< 2.00 ug	2 ug	< 0.001 mg/M3	11/06/08
-007 7	Samp Date: 10/23/08		0.8 micron MCE filter			
-	Gold	1269 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/13/08
-	Potassium	1269 L	< 2.50 ug	2.5 ug	< 0.002 mg/M3	11/13/08
-008 OB	Samp Date: 10/23/08		BLANK 0.8 micron MCE filter			
-	Gold	0 L	< 2.00 ug	2 ug	--	11/13/08
-	Potassium	0 L	< 2.50 ug	2.5 ug	--	11/13/08

Page 1

Attachment 13b continued

ANALYTICS

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Ashland, Virginia 23005
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www.analyticscorp.com

Group No. M309-018
Account No. 19802030
Report Date: 11/21/08

CHING BIEU
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Date Received: 11/04/08
Sample Type: 8 - Air Sample(s)
Project: BLDG PLATING SHP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-	Sodium	0 L	4.38 ug	2.5 ug	--	11/13/08
-	Nickel	0 L	< 2.00 ug	2 ug	--	11/13/08

Laboratory control spikes for Gold recovered at 69%,results may be biased low.

Laboratory Media Blank(LMB) for Sodium = < 2.0 micrograms.

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13b continued

ANALYTICS

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Group No. M309-018
Account No. 19802030
Report Date: 11/21/08

CHING BIEU
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Gold	NIOSH 7300M	----
Potassium	NIOSH 7300	----
Sodium	NIOSH 7300M	----
Nickel	NIOSH 7300	----

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 3

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13b continued

LABO[illegible]RY TEST REQUEST

ACCOUNT NU[illegible]ER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
10-31-08	8	Filter	Bldg 5. Plating shop

PURCHASE ORDER NO.:
CONTACT: Ching-tseu Bien
TELEPHONE NUMBER: 301-286-6918

TURN AROUND TIME: • ☐ SAMEDAY • ☐ 1 DAY * CALL FOR AVAILABILITY • ☐ 2 DAY ☑ STANDARD * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:

☐ FAX RESULTS FAX NUMBER: ( )

☑ EMAIL RESULTS - EMAIL: nasa.gov Ching-tseu.bien-1@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	2	10-22-08	1,035	Nickel
	3		1,464	Sodium
	4		1,620	Potassium (K) and gold
	00 B		0 (Blank)	for the above
	5	10-23-08	1,731	Sodium
	6		1,966	Nickel
	7		1,269	potassium and gold
	0 B		0 (Blank)	for the above

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

IF "ANALYTICS COURIER" SIGN HERE

SIGN HERE TO INITIATE CHAIN OF CUSTODY: Ching-tseu Bien

DATE: 10-31-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
11/4/08 1000	Intact	SIGNATURE(SAMPLE RECEIVING) [signature]	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 13b concluded

TERMS AND CONDITIONS

Except as otherwise provided on this document or other related documents, the parties agree to the following provisions:

1. Acceptance and Modification: This document contains all terms of the parties' agreement concerning the services described on this document or other related documents (to include, but not limited to, environmental *analysis policies* listed in the Analytics Environmental Laboratory services brochure), can be accepted only upon the provisions expressed herein, and may not be modified, added to, amended, superseded or waived except in writing by Analytics Corporation, duly authorized representative. Client may accept this document by acknowledging or confirming it or by accepting any performance, partial or complete, by Analytics Corporation. Reference by Analytics Corporation to any purchase or work order number supplied by Client shall be for accounting identification purposes only. This document shall be binding upon the successors and assigns of the parties.

2. Independent Contractor: In performing its services, Analytics Corporation shall be deemed to be acting solely as an independent contractor, and only to the extent and for the specific purpose expressly set forth on this document or other related documents.

3. Force Majeure: Delay in performance or failure to perform by Analytics Corporation shall be excused to the extent caused by any act of God, labor trouble, fire, inclement weather, act of governmental authority, failure of transportation, accident or any other limitation. Client's failure to furnish information or to approve or disapprove Analytics Corporations' work. In the event of any of these circumstances, Analytics Corporations' time for completion of its services shall be extended accordingly.

4. Limited Warranty and Limitation of Liability: ANALYTICS CORPORATION MAKES NO EXPRESS OR IMPLIED REPRESENTATION, WARRANTY OR CONDITION AS TO ITS SERVICES, FINDINGS, RECOMMENDATIONS OR PROFESSIONAL ADVICE EXCEPT THAT THEY ARE PREPARED, PERFORMED AND RENDERED IN ACCORDANCE WITH PROCEDURES, PROTOCOLS AND PRACTICES GENERALLY ACCEPTED IN ANALYTICS CORPORATIONS' PROFESSION FOR USE IN SIMILAR ASSIGNMENTS. ANALYTICS CORPORATION SHALL NOT BE LIABLE TO CLIENT IF SUCH NON-COMPLIANCE IS CAUSED BY NEGLIGENCE OR WILLFUL MISCONDUCT OF CLIENT. NOTWITHSTANDING ANY OTHER PROVISION OF THIS AGREEMENT, THE LIABILITY OF ANALYTICS CORPORATION TO CLIENT, OR TO ANY OTHER PERSON OR ENTITY, ARISING OUT OF, RESULTING FROM OR IN CONNECTION WITH THIS AGREEMENT OR THIS SERVICES PROVIDED BY ANALYTICS CORPORATION, INCLUDING BUT NOT LIMITED TO ANALYTICS CORPORATIONS' NEGLIGENT PROFESSIONAL ACTS. ERRORS OR OMISSIONS, WHETHER ACTIVE OR PASSIVE AND WHETHER OR NOT RELATED TO HAZARDOUS WASTES OR SUBSTANCES, SHALL NOT CONSTITUTE A FUNDAMENTAL BREACH, INCLUDING LIABILITY FOR CONSEQUENTIAL, INDIRECT, SPECIAL INCIDENTAL OR EXEMPLARY DAMAGES, OR EXCEED THE COMPENSATION PAID TO ANALYTICS CORPORATION. NO ACTION, SUIT OR PROCEEDING SHALL BE INSTITUTED IN CONNECTION WITH THIS AGREEMENT MORE THAN TWO YEARS AFTER ANALYTICS CORPORATION CEASES ITS PERFORMANCE HEREUNDER.

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6. Indemnification: Client shall indemnify and hold harmless Analytics Corporation and its affiliated corporations from and against any and all claims, causes of action, demands, losses, costs, expenses, liabilities, damages, settlements or judgments of any nature, including without limitation those related to the defense or investigation thereof and all attorney's fees incurred, which are attributable to the negligence or wrongful conduct of Client or its employees or agents, which arise from or are related to any matter or circumstances as to which Analytics Corporation does not expressly assume responsibility or disclaims responsibility, which exceed the maximum amount for which Analytics Corporation is liable as set forth herein, or which are attributable to the acts, errors, or omissions of others and arise from or are related to this agreement or the work to be performed hereunder.

7. Waiver: One or more waivers of any term, condition or covenant by Analytics Corporation shall not be construed by Client as a waiver of a subsequent breach of the same or of any other term, condition or covenant.

8. Severability: In the event any provision of this agreement shall be held to be invalid and unenforceable, the other provisions shall be valid and binding on the parties hereto.

9. Retention of Samples: All samples received by Analytics Corporation may be disposed of 30 days after submission of Analytics Corporation report to Client unless otherwise mutually agreed.

Attachment 13c: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-012

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-012
Account No. 19802030
Report Date: 11/11/08

CHIY-TIEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 11/04/08
Sample Type: 4 - Air Sample(s)
Project: BLDG 5, PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	21 Samp Date: 10/29/08		0.8 micron MCE filter			
-	Copper	1290 L	< 1.00 ug	1 ug	< 0.001 mg/M3	11/07/08
-002	22 Samp Date: 10/29/08		0.8 micron MCE filter			
-	Nickel	1212 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/07/08
-003	23 Samp Date: 10/29/08		0.8 micron MCE filter			
-	Barium	1191 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/07/08
-	Chromium	1191 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/07/08
-004	B-20 Samp Date: 10/29/08		BLANK 0.8 micron MCE filter			
-	Barium	0 L	< 2.00 ug	2 ug	--	11/07/08
-	Chromium	0 L	< 2.00 ug	2 ug	--	11/07/08
-	Copper	0 L	< 1.00 ug	1 ug	--	11/07/08
-	Nickel	0 L	< 2.00 ug	2 ug	--	11/07/08

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13c continued

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-012
Account No. 19802030
Report Date: 11/11/08

CHIY-TIEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Barium	NIOSH 7300	----
Chromium	NIOSH 7300	----
Copper	NIOSH 7300	----
Nickel	NIOSH 7300	----

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13c continued

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
10-31-08	4	Filter	Bldg 5, Plating Shop
PURCHASE ORDER NO.		CONTACT: Ching-Hsien Bien	TELEPHONE NUMBER: 301-286-6918

TURN AROUND TIME: ☐ SAMEDAY ☐ 1 DAY * CALL FOR AVAILABILITY ☐ 2 DAY ☑ STANDARD * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:

☐ FAX RESULTS FAX NUMBER: ( )

☒ EMAIL RESULTS - EMAIL: Ching.tsen.bien-1@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	21	10-29-08	1,290	Copper, Sulfuric acid*
	22		1,212	Nickel
	23		1,191	Barium, chromium
	B-20		0 (Blank)	Copper, nickel, barium, chromium
	* please contact if method is not available			

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

IF "ANALYTICS COURIER" SIGN HERE

SIGN HERE TO INITIATE CHAIN OF CUSTODY: [signature]

DATE: 10-31-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
11/4/08 1000	Intact	SIGNATURE(SAMPLE RECEIVING) [signature]	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 13c concluded

TERMS AND CONDITIONS

Except as otherwise provided on this document or other related documents, the parties agree to the following provisions:

1. Acceptance and Modification: This document contains all terms of the parties' agreement concerning the services described on this document or other related documents (to include, but not limited to, environmental analysis policies listed in the Analytics Environmental Laboratory services brochure), can be accepted only upon the provisions expressed herein, and may not be modified, added to, amended, superseded or waived except in writing by Analytics Corporation, duly authorized representative. Client may accept this document by acknowledging or confirming it or by accepting any performance, partial or complete, by Analytics Corporation. Reference by Analytics Corporation to any purchase or work order number supplied by Client shall be for accounting identification purposes only. This document shall be binding upon the successors and assigns of the parties.

2. Independent Contractor: In performing its services, Analytics Corporation shall be deemed to be acting solely as an independent contractor, and only to the extent and for the specific purpose expressly set forth on this document or other related documents.

3. Force Majeure: Delay in performance or failure to perform by Analytics Corporation shall be excused to the extent caused by any act of God, labor trouble, fire, inclement weather, act of governmental authority, failure of transportation, accident or any other limitation. Client's failure to furnish information or to approve or disapprove Analytics Corporations' work. In the event of any of these circumstances, Analytics Corporations' time for completion of its services shall be extended accordingly.

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8. Severability: In the event any provision of this agreement shall be held to be invalid and unenforceable, the other provisions shall be valid and binding on the parties hereto.

9. Retention of Samples: All samples received by Analytics Corporation may be disposed of 30 days after submission of Analytics Corpora[illegible] report to Client unless otherwise mutually agreed.

Attachment 13d: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-017

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-017
Account No. 19802030
Report Date: 11/10/08

CHING-TSEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 11/04/08
Sample Type: 5 - Air Sample(s)
Project: BLDG 5 PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001 31	Samp Date: 10/30/08	5um PVC filter with quartz support pad				
-	Chromium	1232 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/07/08
-	Nickel	1232 L	< 2.00 ug	2 ug	< 0.002 mg/M3	11/07/08
-002 32	Samp Date: 10/30/08	5um PVC filter with quartz support pad				
-	CRVI	1021 L	< 0.025 ug	.025 ug	< 0.024 ug/M3	11/10/08
-003 33	Samp Date: 10/30/08	0.8 micron MCE filter				
-	Phosphoric Acid	529 L	* --	10 ug	NA --	11/06/08
* Sample was lost during sample preparation. No results are available.						
-004 B-30	Samp Date: 10/30/08	0.8 micron MCE filter				
-	Nickel	0 L	< 2.00 ug	2 ug	--	11/05/08
-005 30-CRB	Samp Date: 10/30/08	5um PVC filter with quartz support pad				
-	CRVI	0 L	< 0.025 ug	.025 ug	--	11/10/08

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13d continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-017
Account No. 19802030
Report Date: 11/10/08

CHING-TSEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Chromium	NIOSH 7300	----
Hexavalent Chromium	OSHA ID 215	CRVI
Phosphoric Acid	OSHA 111	----
Nickel	NIOSH 7300	----

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13d continued

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
10-30-08	5	Filter	Bldg 5, Plating Shop

PURCHASE ORDER NO.	CONTACT	TELEPHONE NUMBER
	Ching-tsen BIEN	301-286-6918

TURN AROUND TIME: ☐ SAMEDAY ☐ 1 DAY * CALL FOR AVAILABILITY ☐ 2 DAY ☑ STANDARD * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:

☐ FAX RESULTS FAX NUMBER: ( )

☑ EMAIL RESULTS - EMAIL: Ching-tsen.bien-1@ nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	31	10-30-08	1,232	Chromium, nickel
	32		1021	Chromic acid as Chromium(VI) barium
	33		529	phosphoric acid
	B-30		0 (Blank)	Nickel, phosporic acid
	30-CRB		0 (Blank)	chromium(VI)

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

CARRIER

IF "ANALYTICS COURIER" SIGN HERE

SIGN HERE TO INITIATE CHAIN OF CUSTODY: Ch-tsen B

DATE 10-31-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
11/4/08 1000	Intact	SIGNATURE(SAMPLE RECEIVING) [signature]	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 13d concluded

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8. Severability: In the event any provision of this agreement shall be held to be invalid and unenforceable, the other provisions shall be valid and binding on the parties hereto.

9. Retention of Samples: All samples received by Analytics Corporation may be disposed of 30 days after submission of Analytics Corp[illegible]n report to Client unless otherwise mutually agreed.

Attachment 13e: Bldg. 5 Plating Lab Air Monitoring Oct 2008 Group No. M309-027

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

G_oup No. M309-027
Account No. 19802030
Report Date: 11/10/08

CHING-TSEU BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 11/04/08
Sample Type: 6 - Air Sample(s)
Project: BLDG 5 PLATING PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	S-1 Samp Date: 10/29/08		Silica Gel 200/400 (Specially Cleaned)			
-	HCl-Front		< 2.5 ug	2.5 ug		11/07/08
-	HCl-Rear		ND	2.5 ug		11/07/08
-	HCl-Total	88.6 L	< 2.5 ug	2.5 ug	< 0.028 mg/M3	11/07/08
-002	S-2 Samp Date: 10/29/08		Silica Gel 200/400 (Specially Cleaned)			
	HNO3 Front		< 5 ug	5 ug		11/07/08
	HNO3 Rear		ND	5 ug		11/07/08
-	HNO3 Total	81.0 L	< 5 ug	5 ug	< 0.062 mg/M3	11/07/08
-003	SB-1 Samp Date: 10/29/08		BLANK Silica Gel 200/400 (Specially Cleaned)			
-	HCl-Front		< 2.5 ug	2.5 ug		11/07/08
-	HCl-Rear		ND	2.5 ug		11/07/08
-	HCl-Total	0 L	< 2.5 ug	2.5 ug	--	11/07/08
-	HNO3 Front		< 5 ug	5 ug		11/07/08
-	HNO3 Rear		ND	5 ug		11/07/08
-	HNO3 Total	0 L	< 5 ug	5 ug	--	11/07/08
-004	S-11 Samp Date: 10/30/08		Silica Gel 200/400 (Specially Cleaned)			
-	H2SO4 Front		< 5 ug	5 ug		11/07/08
-	H2SO4 Rear		ND	5 ug		11/07/08
-	H2SO4 Total	82.1 L	< 5 ug	5 ug	< 0.061 mg/M3	11/07/08
-005	S-12 Samp Date: 10/30/08		Silica Gel 200/400 (Specially Cleaned)			
-	HCl-Front		< 2.5 ug	2.5 ug		11/07/08
-	HCl-Rear		ND	2.5 ug		11/07/08
-	HCl-Total	82.7 L	< 2.5 ug	2.5 ug	< 0.030 mg/M3	11/07/08

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Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13e continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-027
Account No. 19802030
Report Date: 11/10/08

CHING-TSEU BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Date Received: 11/04/08
Sample Type: 6 - Air Sample(s)
Project: BLDG 5 PLATING PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-	HF Front		< 5 ug	5 ug		11/07/08
-	HF Rear		ND	5 ug		11/07/08
-	HF Total	82.7 L	< 5 ug	5 ug	< 0.060 mg/M3	11/07/08
-006	SB-2 Samp Date: 10/30/08		BLANK			
			Silica Gel 200/400 (Specially Cleaned)			
	H2SO4 Front		< 5 ug	5 ug		11/07/08
	H2SO4 Rear		ND	5 ug		11/07/08
-	H2SO4 Total	0 L	< 5 ug	5 ug	--	11/07/08
-	HCl-Front		< 2.5 ug	2.5 ug		11/07/08
-	HCl-Rear		ND	2.5 ug		11/07/08
-	HCl-Total	0 L	< 2.5 ug	2.5 ug	--	11/07/08
-	HF Front		< 5 ug	5 ug		11/07/08
-	HF Rear		ND	5 ug		11/07/08
-	HF Total	0 L	< 5 ug	5 ug	--	11/07/08

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13e continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M309-027
Account No. 19802030
Report Date: 11/10/08

CHING-TSEU BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Sulfuric Acid Total	NIOSH 7903	H2SO4 Total
	NIOSH 7903	HCl
Hydrofluoric Acid Total	NIOSH 7903	HF Total
Nitric Acid Total	NIOSH 7903	HNO3 Total

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

Unless the signature of the appropriate manager(s) appears on the final page of this report, this report should be considered PRELIMINARY and is subject to change.

We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 3

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13e continued

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
10-31-08	6	Sorbent tube	Bldg 5 - Plating

PURCHASE ORDER NO.:
CONTACT: Ching-tseu Bien
TELEPHONE NUMBER: 301-286-6918

TURN AROUND TIME: ☐ SAMEDAY ☐ 1 DAY ☐ CALL FOR AVAILABILITY ☐ 2 DAY ☒ STANDARD ☐ EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS: Report concentrations on the front and back sections.

☐ FAX RESULTS FAX NUMBER: ( )
☒ EMAIL RESULTS - EMAIL: CHING-TSEN.BIEN-1@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	S-1	10-29-08	~~88.6~~ 88.6	Hydrochloric acid
	S-2	(	~~87.0~~ 81.0	Nitric acid
	SB-1		Blank	for above
	S-11	10-30-08	82.1	Sulfuric acid
	S-12	(	82.7	Hydrochloric acid Hydrofluoric acid
	SB-2	)	Blank	for above

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

SIGN HERE TO INITIATE CHAIN OF CUSTODY: Ching-tseu [signature]

CARRIER: IF "ANALYTICS COURIER" SIGN HERE: DATE 10-31-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
11/4/08 1000	Intact	SIGNATURE(SAMPLE RECEIVING) [signature]	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 13e concluded

TERMS AND CONDITIONS

Except as otherwise provided on this document or other related documents, the parties agree to the following provisions:

1. Acceptance and Modification: This document contains all terms of the parties' agreement concerning the services described on this document or other related documents (to include, but not limited to, environmental analysis policies listed in the Analytics Environmental Laboratory services brochure), can be accepted only upon the provisions expressed herein, and may not be modified, added to, amended, superseded or waived except in writing by Analytics Corporation, duly authorized representative. Client may accept this document by acknowledging or confirming it or by accepting any performance, partial or complete, by Analytics Corporation. Reference by Analytics Corporation to any purchase or work order number supplied by Client shall be for accounting identification purposes only. This document shall be binding upon the successors and assigns of the parties.

2. Independent Contractor: In performing its services, Analytics Corporation shall be deemed to be acting solely as an independent contractor, and only to the extent and for the specific purpose expressly set forth on this document or other related documents.

3. Force Majeure: Delay in performance or failure to perform by Analytics Corporation shall be excused to the extent caused by any act of God, labor trouble, fire, inclement weather, act of governmental authority, failure of transportation, accident or any other limitation. Client's failure to furnish information or to approve or disapprove Analytics Corporations' work. In the event of any of these circumstances, Analytics Corporations' time for completion of its services shall be extended accordingly.

4. Limited Warranty and Limitation of Liability: ANALYTICS CORPORATION MAKES NO EXPRESS OR IMPLIED REPRESENTATION, WARRANTY OR CONDITION AS TO ITS SERVICES, FINDINGS, RECOMMENDATIONS OR PROFESSIONAL ADVICE EXCEPT THAT THEY ARE PREPARED, PERFORMED AND RENDERED IN ACCORDANCE WITH PROCEDURES, PROTOCOLS AND PRACTICES GENERALLY ACCEPTED IN ANALYTICS CORPORATIONS' PROFESSION FOR USE IN SIMILAR ASSIGNMENTS. ANALYTICS CORPORATION SHALL NOT BE LIABLE TO CLIENT IF SUCH NON-COMPLIANCE IS CAUSED BY NEGLIGENCE OR WILLFUL MISCONDUCT OF CLIENT. NOTWITHSTANDING ANY OTHER PROVISION OF THIS AGREEMENT, THE LIABILITY OF ANALYTICS CORPORATION TO CLIENT, OR TO ANY OTHER PERSON OR ENTITY, ARISING OUT OF, RESULTING FROM OR IN CONNECTION WITH THIS AGREEMENT OR THIS SERVICES PROVIDED BY ANALYTICS CORPORATION, INCLUDING BUT NOT LIMITED TO ANALYTICS CORPORATIONS' NEGLIGENT PROFESSIONAL ACTS. ERRORS OR OMISSIONS, WHETHER ACTIVE OR PASSIVE AND WHETHER OR NOT RELATED TO HAZARDOUS WASTES OR SUBSTANCES, SHALL NOT CONSTITUTE A FUNDAMENTAL BREACH, INCLUDING LIABILITY FOR CONSEQUENTIAL, INDIRECT, SPECIAL INCIDENTAL OR EXEMPLARY DAMAGES, OR EXCEED THE COMPENSATION PAID TO ANALYTICS CORPORATION. NO ACTION, SUIT OR PROCEEDING SHALL BE INSTITUTED IN CONNECTION WITH THIS AGREEMENT MORE THAN TWO YEARS AFTER ANALYTICS CORPORATION CEASES ITS PERFORMANCE HEREUNDER.

5. Information from Client: Client shall provide Analytics Corporation with all information and samples required to enable Analytics Corporation to perform its services. Analytics Corporation shall not be liable for any incorrect advice, judgment, recommendation, finding, decision or [illegible]ct based upon any inaccurate or incomplete information or samples supplied by Client, or the failure of any such samples to be representative.

6. Indemnification: Client shall indemnify and hold harmless Analytics Corporation and its affiliated corporations from and against any and all claims, causes of action, demands, losses, costs, expenses, liabilities, damages, settlements or judgments of any nature, including without limitation those related to the defense or investigation thereof and all attorney's fees incurred, which are attributable to the negligence or wrongful conduct of Client or its employees or agents, which arise from or are related to any matter or circumstances as to which Analytics Corporation does not expressly assume responsibility or disclaims responsibility, which exceed the maximum amount for which Analytics Corporation is liable as set forth herein, or which are attributable to the acts, errors, or omissions of others and arise from or are related to this agreement or the work to be performed hereunder.

7. Waiver: One or more waivers of any term, condition or covenant by Analytics Corporation shall not be construed by Client as a waiver of a subsequent breach of the same or of any other term, condition or covenant.

8. Severability: In the event any provision of this agreement shall be held to be invalid and unenforceable, the other provisions shall be valid and binding on the parties hereto.

9. Retention of Samples: All samples received by Analytics Corporation may be disposed of 30 days after submission of Analytics Cor[illegible]tion report to Client unless otherwise mutually agreed.

Attachment 13f: Bldg. 5 Plating Lab Air Monitoring Nov 2008 Group No. M316-054

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

```
G oup No.      M316-054
Account No.    19802030
Report Date:   11/13/08

CHING-TSEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD  20771                    **** FINAL REPORT ****

Date Received:  11/11/08
Sample Type:  2 - Air Sample(s)
Project:   PLATING SHOP              PO Number:

Analytical Results
```

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	S-34 Samp Date: 11/10/08 Silica Gel 200/400 (Specially Cleaned)					
-	H3PO4 Front		< 10 ug	10 ug		11/13/08
-	H3PO4 Rear		ND	10 ug		11/13/08
-	H3PO4 Total	102 L	< 10 ug	10 ug	< 0.098 mg/M3	11/13/08
-002	S-34B Samp Date: 11/10/08 BLANK Silica Gel 200/400 (Specially Cleaned)					
	H3PO4 Front		< 10 ug	10 ug		11/13/08
-	H3PO4 Rear		ND	10 ug		11/13/08
-	H3PO4 Total	0 L	< 10 ug	10 ug	--	11/13/08

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 1

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13f continued

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. M316-054
Account No. 19802030
Report Date: 11/13/08

CHING-TSEN BIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Phosphoric Acid Total	NIOSH 7903	H3PO4 Total

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

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We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

End of Report
Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 13f concluded

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
11-10-2008	2	Silica gel tube	Plating Shop

PURCHASE ORDER NO.	CONTACT	TELEPHONE NUMBER
	Ching-tsen Bien	301-286-6918

TURN AROUND TIME: ☐ SAMEDAY ☐ 1 DAY * CALL FOR AVAILABILITY ☐ 2 DAY ☐ STANDARD * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS:

☐ FAX RESULTS FAX NUMBER: ( )

☑ EMAIL RESULTS - EMAIL: ching-tsen.bien-1@NASA.GOV

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED-PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	S-34	11-10-2008	102	Phosphoric acid
	S-34B	11-10-2008	0 (Blank)	"

Please report concentration of Phosphoric acid on both sections of the silica gel tube

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

[signature] SIGN HERE TO INITIATE CHAIN OF CUSTODY

CARRIER IF "ANALYTICS COURIER" SIGN HERE

DATE 11-10-2008

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
9:50 11/11/08	[initials]	SIGNATURE(SAMPLE RECEIVING) Gail McKinley	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

Attachment 14: Bldg. 5 Plating Lab Air Monitoring Jan 2009 Group No. N019-027

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. N019-027
Account No. 19802030
Report Date: 01/23/09

CHING-TSENBIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

**** FINAL REPORT ****

Date Received: 01/19/09
Sample Type: 3 - Air Sample(s)
Project: BLDG PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis
-001	PS-011609-1	Samp Date: 01/16/09	0.8 micron MCE filter			
-	Gold	90.5 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Barium	90.5 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Chromium	90.5 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Potassium	90.5 L	< 2.50 ug	2.5 ug	< 0.022 mg/M3	01/22/09
-	Sodium	90.5 L	< 2.50 ug	2.5 ug	< 0.028 mg/M3	01/22/09
	Nickel	90.5 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-002	PS-011609-2	Samp Date: 01/16/09	0.8 micron MCE filter			
-	Gòld	91.3 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Barium	91.3 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Chromium	91.3 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-	Potassium	91.3 L	< 2.50 ug	2.5 ug	< 0.022 mg/M3	01/22/09
-	Sodium	91.3 L	< 2.50 ug	2.5 ug	< 0.027 mg/M3	01/22/09
-	Nickel	91.3 L	< 2.00 ug	2 ug	< 0.022 mg/M3	01/22/09
-003	PS-011609-3B	Samp Date: 01/16/09	BLANK 0.8 micron MCE filter			
-	Gold	0 L	< 2.00 ug	2 ug	--	01/22/09
-	Barium	0 L	< 2.00 ug	2 ug	--	01/22/09
-	Chromium	0 L	< 2.00 ug	2 ug	--	01/22/09
-	Potassium	0 L	< 2.50 ug	2.5 ug	--	01/22/09
-	Sodium	0 L	3.27 ug	2.5 ug	--	01/22/09
-	Nickel	0 L	< 2.00 ug	2 ug	--	01/22/09

Laboratŏry control spikes for Gold failed with recovery at 1.25-2.48%.
Results may biased low.

Sodium present in client blank. Samples are corrected.

Page 1

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 14 continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. N019-027
Account No. 19802030
Report Date: 01/23/09

CHING-TSENBIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Date Received: 01/19/09
Sample Type: 3 - Air Sample(s)
Project: BLDG PLATING SHOP PO Number:

Analytical Results

Lab	Parameter	Volume	Amount	LOQ	Concentration	Analysis

Abbreviations: ug = micrograms, mg = milligrams, mg/M3 = milligrams per cubic meter of air, g = grams, ug/M3 = micrograms per cubic meter of air, L = liters, all Volumes given in liters, ppm = parts per million, ppb = parts per billion, Areas given in square feet; ND = Not Detected; ug/wp = ug/wipe; NVG = No Volume Given. NAG = No Area Given, LOQ = Limit of Quantitation.

Page 2

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 14 continued

ANALYTICS

ANALYTICS CORPORATION
10329 Stony Run Lane
Ashland, Virginia 23005
804-365-3000 Phone
800-888-8061 Phone
804-365-3002 Fax
www.analyticscorp.com

Group No. N019-027
Account No. 19802030
Report Date: 01/23/09

CHING-TSENBIEN
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.9, BUILDING 97
GREENBELT, MD 20771

Final Report

Summary of Analytical Methods

Compound Name	Analytical Method	Abbreviation
Gold	NIOSH 7300M	----
Barium	NIOSH 7300	----
Chromium	NIOSH 7300	----
Potassium	NIOSH 7300	----
Sodium	NIOSH 7300M	----
Nickel	NIOSH 7300	----

Notes

Results provided in this report relate only to the items tested.

Attached are the results we obtained on the analysis of your samples. Any Chains-of-Custody associated with this sample group are also enclosed. Air concentrations are calculated as a convenience to the client and the overall accuracy of this result depends on both the accuracy of the air volume and the amount found by analysis. Theoretical Air Volumes for passive monitors are calculated using the sampling time submitted and the manufacturer's listed sampling rate for each compound.

For blanks and non-detects the results indicated with a '<' value represents the reporting limit for that analysis. Unless otherwise noted results are not corrected for blank values.

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We appreciate your confidence in allowing Analytics to be your testing laboratory. Any questions regarding this report can be addressed by calling our client services department (800-888-8061).

James A. Calpin, CIH
Laboratory Director

Quality Industrial Hygiene and Environmental Laboratory Testing

Attachment 14 concluded

LABORATORY TEST REQUEST

ACCOUNT NUMBER, NAME AND ADDRESS
PROJECT ENHANCEMENT CORPORATION
NASA GODDARD SPACE FLIGHT CENTER
MAILSTOP 250.3, BUILDING 97
GREENBELT, MD 20771
Phone: 301-286-6795
Fax: 1-301-286-1618
PROJ#: 19802030

ANALYTICS
10329 Stony Run Lane
Ashland, VA 23005
(804) 365-3000
TOLL FREE (800) 888-8061
FAX (804) 365-3002

DATE SHIPPED	# OF SAMPLES	SAMPLE TYPE/MEDIA	PROJECT NAME OR NUMBER
01-16-09		Filter	Bldg. Plating Shop
PURCHASE ORDER NO.		CONTACT	TELEPHONE NUMBER
		CHING-TSEN BIEN	301-286-6918

TURN AROUND TIME: ☐ SAME DAY* ☐ 1 DAY* ☐ 2 DAY* ☑ STANDARD
* CALL FOR AVAILABILITY * EXTRA CHARGE

SPECIAL INSTRUCTIONS AND/OR UNUSUAL CONDITIONS

☐ FAX RESULTS FAX NUMBER: ( ) ______
☑ EMAIL RESULTS - EMAIL: Ching-tsen.bien-1@nasa.gov

FOR LABORATORY USE ONLY	SAMPLE # OR SAMPLE AREA	SAMPLE DATE	SAMPLE VOLUME/LITERS	ANALYSIS REQUESTED PLEASE USE SEPARATE LABORATORY TEST REQUEST FOR EACH SAMPLE TYPE
	PS-011609-1	01-16-09	90.5	Chromium, nickel, gold, potassium, sodium, barium
	PS-011609-2	/	91.3	"
	PS-011609-3B	\	0 (Blank)	"
				Ching-tsen.Bien-1@nasa.gov

CHAIN OF CUSTODY RECORD

SAMPLES HAVE BEEN SEALED FOR TRANSPORT AND DELIVERED TO LABORATORY VIA:

SIGN HERE TO INITIATE CHAIN OF CUSTODY

CARRIER IF "ANALYTICS COURIER" SIGN HERE DATE

DATE/TIME	CONDITION OF SAMPLE	SAMPLES RECEIVED BY:	SAMPLES RELEASED BY:
1/15/09 1000	Intact	SIGNATURE(SAMPLE RECEIVING) John R. Smily	SIGNATURE(SAMPLE RECEIVING)
		SIGNATURE(SAMPLE ADMINISTRATION)	SIGNATURE(SAMPLE ADMINISTRATION)
		SIGNATURE(LAB)	SIGNATURE(LAB)
		SIGNATURE(LAB)	SIGNATURE(LAB)

PLEASE RETAIN PART 3 FOR YOUR RECORDS

FOLEY COMPANY — P.O. BOX 442, RICHMOND, VA 23218 (804) 649-5590

Attachment 15: Bldg. 5 Plating Lab Field Activity Report Oct 1987(3)

DATE 10-27-87

PRODUCT MANUFACTURED OR SERVICE

GODDARD SPACE FLIGHT CENTER
OCCUPATIONAL HEALTH
FIELD ACTIVITY REPORT
8½ x 11

EMPLOYEES
MALE 3-4
FEMALE
TOTAL 3-4

DIVISION CODE 752.2 | BUILDING NO. 5 | ROOM NO. Electroplating Shop

PERSON INTERVIEWED Pilar Martin | TITLE

PURPOSE: ☐ INVESTIGATION ☒ SURVEY ☐ INSPECTION ☐ PRELIMINARY ☐ FOLLOW-UP ☐ CONFERENCE ☐ VISIT ☐ OTHER

REASON: ☒ SELF-INITIATED ☐ OCCUPATIONAL DISEASE REPORTED ☐ COMPLAINT ☐ REQUEST (SOURCE)

SPECIFIC HAZARD OR CONDITION	WORKERS EXPOSED	RECOMMENDATIONS WRITTEN — VERBAL	ACCOMPLISHED YES	NO	IN PROGRESS
Potential Chromic Acid + Phosphoric Acid exposure.	3-4				

SAMPLES COLLECTED (NO. & KIND) Chromic Acid: 1 personal, 1 area NIOSH Method 5317; Phosphoric Acid: 1 personal, 1 area NIOSH Method 7401 TOTAL 4

DETERMINATION MADE (NO. & KIND) All sample results were < Minimum Detection Limit TOTAL

MEDICAL N/A OCCUPATIONAL DISEASE REPORTED, NO. & KIND

REMARKS

BY Lisa D. Martin

INSPECTED ☐ YES ☐ NO FOLDER ☐ YES ☐ NO

	Sample #	AML #	Sample Location	Result
1.	87GSFC-5-EPS-Area-01	7137-1010	Breathing zone between Anodizing Strip and Aluminum Polish - Center Aisle (Chromic Acid)	<0.008 mg/m3
2.	87GSFC-5-EPS-Personal-02	7137-1011	Personal sample, Cleophus Hunt, worked mainly in center aisle. (Chromic Acid)	<0.001 mg/m3
3.	87GSFC-5-EPS-Area-03	7137-1020	Breathing zone between Anodizing Strip and Aluminum Polish - Center Aisle (Phosphoric Acid)	<0.005 mg/m3
4.	87GSFC-5-EPS-Personal-04	7137-1021	Personal Sample, Ben White, worked mainly in center aisle (Phosphoric Acid)	<0.002 mg/m3

TLV's: Chromic Acid = 0.05 mg/m3
Phosphoric Acid = 1 mg/m3

Attachment 15 continued

DATE:	10-27-87
SAMPLE NO.	87 GSFC-5-EPS - Area - Ø1 AAL-7137-1010
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Breathing Zone between Anodizing Strip + Aluminum Polish - Center Aisle
OPERATION:	Anodizing Strip and Aluminum Polish containing Chromic Acid
WORKERS INVOLVED:	2-3
NAME & I.D.	N/A
SAMPLING MEDIA:	37 mm, 5.0 µm PVC Filter
PUMP NO.	4
FLOW RATE:	1.5 lpm
TIME STARTED:	1:31 PM
TIME FINISHED:	1:46 PM
VOLUME:	22.5 liters $15 \text{ minutes} \times \frac{1.5 \text{ liters}}{\text{minute}} = 22.5 \text{ liters}$
REMARKS:	NIOSH Method 5317 Area Sample for Chromic Acid Result: < MDL $MDL = 0.008\ mg/m^3$ $TLV = 0.05\ mg/m^3$

Attachment 15 concluded

DATE:	10-27-87
SAMPLE NO.	87 GSFC -5-EPS- Personal -02 AML-7137-1011
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Personal Sample, worked mainly in center aisle.
OPERATION:	Anodizing Strip and Aluminum Polish containing Chromic Acid
WORKERS INVOLVED:	2-3
NAME & I.D.	Cleophus Hunt
SAMPLING MEDIA:	37 mm, 5.0 um PVC Filter
PUMP NO.	11
FLOW RATE:	1.5 liters per minute.
TIME STARTED:	9:25 AM
TIME FINISHED:	3:16 PM
VOLUME:	526.5 liters 351 minutes x 1.5 liters/minute = 526.5 l
REMARKS:	NIOSH method 5317 Personal Sample for Chromic Acid Result: < MDL MDL = 0.001 mg/m3 TLV = 0.05 mg/m3

Attachment 16: Bldg. 5 Plating Lab Field Activity Report Oct 1987_01(3)

file

DATE 10-28-87

PRODUCT MANUFACTURED OR SERVICE

GODDARD SPACE FLIGHT CENTER
OCCUPATIONAL HEALTH
FIELD ACTIVITY REPORT
8½ x 11

[illegible] 12/14/87

EMPLOYEES
MALE 3-4
FEMALE
TOTAL 3-4

DIVISION CODE	BUILDING NO.	ROOM NO.
752.2	5	Electroplating Shop

PERSON INTERVIEWED: Pilar Martin TITLE:

PURPOSE: ☐ INVESTIGATION ☒ SURVEY ☐ INSPECTION ☐ PRELIMINARY ☐ FOLLOW-UP ☐ CONFERENCE ☐ VISIT ☐ OTHER

REASON: ☒ SELF-INITIATED ☐ OCCUPATIONAL DISEASE REPORTED ☐ COMPLAINT ☐ REQUEST (SOURCE)

SPECIFIC HAZARD OR CONDITION	WORKERS EXPOSED	RECOMMENDATIONS WRITTEN — VERBAL	ACCOMPLISHED YES	NO	IN PROGRESS
Potential Sodium Hydroxide Exposure	3-4				

SAMPLES COLLECTED (NO. & KIND) 1 personal for sodium hydroxide, NIOSH Method 43.02 TOTAL 1

DETERMINATION MADE (NO. & KIND) < Minimum Detection Limit TOTAL

MEDICAL N/A OCCUPATIONAL DISEASE REPORTED, NO. & KIND

REMARKS

BY Lisa T. Martin

INSPECTED ☐ YES ☐ NO FOLDER ☐ YES ☐ NO

Sample #	AML #	Sample Location	Result
876SFC-5-EPS-Personal-01	7137-1040	Personal Sample, Joel Mitchell, worked mainly in center aisle, between Aluminum Etch and Oakite 160	< 0.15 mg/m3

TLV for Sodium Hydroxide = 2 mg/m3 (ceiling)

NOTE: Sampling + analysis data for AML # 7137-1030 for Hydrogen Chloride also attached. Appears that wrong sampling medium was used – AML recommended resampling. LTM 12-14-87

Attachment 16 concluded

DATE:	10-28-87
SAMPLE NO.	87GSFC-5-EPS-Personal-Ø1 AML-7137-1040
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Personal Sample - worked mainly in center aisle between Aluminum Etch and Oakite 160
OPERATION:	Aluminum Etch and Oakite 160 containing Sodium Hydroxide
WORKERS INVOLVED:	2-3
NAME & I.D.	Joel Mitchell
SAMPLING MEDIA:	0.0075 N HCl (10 ml)
PUMP NO.	11
FLOW RATE:	1.0 lpm
TIME STARTED:	9:00 AM
TIME FINISHED:	1:30 PM
VOLUME:	270 liters 270 minutes x 1 liter/minute = 270 liters
REMARKS:	NIOSH Method 42.02 Personal Sample for Sodium Hydroxide Result: < MDL MDL = 0.15 mg/m³ TLV = 2 mg/m³ (Ceiling)

Attachment 17a: Bldg. 5 Plating Lab Air Monitoring Oct 1987 Feb 1988(4)

March 31, 1988

TO: 205/Chief, Health, Safety and Security

THRU: 205.2/Director of Environmental Health, Health Unit
National Health Services, Inc.

FROM: 205.2/Industrial Hygienist, Health Unit, National
Health Services, Inc.

SUBJECT: Building 5 - Electroplating Shop Air Monitoring

During the 1987 Annual Local Exhaust Ventilation System Survey of the Building 5 Electroplating Shop, it was noted that 64 percent of the push-pull type exhaust systems were not operating at the ventilation rates required by the OSHA Ventilation Standard, 29 CFR 1910.94 (d) or the American Conference of Governmental Industrial Hygienists (ACGIH) recommendations manual "Industrial Ventilation - 17th Edition". It was therefore recommended that air sampling be conducted in the Electroplating Shop to assure that employee exposures to various chemical vapors and mists were within the acceptable limits established by OSHA and the ACGIH.

Air monitoring for chromic acid, phosphoric acid and sodium hydroxide was conducted on October 27 and 28, 1987. Due to renovation of the Electroplating Shop, several tank solutions were not in operation at this time; therefore, monitoring for sulfuric acid, nickel and hydrogen chloride was conducted on February 2, 1988. Air sampling was conducted using calibrated portable pumps to draw air through various filter or liquid mediums, in accordance with NIOSH Methods of Sampling. All samples were analyzed by an AIHA accredited laboratory.

The attached table summarizes the sampling data and analytical results received. It should be noted that at the time of the surveys, concentrations of all chemicals sampled were well below their respective OSHA Permissible Exposure Limits (PELs) and ACGIH Threshold Limit Values (TLVs), based on an eight-hour time-weighted average (TWA).

Lisa G. Martin

Lisa G. Martin

Enclosure

cc: J. Munford/752.0
J. Henninger/752.2
P. Martin/752.2

Attachment 17a concluded

Building 5 - Electroplating Shop

Air Monitoring Results

Chemical Sampled	Date	Location of Sample	Sample Time (Minutes)	Sample Volume (Liters of Air)	Result (mg/m^3)*	OSHA PEL (mg/m^3)	ACGIH TLV-TWA (mg/m^3)
Chromic Acid	10-27-87	Personal Sample/Cleophus Hunt Center Aisle, Anodizing Strip/ Aluminum Polish	351 min.	526.5 l.	less than 0.001 mg/m^3	0.1 mg/m^3	0.05 mg/m^3
Chromic Acid	10-27-87	Area Sample/Breathing Zone Center Aisle, Between Anodizing Strip & Aluminum Polish	15 min.	22.5 l.	less than 0.008 mg/m^3	0.1 mg/m^3	0.05 mg/m^3
Phosphoric Acid	10-27-87	Personal Sample/Ben White Center Aisle, Anodizing Strip/ Aluminum Polish	353 min.	529.5 l.	less than 0.002 mg/m^3	1 mg/m^3	1 mg/m^3
Phosphoric Acid	10-27-87	Area Sample/Breathing Zone Center Aisle, Between Anodizing Strip & Aluminum Polish	130 min.	195 l.	less than 0.005 mg/m^3	1 mg/m^3	1 mg/m^3
Sodium Hydroxide	10-28-87	Personal Sample/Joel Mitchell Center Aisle, Aluminum Etch/ Oakite 160 Bath	270 min.	270 l.	less than 0.15 mg/m^3	2 mg/m^3	2 mg/m^3
Sulfuric Acid	2-2-88	Personal Sample/Cleophus Hunt Center Aisle, Anodize II Bath	321 min.	481.5 l.	less than 0.01 mg/m^3	1 mg/m^3	1 mg/m^3
Sulfuric Acid	2-2-88	Area Sample/Breathing Zone Center Aisle, Above Anodize II Bath	120 min.	180 l.	0.02 mg/m^3	1 mg/m^3	1 mg/m^3
Nickel (Soluble Compounds)	2-2-88	Personal Sample/Charlie Adams Center Aisle, Anodize Sealer Bath	332 min.	505 l.	less than 0.002 mg/m^3	1 mg/m^3	0.1 mg/m^3
Nickel (Soluble Compounds)	2-2-88	Area Sample/Breathing Zone Center Aisle, Above Anodize Sealer Bath	60 min.	90 l.	less than 0.01 mg/m^3	1 mg/m^3	0.1 mg/m^3
Hydrogen Chloride	2-2-88	Area Sample/Breathing Zone Northwest Aisle, Above Hydrogen Chloride Dip	15 min.	15 l.	less than 0.07 mg/m^3	7 mg/m^3	7 mg/m^3

*mg/m^3 = Milligrams per cubic meter of air

Attachment 17b: Bldg. 5 Plating Lab Field Activity Report Feb 1988(3)

DATE 2 Feb 88

PRODUCT MANUFACTURED OR SERVICE

GODDARD SPACE FLIGHT CENTER
OCCUPATIONAL HEALTH

FIELD ACTIVITY REPORT
8½ x 11

MAR 31 1988

EMPLOYEES
MALE
FEMALE
TOTAL

DIVISION CODE	BUILDING NO.	ROOM NO.
752.2	5	Electroplating Shop

PERSON INTERVIEWED	TITLE
Pilar Martin	

PURPOSE: ☐ INVESTIGATION ☒ SURVEY ☐ INSPECTION ☐ PRELIMINARY ☐ FOLLOW-UP ☐ CONFERENCE ☐ VISIT ☐ OTHER

REASON: ☒ SELF-INITIATED ☐ OCCUPATIONAL DISEASE REPORTED ☐ COMPLAINT ☐ REQUEST (SOURCE)

SPECIFIC HAZARD OR CONDITION	WORKERS EXPOSED	RECOMMENDATIONS WRITTEN — VERBAL	ACCOMPLISHED YES	ACCOMPLISHED NO	ACCOMPLISHED IN PROGRESS
Potential Sulfuric Acid, Nickel and Hydrogen Chloride exposure.	3-4				

SAMPLES COLLECTED (NO. & KIND): Sulfuric Acid: 1 personal, 1 area NIOSH Method 5174; Nickel: 1 personal, 1 area NIOSH Method 5206; Hydrogen Chloride: 1 area, NIOSH method 5246 TOTAL 5

DETERMINATION MADE (NO. & KIND) TOTAL

MEDICAL N/A OCCUPATIONAL DISEASE REPORTED, NO. & KIND N/A

REMARKS ACGIH TLV-TWAs: Sulfuric Acid - 1 mg/m³, Nickel - 0.1 mg/m³, Hydrogen Chloride - 7 mg/m³ BY Lisa St Martin

INSPECTED ☐ YES ☐ NO FOLDER ☐ YES ☐ NO

Sample #	AML #	Sample Location	Result
88GSFC-5-EPS - Personal -Ø1	7137-1250	Personal Sample - Cleophus Hunt Center Aisle, Anodize II Bath (Sulfuric Acid)	< 0.01 mg/m³
88GSFC-5-EPS - Area - Ø2	7137-1251	Area Sample - Breathing Zone Center Aisle above Anodize II Bath (Sulfuric Acid)	0.02 mg/m³
88GSFC-5-EPS - Personal -Ø3	7137-1253	Personal Sample - Charlie Adams Center Aisle, Anodize Sealer Bath/ Nickel Acetate (Nickel - Soluble Compounds)	< 0.002 mg/m³
88GSFC-5-EPS - Area - Ø4	7137-1255	Area Sample - Breathing Zone Center Aisle, above Anodize Sealer Bath and Nickel Acetate (Nickel-Soluble Compounds)	<0.01 mg/m³
88GSFC-5-EPS - Area - Ø5	7137-1258	Area Sample - Breathing Zone Northwest Aisle, above Hydrogen Chloride Dip. (Hydrogen Chloride)	<0.07 mg/m³

File

Attachment 17b continued

NIOSH Method 5174

Sulfuric Acid

DATE:	2-2-88
SAMPLE NO.	88GSFC-5-EPS-Personal-01 AML# 7137-1250
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Mainly center aisle, sulfuric acid Anodize II. Bath
OPERATION:	
WORKERS INVOLVED:	2-4
NAME & I.D.	Cleophus Hunt
SAMPLING MEDIA:	37 mm, 0.8 um MCEF
PUMP NO.	11
FLOW RATE:	1.5 lpm Post Calibration: 1.45 l/min
TIME STARTED:	9:25
TIME FINISHED:	2:46 PM
VOLUME:	481.5 liters 321 min x $\frac{1.5\ l}{min}$ = 481.5 liters
REMARKS:	Result: < 0.01 mg/m^3 ACGIH TLV-TWA = 1 mg/m^3

Attachment 17b continued

NIOSH Method 5206

7

	Nickel, Metal and Soluble Compounds as Nickel
DATE:	2-2-88
SAMPLE NO.	88 GSFC-5-EPS-Personal-Ø3 AML# 7137-1253
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Mainly center aisle, Nickel Acetate, Anodize Sealer Bath
OPERATION:	
WORKERS INVOLVED:	2-4
NAME & I.D.	Charlie Adams
SAMPLING MEDIA:	37 mm, 0.8 um MCEF
PUMP NO.	12
FLOW RATE:	1.52 l/min Post Calibration: 1.55 l/min
TIME STARTED:	9:11 AM
TIME FINISHED:	2:43 PM
VOLUME:	505 liters $332 \text{ min} \times \frac{1.52 \text{ l}}{\text{min}} = 505$ liters
REMARKS:	Result: < MDL MDL = 0.002 mg/m³ ACGIH TLV-TWA = 0.1 mg/m³

Attachment 17b continued

NIOSH Method 5206

	Nickel, Metal and Soluble Compounds as Nickel
DATE:	2-2-88
SAMPLE NO.	88GSFC-5-EPS-Area-Ø4 AMLH 7137-1255
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Breathing Zone above Nickel Acetate, Anodize Sealer, Center Aisle
OPERATION:	
WORKERS INVOLVED:	
NAME & I.D.	N/A
SAMPLING MEDIA:	37 mm, 0.8 um mcEF
PUMP NO.	9
FLOW RATE:	1.5 lpm Post Calibration: 1.8 lpm
TIME STARTED:	11:28 AM
TIME FINISHED:	12:28 PM
VOLUME:	90 liters 60 minutes $\times \frac{1.5\ l}{min}$ = 90 liters
REMARKS:	Result: < MDL MDL = 0.01 mg/m^3 ACGIH TLV-TWA = ~1 mg/m^3

Attachment 17b concluded

NIOSH Method S246

Hydrogen Chloride

DATE:	2-2-88
SAMPLE NO.	88GSFC-5-EPS-Area-Ø5 AML # 7137-1258
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Approximate breathing zone above Hydrogen chloride Dip, first aisle. (Solution cold)
OPERATION:	
WORKERS INVOLVED:	0 at time of sampling
NAME & I.D.	N/A
SAMPLING MEDIA:	10 ml of 0.5 M Sodium Acetate
PUMP NO.	2
FLOW RATE:	1.0 lpm
TIME STARTED:	11:00 AM.
TIME FINISHED:	11:15 AM.
VOLUME:	15 liters $1 \frac{l}{min} \times 15 min = 15$ liters
REMARKS:	Result: < MDL MDL = 0.07 mg/m^3 ACGIH TLV-TWA = 7 mg/m^3

Attachment 18: Bldg. 5 Plating Lab Field Activity Report July 1988(2)

DATE 8 July 1988
PRODUCT MANUFACTURED OR SERVICE

GODDARD SPACE FLIGHT CENTER
OCCUPATIONAL HEALTH
FIELD ACTIVITY REPORT
8½ x 11

MM 9/20/88

EMPLOYEES
MALE
FEMALE
TOTAL

DIVISION CODE 752.2 | BUILDING NO. 5 | ROOM NO. Electroplating Shop

PERSON INTERVIEWED Pilar Martin 6-8622 | TITLE

PURPOSE: ☐ INVESTIGATION ☒ SURVEY ☐ INSPECTION ☐ PRELIMINARY ☐ FOLLOW-UP ☐ CONFERENCE ☐ VISIT ☐ OTHER

REASON: ☐ SELF-INITIATED ☐ OCCUPATIONAL DISEASE REPORTED ☐ COMPLAINT ☒ REQUEST (SOURCE) Pilar Martin

SPECIFIC HAZARD OR CONDITION	WORKERS EXPOSED	RECOMMENDATIONS WRITTEN — VERBAL	ACCOMPLISHED YES	NO	IN PROGRESS
EPS employees concerned about	1	N/A			
potential exposure to hydrogen					
cyanide from cyanide copper strike.					

SAMPLES COLLECTED (NO. & KIND) 2 air samples; 37mm 0.8 um MCEF, 10 ml, 0.1 N KOH sampling train TOTAL 2

DETERMINATION MADE (NO. & KIND) < MDL for Cyanides as CN⁻ on filters; < MDL for HCN in liquid TOTAL 4

MEDICAL N/A OCCUPATIONAL DISEASE REPORTED, NO. & KIND N/A

REMARKS

BY Lisa ST. Martin

INSPECTED ☐ YES ☐ NO FOLDER ☐ YES ☐ NO

Sample #	AML #	Location	Result	ACGIH TLV-TWA
88GSFC-5-EPS-CS-Ø1A (Filter)	7137-1490	Breathing zone, above cyanide copper-strike	< 0.833 mg/m³	Cyanides as CN⁻ 5 mg/m³
88GSFC-5-EPS-CS-Ø1B (Impinger)	7137-1491	Breathing zone, above cyanide copper strike	< 0.833 mg/m³	Hydrogen cyanide C 10 mg/m³
88GSFC-5-EPS-CS-Ø2A (Filter)	7137-1492	Breathing zone, above cyanide copper strike	< 0.521 mg/m³	Cyanides as CN⁻ 5 mg/m³
88GSFC-5-EPS-CS-Ø2B (Impinger)	7137-1493	Breathing zone, above cyanide copper strike	< 0.521 mg/m³	Hydrogen cyanide C 10 mg/m³

Attachment 18 continued

	Cyanides, aerosol and gas
DATE:	July 8, 1988
SAMPLE NO.	88GSFC-5-EPS-CS-Ø1 A (Filter) AML #s 7137-1490 -01 B (Impinger) -1491
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Breathing zone, above cyanide copper strike
OPERATION:	Copper cyanide plating operation
WORKERS INVOLVED:	1
NAME & I.D.	Area Sample
SAMPLING MEDIA:	0.8 um mixed Cellulose Ester Filter (37 mm diameter) 10 ml 0.1 N KOH
PUMP NO.	# 2 MSA
FLOW RATE:	Pre-Calibration - 1.0 lpm > 0.5 lpm Post-Calibration - 0.5 lpm
TIME STARTED:	9:51 AM
TIME FINISHED:	11:51 AM
VOLUME:	120 minutes x $\frac{0.5\ l}{min}$ = 60 liters
REMARKS:	RESULTS: Filter: < MDL (50 ug total) < 50 ug/60 l = < 0.833 mg/m³ Impinger: < MDL (50 ug total) < 50 ug/[illegible] [illegible] mg/m³ ACGIH TLV-TWA Cyanides (CN⁻) = 5 mg/m³ HCN = 10 mg/m³ (C)

Attachment 18 concluded

	Cyanides, aerosol and gas
DATE:	July 8, 1988
SAMPLE NO.	88 GSFC - 5 - EPS - CS - Ø2 A (Filter) AML #s 7137-1492 Ø2 B (Impinger) -1493
BUILDING NO.	5
ROOM NO.	Electroplating Shop
SAMPLING LOCATION:	Breathing zone, above cyanide copper strike
OPERATION:	Copper cyanide plating operation
WORKERS INVOLVED:	1
NAME & I.D.	Area Sample
SAMPLING MEDIA:	0.8 um Mixed Cellulose Ester Filter (37 mm diameter) 10 ml 0.1 N KOH
PUMP NO.	#12 MSA Flow-Lite
FLOW RATE:	Pre-Calibration - 1 lpm Post-Calibration - 0.96 lpm
TIME STARTED:	12:35 PM
TIME FINISHED:	2:15 PM
VOLUME:	100 minutes x $\frac{0.96 \text{ liters}}{\text{min}}$ = 96 liters
REMARKS:	RESULTS: Filter: <MDL (50 ug total) <50 ug/96 l = < 0.521 mg/m3 Impinger: <MDL (50 ug total) <50 ug/96 l = < 0.521 mg/m3 ACGIH TLV-TWA Cyanides as CN⁻ = 5 mg/m HCN = 10 mg/m3 (C

Attachment 19: Bldg. 5 Plating Lab Air Monitoring Aug 1988(3)

AMERICAN MEDICAL LABORATORIES, INC.®
P.O. Box 10841 • 14225 Newbrook Drive
Chantilly, VA 20153-0841
Telephone: (703) 802-6900 • (800) 336-3718

INDUSTRIAL HYGIENE DEPARTMENT

PAGE 1 X

```
RECEIVED   :  08/23/99        17772 NASA/GODDARD SPACE FLIGHT CTR
RELEASED   :  09/03/99              ATTN: JAY LEUNG
REPORTED   :  09/03/99              OCCU-HLTH, INC CODE 205.9
WORK ORDER:     158412              GREENBELT              , MD
                                                          20771

PROJECT NAME/JOB ID: BUILDING 5

AML NUMBER----------------------VALUE-----UNITS-------------------

 8695962  081999-01              FILTER, AIR
    1653  NICKEL (7440-02-0)
          MASS:                  Less than quantitation limit.
          QUANTITATION LIMIT:    0.0010    mg
          ANALYST:               Luis Rossi
    8457  PREPARATION FEE
          SITE/LOCATION:         BLANK
          ANALYST:               Luis Rossi

 8695963  081999-02              FILTER, AIR
    1653  NICKEL (7440-02-0)
          MASS:                  Less than quantitation limit.
          QUANTITATION LIMIT:    0.0010    mg
          ANALYST:               Luis Rossi
    8457  PREPARATION FEE
          SITE/LOCATION:         BLANK
          ANALYST:               Luis Rossi

 8695964  081999-03              FILTER, AIR
    1653  NICKEL (7440-02-0)
          MASS:                  Less than quantitation limit.
          QUANTITATION LIMIT:    0.0010    mg
          CONCENTRATION:         Less than quantitation limit.
          QUANTITATION LIMIT:    0.0045    mg/M3
          AIR VOLUME:            226       LITERS
          ANALYST:               Luis Rossi
    8457  PREPARATION FEE
          SITE/LOCATION:         BENJAMINE WHITE
          AIR VOLUME:            226       LITERS
          ANALYST:               Luis Rossi

 8695965  081999-04              FILTER, AIR
    1653  NICKEL (7440-02-0)
          MASS:                  Less than quantitation limit.
          QUANTITATION LIMIT:    0.0010    mg
          CONCENTRATION:         Less than quantitation limit.
          QUANTITATION LIMIT:    0.0013    mg/M3
          AIR VOLUME:            774.6     LITERS
          ANALYST:               Luis Rossi
          CONTINUED ON NEXT PAGE
```

Age and sex dependent reference ranges are printed when available if age and sex are designated. Otherwise, adult values are given.
167086 R 2/99

IRA D. GODWIN, M.D.
DIRECTOR OF LABORATORIES

Attachment 19 concluded

AMERICAN MEDICAL LABORATORIES, INC.®
P.O. Box 10841 • 14225 Newbrook Drive
Chantilly, VA 20153-0841
Telephone: (703) 802-6900 • (800) 336-3718

INDUSTRIAL HYGIENE DEPARTMENT

PAGE 2 X

RECEIVED : 08/23/99 17772 NASA/GODDARD SPACE FLIGHT CTR
RELEASED : 09/03/99 ATTN: JAY LEUNG
REPORTED : 09/03/99 OCCU-HLTH, INC CODE 205.9
WORK ORDER: 158412 GREENBELT , MD 20771

PROJECT NAME/JOB ID: BUILDING 5

AML NUMBER----------------------VALUE-----UNITS------------------

CONTINUED FROM PRIOR PAGE

8457 PREPARATION FEE

SITE/LOCATION:	CN-6 TANK	
AIR VOLUME:	774.6	LITERS
ANALYST:	Luis Rossi	

NOTATIONS

The calculation of analyte concentrations is based on information (i.e. air volumes, exposure times, areas, etc.) provided by the client.

The current OSHA 8-hour permissible exposure limit, (PEL) for insoluble nickel compounds is 1 mg/M3 as an 8 hour time weighted average, (TWA). Soluble compounds have a PEL of 0.1 mg/M3 as an 8 hour TWA.

*** FINAL REPORT ***

CHRISTOPHER KASE
MANAGER, IND. HYGIENE

FOR INDUSTRIAL HYGIENE RELATED QUESTIONS,
INCLUDING REQUESTS FOR SUPPLIES, CALL
1-800-348-1590

Age and sex dependent reference ranges are printed when available if age and sex are designated. Otherwise, adult values are given.
167086 R 2/99

IRA D. GODWIN, M.D.
DIRECTOR OF LABORATORIES

Attachment 20: GSFC Bldg. 5 Plating Lab Air Sampling Field Sheets June 2009

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	**DATE (YYYYMMDD)** 2009/06/24	**WORKPLACE IDENTIFIER**	G S F C [redacted] [redacted]
	WORKPLACE Plating Shop		**LOCATION (BLDG/AREA/ROOM)** Bldg.5, Room E14D
NUMBER OF PERSONNEL	**SHIFTS/DAY** / DAY	**SUPERVISOR**	**EXTENTION:**
ORGANIZATION NAME Adv. Manufacturing Branch	**CODE** 547		

SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION

SEG CODE:	**SEG DESCRIPTION:**

SAMPLE NUMBER	CB-09-06-24-04	CB-09-06-24-05	CB-09-06-24-06
PUMP NUMBER	Field blank	2022	917
PRE CAL DATE/TIME		06-23-09	06-23-09
PRE CAL FLOW RATE, ml/min.		503	510
POST CAL DATE/TIME		06-24-09	06-24-09
POST CAL FLOW RATE		482	0.58
SAMPLE FLOW RATE		492	545
SAMPLE START TIME		10:28	10:32
SAMPLE STOP TIME		15:39	15:40
DOWN TIME			
SAMPLE TIME, min.		311	308
SAMPLE VOLUME, L		153	168
Bar. P / Temp.	/ 23° C	/ 23° C	/ 23° C
CORRECTED VOLUME, L	0	154	169
PERSONNEL OR AREA SAMPLED	G-1 tank, Gold Strike.	Area Sample, A-6 tank, Sulfuric Acid Anodize.	Area Sample, B-10 tank, Acid Copper.
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	HCN	H_2SO_4	H_2SO_4
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial, Etc)			

COMMENTS

SURVEYED BY *(Print Name and Sign)*	**REVIEWED BY** *(Print Name and Sign)*
Ching-tsen Bien [signature]	R B Deza [signature]

250 IH 014 11/03

Attachment 20 continued

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	**DATE** 2009/06/24	**WORKPLACE IDENTIFIER** G S F C [redacted]	
	WORKPLACE Plating Shop		**LOCATION (BLDG/AREA/ROOM)** Bldg.5, Room E14D
NUMBER OF PERSONNEL / **SHIFTS/DAY / DAY**	**SUPERVISOR**	**EXTENTION:**	**ORGANIZATION NAME** Adv. Manufacturing Branch / **CODE** 547
SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION			
SEG CODE:	**SEG DESCRIPTION:**		
SAMPLE NUMBER	CB-09-06-24-07	CB-09-06-24-08	CB-09-06-24-09
PUMP NUMBER	Field Blank	H-2	H-1
PRE CAL DATE/TIME		06-23-09	06-23-09
PRE CAL FLOW		4,050	4,060
POST CAL DATE/TIME		06-24-09	06-24-09
POST CAL FLOW RATE		4,060	4,096
SAMPLE FLOW RATE		4,055	4,078
SAMPLE START TIME		11:15	11:08
SAMPLE STOP TIME		15:44	15:43
DOWN TIME			
SAMPLE TIME, min		269	275
SAMPLE VOLUME, L		1,091	1,121
Bar. P / Temp.	/ 23° C	/23° C	/23° C
CORRECTED VOLUME, L		1,098	1,129
PERSONNEL OR AREA SAMPLED	A-6 and B-10 Tanks.	Area Sample, A-2 tank, Aluminum Etch Cleaner.	Area Sample, B-3 tank, Aluminum Zincate.
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	H_2SO_4	NaOH	NaOH
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial)			

COMMENTS

SURVEYED BY *(Print Name and Sign)*
Ching-tsen Bien

REVIEWED BY *(Print Name and Sign)*
R. B. DEZA

Attachment 20 continued

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	DATE (YYYYMMDD) 2009/06/24	WORKPLACE IDENTIFIER G S F C [redacted] [redacted]	
	WORKPLACE Plating Shop	LOCATION (BLDG/AREA/ROOM) Bldg.5, Room E14D	
NUMBER OF PERSONNEL	SHIFTS/DAY / DAY	SUPERVISOR	EXTENTION:
ORGANIZATION NAME Adv. Manufacturing Branch	CODE 547		

SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION

SEG CODE:	SEG DESCRIPTION:

SAMPLE NUMBER	CB-09-06-24-10	CB-09-06-24-11	CB-09-06-24-12
PUMP NUMBER	H-4	Field Blank	913
PRE CAL DATE/TIME	06-23-09		06-23-09
PRE CAL FLOW RATE, ml/min.	4,040		540
POST CAL DATE/TIME	06-24-09		06-24-09
POST CAL FLOW RATE	3,960		80
SAMPLE FLOW RATE	4,000		**VOID**
SAMPLE START TIME	11:06		11:38
SAMPLE STOP TIME	15:45		15:44
DOWN TIME			
SAMPLE TIME, min.	279		
SAMPLE VOLUME	1,116		
Bar. P / Temp.	/ 23° C	/23° C	/23° C
CORRECTED VOLUME, L	1,123		
PERSONNEL OR AREA SAMPLED	Area Sample,N-1 Tank, Electro Cleaner	NaOH	Area Sample, N-3A, Stainless Steel Etch
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	NaOH	NaOH	
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial, Etc)			

COMMENTS

Sample 12 was voided due to pump failure.

SURVEYED BY *(Print Name and Sign)*	**REVIEWED BY** *(Print Name and Sign)*
Ching-tsen Bien	R. B. DEZA

250 IH 014 11/03

Attachment 20 continued

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	DATE (YYYYMMDD) 2009/06/24	WORKPLACE IDENTIFIER	G S F C [redacted] [redacted]
	WORKPLACE Plating Shop		LOCATION (BLDG/AREA/ROOM) Bldg.5, Room E14D
NUMBER OF PERSONNEL	SHIFTS/DAY / DAY	SUPERVISOR	EXTENTION:
ORGANIZATION NAME Adv. Manufacturing Branch	CODE 547		

SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION

SEG CODE:	SEG DESCRIPTION:

SAMPLE NUMBER	CB-09-06-24-13	CB-09-06-24-14	
PUMP NUMBER	3005	3003	
PRE CAL DATE/TIME	06-24-09	06-24-09	
PRE CAL FLOW RATE	2,050	2,015	
POST CAL DATE/TIME		06-24-09	
POST CAL FLOW RATE		2,060	
SAMPLE FLOW RATE		2,040	
SAMPLE START TIME		11:56	
SAMPLE STOP TIME		15:42	
DOWN TIME			
SAMPLE TIME min	VOID	226	
SAMPLE VOLUME		466	
Bar. P / Temp.	/ 23° C	/23° C	
CORRECTED VOLUME / L		469	
PERSONNEL OR AREA SAMPLED		Area Sample, A-12 tank, Iridite 14-2.	
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number		Chromic acid	
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial)			

COMMENTS
#13 sample was contaminated.

SURVEYED BY *(Print Name and Sign)*	REVIEWED BY *(Print Name and Sign)*
Ching-tsen Bien [signature]	R. B. DEZA [signature]

250 IH 014 11/03

Attachment 20 continued

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	DATE (YYYYMMDD) 2009/06/25	WORKPLACE IDENTIFIER G S F C [redacted]	
	WORKPLACE Plating Shop		LOCATION (BLDG/AREA/ROOM) Bldg.5, Room E14D
NUMBER OF PERSONNEL	SHIFTS/DAY / DAY	SUPERVISOR · / EXTENTION:	ORGANIZATION NAME Adv. Manufacturing Branch / CODE 547
SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION			
SEG CODE:	SEG DESCRIPTION:		
SAMPLE NUMBER	CB-09-06-25-21	CB-09-06-25-22	CB-09-06-25-23
PUMP NUMBER	1011	2022	
PRE CAL DATE/TIME	06-25-09	06-25-09	
PRE CAL FLOW RATE, ml/min.	204	207	
POST CAL DATE/TIME	06-25-09	06-25-09	
POST CAL FLOW RATE	203	203	
SAMPLE FLOW RATE	2035	205	
SAMPLE START TIME	09:49	09:50	Field Blank
SAMPLE STOP TIME	15:49	15:48	
DOWN TIME			
SAMPLE TIME, min.	360	358	
SAMPLE VOLUME, L	73.2	72.6	
Bar. P / Temp.	/ 24° C	/24° C	/24° C
CORRECTED VOLUME, L	73.4	72.8	
PERSONNEL OR AREA SAMPLED	Area sample, CN-8 Silver Strike.	Area sample, CN-6 Silver Plating.	Blank
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	HCN	HCN	HCN
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial, Etc)			

COMMENTS

SURVEYED BY *(Print Name and Sign)*
Ching-tsen Bien

REVIEWED BY *(Print Name and Sign)*
R. B. DEZA

250 IH 014 11/03

Attachment 20 continued

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	DATE (YYYYMMDD) 2009/06/25	WORKPLACE IDENTIFIER	G S F C [redacted] [redacted]	
	WORKPLACE Plating Shop		LOCATION (BLDG/AREA/ROOM) Bldg.5, Room E14D	
NUMBER OF PERSONNEL	SHIFTS/DAY / DAY	SUPERVISOR	EXTENTION:	ORGANIZATION NAME Adv. Manufacturing Branch	CODE 547

SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION

SEG CODE:	SEG DESCRIPTION:

SAMPLE NUMBER	CB-09-06-25-24	CB-09-06-25-25	CB-09-06-25-26
PUMP NUMBER	919	917	
PRE CAL DATE/TIME	06-25-09	06-25-09	
PRE CAL FLOW RATE	552	572	
POST CAL DATE/TIME	06-25-09	06-25-09	
POST CAL FLOW RATE	314	586	
SAMPLE FLOW RATE	2035	579	
SAMPLE START TIME	10:20; 14:28	10:47	Field Blank
SAMPLE STOP TIME	12:20: 15:47	15:30	
DOWN TIME	12:20 – 14:28		
SAMPLE TIME	218	283	
SAMPLE VOLUME L	68.5	164	
Bar. P / Temp.	/ 24° C	/24° C	/24° C
CORRECTED VOLUME L	68.7	165	
PERSONNEL OR AREA SAMPLED	Personal Sample.	Area sample, A-4 tank, Aluminum Deoxizer.	Blank
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	H_2SO_4, HF, HCl	HF	H_2SO_4, HF, HCl
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial			

COMMENTS

Test subject was not in the building during the down time.

SURVEYED BY *(Print Name and Sign)*	REVIEWED BY *(Print Name and Sign)*
Ching-tsen Bien Ch-tsen Bien	R. B. DEZA Rbdeza

250 IH 014 11/03

Attachment 20 concluded

AIR SAMPLING FIELDSHEET (data is subject to the Privacy Act of 1974, as amended)	**DATE (YYYYMMDD)** 2009/06/26	**WORKPLACE IDENTIFIER**	G S F C [redacted] [redacted]	
	WORKPLACE Plating Shop		**LOCATION (BLDG/AREA/ROOM)** Bldg.5, Room E14D	
NUMBER OF PERSONNEL	**SHIFTS/DAY / DAY**	**SUPERVISOR**	**EXTENTION:**	**ORGANIZATION NAME** Adv. Manufacturing Branch
CODE 547				

SIMILAR EXPOSURE GROUP (SEG) DESCRIPTION

SEG CODE: **SEG DESCRIPTION:**

SAMPLE NUMBER	CB-09-06-25-31	CB-09-06-25-32	CB-09-06-25-33
PUMP NUMBER	1011	2022	
PRE CAL DATE/TIME	06-26-09	06-26-09	
PRE CAL FLOW RATE	516	520	
POST CAL DATE/TIME	06-26-09	06-26-09	
POST CAL FLOW RATE	493	485	
SAMPLE FLOW RATE	504	503	
SAMPLE START TIME	09:54	09:55	Field Blank
SAMPLE STOP TIME	13:24	13:26	
DOWN TIME			
SAMPLE TIME min min.	210	211	
SAMPLE VOLUME L	105.8	106.1	
Bar. P / Temp.	/ 24° C	/24° C	/24° C
CORRECTED VOLUME / L	106.2	106.5	
PERSONNEL OR AREA SAMPLED	Area sample, N-3A, Stainless Steel Etch.	Area sample, N-3A, Stainless Steel Etch.	Tank N-3A, Stainless Steel Etch.
SSN			
JOB TITLE			
ANALYSIS REQUESTED			
Name/CAS Number	HF, HCl	HF, HCl	HF, HCl
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
Name/CAS Number			
NIOSH / OSHA METHOD			
SAMPLING MEDIA			
Sample Type (Full, Partial)			

COMMENTS
#32 and #33 samples were collected at the same area and same time to avoid the pump failure. Only one of these samples needs to be analyzed.

SURVEYED BY *(Print Name and Sign)* Ching-tsen Bien Ch-tsen Bien	**REVIEWED BY** *(Print Name and Sign)* R. B. DEZA Rdeza

250 IH 014 11/03

Attachment 21: Copy of Tank Info April 2009

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS L x W x H	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
N-1	36" x 24" x 32"	112 Gallons	Electrocleaner	**Oakite 90**	6 oz/gal
			160 F	Sodium Hydroxide	50% by weight
				Sodium metasilicate	25% by weight
				Sodium Carbonate	10% by weight
				Tetrasodium Pyrophosphate	10% by weight
N-2	72" x 24" x 32"	224 Gallons	Counter-flow Rinse	DI Water	
N-3A	18" x 24" x 24"	29 Gallons	Stainless Steel Etch	Chromium Chloride	10.2 oz/gal
Cover when			100 F	Ferric Chloride	33.71 oz/gal
not in use				Ferric Nitrate	17.92 oz/gal
				Hydrochloric Acid	8.78 oz/gal
				Nickel Chloride	14.17 oz/gal
				Hydrofluoric Acid	6.076 oz/gal
N-3B	18" x 24" x 24"	33 Gallons	Red Dye	**Sandoz Al. Fiery Red ML**	2g/l (.26 oz/gal)
				Sodium Acetate	4g/l (.53 oz/gal)
N-3C	18" x 24" x 24"	33 Gallons	ARP 28	Ammonium Biflouride	6.67 fl. oz/gal
Cover when					
not in use					
N-4	72" x 24" x 32"	224 Gallons	Counter-flow Rinse	DI Water	
N-5A	18" x 24" x 32"	50 Gallons	Titanium Etch	Nitric Acid	
Cover when				Ammonium Bifluoride	7 oz/gal%
not in use					
N-5B	18" x 24" x 32"	50 Gallons	Passivation	**Citri-Surf 2250**	1 part
Cover when			for Stainless Steel	DI Water	3 parts
not in use					
N-6	72" x 24" x 32"	224 Gallons	Blue Dye	**Sandoz Al. Blue 2LW**	1g/l (.4oz/gal)
				Sodium Acetate	4g/l
N-7	36" x 24" x 32"	112 Gallons	Stainless Steel Electropolish	Phosphoric Acid	75% by volume
			71 F		
N-8	24" x 24" x 30"	59 Gallons	Iridite 15	**Iridite 15 (Proprietary)**	.5 oz/gal
Cover when			**Not in use**	Chromic Acid	2% by volume
not in use				ARP #2	1 ml/gal
				Hydrochloric Acid	1.25 oz./gal

Attachment 21 continued

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
	L x W x H				
A-1	48" x 24" x 32"	148 Gallons	Aluminum Soak Cleaner	Oakite 61B	6 oz./gal
must be			160 F	Disodium Phosphate <5%	0.3 oz./gal
covered with					0.42 oz./gal
plastic balls				Tetra Sodium Pyrophosphate 7%	
A-2	48" x 24" x 32"	148 Gallons	Aluminum Etch Cleaner	Oakite 160	5 oz./gal
must be			160 F	Sodium Hydroxide 80-90%	4-4.5 oz./gal
covered with				Sodium Carbonate <10%	0.5 oz./gal
plastic balls					
A-3	48" x 24" x 32"	148 Gallons	Cold Water Rinse		
A-4	48" x 24" x 32"	148 Gallons	Aluminum Deoxidizer	LNC Deoxidizer	17.5% by volume
must be			75 F	Nitric Acid	15% by volume
covered with				Hydrofluoric Acid	25% by volume
plastic balls				Ferric Sulfate	25% by volume
A-5	48" x 24" x 32"	148 Gallons	Cold Water Rinse		
A-6	48" x 24" x 32"	148 Gallons	Sulfuric Anodize Type II	Sulfuric Acid	2g/l (.26 oz/gal)
			72 F		4g/l (.53 oz/gal)
					15% by weight
A-7	48" x 24" x 32"	148 Gallons	Cold Water Rinse		
A-9	24" x 26" x 28"	76 Gallons	Black Dye	Sandoz Fast Black MLW	2.3 lb/gal
			130 F	Chromium as part of the molecule 6%	0.08 oz/gal
A-10	24" x 26" x 28"	76 Gallons	Anodize Sealer	Sandoz Sealing Salts AS	1 oz/gal
must be			200 F	Benzoic Acid 10%	0.1 oz/gal
covered with				Nickel Acetate 20%	
plastic balls					
A-12	48" x 24" x 32"	148 Gallons	Aluminum Iridite	Iridite 14-2	1.25 oz/gal
Must be			72 F	Sodium Silicofluoride 2%	0.025 oz/gal
covered with				Chromic Acid <2%	<0.025 oz/gal
plastic balls				Barium Nitrate < 2%	<0.025 oz/gal

Attachment 21 continued

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
	L x W x H				
B-1a	18" x 24" x 30"	56 Gallons	Hydrochloric Acid Dip	Hydrochloric Acid	30%
Cover when					
not in use					
B-1b	18" x 24" x 30"	56 Gallons	Hydrochloric Acid Dip	Hydrochloric Acid	30%
Cover when					
not in use					
B-2	72" x 24" x 32"	224 Gallons	Counter-flow Rinse	Cold Water Rinse	
B-3	36" x 24" x 32"	112 Gallons	Aluminum Zincate	Fidelity 3116 Zincate	25%
				Sodium Hydroxide 30%	7.50%
B-4a	18" x 24" x 32"	60 Gallons	Nitric Acid/Ammonium	Nitric Acid	50%
Cover when			Bifluoride	Ammonium Bifluoride	50%
not in use			75 F		
B-4b	18" x 24" x 32"	60 Gallons	Nitric Acid Dip	Nitric Acid	50%
Cover when					
not in use					
B-5	72" x 24" x 32"	224 Gallons	Counter-flow Rinse	Cold Water Rinse	
B-6	36" x 24" x 30"	135 Gallons	Woods Nickel Strike	Hydrochloric Acid	
			75 F	Nickel Chloride	6 oz/gal
B-7	36" x 24" x 30"	100 Gallons	Black Nickel	Nickel Sulfate	10 oz/gal
			70 F	Nickel Ammonium Sulfate	
				Zinc Sulfate	5 oz/gal
				Sodium Thiocyanate	2 oz/gal

Attachment 21 continued

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
	L x W x H				
B-8	36" x 24" x 32"	112 Gallons	Watts Nickel	Nickel Chloride	240 oz/gal
			125 F	Nickel Sulfate	40 oz/gal
				Boric Acid	6 oz/gal
				Sel-Rex - Lectroc Nic 1030	1.3% by volume
				Stress Reducer 85g/l	6.4 g/gal
				Anti-Pit Agents	
B-9	72" x 24" x 36"	224 Gallons	Counter -flow Rinse	Cold Water Rinse	
B-10	36" x 24" x 36"	112 Gallons	Acid Copper	Cupric Sulfate	26 oz/gal
			75 F	Sulfuric Acid	9 oz/gal
				Chloride Ions	50 mg/l
				Sel-Rex - UBAC #1	0.20%
B-11	36" x 24" x 36"	112 Gallons	Hot Water Rinse	DI Water	
			160 F		
E-1	24" x 24" x 18"	34 Gallons	Nickel Strip	Nitric Acid	50% by volume
Cover when					
not in use					
E-2	24" x 24" x 18"	34 Gallons	Iridite Strip	Nitric Acid	2 parts
Cover when			75 F	1 part DI Water	1 part
not in use				7.5 gm/gal Ammonium Bifluoride	
E-3	24" x 24" x 18"	30 Gallons	Tungsten Etch	Ammonium Bifluoride	2.6 lbs/gal
Cover when			70-80 F		
not in use					
E-4	48" x 24" x 18"	70 Gallons	Counter-flow Rinse	Cold DI Water	
E 5	24" x 24" x 18"	15 Gallons	Copper Bright Dip	Nitric Acid	75%
Cover when			70-80 F	DI Water	25%
not in use					

Attachment 21 continued

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
	L x W x H				
E-6	48" x 24" x 18"	70 Gallons	Counter-Flow Rinse	Cold DI Water	
E-7	18" x 24" x 24"	32 Gallons	Electroless Nickel	**Fidelity 623**	
Cover when			200 F	**Fidelity 623A**	6% by volume
not in use				Nickel Sulfate 75%	4.50%
				Sodium Hydroxide 9%	15% by volume
				Fidelity 623BM	
				Sodium Hypophosphite	1.35%
				Ammonium Carbonate 6%	4 oz/gal%
				Fidelity 623C -Replenisher	
				Sodium Hypophosphite 23%	
				Ammonium Hydroxide <5%	
E-8	48" x 24" x 24"	75 Gallons	Electroless Nickel	**Fidelity 623**	
Cover when			200 F	**Fidelity 623A**	6% by volume
not in use			**Not in Use**	Nickel Sulfate 75%	4.50%
				Sodium Hypophosphite	15% by volume
				Fidelity 623BM	1.35%
				Ammonium Hydroxide	5.00%
					4 oz/gal
				Fidelity 623 C -Replenisher	
				Sodium Hypophosphite 23%	
				Sodium Hydroxide 9%	
CN-1	24" x 24" x 24"	49 Gallons	Cyanide Dead Rinse	DI Water	
CN-2	24" x 24" x 24"	49 Gallons	Not in Use		
CN-3	48" x 24" x 24"	99 Gallons	Counter-flow Rinse	DI Water	
CN-4	36" x 24" x 32"	112 Gallons	Copper Strike E-Brite 30/30	E-Brite 30/30	50% by volume
				Copper Metal	1.2 oz/gal
				E-Brite 30/31	3% by volume

Attachment 21 concluded

Building 5 Plating Facility		4/13/2008			
TANK #	TANK DIMENSIONS L x W x H	TANK CAPACITY	TANK PROCESS AND TEMPERATURE	BATH PROFILE (PROPRIETARY INGREDIENTS IF APPLICABLE)	BATH CONCENTRATION
CN-5	48" x 24" x 24"	99 Gallons	Cyanide Dead Rinse	DI Water	
CN-6	30" x 24" x 24"	62 Gallons	Silver Plating Bath	Silver Metal - 3.84 to 5.48 Troy oz/gal	4.93 Troy oz/gal
Cover when				Potassium Cyanide - 16 to 18 oz/gal	2.3 lb/gal
not in use				Potassium Carbonate	2 oz/gal
CN-7	48" x 24" x 24"	99 Gallons	Cyanide Spray Rinse	DI Water	
CN-8	30" x 24" x 24"	62 Gallons	Silver Strike Bath	Silver Cyanide	.6 oz/gal
Cover when				Potassium Cyanide	11 oz/gal
not in use					
CN-9	24" x 24" x 24"	49 Gallons	Spare		
CN-10	48" x 24" x 24"	99 Gallons	Counter-flow Rinse	DI Water	
G-1	36" x 24" x 36"	112 Gallons	Gold Strike	**Sel-Rex Aurobond TN**	
			130 F	Aurobond TN Conducting Salts	2.3 lb/gal
				Gold Strike as potassium gold cyanide	0.29 oz/gal
					0.2 tr.oz/gal
G-2	36" x 24" x 24"		Cold Water Spray Rinse	DI Water	
G-3	36" x 24" x 36"	112 Gallons	Gold Plating	**Sel-Rex BDT 510**	
			120 F	BDT 510 Conducting Salts as	0.5 g/l
				Sodium Gold Sulphite	30 g/l
				Gold	1 tr. Oz/gal
G-4	36" x 24" x 24"		Cold Water Rinse	DI Water	
Prototype 1-10				Prototype	
Blue Gold	23"x46"x17"	90 Gallons	Aqueous Cleaner		
			160-180 F		

Attachment 22 Copy of LEV GSFC Working Copy

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
2	W101	CFH1	fume hood	Joe Nuth	Joe Nuth		80-120 fpm	100 fpm	20	Adequate	Yes	6/2/2004	EJN		Acetone, Lithium, Potassium rod
2	W10C	LEV1	spray booth	Curtis Odell 6-4479	Curtis O'Dell	662	TBD	98.8 fpm	N/A	Adequate	Yes	6/2/2004	EJN	None	Epoxy, toluene
2	W110	CFH1	fume hood	Dennis Reuter 6-2042	Dennis Reuter	693	80-120 fpm	107 fpm	18	Adequate	Yes	6/4/2004	EJN	None	toluene, alcohol, acetone
2	*P-1*	*CFH1*	*fume hood*	*Curtis Odell 6-4479*	*Decommissioned*	*660.2*	*80-120 fpm*	*112*	*16*	*Adequate*	*Yes*	*6/8/2004*	*EJN*	*In the penthouse*	*toluene, alcohol*
2	126	CFH1	fume hood	Everett Worley 6-3525	Mario Acuna	695	80-120 fpm	Not working	N/A	Inadequate	N/A	6/9/2004	EJN	Will be moved to BLDG 21 Room 283	
2	264B	CFH1	fume hood	Curtis Odell 6-4479	Curtis O'Dell	662	80-120 fpm	89.5	16	Adequate	Yes	6/9/2004	EJN	clean room	Toluene, alcohol
2	W104	CFH1	fume hood	David Gleonard 6-3354	Pete Wasilewski	691	80-120 fpm	135 fpm	19	Adequate	Yes	6/9/2004	EJN	Not used often.	Propellant for spray painting
2	W109	CFH1	fume hood	Jason Dworkin 6-8631	Joe Nuth	691	80-120 fpm	141 fpm	16	Adequate	Yes	6/9/2004	EJN	This hood is kept w/ the sash 5-6" when possible. 105 at 5-6"	Acetone, Methyl alcohol, Potassium cyanide
2	W112	CFH1	fume hood	David Gleonard 6-3354	Ted Kostiuk	691	80-120 fpm	128 fpm	16	Adequate	Yes	6/9/2004	EJN	None	Nitric acid, methyl iodide, sulfuric acid, hydrochloric acid, ammonium hydroxide
2	170	CFH1	fume hood	Mike Mumma 6-6994	Mike Mumma	690	80-120 fpm	109	17	Adequate	Yes	6/19/2004	EJN	None	Leak Detector Fluid, Ethyl Alcohol, Methyl Alcohol, Mineral oil, Spray Adhesive
2	W102A	CFH1	fume hood	Sam Floyd 6-6881	Jack Trompka	691	80-120 fpm	84 fpm	16	Adequate	Yes	7/20/2004	EJN	cluttered, not used often	bromine, alcohol
2	W103	CFH1	fume hood	John Allen 6-5896	John Allen	691	80-120 fpm	137 fpm	19	Adequate	Yes	7/20/2004	EJN	sash has to be kept below 5 inches or alarm will go off	acetone, alcohol
2	W111	CFH1	fume hood	Lou Stief 6-7529	Regina Cody	691	80-120 fpm	117 fpm	18	Adequate	Yes	7/20/2004	EJN	This hood is kept w/ the sash at 5-6" when possible. 107 at 5-6"	Isobutene, Acetone, Alcohol, Chlorine, Bromine
2	110	FD1	fume hood	B. Harris	C Harris	547	100 at 6" away	100 at 8 inches	N/A	Adequate	Yes	9/30/2004	EJN	??	Metal fumes
2	110	FD2	fume hood	B. Harris	C Harris	547	100 at 6" away	100 at 8 inches	N/A	Adequate	Yes	9/30/2004	EJN	??	Metal fumes
2	W10D	LEV1	spray booth	Curtis Odell 6-4479	Curtis O'Dell	662	??	179 fpm	N/A	Adequate	Yes	10/21/2004	EJN	None	Epoxy, toluene
4	150	FD1	flexible duct	Matt Conway 6-5422	NA - not a laboratory	227.5	100 at 6" away	100 at 8 inches	N/A	Adequate	Yes	3/29/2005	EJN	None	welding
4	175	FD1	flexible duct	Larue Phillips 6-4055	NA - not a laboratory	227.5	100 fpm at 6" away	100 fpm at 6 inches	N/A	Adequate	Yes	3/29/2005	EJN	None	soldering
4	181	CFH1	fume hood	Ron Rector 6-4365	Ron Rector	545	80-120 fpm	156.3 fpm	20	Adequate	Yes	3/15/2004	EJN	cluttered	adhesives, epoxy, ammonia
4	181	CFH1	Laboratory Hood	Ron Rector 6-4365	Ron Rector	545	80-100 fpm	155 fpm	20	Adequate	Yes	3/29/2005	EJN	None	
4	195	CFH1	fume hood	George Harris 6-5743	George Harris	545	80-120 fpm	91.6 fpm	20	Adequate		2/25/2004	EJN	None	acetone, alcohol, toluene,
4	150A	FD1	flexible duct	Matt Conway 6-5422	NA - not a laboratory	227.5	100 at 6" away	100 at 12 inches	N/A	Adequate	Yes	11/2/2004	EJN	None	grease, paint
4	175A	FD1	flexible duct	Larue Phillips 6-4055	NA - not a laboratory	227.5	100 at 6" away	100 at 6 inches	N/A	Adequate	Yes	3/15/2004	EJN	None	soldering
4	183I	GC1	gas cabinet	Ron Rector 6-4365	Ron Rector	545	50 cfm/ft2	25 cfm	N/A	Inadequate	N/A	3/29/2005	EJN	Fan was broken at time of survey	
4	183I	CC1	Chemical cabinet	Ron Rector 6-4365	Ron Rector	545	50 cfm/ft2	8 cfm	N/A	Inadequate	N/A	3/29/2005	EJN	Fan was broken at time of survey	
4	183I	CC2	Chemical cabinet	Ron Rector 6-4365	Ron Rector	545	250 cfm	7 cfm	N/A	Inadequate	N/A	3/29/2005	EJN	Fan was broken at time of survey	Amonia
4	195A	CFH1	fume hood	Grace Miller 6-5738	George Harris	545	80-120 fpm	81.3 fpm	20	Adequate		2/25/2004	EJN	None	acetone, alcohol, toluene, ChemLock, MEK,
4	195A	Paint booth 1	Paint booth	Grace Miller 6-5738	George Harris	545	TBD	154 fpm at 58" away	N/A	Adequate	Yes	11/2/2004	EJN		paints
4	195A	Paintbooth 2	Paint booth	Grace Miller 6-5738	George Harris	545	TBD	175 fpm at 144" away	N/A	Adequate	Yes	11/2/2004	EJN		
4	N100A	FD1	flexible duct	Larue Phillips 6-4055	NA - not a laboratory	227.5	100 fpm at 6" away	Not working	N/A	inoperable	N/A	3/29/2005	EJN	not operating at the time	soldering
5	E-014	CFH1	fume hood	Lisa Early 6-8315	Charlie Adams	547	80-120 fpm	121fpm	18	Adequate	Yes	11/1/2004	EJN		
5	E-014D	CFH1	fume hood	Lisa Early 6-8315	Charlie Adams	547	80-120 fpm	130 fpm	24	Adequate		11/4/2004	EJN	None	
5	E-014D	Tank A1	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 632 cfm 3" push: 43 cfm face push: N/A	pull: 310 cfm 3" push: 320 cfm face push: 25 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x32" Temp 160° F	Disodium Phosphate <5% Tetra Sosium Pyrophosphate 7%
5	E-014D	Tank A2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 632 cfm 3" push: 43 cfm face push: N/A	pull: 590 cfm 3" push: 420 cfm face push: 18.1 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x32" Temp 160° F	Sodium Hydroxide 90-90% Sodium Carbonate ~10%
5	E-014D	Tank A3	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank A4	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 600 cfm 3" push: 18 cfm face push: N/A	pull: 335 cfm 3" push: 77 cfm face push: 20.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x32" Temp 75° F	Nitric Acid Hydrofluric Acid Ferric Acid
5	E-014D	Tank A5	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 62 cfm face push: 32 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank A6	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 600 cfm 3" push: 43 cfm face push: N/A	pull: 330 cfm 3" push: 108 cfm face push: 26.4 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x32" Temp 160° F	Sulfuric Acid
5	E-014D	Tank A7	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 174 cfm face push: 41.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank A9	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 325 cfm 3" push: 30 cfm face push: N/A	pull: 618 cfm 3" push: 51.2 cfm face push: 10.5 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x28" Temp 130° F	Chromium as part of the molecule 6%
5	E-014D	Tank A10	push-pull slot	John Wolfe 6-5708	George Harris	547	pull: 412 cfm 3" push: 14 cfm face push: N/A	pull: 720 cfm 3" push: 41 cfm face push: 12.5 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x28" Temp 200° F	Sandoz Sealing Salts AS Benzoic Acid 10% Nickel Acetate 20%

Attachment 22 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
5	E-014D	Tank A11	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 600 cfm 3" push: 43 cfm face push: N/A	pull: 445 cfm 3" push: 158 cfm face push: 12.1 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank A12	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 600 cfm 3" push: 43 cfm face push: N/A	pull: 697 cfm 3" push: 123 cfm face push: 12.6 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x32" Temp 72° F	Sodium Silicofluoride 2% Chromic Acid <2% Barium Nitrate <2%
5	E-014D	Tanks B1 A/B	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 520 cfm 3" push: 88 cfm face push: 13.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x30" Temp 77° F	Hydrochloric Acid
5	E-014D	Tank B2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank B3	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 410 cfm 3" push: 88 cfm face push: 14.1 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp 70° F	Sodium Hydroxide 30% Zinc Oxide <11%
5	E-014D	Tanks B4 A/B	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 620 cfm 3" push: 41 cfm face push: 11 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp 75° F	Nitric Acid Ammonium Bifluride
5	E-014D	Tank B5	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 81.2 cfm face push: 16.2	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank B6	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 410 cfm 3" push: 61 cfm face push: 11.8 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x30" Temp 75° F	Hydrochloric Acid Nickel Chloride
5	E-014D	Tank B7	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 720 cfm 3" push: 61 cfm face push: 9.8 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x30" Temp 70° F	Nickel Sulfate Nickel Ammonium Sulfate Zinc Sulfate Sodium Thiocyanate
5	E-014D	Tank B8	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 710 cfm 3" push: 120 cfm face push: 8.9 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp 125° F	Nickel Chloride Nickel Sulfate Boric Acid Sel-Rex - Lectroc Nic 1030 Stress Reducer 85g/l Anti-Pit Agents
5	E-014D	Tank B9	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 69 cfm face push: 12.8 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank B10	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 620 cfm 3" push: 62.3 cfm face push: 9.7 cfm	N/A	Marginal	N/A	2/24/2005	EJN	LxWxH 36"x24x36" Temp 75° F	Cupric Acid Sulfuric Acid Chloride Ions Sel-Rex - UBAC #1
5	E-014D	Tank B11	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 474 cfm 3" push: 32 cfm face push: N/A	pull: 740 cfm 3" push: 40.2 cfm face push: 15 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x36" Temp 160° F	Hot Water Rinse
5	E-014D	Tank E2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 21 cfm face push: N/A	pull: 321 cfm 3" push: 71 cfm face push: 12 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x18" Temp 75° F	Nitric Acid
5	E-014D	Tank E3	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 21 cfm face push: N/A	pull: 450 cfm 3" push: 212 cfm face push: 16.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x18" Temp 75° F	Nitric Acid Sulfuric Acid
5	E-014D	Tank E4	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 180 cfm face push: 12.6 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Cold Water Rinse
5	E-014D	Tank E5	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 21 cfm face push: N/A	pull: 780 cfm 3" push: 71 cfm face push: 18 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x18" Temp 75° F	Sulfuric acid
5	E-014D	Tank E6	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 74 cfm face push: 17 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Cold Water Rinse
5	E-014D	Tank E7	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 285 cfm 3" push: 18 cfm face push: N/A	pull: 620 cfm 3" push: 898 cfm face push: 12 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x18" Temp 200° F	Electroless Nickel
5	E-014D	Tank E8	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 760 cfm 3" push: 7 cfm face push: N/A	pull: 510 cfm 3" push: 94 cfm face push: 14 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 48"x24x24" Temp 200° F	Electroless Nickel
5	E-014D	Tank N1	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 474 cfm 3" push: 32 cfm face push: N/A	pull: 465 cfm 3" push: 490 cfm face push: 12.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp 160° F	Electro cleaner
5	E-014D	Tank N2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 251 cfm face push: 15.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tanks N3 A/B/C	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 675 cfm 3" push: 48 cfm face push: N/A	pull: 299 cfm 3" push: 141 cfm face push: 14.9 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 54"x24x24" Temp 100° F	Chromium Cloride, Ferric Chloride, Ferric Nitrate, Hydrocloric Acid, Nickel Chloride,

Attachment 22 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
5	E-014D	Tank N4	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: 564 cfm 3" push: 150 face push: 8.2	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tanks N5 A/B/C	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 675 cfm 3" push: 48 cfm face push: N/A	pull: 540 cfm 3" push: 120 cfm face push: 17.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 54"x24x32" Temp ???" F	Nitric Acid
5	E-014D	Tank N6	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 420 cfm face push: 17.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cold Water Rinse	Cold Water Rinse
5	E-014D	Tank N7	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 32 cfm face push: N/A	pull: 710 cfm 3" push: 104 cfm face push: 12.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp 71" F	Phosphoric Acid
5	E-014D	Tank N8	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 21 cfm face push: N/A	pull: 590 cfm 3" push: 82 cfm face push: 14.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x30" Temp ???" F	Iridite 15, Chromic acid, ARP #2, Hydrochloric Acid
5	E-014D	Tank N9	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: 450 cfm 3" push: 72 cfm face push: 12.5 fm	N/A	Adequate	N/A	2/24/2005	EJN	Hot Water Rinse	Water
5	E-014D	Tank CN1	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 30 cfm face push: N/A	pull: 214 cfm 3" push: 140 cfm face push: 51 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cynaide Dead Rinse	Water
5	E-014D	Tank CN2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 15 cfm face push: N/A	pull: 250 cfm 3" push: 120 cfm face push: 17 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Not in use	Not in use
5	E-014D	Tank CN3	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Water
5	E-014D	Tank CN4	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: 12 cfm face push: N/A	pull: 420 cfm 3" push: 41.5 cfm face push: 14.2 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x32" Temp ???" F	Copper Strike E-Brite
5	E-014D	Tank CN5	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 600 cfm 3" push: 34 cfm face push: N/A	pull: 174 cfm 3" push: 312 cfm face push: 28 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Cynaide Dead Rinse	Water
5	E-014D	Tank CN6	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 375 cfm 3" push: 14 cfm face push: N/A	pull: 412 cfm 3" push: 182 cfm face push: 19.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 30"x24x24" Temp ???" F	Silver plating bath
5	E-014D	Tank CN7	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Water
5	E-014D	Tank CN8	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 375 cfm 3" push: 43 cfm face push: N/A	pull: 610 cfm 3" push: 142 cfm face push: 18.3 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 30"x24x24" Temp ???" F	Silver strike bath
5	E-014D	Tank CN9	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 419 cfm face push: 12.6 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x24" Temp ???" F	Not in use
5	E-014D	Tank CN10	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: 620 cfm face push: 17.6 cfm	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Water
5	E-014D	Tank E1	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 300 cfm 3" push: 21 cfm face push: N/A	pull: 287 cfm 3" push: 91.0 cfm face push: 12.5 cfm	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 24"x24x18" Temp 75" F	Nitric Acid
5	E-014D	CFH1	fume hood	Lisa Early 6-8315	Charlie Adams	547	80-120 fpm	173 fpm	17	Adequate	Yes	11/1/2004	EJn	None	hydrochloric acid, ammonium hydroxide, potassium carbonate
5	E-014D	LEV1	fume hood	John Wolfe 6-5708	Charlie Adams	547	TBD	Not working	N/A	Inadequate	N/A	11/1/2004	EJn	None	tolnol reducer, xp-2000, acetone
5	E-014E	LEV1	fume hood	John Wolfe 6-5708	Charlie Adams	547	TBD	Not working	N/A	Inadequate	N/A	11/1/2004	EJN		
5	E-014E	LEV2	fume hood	John Wolfe 6-5708	Charlie Adams	547	TBD	Not working	N/A	Inadequate	N/A	11/1/2004	EJN		
5	E-014F	P2	fume hood	John Wolfe 6-5708	Charlie Adams	547	TBD	Not working		Inadequate		11/1/2004	EJN	None	plating with acids, cyanide
5	E-014G	Tank G1	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: N/A face push: N/A	pull: 420 cfm 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x36" Temp 130" F	Gold Strike
5	E-014G	Tank G2	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Water spray rinse	Cold Water Rinse
5	E-014G	Tank G3	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: 450 cfm 3" push: N/A face push: N/A	pull: 551 cfm 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	LxWxH 36"x24x36" Temp 120" F	Gold plating
5	E-014G	Tank G4	push-pull slot	John Wolfe 6-5708	Charlie Adams	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	Adequate	N/A	2/24/2005	EJN	Counter-flow rinse	Cold Water Rinse
5	E-014K	Buffer1	buffer exhaust	John Wolfe 6-5708	Charlie Adams	547	420 cfm	129 cfm	N/A	Inadequate	N/A	2/24/2005	EJN	Wheel diameter < 9 inches (1500 fpm) (0.086)= 129 cfm	
5	E-014K	Buffer2	buffer exhaust	John Wolfe 6-5708	Charlie Adams	547	388 cfm	198 cfm	N/A	Inadequate	N/A	2/24/2005	EJN	Wheel diameter < 9 inches (2300 fpm) (0.086)= 198 cfm	

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Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
5	E-014K	Buffer3	buffer exhaust	John Wolfe 6-5708	Charlie Adams	547	410 cfm	250 cfm	N/A	Inadequate	N/A	2/24/2005	EJN	Wheel diameter < 9 inches (2900 fpm) (0.086)= 250 cfm	
5	E-014K	Buffer4	buffer exhaust	John Wolfe 6-5708	Charlie Adams	547	400 cfm	322 cfm	N/A	Inadequate	N/A	2/24/2005	JD/EJN	Wheel diameter < 9 inches (3740 fpm) (0.086)= 322 cfm	
5	E-038	FD1	flexible duct	Chris Bunyea 6-3956	NA - not a laboratory	547	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/1/2004	EJN	None	welding/ soldering fumes
5	E-038	FD2	flexible duct	Chris Bunyea 6-3956	NA - not a laboratory	547	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/1/2004	EJN	None	welding/ soldering fumes
5	E-038	FD3	flexible duct	Chris Bunyea 6-3956	NA - not a laboratory	547	100 at task	100 at 6 inches	N/A	Adequate	Yes	11/1/2004	EJN	None	welding/ soldering fumes
5	E-038	FD4	flexible duct	Chris Bunyea 6-3956	NA - not a laboratory	547	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/1/2004	EJN	None	welding/ soldering fumes
5	E-038	FD5	flexible duct	Chris Bunyea 6-3956	NA - not a laboratory	547	100 at task	102 at 6 inches	N/A	Adequate	Yes	11/1/2004	EJN	None	welding/ soldering fumes
5	E-047	PB1	paint fume hood	Carl Strozjny 6-7269	Carl Strozey	551	80-120 fpm	192.6 fpm	7	Adequate	Yes	6/3/2004	EJN	sash is on a hinge	silver solution, sodium hydroxide, formaldehyde, ammonium oxide, alcohol, silver nitrate
5	E-047	PB2	paint fume hood	Carl Strozjny 6-7269	Carl Strozey	551	80-120 fpm	84.3 fpm	7	Adequate	Yes	6/3/2004	EJN	sash is on a hinge	acetone
5	E-048	Lev1	floor exhaust	Gary Moffat 6-8508	NA - not a laboratory	547	none	100 fpm at 24" away	N/A	Adequate	Yes	2/24/2005	EJn		Plexiglas and wood dust
5	E-048	Lev2	floor exhaust	Gary Moffat 6-8508	NA - not a laboratory	547	none	100 fpm at 30" away	N/A	Adequate	Yes	2/24/2005	EJn		wood sawdust
5	E-048	Lev3	floor exhaust	Gary Moffat 6-8508	NA - not a laboratory	547	none	100 fpm at 30" away	N/A	Adequate	Yes	2/24/2005	EJn		sawdust, Plexiglas
5	E-048	FD1	flexible duct	Gary Moffat 6-8508	NA - not a laboratory	547	100" at 6 inches	100 fpm at 12" away	N/A	Adequate	Yes	2/24/2005	EJn		sawdust, Plexiglas
5	E-048	FD2	flexible duct	Gary Moffat 6-8508	NA - not a laboratory	547	100" at 6 inches	100 fpm at 12" away	N/A	Adequate	Yes	2/24/2005	EJn		sawdust, Plexiglas
5	E-048	ww1	disc sander	Gary Moffat 6-8508	NA - not a laboratory	547	3500 fpm; 440 cfm	4340 fpm	N/A	Adequate	Yes	2/24/2005	EJn	14 inch wheel	sawdust, Plexiglas
5	E-048	ww2	verticle belt sander	Gary Moffat 6-8508	NA - not a laboratory	547	3500 fpm; 550 cfm	646 cfm	N/A	Adequate	Yes	2/24/2005	EJn	6 inch belt	sawdust, Plexiglas
5	E-048	ww3	Band saw	Gary Moffat 6-8508	NA - not a laboratory	547	3500fpm; 700 cfm	835 cfm	N/A	Adequate	Yes	2/24/2005	EJn	1/4 inch blade; 6 inch duct	sawdust
5	E-048	ww4	Band saw	Gary Moffat 6-8508	NA - not a laboratory	547	3500 fpm; 700 cfm	1609 cfm	N/A	Adequate	Yes	2/24/2005	EJn	1/2 inch blade; 6 inch duct	epoxy, Plexiglas
5	E-048	ww5	Planer	Gary Moffat 6-8508	NA - not a laboratory	547		2825 cfm	N/A	Adequate	Yes	2/24/2005	EJn	>20 inch knife; 8 inch duct	sawdust
5	E-048	ww6	Radial arm saw	Gary Moffat 6-8508	NA - not a laboratory	547	4000 fpm	6200 fpm	N/A	Adequate	Yes	2/24/2005	EJn	16 inch blade	epoxy, Plexiglas
5	E-048	ww7	Spindle sander	Gary Moffat 6-8508	NA - not a laboratory	547	??	874 cfm	N/A	Adequate	Yes	2/24/2005	EJn		sawdust
5	E-048A	Lev1	floor exhaust	Gary Moffat 6-8508	NA - not a laboratory	547	none	100 fpm at 24" away	N/A	Adequate	Yes	2/24/2005	EJn	Floor exhaust	Plexiglas and wood dust
5	E-048A	ww1	Table saw	Gary Moffat 6-8508	NA - not a laboratory	547	350 cfm	1591 cfm	N/A	Adequate	Yes	2/24/2005	EJn	10 inch blade; 6 inch duct	Plexiglas and wood dust
5	E-048A	ww2	Jointer	Gary Moffat 6-8508	NA - not a laboratory	547	440 cfm	1591cfm	N/A	Adequate	Yes	2/24/2005	EJn	8 inch knife; 6 inch duct	Plexiglas and wood dust
5	E-048A	ww3	Shaper/Router	Gary Moffat 6-8508	NA - not a laboratory	547	850 cfm	1701 cfm	N/A	Adequate	Yes	2/24/2005	EJn	6 inch duct	metals, plastic, glass
5	E-048A	ww4	Buffer/polisher	Gary Moffat 6-8508	NA - not a laboratory	547	400 cfm	1548 cfm	N/A	Adequate	Yes	2/24/2005	EJn	6 inch wheel; 6 inch duct	Plexiglas and wood dust
5	E-048A	ww5	flexible duct	Gary Moffat 6-8508	NA - not a laboratory	547	100" at 6 inches	100 fpm at 8 inches	N/A	Adequate	Yes	2/24/2005	EJn		Plexiglas and wood dust
5	E-048A	ww6	Panel saw	Gary Moffat 6-8508	NA - not a laboratory	547	350 cfm	1150 cfm	N/A	Adequate	Yes	2/24/2005	EJn	6 inch duct	Plexiglas and wood dust
5	E-052	Lev1	chemical cabinet	Gary Moffat 6-8508	NA - not a laboratory	547	??	125 fpm	N/A	Adequate	Yes	2/24/2005	EJn	measured in duct opening	paints, solvents
5	E-052	Lev2	floor exhaust	Gary Moffat 6-8508	NA - not a laboratory	547	none	100 fpm at 24" away	N/A	Adequate	Yes	2/24/2005	EJn	None	sawdust, Plexiglas
5	E-052	FD1	flexible duct	Gary Moffat 6-8508	NA - not a laboratory	547	100 fpm at 6" away	100 fpm at 12" away	N/A	Adequate	Yes	2/24/2005	EJn	None	sawdust, Plexiglas
5	E-052	FD2	flexible duct	Gary Moffat 6-8508	NA - not a laboratory	547	100 fpm at 6" away	100 fpm at 12" away	N/A	Adequate	Yes	2/24/2005	EJn	None	sawdust, Plexiglas
5	E-052	SH1	slot hood	Gary Moffat 6-8508	NA - not a laboratory	547	80-100 fpm	153 fpm at face	N/A	Adequate	Yes	2/24/2005	EJn	None	paints, solvents
5	E-070	CFH1	fume hood	Jeff Gum 6-8200	Charlie Adams	551	80-120 fpm	124 fpm	20	Adequate		3/29/2005	EJN	None	Hydrochloric acid, Sulfuric acid, Nitric acid, Chromic acid, Sodium hydroxide, Cupric sulfate
5	E-070	CFH2	fume hood	Jeff Gum 6-8200	Charlie Adams	551	80-120 fpm	103 fpm	16	Adequate		3/29/2005	EJN	Hood area enclosed in plastic	Acetone, Alconox Detergent
5	E-070	LEV1	slot hood	Jeff Gum 6-8200		551	TBD	472 fpm at face 72 fpm at 12 inches	N/A	Adequate	yes	3/29/2005	EJN	Slot hood below acetone distillation. Not used often	Acetone
5	E-070A	CFH1	fume hood	Jeff Gum 6-8200	Charlie Adams	551	80-120 fpm	84.6 fpm	16	Adequate		3/10/2004	EJN	Clean Room sticker needed	Acetone, Alconox Detergent
5	W-021	CFH1	fume hood	Dave Clark 6-0710	David Clark	547	80-120 fpm	Not working	N/A	Fail	N/A	6/3/2004	EJN	None	acetone, alcohol
5	W-028	SH1	slot hood	Paul Haney 6-6176	NA - not a laboratory	544	TBD	100 fpm at 16 inches	N/A	Adequate	N/A	6/3/2004	EJN	Not used often.	
5	W-028	CFH1	fume hood	Paul Haney 6-6176	NA - not a laboratory	544	80-120 fpm	87.2 fpm	20	Adequate	N/A	6/3/2004	EJN	Not used often.	currently none
5	W-06H	FD1	flexible duct	Dwight Roberts x6-2130	Dwight Roberts	544	100 at 6" away	32 fpm at 6 inches 100 fpm at 4 inches	N/A	Inadequate	N/A	6/3/2004	EJN	System may need maintenance for better air flow.	soldering
5	W-06H	FD2	flexible duct	Dwight Roberts x6-2130	Dwight Roberts	544	100 at 6" away	48 fpm at 6 inches 100 fpm at 4 inches	N/A	Inadequate	N/A	6/3/2004	EJN	System may need maintenance for better air flow.	soldering
5	W-06H	FD3	Portable flexible duct	Dwight Roberts x6-2130	Dwight Roberts	544	100 at 6" away	25 fpm at 6 inches 100 fpm at 2 inches	N/A	Inadequate	N/A	6/3/2004	EJN	System may need maintenance for better air flow.	soldering
5	W-087	CFH1	fume hood	Gordon Bowers 6-4604	Gordon Bowers	691	80-120 fpm	Not working	N/A	Fail	N/A	6/3/2004	EJN	Will be transferred to another room	acetone, alcohol
5	W-087	CFH2	fume hood	Gordon Bowers 6-4604	Gordon Bowers	691	80-120 fpm	Not working	N/A	Fail	N/A	6/3/2004	EJN	Will be transferred to another room	acetone, alcohol
5	W-090	CFH1	fume hood	Gordon Bowers 6-4604	Gordon Bowers	691	80-120 fpm	Not working	N/A	Fail	N/A	6/3/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS. Not used very often.	alcohol, acetone
7	N100	CB1	clean bench	Colette Lapage x6-7099	Colette Lapage? Phonecon btwn SR/CL 8 nov 04. This is a clean bench not a fume hood.	552	80-120 fpm	121.5 fpm	none	Adequate	3/29/2005	3/15/2004	EJN	None	Dmysol 165, Sulfuric Acid, Gadolinium Chloride, Sodium Carbonate, Cesium Chloride, NaCl

Attachment 22 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
7	N100	CFH1	fume hood	Colette Lapage x6-7099	Colette Lapage? Phonecon btwn SR/CL 8 nov 04. This is a clean bench not a fume hood.	552	80-100 fpm	172.1 fpm	16	Adequate	Yes	3/29/2005	EJN	None	
7	006	CFH1	fume hood	Kevin Rudman 6-2767	Kevin Rudman	551	80-120	175 fpm	20	Adequate	Yes	3/29/2005	EJN	None	Bonding Optics NO hazardous chemicals
7	190	Canopy1	canopy	Mike Drury x6-4622	NA - not a laboratory	540.5	100	Not working		N/A	Yes	6/2/2004		N/A	N/A
7	190	CFH1	fume hood	Mike Drury x6-4622	NA - not a laboratory	540.5	80-120 fpm	81.3	19	Adequate	Yes	6/2/2004	EJN	None	Spray paints, adhesives, acetone, alcohol, epoxy
7	150 (Gas Tent near 150)	Canopy1	canopy	Gene McAlicher 6-0490	NA - not a laboratory	540.5	100	43 at 30 inches		Inadequate	N/A	6/4/2004	EJN	**HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS**	**Hydrogen gas, Methane Gas, Nitrogen Gas**
7	003	CFH1	fume hood	Vicki Roberts 6-2782	NA - not a laboratory	540.5	80-120 fpm	83	16	Adequate	Yes	7/21/2004	EJN	Large items blocking the baffles	Chloroform, Isopropyl Alcohol
10	130	CFH1	fume hood	John DiBartolo 6-1329	Fred Richards? 64765 SR Left Voicemail 3 Nov 04	545	80-120 fpm	214	20	Adequate	Yes	6/4/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	Isopropyl Alcohol, Glass Apparatus
10	130	FD1	flexible duct	Alan Winters 6-7202	Fred Richards? 64765 SR Left Voicemail 3 Nov 04	545	100 fpm	100 at 12" away	N/A	Adequate	N/A	6/4/2004	EJN	NOT USUALLY USED Keep task directly 12 inches under exhaust source.	Spray solvents containing isopropyl alcohol and petroleum. Magnetic particle dust
10	130	FD2	flexible duct	Alan Winters 6-7202	Fred Richards? 64765 SR Left Voicemail 3 Nov 04	545	100 at fpm	100 at 12" away	N/A	Adequate	N/A	6/4/2004	EJN	NOT USUALLY USED Keep task directly 12 inches under exhaust source.	Spray solvents containing isopropyl alcohol and petroleum. Magnetic particle dust
10	B1	SH1	slot hood	Jerry Wild 6-4805 Tom Delaney 6-6048	NA - not a laboratory	540.5	100 fpm	0		Inadequate	N/A	6/4/2004	EJN	HOOD INOPERABLE NOT IN USE	Soldering, Welding
11	E38A	1	flexible duct	Travis Travers 6-2449	Travis Travers	553	100 at task	80 at 4-5 inches		Marginal		6/27/2003	KAW	System may need maintenance for better air flow.	soldering, welding
11	E106A	CFH1	fume hood	Joe Roman 6-6151	Joe Roman	596	80-120 fpm	152.3 fpm	8.5	Adequate	Yes	6/9/2004	EJN	Sash does not move.	heptane, alcohol, epoxy, ferric chloride, urolane, sodium carbonate, versamid 140, liquid nitrogen, methyl chloride, methyl ethyl ketone
11	E120	CFH1	fume hood	Joe Roman 6-6151	Joe Roman	596	80-120 fpm	78 fpm	20	Adequate	Yes	6/9/2004	EJN	None	acetone, alcohol, solvents
11	E32A	FD1	flexible duct	Andre Burgess 6-5650	NA - not a laboratory	553	100 at 6" away	100 at 6 inches	N/A	Marginal	Yes	6/9/2004	EJN	portable flex duct	soldering
11	S340	CFH1	fume hood	Andre Burgess 6-5650	NA - not a laboratory	553	80-120 fpm	122 fpm	18	Adequate	yes	7/20/2004	EJN	Penthouse level	Waste holding area, Alcohol, soap
11	S140	CFH1	fume hood	Andre Burgess 6-5650	Andre Burgess	553	80-120 fpm	107 fpm	17	Adequate	yes	7/22/2004	EJN	None	currently none
11	S019	Wetbench1	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120 fpm	127 fpm	13	Adequate	N/A	7/22/2004	EJN		Acids and Bases
11	S019	Wetbench2	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120 fpm	101 fpm	10	Adequate	N/A	7/22/2004	EJN	None	Isopropyl, Ethyl, Methyl alcohol
11	S019	Wetbench3	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120 fpm	115 fpm	10	Adequate	N/A	7/22/2004	EJN		Acids, MCT Rinse, Fixture wash
11	S019	GB1	Glove box	Andre Burgess 6-5650	Andre Burgess	553	80-120 fpm	330 fpm	N/A	Inadequate	N/A	7/22/2004	EJN	Blanked off	Blanked off
11	C301	CFH1	fume hood	Andre Burgess 6-5650		553	80-120 fpm	106 fpm	16	Adequate	yes	7/22/2004	EJN	??	??
11	S007	CFH1	fume hood	Andre Burgess 6-5650	David Franz	553	80-120 fpm	91 fpm	16	Adequate	yes	7/22/2004	EJN	None	epoxy, alcohol, ketones
20	33	CFH1	fume hood	Arthur Ruitberg 6-4812	Arthur Ruitberg	563	80-120 fpm	Not working	11	Inadequate	N/A	6/7/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIV MATERIALS. Fan will not turn on.	currently none
20	59	CFH1	fume hood	Arthur Ruitberg 6-4812	Arthur Ruitberg	563	80-120 fpm	63.5	11	Inadequate	N/A	6/7/2004	EJN	Can not move sash	alcohol, solder residue, soldering pot
20	65	CFH1	fume hood	Arthur Ruitberg 6-4812	Arthur Ruitberg	563	80-120 fpm	104.2	11	Adequate	yes	6/7/2004	EJN	C an not move sash	
21	283A	CFH1	fume hood	Ernest Buchanan 6-5018	Computer Lab - EB reported on 3 Nov 04: abandoned by 685 in 2000.	685	80-120 fpm	Not working	N/A	Inadequate	No	6/7/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	currently none
21	149	CFH1	fume hood	Ernest Buchanan 6-5018	Harvey Mosley Dominic Benford 68771	685	80-120 fpm	145 fpm	20	Adequate	Yes	2/17/2005	EJN	None	Methanol
21	153	CFH1	fume hood	Ernest Buchanan 6-5018	Harvey Mosley Dominic Benford 68771	685	80-120 fpm	Does not run	N/A	Inadequate	No	6/9/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	currently none
21	217A	Canopy1	canopy hood	Glen Gardner	Paulo Uribe	696	100 at task	100 fpm at 22"	N/A	Inadequate	No	6/9/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS. Not the most efficient design for this operation.	soldering
21	233B	CFH1	fume hood				80-100 fpm	Not working	N/A	Inadequate	No	1/7/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	
21	017	CFH1	fume hood	Al Kogut 6-0853	Al Kogut? SR left Voicemail 3 Nov 04	685	80-120 fpm	210.5 fpm	18	Too high	yes	7/21/2004	EJN		Isopropyl alcohol
21	071	CFH1	fume hood	Al Kogut 6-0853	Al Kogut? SR left Voicemail 3 Nov 04	685	80-120 fpm	222 fpm	18	Too high	yes	9/30/2004	EJN		Porys
22	198	FD1	flexible duct	Jim Mazzarella 6-3410 or 6-1409	Curtis O'Dell	660	100 at 6" away	Not working	N/A	Inadequate	No	11/16/2004	EJN		

Attachment 22 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
22	198	PB1	Paint Booth	Jim Mazzarella 6-3410 or 6-1409	Curtis O'Dell	660	100 FPM	115 at face	N/A	Adequate	Yes	11/16/2004	EJN		
22	C057	CFH1	fume hood	Pat Freidberg x6-9158	Pat Friedberg	562	80-120 fpm	126.3 fpm	20	Adequate		3/15/2004	EJN	clean room sticker Room located behind high bay	Acids, Alcohol
22	C075	CFH1	fume hood	Pat Freidberg x6-9158	Patty Hart	562	80-120 fpm	123.5 fpm	20	Adequate		3/15/2004	EJN		Acids, Alcohol
22	C047	CFH1	fume hood	Pat Freidberg x6-9158	Patty Hart	562	80-120 fpm	117 fpm	24	Adequate	Clean room	2/17/2005	EJN	None	Isopropyl Alcohol, Poxys
22	C051B	CFH1	fume hood	Pat Freidberg x6-9158	Bright Wong	562	80-120 fpm	Not working	24	Inadequate	No	3/29/2005	EJN	None	Calcium Sulfate Aniline Hydrochloride
22	C031E	Canopy1	canopy hood				100 at task	Not working	N/A	Inadequate	No	6/7/2004	EJN		
22	C039	CFH1	fume hood	Patty Hart 6-3845	Shavesa Anderson 64280	562	80-100 fpm	68 fpm	15	Inadequate	No	6/7/2004	EJN		Plasma etching
22	C039	CFH2	fume hood	Patty Hart 6-3845	Shavesa Anderson 64280	562	80-100 fpm	80 fpm	20	Adequate	Yes	6/7/2004	EJN		bases and cyanide
22	C039	CFH3	fume hood	Patty Hart 6-3845	Shavesa Anderson 64280	562	80-100 fpm	123 fpm	16	Adequate	Yes	6/7/2004	EJN		Acetone, Acids, Glacial acidic acid
22	C039	CFH4	fume hood	Patty Hart 6-3845	Shavesa Anderson 64280	562	80-100 fpm	125 fpm	20	Adequate	Yes	6/7/2004	EJN	None	acetone, alcohol, acids
22	C041	Canopy1	canopy hood	Dennis Ratliff 6-0790	Alix Duvalsaint 6-9691	562	100 at 6" away	52.5 fpm	N/A	Inadequate	N/A	6/7/2004	EJN	Difficult to read because oven is right on Canopy	Oven
22	C095A	Canopy1	canopy hood	TBD	TBD		100 at 6" away	130 fpm	N/A	Adequate	N/A	6/7/2004	EJN	Difficult to read because oven is right on Canopy	Oven
22	G070D	CFH1	fume hood	Steve Brown 6-5795	Steve Brown	562	80-120 fpm	Not working	N/A	Inadequate	No	6/7/2004	EJN		T Blanchard 3 Nov 04 - Soldering Only
22	G070L	CFH1	fume hood	Tad Blanchard 6-8482	NA - not a laboratory		80-120 fpm	138 fpm	17	Adequate	Yes	6/7/2004	EJN		Radioactive material
22	G070U	CFH1	fume hood	Steve Brown 6-5795	Steve Brown	562	TBD	152 fpm	16	Adequate	Yes	6/7/2004	EJN	Sash is broken	
22	G070V	CFH1	fume hood	Steve Brown 6-5795	Steve Brown	562	TBD	129.8 fpm	16	Adequate	Yes	6/7/2004	EJN		Cyanogen, sulfer dioxide, isopropylisocyanide, Potassium Cyanide, Phenol
22	C237	CFH1	fume hood	Antonio Mannino	Antonio Mannino	971	80-120 fpm	116 fpm	20	Adequate	Yes	9/10/2004	EJN	None	Acetone, Isopropanol, Ethyl acetate, Methanol
22	C237	Canopy1	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN	Oven	Dry samples
22	C237	Canopy2	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN	Oven	High temperature furnace
22	C237	Canopy3	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN	Oven	??
22	C237A	CFH1	fume hood	Antonio Mannino	Antonio Mannino	971	80-120 fpm	154 fpm	20	Adequate	Yes	9/10/2004	EJN	None	Hydrochloric acid, Acedic Acid, Phosphoric acid, Hydrophoric acid, Sulfuric acid
22	C237A	Canopy1	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN		High temerature chromotograph
22	C237A	Canopy2	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN		future mass spectametor
22	C237A	Canopy3	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN		Gas chromotograph
22	C237A	Canopy4	canopy hood	Antonio Mannino	Antonio Mannino	971	100 at 6" away	100 at 3" away	N/A	Marginal	Yes	9/10/2004	EJN		Gas chromotograph
22	C283	CFH1	fume hood	Kirby Worthington x6-9320	Kirby Worthington	971	80-120 fpm	154 fpm	20	Adequate	yes	9/10/2004	EJN		Alcohol, Bacteria
27	Garage	FD1	flexible ducts	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	75.2 cfm	N/A	Inadequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD2	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	78.2 cfm	N/A	Inadequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD3	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	110 cfm	N/A	Adequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD4	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	104 cfm	N/A	Adequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD5	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	119.5 cfm	N/A	Adequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD6	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	201 cfm	N/A	N/A	N/A	7/19/2004	EJN	Not connected	automobile exhaust <200 HP
27	Garage	FD7	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	106.6 cfm	N/A	Adequate	N/A	7/19/2004	EJN		automobile exhaust <200 HP
27	Garage	FD8	flexible duct	Larry Whitt 6-3780	NA - not a laboratory	239	100 cfm	286 cfm	N/A	N/A	N/A	7/19/2004	EJN	Not connected	automobile exhaust <200 HP
30	148A	1	fume hood	Mark Underwood 6-6241	Mark Underwood	597	80-120 fpm	50		Inadequate		7/1/2003	KAW	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	peroxide, epoxy
30	DDL	Wetbench 1	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	182.3 fpm	17	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	acids
30	DDL	Wetbench 2	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	107.9 fpm	17	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	bases
30	DDL	Wetbench 3	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	137.4 fpm	10	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	xylene, ethelene acetate black hole ether
30	DDL	Wetbench 4	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	143.8 fpm	17	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	acids H2SO4, H2O2
30	DDL	Wetbench 5	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	182.7 fpm	15	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	solovents
30	DDL	Wetbench 6	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	122.7 fpm	12	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	bases

Attachment 22 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
30	DDL	Wetbench 7	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	157 fpm	12	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	acids, phosporic acid mix
30	DDL	Wetbench 8	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	164.2 fpm	18	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	acids, bromine
30	DDL	Wetbench 9	Wetbench	Andre Burgess 6-5650	Andre Burgess	553	80-120	121.2 fpm	17	Adequate	NA -Clean room	4/9/2004	EJN	measurement taken at the face	solovents
30	DDL	CFH1	Fume Hood	Andre Burgess 6-5650	Andre Burgess	553	80-120	83.1 fpm	19	Adequate	NA -Clean room	4/9/2004	EJN	No chemicals just bag out	acids
30	DDL	CFH2	Fume Hood	Andre Burgess 6-5650	Andre Burgess	553	80-120	139.5 fpm	21	Adequate	NA -Clean room	4/9/2004	EJN	Cleaning and servicing parts	solovents
30	DDL	GB1	Glove box	Andre Burgess 6-5650	Andre Burgess	553	TBD	248 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	8" duct @ 353 fpm	N/A
30	DDL	GB2	Glove box	Andre Burgess 6-5650	Andre Burgess	553	TBD	395 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	N/A	N/A
30	DDL	Spinner-1A	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	76 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Left set of spinners 4" duct @ 1787 fpm	
30	DDL	Spinner-1B	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	104 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Left set of spinners 4" duct @ 1787 fpm	
30	DDL	Spinner-2A	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	155 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Middle set of spinners 4" duct @ 1653 fpm	
30	DDL	Spinner-2B	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	117 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Middle set of spinners 4" duct @ 1653 fpm	
30	DDL	Spinner 3/4 A	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	0 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Right set of spinners 4" duct @ 1627 fpm	
30	DDL	Spinner 3/4 B	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	134 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Right set of spinners 4" duct @ 1627 fpm	
30	DDL	Spinner 3/4 C	Spinner	Andre Burgess 6-5650	Andre Burgess	553	TBD	91 fpm	N/A	TBD	NA -Clean room	4/9/2004	EJN	Right set of spinners 4" duct @ 1627 fpm	
30	DDL	Bakeout oven	Bakeout oven	Andre Burgess 6-5650	Andre Burgess	553	TBD	15.73 cfm	N/A	TBD	NA -Clean room	4/9/2004	EJN	3" duct avg fpm= 321	
30	DDL	Ion Implanter	Ion Implanter	Andre Burgess 6-5650	Andre Burgess	553	TBD	1578 cfm	N/A	TBD	NA -Clean room	4/9/2004	EJN	12" duct avg fpm= 2010	
30	DDL	Verticle high temp furnace	Verticle high temp furnace	Andre Burgess 6-5650	Andre Burgess	553	TBD	298 cfm	N/A	TBD	NA -Clean room	4/9/2004	EJN	12" duct avg fpm= 379	
30	104	CFH1	fume hood	Alex Montoga 6-5289	Alex Montoya	541	80-120 fpm	151.5 fpm	12	Adequate		4/28/2004	EJN	None	Organic solvents mostly <100ml
30	104	CB1	clean bench	Diane Kolos 6-3880	Alex Montoya	541	100 fpm at face	94.5 fpm	N/A	Adequate		4/28/2004	EJN	None	
30	130	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120	152 fpm	20	Adequate		4/28/2004	EJN	None	nitric acid, hydrochloric acid, acetone, xylene
30	105	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	89 fpm	18	Adequate		6/8/2004	EJN	None	alcohol, acetone, calcium carbonate
30	111	SH1	slot hood	Diane Kolos 6-3880	Diane Kolos	541	??	86 fpm		??	yes	6/8/2004	EJN	None	soldering
30	125	SH1	slot hood	Diane Kolos 6-3880	Diane Kolos	541	100 at task	104 fpm at 13" away	N/A	Adequate	yes	6/8/2004	EJN	None	soldering
30	136	SH1	slot hood	Diane Kolos 6-3880	Diane Kolos	541	100 at task	96	N/A	Adequate	yes	6/8/2004	EJN		hot plate, Chemlok Ap-131 primer
30	139	FD1	flexible duct	Diane Kolos 6-3880	Diane Kolos	541	100 at 6" away	107 at 4" away	N/A	Inadequate	yes	6/8/2004	EJN	None	hot plate, Chemlok Ap-131 primer
30	140	FD1	flexible duct	Diane Kolos 6-3880	Diane Kolos	541	100 at 6" away	100 at 6 inches	N/A	Inadequate	yes	6/8/2004	EJN	None	acetone, alcohol, toluene,
30	140	FD2	flexible duct	Diane Kolos 6-3880	Diane Kolos	541	100 at 6" away	100 at 6 inches	N/A	Inadequate	yes	6/8/2004	EJN	None	acetone, alcohol, toluene,
30	140	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	129	20	Adequate	yes	6/8/2004	EJN	None	acetone, DMF, alcohol, toluene
30	140	CFH2	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	107.5 fpm	16	Adequate	yes	6/8/2004	EJN	None	Ethyl alcohol, toluene, Acetone
30	158	CFH1	fume hood	Diane Kolos 6-3880	Mark Underwood	541	80-120 fpm	108 fpm	20	Adequate	yes	6/8/2004	EJN	None	solvents
30	177	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	100 fpm	23	Adequate	yes	6/8/2004	EJN	None	acids, bases, solvents
30	171	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	159	20	Adequate	yes	6/9/2004	EJN	None	ultrasonic cleaning, alcohol, solvents
30	158A	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	Not working	N/A	Inadequate	No	6/10/2004	EJN	Not operating for clean room purposes per Mike Veins	
30	105	FD1	flexible duct	Diane Kolos 6-3880	Diane Kolos	541	100 at 6" away	55.6 fpm	N/A	Inadequate	No	6/17/2004	EJN		
30	146	CFH1	fume hood	Diane Kolos 6-3880	Diane Kolos	541	80-120 fpm	107 fpm	18	Adequate	Yes	11/2/2004	EJN	Cleanroom in Room 140	toluene, alcohol
30	177	FD1	flexible duct	Diane Kolos 6-3880	Diane Kolos	541	100 at 6" away	100 at 4" away	N/A	Adequate	Yes	11/2/2004	EJN	None	soldering
33	205C	FD1	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 12 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil

Attachment 22 concluded

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Code	Required Capture Velocity	Capture Velocity	Sash Height	Status	Smoke Capture	Date	Evaluator	Notes	Chemicals
33	205C	FD2	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 12 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil
33	205C	FD3	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil
33	205C	FD4	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 12 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil
33	205C	FD5	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil
33	205C	FD6	flexible duct	Steve Cagiano 4-6386	Steve Cagiano	544	100 at task	100 at 8 inches	N/A	Adequate	Yes	11/17/2004	EJN	Open one other duct while testing.	soluble and cutting oil
33	H009	FB1	Flow bench	Barry Coyle 4-5859	Barry Coyle	920.3	80-120 fpm	turned off	N/A	Inadequate	Yes	2/25/2004	EJN	**HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS**	Used to keep dust off clean material
33	H009	CFH1	fume hood	Barry Coyle 4-5859	Barry Coyle	920.3	80-120 fpm	150 fpm	20	Adequate		2/25/2004	EJN	Captured smoke with no eddys	acetone, alcohol, WD40, 409
33	D105	CFH1	fume hood	Robert Abell x46366	Dan Harpold	544/915	80-120 fpm	115.8 fpm	18	Adequate	Yes	6/9/2004	EJN	Sash Height locked	Nitrogen, distillations
33	D115	FD1	flexible duct	Dan Harpold 4-6378	Dan Harpold	915	100 at 6" away	108 at 8" away	N/A	Adequate	Yes	6/9/2004	EJN	None	welding fumes
33	B423	CFH1	fume hood	Stan Scott 6-6280	Stan Scott	912	80-120 fpm	Not working	N/A	Inadequate	No	6/10/2004	EJN	Sash does not move.	acetone, alcohol
33	D105	CFH2	fume hood	Robert Abell x46366	Dan Harpold	544/915	80-120 fpm	85.8 fpm	17	Adequate	Yes	6/10/2004	EJN	none	Formic acid, nitric acid, Bosfer solutions,
33	D219	CFH1	fume hood	Dan Harpold 4-6378	Dan Harpold	915	80-120 fpm	Not working	N/A	Inadequate	No	6/10/2004	EJN	HOOD INOPERABLE DO NOT USE FOR TOXIC MATERIALS	methane, nitrogen dioxide, benzene
33	B323	CFH1	fume hood	John Marketon 4-6085	John Marketon	920.1	80-120 fpm	Not working	N/A	Inadequate	No	11/2/2004	EJN	None	alcohol, acetone
33	D121A	GC1	gas cabinet	Dan Harpold 4-6378	Dan Harpold	915	TBD	556.8 cfm	N/A	Adequate	Yes	11/2/2004	EJN		
33	D121A	GC2	gas cabinet	Dan Harpold 4-6378	Dan Harpold	915	TBD	654.24 cfm	N/A	Adequate	Yes	11/2/2004	EJN		
33	D121A	GC3	gas cabinet	Dan Harpold 4-6378	Dan Harpold	915	TBD	661.2 cfm	N/A	Adequate	Yes	11/2/2004	EJN	None	gas fumes
33	D105	1	Dip Tank	Robert Abell x46366	Dan Harpold	544/915	TBD							not used much	phosphoric acid
84	NA	2	fume hood	Joe Hammerbacher 6-3480	Randy Hedgeland	545	100	147 at 13 inches		Adequate		6/20/2003	KAW	None	alcohols
84	NA	1	fume hood	Joe Hammerbacher 6-3480	Randy Hedgeland	545	100	123 at 26 inches		Adequate		6/20/2003	KAW	None	alcohol extraction
92	Kitchen	1	Canopy	Randy Schum 6-68440	NA - not a laboratory		100	100 at 16 inches away	N/A	Adequate	Yes	11/16/2004	EJN	Not used much for cooking	Steam for boiling water
97	N4	CFH1	fume hood	IH Dept. 6-6669	NA - not a laboratory	205.9	80-120 fpm	Not working	N/A	Inadequate	No	6/10/2004	EJN	Duct sealed during roof work, Fall 2003	Not used, Tagged out, "DO NOT USE"
201	Moblas 7	1	fume hood	Michael Perry 6-5300	Michael Perry	924	100	119 at 9 inches		Adequate		6/24/2003	KAW	M.P. 3 Nov 04 - Generally used at night for the mixing chlorobenzene with developing chemical.	alcohol, chlorobenzene
208	D	1	fume hood	Michael Perry 6-5300	Michael Perry	924	100	128		Adequate		6/24/2003	KAW	Sash does not move.	1,2 dichloroethane
16 W	S010	LEV1	Cleaner	Sherry Warner 6-7447	NA - not a laboratory	561		83 fpm	N/A		N/A	7/22/2004	EJN	Measured while the cleaning door was closed	axarel
16W	S010	LEV2	Infered oven	Sherry Warner 6-7447	NA - not a laboratory	561		56 fpm	N/A		N/A	7/22/2004	EJN	Dampers were open	
5A	20	LEV1	slot hood	Michael Schoolman 65217	Michael Schoolman	547	100 at task	100at 12 inches	N/A	Marginal	Yes	7/21/2004	EJN	Vents are very dirty. Suggested cleaning them for better air flow. According to Yolanda Williams (6-0869), Schoolman is POC.	acetone, alcohol, primer, freecoat
Area 400	407	CFH1	fume hood	Stuart Banks x66618	Stuart Banks	552	80-120 fpm	Not working	N/A	Inadequate	No	11/15/2004	EJN	not used	storage
Area 400	416	CFH1	enclosure	Stuart Banks x66618	Stuart Banks	552	80-120 fpm	Not working	N/A	Inadequate	No	11/15/2004	EJN	Not used for other than water	Water , ultrasonic cleaner

Attachment 23: Bldg. 5 Plating Lab Push-Pull Ventilation Survey 2008

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank A1	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 617 fpm 3" push: 165 fpm face push: N/A	pull: 610 fpm 3" push: 210 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 48"x24x32" Temp 160° F	Sodium Hydroxide 90-90% Sodium Carbonate <10%	
005	E-014D	Tank A2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 617 fpm 3" push: 165 fpm face push: N/A	pull: 826 fpm 3" push: 103 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 48"x24x32" Temp 160° F	Cold Water Rinse	
005	E-014D	Tank A3	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Nitric Acid Hydrofluric Acid Ferric Acid	
005	E-014D	Tank A4	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 617 fpm 3" push: 165 fpm face push: N/A	pull: 906 fpm 3" push: 166fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 48"x24x32" Temp 75° F	Cold Water Rinse	
005	E-014D	Tank A5	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Sulfuric Acid	
005	E-014D	Tank A6	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 617 fpm 3" push: 165 fpm face push: N/A	pull: 947 fpm 3" push: 130 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 48"x24x32" Temp 160° F	Cold Water Rinse	

Attachment 23 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank B2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Sodium Hydroxide 30% Zinc Oxide <11%	
005	E-014D	Tank B3	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: 613 fpm, push: 177 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 36"x24x32" Temp 70° F	Nitric Acid Ammonium Bifluride	
005	E-014D	Tanks B4 A/B	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: B4A 610 fpm, B4B 656 fpm push: B4A 114 fpm, B4B 127 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 36"x24x32" Temp 75° F	Cold Water Rinse	
005	E-014D	Tank B5	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Hydrochloric Acid Nickel Chloride	
005	E-014D	Tank B6	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: 537 fpm, push: 127 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 36"x24x30" Temp 75° F	Nickel Sulfate Nickel Ammonium Sulfate Zinc Sulfate Sodium Thiocyanate	
005	E-014D	Tank B7	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: 738 fpm, push: 134 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 36"x24x30" Temp 70° F	Nickel Chloride Nickel Sulfate, Boric Acid Sel-Rex - Lectroc Nic 1030 Stress Reducer 85g/l Anti-Pit Agents	

Attachment 23 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank B8	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: 837 fpm, push: 129 fpm	N/A	Adequate	N/A	12/12/2008	CTB	LxWxH 36"x24x32" Temp 125° F	Cold Water Rinse	
005	E-014D	Tank B9	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Cupric Acid, Sulfuric Acid Chloride Ions, Sel-Rex - UBAC #1	
005	E-014D	Tank B10	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: 885 fpm, push: 114 fpm	N/A	Marginal	N/A	12/12/2008	CTB	LxWxH 36"x24x36" Temp 75° F	Hot Water Rinse	
005	E-014D	Tank B11	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 463 fpm 3" push: 223 fpm face push: N/A	pull: did not check 3" push: DNC face push: N/A	N/A	rinse tank	N/A		CTB	LxWxH 36"x24x36" Temp 160° F	Nitric Acid	
005	E-014D	Tank E2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 404 fpm face push: N/A	pull: 594 fpm, push: 224 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 24"x24x18" Temp 75° F	Nitric Acid Sulfuric Acid	
005	E-014D	Tank E3	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 404 fpm face push: N/A	pull: 580 fpm, push: 203 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 24"x24x18" Temp 75° F	Cold Water Rinse	

Attachment 23 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank E4	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Counter-flow rinse	Sulfuric acid	
005	E-014D	Tank E5	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 404 fpm face push: N/A	pull: 694 fpm, push: 266 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 24"x24x18" Temp 75° F	Cold Water Rinse	
005	E-014D	Tank E6	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Counter-flow rinse	Electroless Nickel	
005	E-014D	Tank E7	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 193 fpm 3" push: 404 fpm face push: N/A	pull: 906 fpm, push: 1148fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 48"x24x18" Temp 200° F	Electroless Nickel	
005	E-014D	Tank E8	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 514 fpm 3" push: 404 fpm face push: N/A	pull: 723 fpm, push: 216 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 48"x24x24" Temp 200° F	Electro cleaner	
005	E-014D	Tank N1	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 386 fpm 3" push: 154 fpm face push: N/A	pull: 695 fpm, push: 101 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 36"x24x32" Temp 160° F	Cold Water Rinse	

Attachment 23 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank N2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Chromium Cloride, Ferric Chloride, Ferric Nitrate, Hydrocloric Acid, Nickel Chloride,	
005	E-014D	Tanks N3 A/B/C	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 579 fpm 3" push: 154 fpm face push: N/A	pull: N3A 677 fpm, N3B 666 fpm push: N3A 99 fpm, B4B 102 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 54"x24x24" Temp 100° F	Cold Water Rinse	
005	E-014D	Tank N4	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Cold Water Rinse	Nitric Acid	
005	E-014D	Tanks N5 A/B/C	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 579 fpm 3" push: 154 fpm face push: N/A	pull: N5A 823 fpm, N5B 807 fpm, N5C 830 fpm push: N5A 823 fpm, N5B 807 fpm, N5C 106 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 54"x24x32" Temp ???° F	Cold Water Rinse	
005	E-014D	Tank N6	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A	rinse tank	N/A		CTB	Cold Water Rinse	Phosphoric Acid	
005	E-014D	Tank N7	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 386 fpm 3" push: 154 fpm face push: N/A	pull: 801 fpm push: 106 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 36"x24x32" Temp 71° F	Iridite 15, Chromic acid, ARP #2, Hydrochloric Acid	

Attachment 23 continued

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank N8	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 154 fpm face push: N/A	pull: 680 fpm push:: 152 fpm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 24"x24x30" Temp ???° F	Water	
005	E-014D	Tank N9	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Hot Water Rinse	Water	
005	E-014D	Tank CN1	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 154 fpm face push: N/A	pull: DID NOT RUN (DNR) 3" push: DNR face push: N/A	N/A		N/A		CTB	Cyanide Dead Rinse	Not in use	
005	E-014D	Tank CN2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 154 fpm face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Not in use	Water	
005	E-014D	Tank CN3	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Counter-flow rinse	Copper Strike E-Brite	
005	E-014D	Tank CN4	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 386 fpm 3" push: 154 fpm face push: N/A	pull: 281 fpm, push: 47pm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 36"x24x32" Temp ???° F	COPPER SULFATE WAS IN THE TANK; THE REST OF THE CN LINE WAS NOT IN USE.	Push side fan was off on 12-17-2008

Attachment 23 concluded

Building	Room	Hood No.	System	Contact Person	Lab Manager/Supervisor	Directorate	Division	Code	Required Capture Velocity	Capture Velocity	Sash Height, in.	Status	Smoke Capture	Survey Date	Evaluator	Notes	Chemicals	Additional Notes
005	E-014D	Tank E1	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 257 fpm 3" push: 404 fpm face push: N/A	pull: 464 fpm 3" push: 95 fpm face push: N/A	N/A		N/A	12/17/2008	CTB	LxWxH 24"x24x18" Temp 75° F	Gold Strike	
005	E-014G	Tank G1	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 386 fpm 3" push: N/A face push: N/A	pull: 337 fpm, push: 78 pm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 36"x24x36" Temp 130° F	Cold Water Rinse	
005	E-014G	Tank G2	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Water spray rinse	Gold plating	
005	E-014G	Tank G3	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: 386 fpm 3" push: N/A face push: N/A	pull: 327 fpm, push: 129 pm	N/A	Adequate	N/A	12/17/2008	CTB	LxWxH 36"x24x36" Temp 120° F	Cold Water Rinse	
005	E-014G	Tank G4	push-pull slot	John Wolfe 6-5708	No supervisor has been assigned as of 12-2008	500	540	547	pull: N/A 3" push: N/A face push: N/A	pull: N/A 3" push: N/A face push: N/A	N/A		N/A		CTB	Counter-flow rinse		

Attachment 24: Purchase Order for Probes

Accent
CONTROL SYSTEMS
Waco Instruments dba
Accent Control Systems

P.O. Box 12943
Philadelphia, PA 19176-0943
610-630-7640

INVOICE

INVOICE	
3090227	
Invoice Date	Page
11/21/2008 14:44:23	1 of 2
ORDER NUMBER	
1092834	

Bill To:

NASA Goddard Space Center
8800 Greenbelt Road
Greenbelt, MD 20771

Ship To:

NASA Goddard Space Center
8800 Greenbelt Road
Greenbelt, MD 20771

Ordered By: Chris Bunyea

Customer ID: 104834

PO Number	Terms Description	Net Due Date	Disc Due Date	Discount Amount
3580 / CC-order	CREDIT CARD	11/21/08	11/21/08	0.00

Order Date	Pick Ticket No	Primary Salesrep Name	Taker
11/12/2008 16:20:48	2087142	Dave Broome	MCATAGNUS

Quantities Ordered	Shipped	Remaining	UOM Unit Size	Disp	Item ID Item Description	Pricing UOM Unit Size		Unit Price	Extended Price
14.00	14.00	0.00	EA 1.0		STIK Myron L Replacement Probe For Control-Stik Rinse Tank Controller	EA	1	152.0000	2,128.00

Delivery Instructions: CC order - please process pick ticket and print invoice

Carrier: UPS Ground - PPD/ADD ***Tracking #:*** 1Z493KAR0362131872

Card: Christopher Bunyea
Tran Type: Final Sale
Name: Chris Bunyea
Account Number: 4015
Authorization Number: 024107
Reference Number: 45758
Batch Number: 0222
Merchant ID: 385100300033719
Authorization Amount: 2,141.94
Retrieval Number:

X____________________

I agree to pay above total amount according to card issuer agreement

ORIGINAL

Attachment 24 concluded

INVOICE

Accent Control Systems

Branch: 01 Waco Instruments dba Accent Control Systems

INVOICE	
3090227	
Invoice Date	Page
11/21/2008 14:44:23	2 of 2
ORDER NUMBER	
1092834	

Total Lines: 1

Total Freight In: 0.00 *Total Freight Out: [illegible]*

PAID

CREDIT CARD

Thank you for your order!

SUB-TOTAL:	2,128.00
TOTAL FREIGHT:	13.94
TAX:	0.00
MC:	2,141.94
AMOUNT DUE:	**0.00**

ORIGINAL

Attachment 25: Electroplated Inspection Form (548.2.14)

DIRECTIVE NO. 548-WI-8072.1.13
EFFECTIVE DATE: 03/04/1999
EXPIRATION DATE: N/A

Electroplated Inspection

					Average Thickness		
Date	Shop #	Visual Inspection	Tape Test	Anodize	Electroplated coatings		
				Positector	Micrometer	X-Ray	Beta-Backscatter
5-7-08	56306	PASS					Mask, BLK Ano
5-7-08	55992	PASS					Mask, BLK Anod
5-8-08	56338	PASS					IRDITE
5-8-08	6045	PASS					Clear Anod
5/8/08	6332	PASS					Iridite
5-8-08	6348	PASS					Iridite
5-9-08	52991	PASS					Blue Anodize
5/12/08	6366	PASS					Iridite
5-13-08	6363	Pass			.00005		STRIPE NI
5-13-08	6354	Pass					gold plate
5-13-08	6357	PASS					Iridite
5-13-08	5762	PASS					Iridite
5-13-08	56301	PASS					BLK Anodize
5-13-08	55421	PASS		→	.00005		Au Plate
~~5-575~~							
5-14-08	56375	PASS			.0002 .00005		EN + AU
5-14-08	6326	PASS					Passivate
5-14-08	6390	PASS					Iridite
5-14-08	6273	PASS					CLR Anodize
5-15-08	6364	PASS					Clean
5-15-08	5994	PASS					ETCH

Form 548.2-14-Electroplated Inspection P.J

March 3,1999

CHECK THE GSFC DIRECTIVES MANAGEMENT SYSTEM AT
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4.0 Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
AESF	American Electroplaters and Surface Finishes Society
AETD	Applied Engineering and Technology Directorate
AIHA	American Industrial Hygiene Association
CFR	Code of Federal Regulations
CHP	Chemical Hygiene Plan
GRC	NASA Glenn Research Center
GSFC	NASA Goddard Space Flight Center
HST	Hubble Space Telescope
HVAC	Heating, Ventilating, and Air Conditioning
HWRT	Hot Water Rinse Tank
IA Team	Independent Assessment Team
IH	Industrial Hygiene or Hygienist
IHO	Industrial Hygiene Office
ISO	International Organization for Standardization
LEV	Local Exhaust and Ventilation
MDL	Method Detection Limit
MSDS	Material Safety Data Sheets
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NIOSH	National Institute for Occupational Safety and Health
NSC	NASA Safety Center
OEL	Occupational Exposure Limit
OSC	U.S. Office of Special Counsel
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
POC	Point of Contact
PPE	Personal Protective Equipment
QA	Quality Assurance
RO	Reverse Osmosis

RO/DI	Reverse Osmosis/De-ionization
S&MA	Safety and Mission Assurance
SAM	Sample Analysis at Mars
TLV	Threshold Limit Value
TWA	Time-Weighted Average
UHV	Ultra-High Vacuum