

**Emission Assessment
for
Molten Solder Surfactant**

Prepared for

P K Metal
2448 E. 25th Street
Vernon, CA 90058

Prepared by

Unmack Corporation
1379 Park Western Drive, PMB 282
San Pedro, California 90732-2217
(310) 377-2367 Fax (310) 377-2589

April 18, 2006

Emission Assessment
for
Molten Solder Surfactant

1 INTRODUCTION

At the request of Larry Kay, president of P.K. Metal, consultant James Unmack, PE, CIH, CSP, evaluated the emissions from MS2™ Molten Solder Surfactant.

2 SUMMARY

Chemical analysis of air samples collected above a wave solder machine operating with MS2 molten solder surfactant detected no emissions from the molten solder surfactant. There was no visible fume, smoke or soot emitted from the molten solder surfactant. A faint odor and ultrafine particles were detected close to the surface of the molten solder surfactant. No hazardous emissions were detected from the surfactant.

3 BACKGROUND

MS2 molten solder surfactant is a unique product developed to eliminate dross from molten solder baths. Dross is formed from metal oxides that float on molten solder and is formed when molten solder comes into contact with oxygen. In wave solder operations, the dross may be as much as 70 % solder. MS2 is an organic material made from fatty acids. The concern is that it may volatilize or decompose at molten solder temperature, 175 - 300 C (350 - 575 F) and emit hazardous material.

4 METHOD

4.1 Total Hydrocarbons

Air samples for analysis by National Institutes of Occupational Safety and Health (NIOSH) Method 1550 for total hydrocarbons were collected over the wave of a wave solder machine. A personal sampling pump was used to pull 10 liters of air at 0.25 liters per minute through an SKC 226-01 charcoal tube. The charcoal tube was capped after 40 minutes of sampling and submitted to DataChem Laboratories in Salt Lake City, Utah, where it was analyzed by gas chromatography with a flame ionization detector (GC/FID).

4.2 Total Particulates

The release of fume and smoke was evaluated by measuring the total particulates in the space above the molten solder surfactant during the operation of a wave solder machine. Air samples were collected by using a personal sampling pump to draw approximately 500 liters of air at 5 liters per minute through matched weight PVC membrane filters. The matched weight filters were submitted to DataChem Laboratories in Salt Lake City, Utah, for analysis by NIOSH Method 0500 to measure total weight gain.

4.3 Breakdown Products

To evaluate release of volatile breakdown products a personal sampling pump was used to pull 10 liters of air through SKC 226-01 charcoal tubes at 0.25 liters per minute. Samples were collected over the molten solder bath of an operating wave solder machine and submitted to DataChem Laboratories in Salt Lake City, Utah, for analysis by gas chromatograph/mass spectrometer (GC/MS).

4.4 Ultrafine Particulate Matter

Ultrafine particles were investigated with a TSI P-Trak, model 8525, serial number 8525-06011018. The P-Trak uses forward scattering nephelometry to count particles with an aerodynamic diameter of 0.02 micrometer to greater than 1 micrometer. The counts are displayed as the number of particles per cubic centimeter (UFP/cm³). The counts were datalogged at 1.0 second intervals. The P-Trak does not discriminate between particles, but responds to all particles in the size range 0.02 to 1 micrometer. Typical particles in this size range include viruses, bacteria, combustion nuclei, sea salt nuclei, atmospheric dust, metal fumes, smoke from various sources and condensation nuclei of hygroscopic molecules.

5 RESULTS

To evaluate the emissions from the molten solder surfactant, a Compac 1025 PCS and an Electrovert Speedline Technologies wave solder machine were charged with lead-free solder and heated to 247 C. Analysis of the solder is included in the Attachment 1. After the operation had stabilized and the bath completely covered by dross, MS2 - 200LF molten solder surfactant was added to the bath. After a few minutes the dross was completely eliminated. Once the operation had stabilized, sample collection filters and charcoal tubes were arranged over the Compac 1025

PCS wave solder bath to sample the air directly above the solder wave 10 to 12 inches above the surface of the bath.

5.1 Total Volatile Organic Compounds

Total volatile organic compounds (VOCs) as hydrocarbons were not detected in the air above the molten solder surfactant. Expressed as hexane equivalent, the detection limit was 0.28 parts per million.

Table 5-1 Total Volatile Organic Compounds

Sample	PK-4
Airborne Concentration	<0.01 mg/m ³ , <0.28 ppm

5.2 Total Particulates

Three samples were collected directly above the molten solder to evaluate fume, soot or smoke from the molten solder surfactant during the operation of a wave solder machine. No visible smoke or other emission was observed from the surface of the solder bath. The airborne particulate averaged 0.33 milligrams per cubic meter (0.33 mg/m³).

Table 5-2 Total Particulates

Sample	PK-1	PK-2	PK-3
Airborne Concentration	0.24 mg/m ³	0.40 mg/m ³	0.35 mg/m ³

5.3 Breakdown Products

Large and complex molecules can split into smaller and more volatile compounds when heated or exposed to air. To evaluate release of volatile breakdown products two samples were collected in the space directly above the wave solder machine. No breakdown product were detected.

Table 5-3 Volatile Organic Compounds

Sample	PK-5	PK-6
Methyl ethyl ketone	ND, <0.17 ppm	ND, <0.17 ppm

Table 5-3 Volatile Organic Compounds

Sample	PK-5	PK-6
Hexane	ND, <0.014 ppm	ND, <0.014 ppm
Tetrahydrofuran	ND, <0.017 ppm	ND, <0.017 ppm
Chloroform	ND, <0.010 ppm	ND, <0.010 ppm
1,1,1-Trichloroethane	ND, <0.0092 ppm	ND, <0.0092 ppm
1,2-Dichloroethane	ND, <0.012 ppm	ND, <0.012 ppm
Benzene	ND, <0.016 ppm	ND, <0.016 ppm
n-Butanol	ND, <0.066 ppm	ND, <0.066 ppm
Cyclohexane	ND, <0.015 ppm	ND, <0.015 ppm
Cyclohexene	ND, <0.015 ppm	ND, <0.015 ppm
2-Pentanone	ND, <0.014 ppm	ND, <0.014 ppm
Trichloroethylene	ND, <0.0093 ppm	ND, <0.0093 ppm
n-Propyl acetate	ND, <0.012 ppm	ND, <0.012 ppm
Methyl isobutyl ketone	ND, <0.012 ppm	ND, <0.012 ppm
Toluene	ND, <0.013 ppm	ND, <0.013 ppm
1,1,2-Trichloroethane	ND, <0.0092 ppm	ND, <0.0092 ppm
Octane	ND, <0.011 ppm	ND, <0.011 ppm
Tetrachloroethylene	ND, <0.0074 ppm	ND, <0.0074 ppm
n-Butyl acetate	ND, <0.011 ppm	ND, <0.011 ppm
Chlorobenzene	ND, <0.011 ppm	ND, <0.011 ppm
Ethylbenzene	ND, <0.012 ppm	ND, <0.012 ppm
Xylene	ND, <0.035 ppm	ND, <0.035 ppm
Styrene	ND, <0.012 ppm	ND, <0.012 ppm
Cellosolve acetate	ND, <0.0093 ppm	ND, <0.0093 ppm
Cumene	ND, <0.010 ppm	ND, <0.010 ppm

Table 5-3 Volatile Organic Compounds

Sample	PK-5	PK-6
Methyl styrene	ND, <0.010 ppm	ND, <0.010 ppm
1,3-Dichlorobenzene	ND, <0.0083 ppm	ND, <0.0083 ppm
1,4-Dichlorobenzene	ND, <0.0083 ppm	ND, <0.0083 ppm
1,2-Dichlorobenzene	ND, <0.0083 ppm	ND, <0.0083 ppm
Naphthalene	ND, <0.0095 ppm	ND, <0.0095 ppm

5.4 Ultrafine Particles

Both the Compac 1025 and the Electrovert Speedline wave solder baths were surveyed with the ultrafine particle counter with similar results. The ultrafine particle counter detected an emission from the molten solder surfactant when heated to the solder bath temperature. The TSI P-Trak ultrafine particle counter saturates at 500,000 particles per cubic centimeter. The P-Trak saturated when the probe was within 2 to 3 inches of the surfactant, but dropped to room levels when more than 6 inches from the surface. The ultrafine particle counts are presented graphically in Attachment 2.

6 DISCUSSION

No visible emission was detected from the molten solder surfactant, but a faint odor indicated that there was some release from the product. The small amount of release was detectable with the ultrafine particle counter, but was not detected by any of the air samples collected for laboratory analysis. The results of the laboratory analysis of air samples collected above the wave solder machine do not indicate any hazardous concentration of material evolving from the molten solder surfactant at operating temperature.

7 CONCLUSION

No hazardous emissions were detected from the MS2 - LF200 product when heated to 247 C (477 F). There was no visible emission of fume, smoke or soot, but a faint odor and ultrafine particles were detected close to the heated surface.

8 SIGNATURE

This report of emissions from MS2 - LF200 was prepared by the undersigned and is based on measurements as detailed herein and information provided by Larry Kay.

James L. Unmack
James L. Unmack, PE, CIH, CSP

4-18-06
Date



Solder Analysis

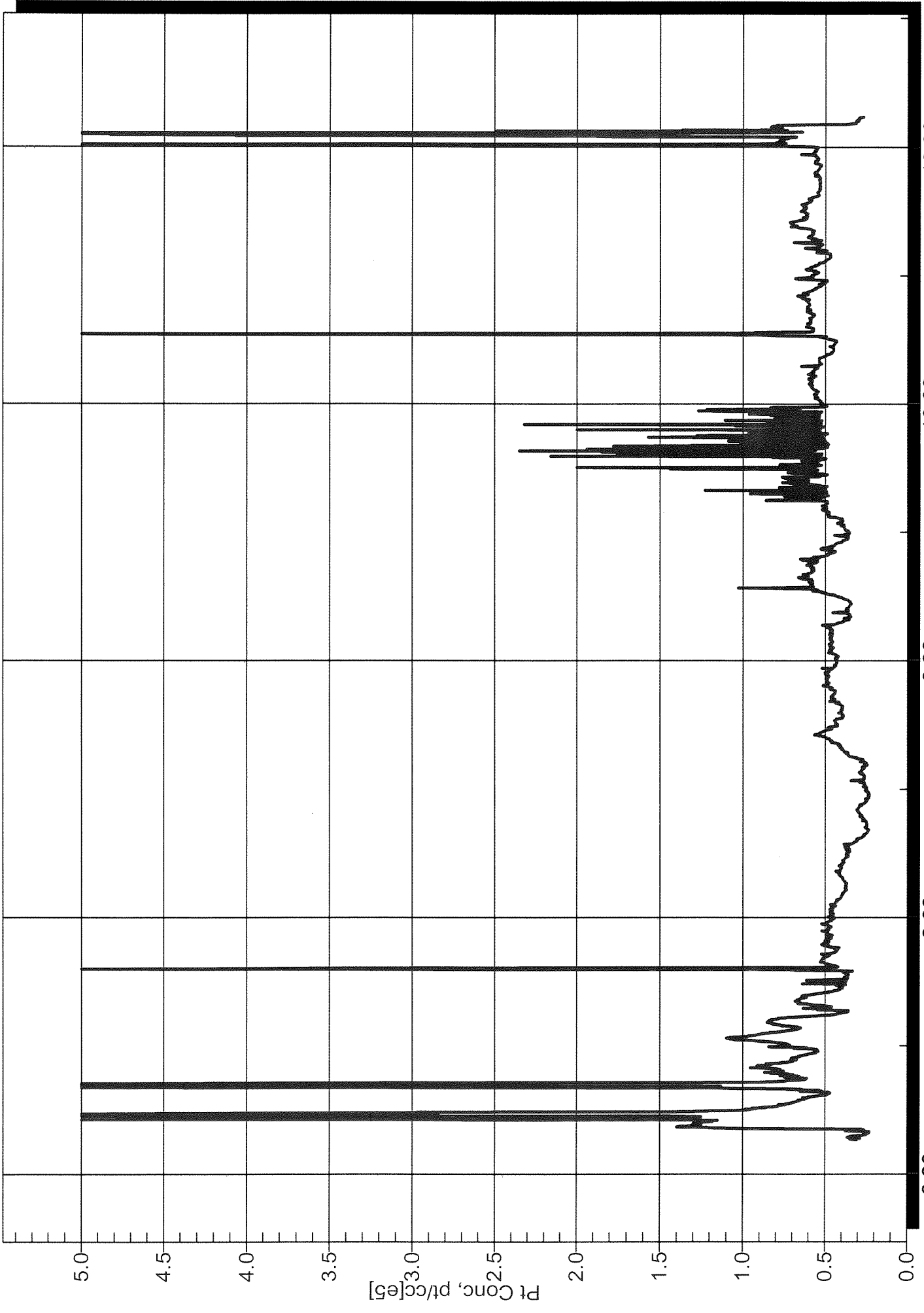
Lead-Free Solder

Sn	Tin	96.4 %
Ag	Silver	2.995 %
Cu	Copper	0.503 %
Pb	Lead	0.0356 %
Sb	Antimony	0.0208 %
In	Indium	0.0037 %
Au	Gold	0.0005 %
<hr/>		99.9586 %

Attachment 2

Ultrafine Particle Counts

Trace_tic_Count
PK Metal



27 Mar 2006

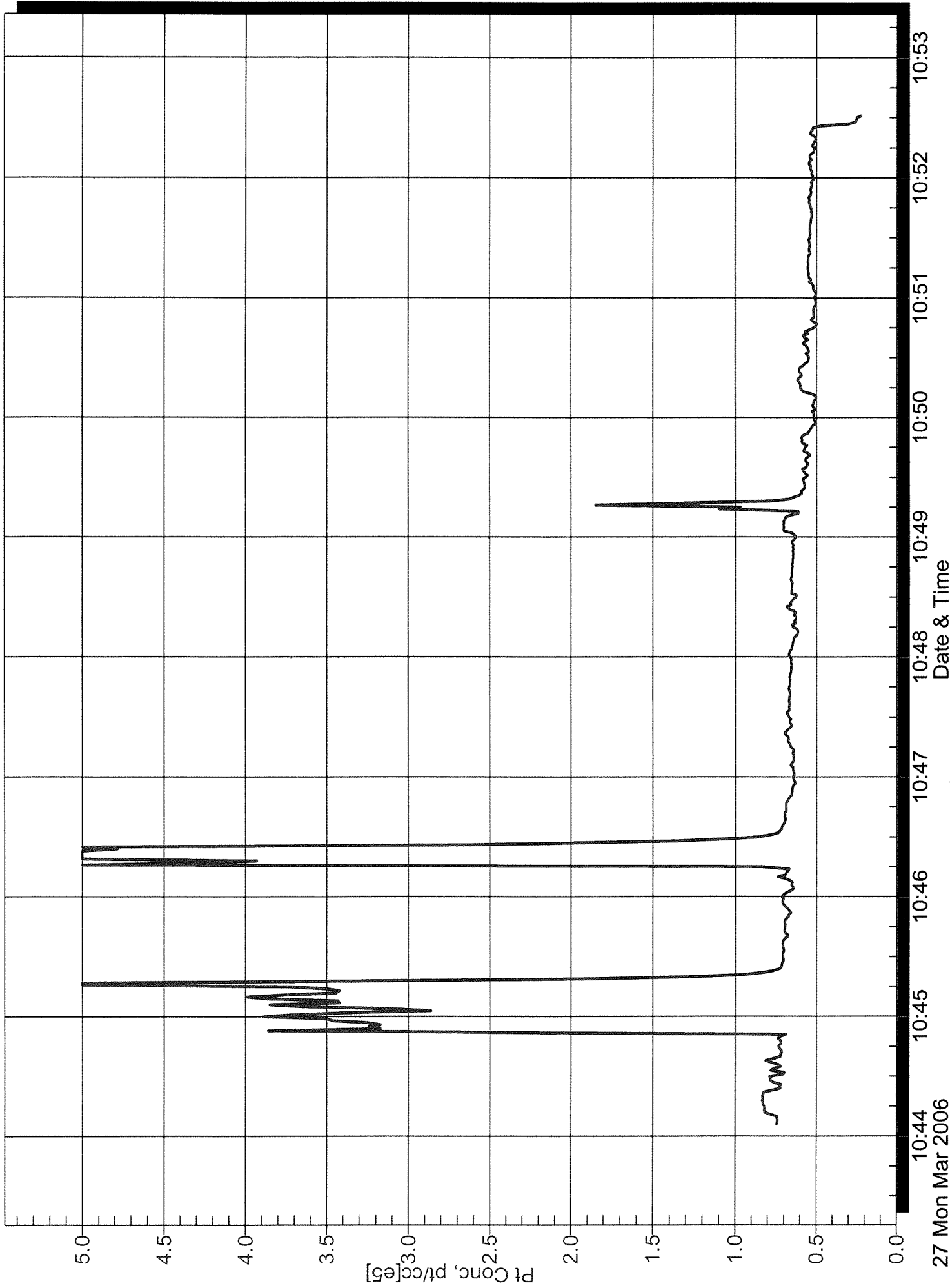
9:00

9:30

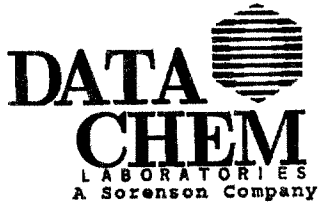
10:00

10:30

Trace I.tic Counts
PK Metal



Attachment 3
Laboratory Reports



ANALYTICAL REPORT

Form ARF-C

Page 2 of 2
04040607194581RX

APR 05 2006

Date _____

Laboratory Group Name 06I-1458-01

General Set Comments

Results are not blank-corrected.

General Lab Comments

The results provided in this report relate only to the items tested.
Samples were received in acceptable condition unless otherwise noted in the General Set Comments above.
Samples have not been field blank corrected unless otherwise noted in the General Set Comments above.
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ANALYTICAL REQUEST FORM

1. REGULAR Status 06I-1458-01

RUSH Status Requested - ADDITIONAL CHARGE
RESULTS REQUIRED BY _____ DATE _____
CONTACT DATACHEM LABS PRIOR TO SENDING SAMPLES

2. Date 3-27-06 Purchase Order No. 0704-1 4. Quote No. _____

3. Company Name UNMACK CORPORATION DCL Project Manager _____

Address 1379 PARK WESTERN DR #282 5. Sample Collection _____

SAN PEDRO, CA 90732-2217 Sampling Site _____

Person to Contact JIM UNMACK Industrial Process _____

Telephone (310) 377-2367 Date of Collection _____

Fax Telephone (310) 377-2589 Time Collected _____

E-mail Address JIM@UNMACK.COM Date of Shipment _____

Billing Address (if different from above) Chain of Custody No. _____

6. REQUEST FOR ANALYSES

Laboratory Use Only	Client Sample Number	Matrix*	Sample Volume	ANALYSES REQUESTED - Use method number if known	Units**
<u>06I 11862</u>	<u>PK-1</u>	<u>F</u>	<u>480</u>	<u>NIOSH 500</u>	
<u>↓ 63</u>	<u>PK-2</u>	<u>F</u>	<u>580</u>	<u>NIOSH 500</u>	
<u>↓ 64</u>	<u>PK-3</u>	<u>F</u>	<u>520</u>	<u>NIOSH 500</u>	
	<u>PK-4</u>	<u>CT</u>	<u>10.29</u>	<u>TOTAL HYDROCARBONS</u>	<u>PPM BY GC/MS</u>
	<u>PK-5</u>	<u>CT</u>	<u>10</u>	<u>VOC by GC/MS</u>	
	<u>PK-6</u>	<u>CT</u>	<u>10</u>	<u>VOC BY GC/MS</u>	

* Specify: Solid sorbent tube, e.g. Charcoal; Filter type; Impinger solution; Bulk sample; Blood; Urine; Tissue; Soil; Water; Other
** 1. mg/sample 2. mg/m³ 3. ppm 4. % 5. ____ (other) Please indicate one or more units in the column entitled Units**

Comments _____

Possible Contamination and/or Chemical Hazards _____

7. Chain of Custody (Optional)

Relinquished by <u>James Unmack</u>	Date/Time <u>3/27/06 13:07</u>
Received by <u>Shirley W. ...</u>	Date/Time <u>3/29/06 12:30</u>
Relinquished by <u>Wesley 3rd</u>	Date/Time _____
Received by _____	Date/Time _____
Relinquished by _____	Date/Time _____
Received by _____	Date/Time _____



ANALYTICAL REPORT

Form ARF-C

Page 2 of 2
04030614585214RX

Date APR 04 2006
Laboratory Group Name 06I-1458-02

General Set Comments

Total Hydrocarbons is the sum of all peaks minus solvent peaks and was quantitated against hexane.

ppm formula: $(24.45 * (\text{Result} * 1000)) / (\text{Volume} * \text{MW})$

General Lab Comments

The results provided in this report relate only to the items tested. Samples were received in acceptable condition unless otherwise noted in the General Set Comments above. Samples have not been field blank corrected unless otherwise noted in the General Set Comments above. This test report shall not be reproduced, except in full, without written approval of DataChem Laboratories, Inc. This page is the concluding page of the report.



ANALYTICAL REQUEST FORM

1. REGULAR Status 06I-1458-02

RUSH Status Requested - ADDITIONAL CHARGE

RESULTS REQUIRED BY _____ DATE _____

CONTACT DATACHEM LABS PRIOR TO SENDING SAMPLES

2. Date 3-27-06 Purchase Order No. 0704-1 4. Quote No. _____

3. Company Name UNMACK CORPORATION DCL Project Manager _____

Address 1379 PARK WESTERN DR #282 5. Sample Collection _____

SAN PEDRO, CA 90732-2217 Sampling Site _____

Person to Contact JIM UNMACK Industrial Process _____

Telephone (310) 377-2367 Date of Collection _____

Fax Telephone (310) 377-2589 Time Collected _____

E-mail Address JIM@UNMACK.COM Date of Shipment _____

Billing Address (if different from above) _____ Chain of Custody No. _____

6. REQUEST FOR ANALYSES

Laboratory Use Only	Client Sample Number	Matrix*	Sample Volume	ANALYSES REQUESTED - Use method number if known	Units**
	PK-1	F	480	NIOSH 500	
	PK-2	F	580	NIOSH 500	
	PK-3	F	520	NIOSH 500	
<u>06I11865</u>	PK-4	CT	10.25	TOTAL HYDROCARBONS ^{MS H-HYD}	
	PK-5	CT	10	VOC by GC/MS	
	PK-6	CT	10	VOC BY GC/MS	

* Specify: Solid sorbent tube, e.g. Charcoal; Filter type; Impinger solution; Bulk sample; Blood; Urine; Tissue; Soil; Water; Other

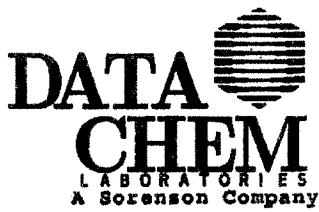
** 1. mg/sample 2. mg/m³ 3. ppm 4. % 5. _____ (other) Please indicate one or more units in the column entitled Units**

Comments _____

Possible Contamination and/or Chemical Hazards _____

7. Chain of Custody (Optional)

Relinquished by <u>James W. [Signature]</u>	Date/Time <u>3/27/06 13:07</u>
Received by <u>Justin W. [Signature]</u>	Date/Time <u>3/29/06 1230</u>
Relinquished by <u>[Signature]</u>	Date/Time _____
Received by <u>E. [Signature]</u>	Date/Time <u>03/29/06 2100</u>
Relinquished by _____	Date/Time _____
Received by _____	Date/Time _____



ANALYTICAL REPORT

Form ARF-AL
 Page 8 of 9
 Part 8 of 8
 04100609114859X

Date APR 10 2006
 Laboratory Group Name 06I-1458-03
 Account No. 07350

Unmack Corporation
 Attention: Jim Unmack
 1379 Park Western Drive
 #282
 San Pedro, CA 90732-2217

FAX (310) 377-2589
 Telephone (310) 377-2367
 E-mail jim@unmack.com

Sampling Collection and Shipment

Sampling Site _____ Date of Collection March 27, 2006
 Date Samples Received at Laboratory March 29, 2006

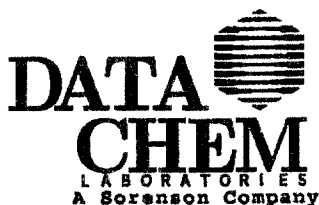
Analysis

Method of Analysis DCL Method
 Date(s) of Analysis April 07, 2006

Analytical Results

Field Sample Number	Laboratory Number	Sample Type	1,3-Dichloro benzene ppm	1,4-Dichloro benzene ppm	1,2-Dichloro benzene ppm	Naphthalene ppm	Air Volume Liters			
PK-5	06111866	TUBE	<0.0083	<0.0083	<0.0083	<0.0095	10			
PK-6	06111867	TUBE	<0.0083	<0.0083	<0.0083	<0.0095	10			
Limit of Detection										

† See comment on last page.
 ND Parameter not detected above LOD.
 NR Parameter not requested.
 NA Parameter not applicable.
 ** See comment on last page.
 () Parameter between LOD and LOQ.



ANALYTICAL REPORT

Form ARF-C
Page 9 of 9
04100609114859X

APR 10 2006

Date _____
Laboratory Group Name 06I-1458-03

General Set Comments

ppm formula: $(24.45 * \text{Result}) / (\text{Volume} * \text{MW})$

General Lab Comments

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Samples were received in acceptable condition unless otherwise noted in the General Set Comments above.
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ANALYTICAL REQUEST FORM

1. REGULAR Status 06I-1458-03

RUSH Status Requested - ADDITIONAL CHARGE

RESULTS REQUIRED BY _____ DATE _____

CONTACT DATACHEM LABS PRIOR TO SENDING SAMPLES

2. Date 3-27-06 Purchase Order No. 0704-1 4. Quote No. _____

3. Company Name UNMACK CORPORATION DCL Project Manager _____

Address 1379 PARK WESTERN DR #282 5. Sample Collection _____

SAN PEDRO, CA 90732-2217 Sampling Site _____

Person to Contact JIM UNMACK Industrial Process _____

Telephone (310) 377-2367 Date of Collection _____

Fax Telephone (314) 377-2589 Time Collected _____

E-mail Address JIM@UNMACK.COM Date of Shipment _____

Billing Address (if different from above) _____ Chain of Custody No. _____

6. REQUEST FOR ANALYSES

Laboratory Use Only	Client Sample Number	Matrix*	Sample Volume	ANALYSES REQUESTED - Use method number if known	Units**
	PK-1	F	480	NOSH 500	
	PK-2	F	580	NOSH 500	
	PK-3	F	520	NOSH 500	
	PK-4	CT	10.29	TOTAL HYDROCARBONS ^{AS N-HEXANE}	
<u>06I 11866</u>	PK-5	CT	10	VOC by GC/MS	
<u>↓ 67</u>	PK-6	CT	10	VOC BY GC/MS	

* Specify: Solid sorbent tube, e.g. Charcoal; Filter type; Impinger solution; Bulk sample; Blood; Urine; Tissue; Soil; Water; Other

** 1. mg/sample 2. mg/m³ 3. ppm 4. % 5. _____ (other) Please indicate one or more units in the column entitled Units**

Comments _____

Possible Contamination and/or Chemical Hazards _____

7. Chain of Custody (Optional)

Relinquished by <u>James Hunt</u>	Date/Time <u>3/27/06 13:07</u>
Received by <u>Shelia W. ...</u>	Date/Time <u>3/29/06 1230</u>
Relinquished by <u>FWH</u>	Date/Time _____
Received by _____	Date/Time _____
Relinquished by _____	Date/Time _____
Received by _____	Date/Time _____

Industrial Hygiene Sampling Data



Unmack Corporation
 1379 Park Western Drive, PMB 282
 San Pedro, CA 90732-2217
 (310) 377-2367

Project Nr.: 0704

Client Name: PK METAL

Project Location: 244B E. 25th ST

Collected by:

Signature: *James L. Unmack*

ID: 3-27-06

Suspected Contaminants:

Exposure Controls:

Employee Name or Sample Location	(1) COMPAC 1025 PCS - Wave Solder	(2) COMPAC 1025 PCS - Wave Solder	(3) COMPAC 1025 PCS Wave Solder	(4) COMPAC 1025 PCS Wave Solder
Field Sample Nr.	PK-1	PK-4	PK-2	PK-3
Bulk Sample Nr.	PIX 2766	PIX 2767/08		PIX 2769
Sample Date	3-27-06	3-27-06	3-27-06	3-27-06
Collection Media	PVC # 45678	CT	PVC # 45803	PK # 45795
Pump or Monitor Nr.	500-303	648228		638561
Run Time: Start	0842	0859	0903	0919
Run Time: Stop	1022	0940	1059	1059
Sample Time (minutes)	100	41	116	104
Avg. flow rate (L/min)	4.8 L/min	0.25	5.0	5.0
Total volume (liters)	480	10.25	580	520
Weather Data				

Comments:

Sample Analysis Requested	TOTAL	CARBOXY	TOTAL	TOTAL
	WEIGHT GAIN	ALKANES	WEIGHT GAIN	WEIGHT GAIN
		TOTAL HYDROCARBONS		
		AS N-HEXANE		

Relinquished by	Signature	Company Name	Date	Time
JAMES L. UNMACK	<i>James L. Unmack</i>	UNMACK	3-27-06	13:07
Received by	Signature	Company Name	Date	Time
Received by	Signature	Company Name	Date	Time
Received by	Signature	Company Name	Date	Time

Industrial Hygiene Sampling Data



Unmack Corporation
 1379 Park Western Drive, PMB 282
 San Pedro, CA 90732-2217
 (310) 377-2367

Project Nr.: **0704**
 Client Name: **P K METAL**
 Project Location: **2448 E. 25th ST**
 Signature: *James L. Unmack* ID: **3-27-06**

Collected by: _____ Suspected Contaminants: _____

Exposure Controls:				
Employee Name or Sample Location	(1) COMPACT 1025	(2) COMPACTORS	(3)	(4)
	PCS - Wagon Gold	PCS - Wagon Gold		
Field Sample Nr.	PK-5	PK-6		
Bulk Sample Nr.	PIX 2770			
Sample Date	3-27-06	3-27-06		
Collection Media	CT	CT		
Pump or Monitor Nr.	648215	648215		
Run Time: Start	0934	0934		
Run Time: Stop	1014	1014		
Sample Time (minutes)	40	40		
Avg. flow rate (L/min)	0.25	0.25		
Total volume (liters)	10	10		
Weather Data				

Comments: _____

Sample Analysis Requested	VOC	VOC		
	BY GC/MS	BY GC/MS		

Relinquished by	Signature	Company Name	Date	Time
James L. Unmack	<i>James L. Unmack</i>	UNMACK	3-27-06	13:07
Received by	Signature	Company Name	Date	Time
Received by	Signature	Company Name	Date	Time
Received by	Signature	Company Name	Date	Time

Attachment 4

Photographs



3/27/2006
MS2 on solder bath of wave solder machine



3/27/2006
Samplers over wave solder machine



3/27/2006
Samplers over wave solder machine



3/27/2006
Arrangement of samplers over wave solder machine



3/27/2006
Samplers over wave solder bath



3/27/2006
Speedline wave solder machine