REGION 8

HAZARD EVALUATIONS

HAZARD EVALUATIONS, INC. • 3836 N. BUFFALO ROAD • ORCHARD PARK, NEW YORK 14127
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File
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June 30, 2005

Henry Sandonato, EE3
Regional Solid & Hazardous Materials Engineer
New York State Department of Environmental Conservation
Region 9 Headquarters
270 Michigan Avenue
Buffalo, New York 14203-2999

Re: **U.S. Chrome Corporation of New York (NYD990774200), Batavia, NY**
CY 2004 Hazardous Waste Reduction Plan Biennial Update

Dear Mr. Sandonato:

Please find enclosed a copy of the 2004 Hazardous Waste Reduction Plan Biennial Update prepared by Hazard Evaluations, Inc. for U.S. Chrome Corporation of New York's (USC) Batavia, New York facility. This HWRP Update addresses various waste streams generated by the facility's Hard Chrome Electroplating process.

The information summarized in this Update should adequately describe USC's current status under this program. If you have any questions concerning the information presented, please contact me directly.

Very truly yours,
HAZARD EVALUATIONS, INC.

C. Mark Hanna, CHMM
President

cc: M. Klotzbach (USC)
NYSDEC Region 9

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June 30, 2005

Richard Kasprowicz, PE
New York State Department of Environmental Conservation
Division of Solid & Hazardous Materials
Bureau of Hazardous Waste Regulation, 8th Floor
625 Broadway
Albany, New York 12233-7251

Re: **U.S. Chrome Corporation of New York (NYD990774200), Batavia, NY**
CY 2004 Hazardous Waste Reduction Plan Biennial Update

Dear Mr. Kasprowicz:

Please find enclosed two copies of the 2004 Hazardous Waste Reduction Plan Biennial Update prepared by Hazard Evaluations, Inc. for U.S. Chrome Corporation of New York's (USC) Batavia, New York facility. This HWRP Update addresses various waste streams generated by the facility's Hard Chrome Electroplating process.

The information summarized in this Update should adequately describe USC's current status under this program. If you have any questions concerning the information presented, please contact me directly.

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NYSDEC Region 9

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HAZARDOUS WASTE REDUCTION PLAN
2004 Biennial Update

Prepared For:
U.S. Chrome Corporation of New York
31 Swan Street
Batavia, New York

Prepared By:
Hazard Evaluations, Inc.
3836 North Buffalo Road
Orchard Park, New York 14127

March 2005

1.0 INTRODUCTION

1.1 Background

The U.S. Chrome Corporation of New York (USC) facility, located at 31 Swan Street, Batavia, New York, specializes in Hard Chrome electroplating of metal parts. The operations performed on-site to produce the facility's end products include very limited machining of metal parts, alkaline cleaning, non-cyanide Chromium electroplating and rinsing. Hazardous waste production is related to the cleaning and processing of metal parts, and the treatment of the resulting wastewaters. The alkaline cleaning involves use of a caustic solution, while the electroplating bath consists of a solution containing Hexavalent Chromium. These operations result in the generation of five separate hazardous waste streams, including: 1) Spent alkaline strip solution; 2) Hazardous wastewater treatment plant filter cake; 3) Chromium acid tank sludge; 4) Chromium contaminated debris and floor sweeping residues; 5) Waste chromic acid solution; and 6) Electroplating process wastewater. The electroplating process wastewater is treated on-site for metals precipitation and clarification prior to being discharged to the local POTW. All other wastes are shipped off-site for treatment, stabilization and landfill disposal.

1.2 Corporate Hazardous Waste Reduction Policy

It is the policy of USC to operate its facility both with the highest regard for the protection of human health and the environment, and in accordance with applicable federal, state and local environmental laws and regulations. Furthermore, it is USC's long term goal to: 1) Reduce the overall quantity of hazardous waste(s) generated; and/or 2) Recover, reuse or recycle any hazardous wastes generated when possible. To that end, USC has already initiated various waste reduction efforts over the past several years.

USC's management has authorized the Batavia facility's General Manager to implement those waste reduction measures which have been deemed technically feasible and economically practical. This individual is also responsible for implementing both the hazardous waste reduction policy and the provisions of this Hazardous Waste Reduction Plan (HWRP).

USC's primary goal is to maintain its existing waste reduction efforts in a manner which maximizes efficiency and effectiveness. To enhance these efforts, USC plans to provide employee training focusing on the implementation, benefits and applicability of waste reduction measures. The recent use of "Porous Pots" in the plating baths has helped reduce waste Chromic Acid solution by removing impurities and extending the life of this process solution. USC will also continue to monitor industry research regarding more efficient methods of managing or recovering the alkaline stripping solution and minimizing the amount of wastewater from the electroplating process. Achieving this goal will reduce both disposal costs and the regulatory requirements for hazardous wastes generated at the facility.

2.0 HAZARDOUS WASTE GENERATION

2.1 General

During calendar year 2004, USC generated a total of 24.13 tons of RCRA hazardous wastes that were shipped off-site. These wastes included 5.80 tons of Chromium contaminated debris (D007, D008), 9.55 tons of wastewater treatment plant filter cake (D006), 2.15 tons of Chromic acid tank sludge (D002, D007), 2.84 tons of alkaline strip solution (D002, D007), and 3.79 tons of waste chromic acid solution. A total of 980 tons of hazardous process wastewater were treated on-site before being discharged to the local POTW. There were no acute hazardous wastes generated by USC during 2004.

2.2 Hazardous Waste Streams

As indicated in the previous section, all of the reportable hazardous waste generated by USC results directly from the facility's cleaning and processing of metal parts. The operation may involve cleaning the parts in an alkaline solution (Tetra Potassium Pyrophosphate - TKPP) and then rinsing the parts with fresh water. The waste generated during this phase of the process consists of spent Tetra Potassium Pyrophosphate alkaline solution. The parts are then charged and placed in an electroplating bath containing Chromic acid. Wastes generated from this process may include waste Chromic acid solution and Chromic acid tank sludges that are removed from the electroplating bath tanks. The plated parts are then rinsed, and the rinse water is treated in the on-site wastewater treatment system via metals precipitation and clarification. The water treatment system includes a filter press which results in production of a filter cake waste. The final waste stream consists of debris produced during processing, including gloves, tape, floor sweepings and other ancillary materials.

Of the various hazardous wastes generated by USC during 2004, only the filter cake, process wastewater, waste chromic acid solution, and chrome contaminated debris will be addressed in this HWRP update. These wastes comprise over 99% of the reportable hazardous wastes generated by USC. The remaining two reportable hazardous wastes (spent alkaline strip solution and chromic acid tank sludge) identified above were each generated at less than the five ton reporting threshold, and together comprise less than 1% of the hazardous waste generated by USC.

2.3 Production Rate Index

A Production Rate Index (PRI) has been developed for this facility to measure and account for changes in the annual amount of parts processed. These data will be used to facilitate the assessment of hazardous waste reduction efforts by allowing USC's management to distinguish inter-year quantity changes that resulted from waste reduction activity from those caused by economic and/or other factors. The PRI for 2004 was calculated based on past production information, as follows:

2003 Production = $1,266,404 sales
2004 Production = $1,858,815 sales
Production Rate Index = $1,858,815/$1,266,404 = 1.47

2.4 Hazardous Waste Management Costs

The 2004 costs of managing USC's hazardous wastes have resulted from the following activities (based on USC estimates):

Labor and Materials for Waste Management (Annual)	
Labor (i.e., operators, technicians):	30,000
Other/Miscellaneous Expenses:	1,400
Transportation & Disposal of Wastes (Annual)	11,360
Total	**$ 42,760**

3.0 HAZARDOUS WASTE STREAM REDUCTION MEASURES

3.1 General

As indicated in the previous sections, USC's hard chrome plating operations may result in the generation of six types of hazardous waste. USC has already committed resources to determining and evaluating various measures for reducing the facility's overall hazardous waste generation rate and volume. The waste reduction measures which are currently utilized (and/or scheduled for implementation) at this facility include research regarding more efficient methods of managing or recovering the alkaline stripping solution and minimizing the amount of wastewater from the electroplating process. Additionally, enhanced employee training will be pursued to improve waste management. These measures are discussed in the following section.

3.2 Waste Reduction Measures

To minimize the quantity of hazardous wastes produced, USC has already implemented various production-related activities. These include the continued use of Porous Pots in the Chromic acid baths to prolong process solution life and reduce tank sludges and continued use of the treatment system sludge dryer to reduce sludge weight. USC is also committed to reviewing industry journals and trade publications for improved methods of using the alkaline cleaning solution. Reduced waste production may result from lengthening the useful life of the solution by filtration, by-product removal, etc., although no solution has been identified to date. Finally, an investigation into reducing the amount wastewater produced from rinsing plated parts is focusing on changing the rinsing nozzles and/or allowing limited recirculation of rinse waters.

A final waste reduction technique which is currently being used by USC is employee training. Currently, all personnel, regardless of their possible exposure to hazardous materials and/or hazardous wastes, receive OSHA Hazard Communications Standard training. RCRA Hazardous Waste training is also provided to a select group of employees that are involved with hazardous management or generation. These training programs are being provided annually and cover a variety of topics including, but not limited to, compliance with applicable federal and state regulations; solid and hazardous waste identification definitions; sources of hazard information; the "cradle to grave" waste tracking system and employee responsibilities regarding waste identification and characterization. USC intends to revise and expand these training programs over the next few years to include additional information focusing on hazardous waste reduction. Among the new topics proposed are applicable waste reduction regulations, corporate waste reduction policy, benefits and incentives for hazardous waste reduction, and implementation of waste reduction techniques.

USC believes that the implementation of the enhanced employee training program and the improved rinsing techniques could result in a 3% reduction in the generation of process wastewater by the end of calendar year 2005.

4.0 IMPACT OF WASTE REDUCTION IMPLEMENTATION

4.1 Schedule

The proposed schedule of implementation for the proposed waste reduction measures identified in Section 3.2 is summarized in Table 2.

4.2 Future Waste Transference Estimate

The implementation of the proposed waste reduction techniques identified in Section 3.2 will not result in the transference of waste to any other environmental media. The enhanced training program will provide employees with valuable information on the benefits of waste reduction and include basic techniques and incentives for reducing wastes at the USC facility. The implementation of this program should help to promote the concept of waste reduction throughout the facility and thus, ultimately minimize the total amount of hazardous waste being generated on-site.

4.3 Economic Practicality

When adjusted for the production increase between 2003 and 2004 of 1.47 (see below) the actual cost savings associated with the implementation of USC's waste reduction measures are estimated to be between $10,000 to $14,000. Continued estimation of cost savings will be reported in the 2005 Hazardous Waste Reduction Plan Annual Status Report, as more accurate information becomes available.

4.4 Waste Reduction Assessments

The measurement of waste reduction effectiveness was completed for each reportable hazardous waste stream generated by USC during 2004. This measurement was completed using a method developed and identified in USC's CY 1996 Hazardous Waste Reduction Plan, with the exception of the calculation of the Actual Hazardous Waste Reduction Rate presented below as Step 5. This calculation has been modified to reflect an example obtained by HEI from the NYSDEC during 2000.

Waste Chromic Acid Solution

Step 1 Percentage change (C) in the waste stream's generation volume from one year to the next (Note: A negative number represents a reduction in the generation volume):

Comparing 2004 to 2003

$$C = \frac{\text{(Unit waste current year -2004) - (Unit waste prior year -2003)}}{\text{(Unit waste prior year - 2003)}} \times 100$$

$$C = \frac{(3.79 - 8.89)}{(8.89)} = -0.57 \times 100$$

C = **57%** Volume decrease from 2003

Step 2 Production Rate Index (PRI) (Note: A number less than 1.0 will represent a reduction in the facility's production rate):

Comparing 2004 to 2003

$$PRI = \frac{\text{(Unit production rate current year - 2004)}}{\text{(Unit production rate prior year - 2003)}}$$

$$PRI = \frac{(\$1,858,815)}{(\$1,266,404)}$$

PRI = 1.47

Step 3 Expected amount of hazardous waste generated (EHW) if no waste reduction was performed in 2004:

EHW = 2004 PRI x Hazardous waste generated during 2003:

EHW = 1.47 x 8.89 tons

EHW = 13.07 tons (expected)

Step 4 Hazardous Waste Reduction (HWR) for CY 2004 (A negative number indicates an increase in hazardous waste generation adjusted for production):

HWR = EHW - Actual hazardous waste generated during 2004.

HWR = 13.07 tons - 3.79 tons = 9.28 tons

HWR = 9.28 ton adjusted hazardous waste decrease from 2003 to 2004.

Step 5 Estimate of the actual hazardous waste reduction rate (RR) achieved based upon the above described production factors:

Using 2004-2003 HWR & EHW

$$RR = \frac{\text{2004 HWR}}{\text{2004 EHW}} \times 100$$

$$RR = \frac{9.28 \text{ tons}}{13.07 \text{ tons}} = 0.71 \times 100$$

RR = **71%** reduction rate

Waste chromic acid solution hazardous waste volume adjusted for production actually decreased for 2004 when compared to 2003.

Chrome Contaminated Debris

Step 1 Percentage change (C) in the waste stream's generation volume from one year to the next (Note: A negative number represents a reduction in the generation volume):

Comparing 2004 to 2003

$$C = \frac{\text{(Unit waste current year -2004) - (Unit waste prior year -2003)}}{\text{(Unit waste prior year - 2003)}} \times 100$$

$$C = \frac{(5.8 - 3.47)}{(3.47)} = 0.67 \times 100$$

C = **67%** Volume increase from 2003

Step 2 Production Rate Index (PRI) (Note: A number less than 1.0 will represent a reduction in the facility's production rate):

Comparing 2004 to 2003

$$PRI = \frac{\text{(Unit production rate current year - 2004)}}{\text{(Unit production rate prior year - 2003)}}$$

$$PRI = \frac{(\$1,858,815)}{(\$1,266,404)}$$

PRI = 1.47

Step 3 Expected amount of hazardous waste generated (EHW) if no waste reduction was performed in 2004:

EHW = 2004 PRI x Hazardous waste generated during 2003:

EHW = 1.47 x 3.47 tons

EHW = 5.10 tons (expected)

Step 4 Hazardous Waste Reduction (HWR) for CY 2004 (A negative number indicates an increase in hazardous waste generation adjusted for production):

HWR = EHW - Actual hazardous waste generated during 2004.

HWR = 5.1 tons - 5.8 tons = -0.7 tons

HWR = -0.7 ton adjusted hazardous waste increase from 2003 to 2004.

Step 5 Estimate of the actual hazardous waste reduction rate (RR) achieved based upon the above described production factors:

Using 2004-2003 HWR & EHW

$$RR = \frac{\text{2004 HWR}}{\text{2004 EHW}} \times 100$$

$$RR = \frac{-0.7 \text{ tons}}{5.1 \text{ tons}} = -0.14 \times 100$$

RR = **-14%** reduction rate

Chrome contaminated debris volume adjusted for production actually increased for 2004 when compared to 2003.

Filter Cake

Step 1 Percentage change (C) in the waste stream's generation volume from one year to the next (Note: A negative number represents a reduction in the generation volume):

Comparing 2004 to 2003

$$C = \frac{\text{(Unit waste current year -2004) - (Unit waste prior year -2003)}}{\text{(Unit waste prior year - 2003)}} \times 100$$

$$C = \frac{(9.55 - 5.94)}{(5.94)} = 0.61 \times 100$$

C = **61%** Volume increase from 2003

Step 2 Production Rate Index (PRI) (Note: A number less than 1.0 will represent a reduction in the facility's production rate):

Comparing 2004 to 2003

$$PRI = \frac{\text{(Unit production rate current year - 2004)}}{\text{(Unit production rate prior year - 2003)}}$$

$$PRI = \frac{(\$1,858,815)}{(\$1,266,404)}$$

PRI = 1.47

Step 3 Expected amount of hazardous waste generated (EHW) if no waste reduction was performed in 2004:

EHW = 2004 PRI x Hazardous waste generated during 2003:

EHW = 1.47 x 5.94 tons

EHW = 8.73 tons (expected)

Step 4 Hazardous Waste Reduction (HWR) for CY 2004 (A negative number indicates an increase in hazardous waste generation adjusted for production):

HWR = EHW - Actual hazardous waste generated during 2003.

HWR = 8.73 tons - 9.55 tons = -0.82 tons

HWR = -0.82 ton adjusted hazardous waste increase from 2003 to 2004.

Step 5 Estimate of the actual hazardous waste reduction rate (RR) achieved based upon the above described production factors:

Using 2004-2003 HWR & EHW

$$RR = \frac{\text{2004 HWR}}{\text{2004 EHW}} \times 100$$

$$RR = \frac{-0.82 \text{ tons}}{8.73 \text{ tons}} = 0.09 \times 100$$

RR = **-9.0%** reduction rate

Filter cake hazardous waste volume adjusted for production actually increased for 2004 when compared to 2003.

Process Wastewater

Step 1 Percentage change (C) in the waste stream's generation volume from one year to the next (Note: A negative number represents a reduction in the generation volume):

Comparing 2004 to 2003

$$C = \frac{\text{(Unit waste current year -2004) - (Unit waste prior year -2003)}}{\text{(Unit waste prior year - 2003)}} \times 100$$

$$C = \frac{(980 - 722)}{(722)} = 0.36 \times 100$$

C = **36%** Volume increase from 2003

Step 2 Production Rate Index (PRI) (Note: A number less than 1.0 will represent a reduction in the facility's production rate):

Comparing 2004 to 2003

$$PRI = \frac{\text{(Unit production rate current year - 2004)}}{\text{(Unit production rate prior year - 2003)}}$$

$$PRI = \frac{(\$1,858,815)}{(\$1,266,404)}$$

PRI = 1.47

Step 3 Expected amount of hazardous waste generated (EHW) if no waste reduction was performed in 2004:

EHW = 2004 PRI x Hazardous waste generated during 2003:

EHW = 1.47 x 722 tons

EHW = 1,061 tons (expected)

Step 4 Hazardous Waste Reduction (HWR) for CY 2004 (A negative number indicates an increase in hazardous waste generation adjusted for production):

HWR = EHW - Actual hazardous waste generated during 2004.

HWR = 1,061 tons - 980 tons

HWR = 81 tons adjusted hazardous waste decrease from 2003 to 2004.

Step 5 Estimate of the actual hazardous waste reduction rate (RR) achieved based upon the above described production factors:

Using 2004 HWR & EHW

$$RR = \frac{\text{2004 HWR}}{\text{2004 EHW}} \times 100$$

$$RR = \frac{81 \text{ tons}}{1{,}061 \text{ tons}} = 0.80 \times 100$$

RR = **8%** reduction rate

Process wastewater hazardous waste volume adjusted for production actually decreased 8% for 2004 when compared to 2003.

HAZARDOUS WASTE GENERATION SUMMARY

COMPANY NAME	EPA I.D. NUMBER
U.S. Chrome Corporation of New York	NYD990774200

TABLE 1

WASTE STREAM ID NUMBER	NAME OF WASTE	SOURCE OF GENERATION	DISPOSAL METHOD	QUANTITY OF WASTE GENERATED (TONS)				PRODUCTIVITY INDEX BASE INDEX = 1 (YEAR HWRP FIRST SUBMITTED)			
				1995	1996	1997	1998	1995	1996	1997	1998
001	Chromic Acid	Plating Solution	Treat/Recycle		6.44	1.19	9.87		0.33	3.0	0.2
	Solution (D)	with Impurities									
002	Chromic Acid	Sediment On	Stabilization		2.63	2.33	6.60		0.30	0.94	0.33
	Tank Sludge (E)	Bottom of Tank	& Secure Landfil								
003	Waste Treatment	WW Metals Removal	Stabilization &	8.1	2.1	2.37	3.34	0.55	1.28	0.664	0.652
	Filter Cake (A)		Secure Landfill								
004	Waste Water (B)	Plating & Rinsing	On-Site Treatment	228	266.5	263.8	260.54	0.62	1.28	0.664	0.652
005	Stripping Solution	Spent Alkaline	Treatment &		5.66	3.65	8.73		0.09	1.496	0.4
		Strip Solution	Secure Landfill								

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DIVISION OF SOLID & HAZARDOUS MATERIALS, BUREAU OF WASTE REDUCTION & RECYCLING

HAZARDOUS WASTE GENERATION SUMMARY

COMPANY NAME	EPA I.D. NUMBER
U.S. Chrome Corporation of New York	NYD990774200

TABLE 1 (continuation #1)

WASTE STREAM ID NUMBER	NAME OF WASTE	SOURCE OF GENERATION	DISPOSAL METHOD	QUANTITY OF WASTE GENERATED (TONS)				PRODUCTIVITY INDEX BASE INDEX = 1 (YEAR HWRP FIRST SUBMITTED)			
				1999	2000	2001	2002	1999	2000	2001	2002
001	Chromic Acid	Plating Solution	Treat/Recycle	3.80	6.25	0.00	0.00	1.5	1.2	1.3	0.97
	Solution (D)	with Impurities									
002	Chromic Acid	Sediment On	Stabilization	0.44	3.90	0.30	1.6	0.11	0.9	0.80	0.97
	Tank Sludge (E)	Bottom of Tank	& Secure Landfil								
003	Waste Treatment	WW Metals Removal	Stabilization &	4.02	3.21	3.13	1.51	0.640	0.631	0.623	0.97
	Filter Cake (A)		Secure Landfill								
004	Waste Water (B)	Plating & Rinsing	On-Site Treatment	264.68	258.21	253.98	1017.0	0.642	0.631	0.623	0.97
005	Stripping Solution	Spent Alkaline	Treatment &	8.15	3.48	5.44	6.05	0.45	0.40	0.42	0.97
		Strip Solution	Secure Landfill								

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HAZARDOUS WASTE GENERATION SUMMARY

COMPANY NAME	EPA I.D. NUMBER
U.S. Chrome Corporation of New York	NYD990774200

TABLE 1 (continuation #2)

WASTE STREAM ID NUMBER	NAME OF WASTE	SOURCE OF GENERATION	DISPOSAL METHOD	QUANTITY OF WASTE GENERATED (TONS)				PRODUCTIVITY INDEX BASE INDEX = 1 (YEAR HWRP FIRST SUBMITTED)			
				2003	2004	2005	2006	2003	2004	2005	2006
001	Chromic Acid	Plating Solution	Treat/Recycle	8.89	3.79			0.99	1.47		
	Solution (D)	with Impurities									
002	Chromic Acid	Sediment On	Stabilization	1.66	2.15			0.99	1.47		
	Tank Sludge (E)	Bottom of Tank	& Secure Landfil								
003	Waste Treatment	WW Metals Removal	Stabilization &	5.94	9.55			0.99	1.47		
	Filter Cake (A)		Secure Landfill								
004	Waste Water (B)	Plating & Rinsing	On-Site Treatment	722.0	980.0			0.99	1.47		
005	Stripping Solution	Spent Alkaline	Treatment &	2.13	2.84			0.99	1.47		
		Strip Solution	Secure Landfill								
006	Chrome Debris	Tape, gloves, etc.	Stab. & Landfill	3.47	5.80			0.99	1.47		

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HAZARDOUS WASTE REDUCTION PROGRAM

COMPANY NAME	EPA I.D. NUMBER
U.S. Chrome Corporation of New York	NYD990774200

TABLE 2

WASTE STREAM ID NUMBER	NAME OF WASTE	WASTE STREAM AFFECTED	REDUCTION PLANS/PROJECTS	ESTIMATED WASTE REDUCTION (TONS)	METHOD USED TO CALCULATE *ROI	*ROI (EST)	GOAL DATE	REMARKS
001	Chromic Acid		a) improved	0.1	N/A	N/A	12/2005	
	Solution		efficiency					
	(D002, D007)		b) employee					
			training					
003	Waste Treatment		a) control	0.3	N/A	N/A	12/2005	
	Filter Cake		chromic acid					
			quality					
004	Process		a) improved	29.0	N/A	N/A	12/2005	
	Wastewater		efficiency					
			b) employee					
			training					

*ROI = RATE OF INVESTMENT AC = ANNUALIZED COST IRR = INCREASED RATE OF RETURN NPV = NET PRESENT VALUE PP = PAYBACK PERIOD PI = PROFITABILITY INDEX

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HAZARDOUS WASTE REDUCTION PROGRAM

COMPANY NAME	EPA I.D. NUMBER
U.S. Chrome Corporation of New York	NYD990774200

TABLE 2 (continuation #1)

WASTE STREAM ID NUMBER	NAME OF WASTE	WASTE STREAM AFFECTED	REDUCTION PLANS/PROJECTS	ESTIMATED WASTE REDUCTION (TONS)	METHOD USED TO CALCULATE *ROI	*ROI (EST)	GOAL DATE	REMARKS
006	Chrome Debris	Tape, gloves, etc.	a) employee training	0.2	N/A	N/A	12/2005	

*ROI = RATE OF INVESTMENT AC = ANNUALIZED COST IRR = INCREASED RATE OF RETURN NPV = NET PRESENT VALUE PP = PAYBACK PERIOD PI = PROFITABILITY INDEX

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