

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

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ENGINEERING DIVISION**APPLICATION PROCESSING AND CALCULATIONS**

APPLICANT'S NAME: NORTHROP GRUMMAN SPACE AND MISSION SYSTEMS CORP.

FACILITY PERMIT ID# 800408

CONTACT PERSON: Ron Frazer

MAILING ADDRESS: ONE SPACE PARK Dr.
BUILDING CS1/1800
REDONDO BEACH, CA 90278

EQUIPMENT ADDRESS: 1700 Rosecrans Ave., BLDG D1
Manhattan Beach, CA 90266

Title V/RECLAIM Permit Revision:

Application No. 462781

PERMIT TO CONSTRUCT**Equipment Description: (Previous Application 475715)**

PROCESS 1: CONTROL EQUIPMENT					
Equipment	Device ID	Connected To	Source Type/ Monitoring Unit	Emissions	Equipment Specific Conditions
SCRUBBER, PACKED BED, HARRINGTON, MODEL NO. HPH 78-4, WIDTH: 8FT, DEPTH: 7FT; LENGTH 6FT 3IN, WITH A 4FT PACKING DEPTH, A 30-HP EXHAUST FAN AND THREE 2-HP RECIRCULATION PUMPS. Reference A/N 499349	C-6	E419, D420, E421, E422, E423, E424, D425, D427, D428, D429, D430, D431, D432, D433, D434, D435, D438, D439, D440, D441, D442, E479, D501, D502, D503, D505, E506, D573, D525, D595 D596, D597 ADD			C8.3, C8.9, D90.1, E158.1, E159.1, K67.3

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Conditions:

C8.3 THE OPERATOR SHALL USE THIS EQUIPMENT IN SUCH A MANNER THAT THE FLOW RATE BEING MONITORED, AS INDICATED BELOW, IS NOT LESS THAN 150 GPM.

To comply with this condition, the operator shall install and maintain a(n) flow meter to accurately indicate the flow rate of the recirculating scrubbing solution.

C8.9 THE OPERATOR SHALL USE THIS EQUIPMENT IN SUCH A MANNER THAT THE pH BEING MONITORED, AS INDICATED BELOW, IS NOT LESS THAN 8 OF THE pH SCALE

To comply with this condition, the operator shall monitor and record the pH as specified in condition D90.1.

D90.1 THE OPERATOR SHALL PERIODICALLY MONITOR THE pH OF THE SCRUBBING SOLUTION ACCORDING TO THE FOLLOWING SPECIFICATIONS:

The operator shall use litmus paper or a portable pH analyzer to monitor the parameter.

The operator shall monitor once every day provided any equipment served by this control system is in operation.

E158.1 THE OPERATOR SHALL MAINTAIN A CONTINUOUS OVERFLOW OF WATER FROM THE SCRUBBER SUMP TO PREVENT THE BUILD UP OF CONTAMINATION.

E159.1 THE OPERATOR SHALL MAINTAIN INSPECTION PORTS WHICH, WHEN OPENED, ALLOW THE OBSERVATION OF THE SPRAY NOZZLES AND SCRUBBING SOLUTION BEING SPRAYED ON THE PACKING.

K67.3 THE OPERATOR SHALL KEEP RECORDS, IN A MANNER APPROVED BY THE DISTRICT, FOR THE FOLLOWING PARAMETERS OR ITEMS:

pH of scrubbing solution on a daily basis.

Flow rate of recirculating scrubbing solution on a daily basis.

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Equipment Description:(Previous A/N 475714)

PROCESS 9: BPL LAB					
SYSTEM 2: INTEGRATED CIRCUIT FABRICATION					
Equipment	Device ID	Connected To	Source Type/ Monitoring Unit	Emissions	Equipment Specific Conditions
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D428	C6			B59.38
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D429	C6			B59.38
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D430	C6			B59.38
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D431	C6			B59.38
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D432	C6			B59.38
PLASMA ETCHER, BACKSIDE VIA ETCH, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 65-KVA Reference A/N 499350	D433	C6			B59.38
PLASMA ETCHER, MATRIX, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 21.4-KVA Reference A/N 499350	D434	C6			B59.12
PLASMA ETCHER, MATRIX, HEIGHT: 6FT,; LENGTH: 3FT; WIDTH: 4FT; 21.4-KVA Reference A/N 499350	D435	C6			B59.12
PLASMA ETCHER, ICP NO. 1, TRIKON, MODEL OMEGA, LENGTH: 3FT; WIDTH: 4FT; HEIGHT: 6FT; 65-KVA, WITH THREE VACUUM PUMPS, 2.0-HP TOTAL Reference A/N 499350	D501	C6			B59.38

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PLASMA ETCHER, ICP NO. 2, TRIKON, MODEL OMEGA, LENGTH: 3FT; WIDTH: 4FT; HEIGHT: 6FT; 65-KVA, WITH THREE VACUUM PUMPS, 2.0-HP TOTAL Reference A/N 499350	D502	C6			B59.38
PLASMA ETCHER, CLEANER, TWO CHAMBER, TECHNIX, MODEL 800-II, LENGTH: 3FT 5IN; WIDTH: 3FT 5IN; HEIGHT: 6FT 0.5IN; 65-KVA, WITH THREE VACUUM PUMPS, 4.0-HP TOTAL Reference A/N 499350	D503	C6			B59.38
PLASMA ETCHER, STS, MODEL MPX HRM, LENGTH: 6FT; WIDTH: 2FT 4IN; HEIGHT: 6FT 1.75IN; WITH TWO VACUUM PUMPS Reference: A/N 499350	D595	C6			B59.55
PLASMA ETCHER, TEGAL, MODEL 110, LENGTH:2FT 9IN; WIDTH: 6FT 4IN; HEIGHT: 6FT 10IN; WITH TWO VACUUM PUMPS Reference: A/N 499350	D596	C6	ADD		B59.66, C1.55

Conditions:

B59.66THE OPERATOR SHALL NOT USE THE FOLLOWING MATERIALS IN THIS DEVICE:

Toxic air contaminants in table 1 of rule 1401 with a listing date of 3/07/08 or earlier

C1.55THE OPERATOR SHALL LIMIT THE MATERIAL PROCESSED TO NO MORE THAN 240 IN ANY ONE MONTH.

For the purpose of this condition, material processed shall be defined as number of wafers processed in this equipment.

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Equipment Description:(Previous a/n 419143

PROCESS 9: BPL LAB					
SYSTEM #1 Photolithographic Processes					
					P13-1
Equipment	Device ID	Connected To	Source Type/ Monitoring Unit	Emissions	Equipment Specific Conditions
BENCH, PHOTORESIST COATER NO. 1 Reference A/N 499348	D411	C455			B59.14, C1.24
BENCH, PHOTORESIST COATER NO. 2 Reference A/N 499348	D412	C455			B59.14, C1.24
BENCH, TRACK DEVELOP/STRIP STATIONS #1 & #2, HEIGHT: 5FT 10IN; LENGTH: 5FT; WIDTH: 3FT 10IN; Reference A/N 499348	D438	C6			B59.20
OVEN NO. 1, LABLINE, MODEL 34390M Reference A/N 499348	D413	C455			B59.14, C1.24
OVEN NO. 2, LABLINE, MODEL 34390M Reference A/N 499348	D414	C455			B59.14, C1.24
OVEN, YES, MODEL YES-10TA Reference A/N 499348	D597	C6		ADD	B59.65, C1.56

Conditions:

B59.65 THE OPERATOR SHALL NOT USE THE FOLLOWING MATERIAL(S) IN THIS DEVICE:

TOXIC AIR CONTAMINANTS (TACS) IN TABLE 1 OF RULE 1401 WITH A LISTING DATE OF MARCH 7, 2008 OR EARLIER EXCEPT AMMONIA.

MATERIALS CONTAINING VOC.

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C1.56 THE OPERATOR SHALL LIMIT THE THROUGHPUT TO NO MORE THAN 480 BATCH(ES) IN ANY ONE MONTH.

Background:

Northrop filed applications 499348(oven D597), 499349(Scrubber C6) and 499350(etcher D596) as a new construction and modification of the scrubber exhaust to vent this equipment. The oven and etcher are to be located under process 9, system 1 (Photolithographic Processes) & 2 (Integrated Circuit Fabrication) respectively.

This is a RECLAIM Cycle 1 title V facility. The proposed project is considered as a “deminimus” significant permit revision to this facilities title V permit.

There was one NOV on file against this facility issued on 11/08/2006 for "Operation of a RECLAIM Title V facility without submitting the 3rd quarter, Cycle 1 emissions report (electronic in a timely manner) The facility was in compliance as of 1/12/2007. There are no other Notices of Violation, Notices to Comply or Complaints issued or filed against this facility as of 12/01/2007.

Scrubber Evaluation:

Application 475715

Scrubber C6 has a exhaust capacity of 25,000cfm. The ventilation needs from the entire system will be approximately 19,280 cfm. The addition of this plasma etcher and oven would increase the ventilation requirements by 100cfm to 19,380cfm. The scrubber will have no problem meeting the exhaust needs. The scrubber has a four foot depth of packing which would result in a 90+ percent capture. This scrubber vents from several sources of acid fumes which will also neutralize any ammonia fumes prior to the scrubber.

Emissions Calculations:

Application 499348(D597)

The emissions are based on the assumption that all the ammonia charged into the oven is un-reacted and vented to the scrubber and PM = PM10. The emissions calculation performed by the applicant is incorrect. A unit analysis has the applicants final answer in lbs-atm/batch. The weight of gas being charged to a batch oven will be estimated using the ideal gas law PV=nRT.

Oven Chamber volume:

$$12 \text{ in} \times 12 \text{ in} \times 13 \text{ in} = 1872 \text{ in}^3 (1.083 \text{ ft}^3)$$

Oven pressurized to 1.136 atm

Initial Temperature is ambient = 68°F(528R)

Gas Constant R = 0.7302 ft³-atm/lb-mol °R

$$PV = nRT$$

$$n = PV/RT$$

$$= 1.136 \text{ atm}(1.083 \text{ ft}^3) / (0.7302 \text{ ft}^3\text{-atm/lbmol R}) 528^\circ\text{R}$$

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$$= 0.00319 \text{ lb-mol}$$

$$MW_{\text{ammonia}} = 17.03 \text{ lbs/lb-mol}$$

$$= 0.00319 \text{ lbs-mol}(17.03 \text{ lbs/lb-mol})$$

$$= 0.0543 \text{ lbs/batch}$$

$$\text{Max Batches are 2 per hour operating 8 hours/day}$$

$$= 0.0543 \text{ lbs/batch}(2 \text{ batches/hr}) = 0.1086 \text{ lbs/hr}$$

Hourly:

$$R1 = 0.1086 \text{ lbs PM 10/hr}$$

$$R2 = 0.1086 \text{ lbs PM10/hr}(1-0.9) = 0.0109 \text{ lbs PM10/hr}$$

Daily:

$$R1 = 0.1086 \text{ lbs PM 10/hr}(8 \text{ hrs/day}) = 0.869 \text{ lbs PM10/day}$$

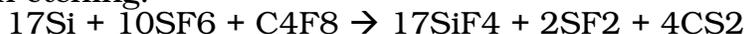
$$R2 = 0.0109 \text{ lbs PM10/hr}(8 \text{ hrs/day}) = 0.0872 \text{ lbs PM10/day}$$

To ensure the emissions remain as estimated and below 0.5 lbs/day for the project, this device will be limited to 480 batches per month.

Application 499350(D596)

Plasma Etcher: The plasma etcher will use the following as reactive gases; SF6 & C4F8 to etch silicon wafers, CHF3 & O2 to etch silicon oxide wafers and Argon & O2 are used to clean silicon deposits from the plasma chamber. Assume 90% control efficiency for the scrubber

Silicon etching:



Silicon Dioxide etching:



Silicon Wafer Etch

4" Wafer Area	12.566in ²
Area Etched	20%
Etch Depth	0.00984 in
Silicon Density	0.0842 lbs/in ³
Weight of Si etched	0.00208 lbs/wafer

Silicon Wafer Etching Gas usage:

GAS	GASFLOW	TIME	DENSITY		
	SCCM	MIN	gm/lt	GRAM/WAFER	LBS/WAFER
C4F8	60	60	9.97	35.892	0.079
SF6	60	60	6.16	22.176	0.049

Silicon Oxide Wafer Etch

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4" Wafer Area	12.566in ²
Area Etched	20%
Etch Depth	0.00984 in
Silicon Density	0.155 lbs/in ³
Weight of SiO ₂ etched	0.00383 lbs/wafer

Silicon Oxide Wafer Etching Gas usage:

GAS	GASFLOW SCCM	TIME MIN	DENSITY gm/lt	GRAM/WAFER	LBS/WAFER
CHF ₃	60	60	2.99	10.764	0.024
O ₂	20	60	1.35	1.620	0.004

Chamber Cleaning Gas usage:

GAS	GASFLOW SCCM	TIME MIN	DENSITY gm/lt	GRAM/WAFER	LBS/WAFER
Ar	60	60	1.67	6.012	0.013
O ₂	20	60	1.35	1.620	0.004
				total	0.017

The total emission is based on the assumption that all the gases used are emitted plus the etched material.

Silicon Wafer

$$0.00208 \text{ lbs/wafer} + 0.079 \text{ lbs C}_4\text{F}_8 + 0.049 \text{ lbs SF}_6 + 0.017 \text{ lbs Ar/O}_2 = 0.147 \text{ lbs/wafer}$$

Silicon Oxide Wafer

$$0.00383 \text{ lbs/wafer} + 0.024 \text{ lbs CHF}_3 + 0.004 \text{ lbs O}_2 + 0.017 \text{ lbs Ar/O}_2 = 0.045 \text{ lbs/wafer}$$

Silicon has the highest emission per wafer. There will be eight wafers process per day for an eight hour day.

Daily:

$$R1 = 0.147 \text{ lbs/wafer}(8 \text{ wafers/day}) = 1.176 \text{ lbs PM/day}$$

$$0.588 \text{ lbs PM}_{10}/\text{day}$$

The equipment is vented to a scrubber with a 90% efficiency

$$R2 = 1.176 \text{ lbs PM/day}(1-0.9) = 0.118 \text{ lbs PM/day}$$

$$0.059 \text{ lbs PM}_{10}/\text{day}$$

Hourly:

$$R1 = 1.176 \text{ lbs PM/day}(/8 \text{ hrs/day}) = 0.147 \text{ lbs PM/hr}$$

$$= 0.0735 \text{ lbs PM}_{10}/\text{hr}$$

$$R2 = 0.147 \text{ lbs PM/hr}(1-0.9) = 0.0147 \text{ lbs PM/hr}$$

$$= 0.0074 \text{ lbs PM}_{10}/\text{hr}$$

To ensure the emissions remain as estimated and below 0.5 lbs/day for the project, this device will be limited to 240 wafers per month.

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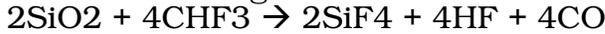
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Risk Assessment:

Silicon etching:



Silicon Dioxide etching:



GAS	GASFLOW SCCM	TIME MIN	DENSITY gm/lt	GRAM/WAFER	LBS/WAFER
C4F8	60	60	9.97	35.892	0.079
SF6	60	60	6.16	22.176	0.049
				mole/wafer	
				0.1794	
				0.1518	

MW_{C4F8} = 200.03gm/gmole
MW_{SF6} = 146.05 gm/gmole

Silicon Oxide Wafer Etching Gas usage:

GAS	GASFLOW SCCM	TIME MIN	DENSITY gm/lt	GRAM/WAFER	LBS/WAFER
CHF3	60	60	2.99	10.764	0.024
O2	20	60	1.35	1.620	0.004
				mole/wafer	
				0.1538	

MW_{CHF3} = 70.01gm/gmole

CS2 emissions:

10mol SF6:1mol C4F8:4mol CS2

C4F8 usage 0.1794 mol/wafer(4molCS2/1 molC4F8) = 0.7176 mol CS2/wafer

SF6 usage 0.1518 mol/wafer(4 mol CS2/10mol SF6) = 0.0607 mol CS2

0.7176 mol CS2(76.14 gm/mol)(8 wafers/day) = 437.10 gm/day
= 0.963 lbs/day
R1 = 0.120 lbs CS2/hr
R2 = 0.01204 lbs CS2/hr

HF emissions:

4mol CHF3:4mol HF

CHF3 usage 0.1538 mol/wafer(4molHF/4 molCHF3) = 0.1538 mol HF/wafer

0.1538 mol HF(20.01 gm/mol)(8 wafers/day) = 24.62 gm/day
= 0.0542 lbs/day
R1 = 0.068 lbs HF/hr
R2 = 0.0068 lbs HF/hr

Oven Ammonia Emissions:

From the oven emission calc's

Hourly:

R1 = 0.1086 lbs/hr
R2 = 0.1086 lbs/hr(1-0.9) = **0.0109 lbs/hr**

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The emissions for the oven and etcher under application 499348 & 499500 passed the Tier 1 screening with the cancer/chronic and acute ASI values as follows;

Cancer/ChronicASI	Acute ASI
6.13E-03	6.69E-02
Passed	Passed

For the oven, a/n 499348

This equipment will be conditioned such that

**THE OPERATOR SHALL NOT USE THE FOLLOWING MATERIALS
IN THIS DEVICE:**

Toxic air contaminants in table 1 of rule 1401 with a listing date of 3/07/08 or earlier except Ammonia.

This equipment will operate in compliance with Rule 1401.

RULE EVALUATION

Rule 212 (c)(1):This section requires a public notice for all new or modified permit units that emit air contaminants located within 1,000 feet from the outer boundary of a school.

No public notice is required since no school is located within 1,000 ft from the above site.

Rule 212 (c)(2):This section requires a public notice for all new or modified facilities that have on-site emission increases exceeding any of the daily maximums as specified by Rule 212(g).

The proposed project will result in a small emission increase for the entire facility. A Rule 212(c) (2) notice will not be triggered since the emission increase is below the daily maximum specified in Rule 212(g).

Rule 212(c)(3):This section requires a public notice for all new or modified permit unit with increases in emissions of toxic air contaminants listed in Table I of Rule 1401 resulting in MICR greater than 1E-6 per permit unit or greater than 10E-6 per facility.

The proposed project will not result in an increase of toxic emissions in excess of the one in a million. Therefore Public Notice is not required under this section of the rule.

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Rule 212(g): This section requires a public notice for all new or modified sources that result in emission increases exceeding any of the daily maximums as specified by Rule 212(g).

The emission increase due to the operation of this equipment is negligible and the following summarizes the emission increase:

	Maximum Daily Emissions					
	<u>ROG</u>	<u>NO_x</u>	<u>PM₁₀</u>	<u>SO₂</u>	<u>CO</u>	<u>Pb</u>
Emission increase	0	0	0	0	0	0
MAX Limit (lb/day)	30	40	30	60	220	3
Compliance Status	Yes	Yes	Yes	Yes	Yes	Yes

No public notice is required since the emission increase is below the thresholds.

Rule 401: With the proper maintenance and operation of this equipment, compliance with this rule is expected.

Rule 402: With proper maintenance and operation, this equipment is not expected to create a nuisance.

Rule 1164: The oven used to cure the photoresist uses an ammonia chemistry to develop the resist. No VOCs are used. The oven and etcher are vented to a scrubber which will comply with the BACT requirements but otherwise there are no VOC to be controlled. The oven will be conditioned such that no materials containing VOC may be used. Compliance with this rule is expected.

Rule 1303(a): The emissions from the plasma etcher and oven are vented to a scrubber which is BACT for this type of operation. Compliance with BACT is achieved.

Rules 1303(b)(1) modeling:

The hourly PM10 emissions from this equipment are 0.007 lbs/hr for the etcher and 0.08 lbs/hr for the oven which is less than the Appendix A screening level of 0.41 lbs/hr. Compliance is expected.

Rule 1303(b)(2) Offsets:

No offsets are required for this operation since the emissions are less than 0.49 lbs PM10/day.

Rule 1303(b)(4): The facility is expected to be in full compliance with all applicable rules and regulations of the District.

Rule 1401: The oven will be conditioned such that no toxic material listed under rule 1401 with an effective date of 3/07/08 except ammonia will be used. The etcher does not use any toxics so there will be no exceptions to its condition. Compliance with this rule is expected.

RULE 2005: Northrop Grumman is a NOx RECLAIM facility. The proposed project will not result in an increase in NOx emissions. Compliance with rule is expected.

REGULATION XXX:

This facility is in the RECLAIM program. The proposed project is considered as a “de minimis significant permit revision” for non-RECLAIM pollutants to the RECLAIM/Title V permit for this facility.

Non-RECLAIM Pollutants or HAPs

Rule 3000(b)(6) defines a “de minimis significant permit revision” as any Title V permit revision where the cumulative emission increases of non-RECLAIM pollutants or HAPs from these permit revisions during the term of the permit are not greater than any of the following emission threshold levels:

Air Contaminant	Daily Maximum (lbs/day)
HAP	30
VOC	30
NOx*	40
PM ₁₀	30
SOx*	60

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* Not applicable if this is a RECLAIM pollutant

To determine if a project is considered as a “de minimis significant permit revision” for non-RECLAIM pollutants or HAPs, emission increases for non-RECLAIM pollutants or HAPs resulting from all permit revisions that are made after the issuance of the Title V renewal permit shall be accumulated and compared to the above threshold levels. This proposed project is the 4th permit revision to the Title V renewal permit issued to this facility on May 9, 2006. The following table summarizes the cumulative emission increases resulting from all permit revisions since the Title V renewal permit was issued:

Revision	HAP	VOC	NO_x*	PM₁₀	SO_x	CO
Previous Permit Revision Total Cummulative to date. Title V permit renewed July 9, 2006	0	0	1	5	0	1
8th Permit Revision; addition of a plasma etcher (D596), a new oven(D597) and modification to scrubber C6 a/n 499350, 499348 & 499349	0	0	0	0	0	0
Cumulative Total	0	0	1*	5	0	1
Maximum Daily	30	30	40*	30	60	220

* RECLAIM pollutant, not subject to emission accumulation requirements

Since the cumulative emission increases resulting from all permit revisions are not greater than any of the emission threshold levels, this proposed project is considered as a “de minimis significant permit revision” for non-RECLAIM pollutants or HAPs.

RECOMMENDATION

The proposed project is expected to comply with all applicable District Rules and Regulations. Since the proposed project is considered as a “de minimis significant permit revision” for non-RECLAIM pollutants and a “minor permit revision”, for RECLAIM pollutant, it is exempt from the public participation requirements under Rule 3006 (b). A proposed permit incorporating this permit revision will be submitted to EPA for a 45-day review pursuant to Rule 3003(j). If EPA does not raise any

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objections within the review period, a revised Title V permit will be issued to this facility.

Conclusion:

This equipment will operate in compliance with all District Rule and Regulations. A Permit to Construct is recommended for application number 499348, 499349 & 499350 subject to preceding conditions.