

RESPONSES TO COMMENTS ON HYNIX PROPOSED PERMIT

Hynix Semiconductor Manufacturing America, Inc. Permit No. 203531

Summary of Public Notice

This permit was open for public comment from November 17, 2006 through March 31, 2007. The permit was placed on public notice from November 17, 2006 to December 19, 2006 by advertisement in the Eugene Register-Guard. A public hearing was requested on December 7, 2006. The public hearing notice appeared in the Eugene Register Guard on January 9, 2007, for the hearing to be held on February 12, 2007, with the public comment period to end on February 13, 2007. Twenty-five (25) citizens attended the hearing, and five (5) provided oral testimony. At the time of the hearing, the public requested an extension on the public comment period, which was granted, and the comment period was extended to March 15, 2007. Additional request(s) for continuance were granted and the comment period was extended to March 31, 2007. A total of 275 people submitted comments. Issues expressed during public review, and the LRAPA's responses, are described in the following section. Actions taken by the LRAPA following consideration of public review are described in the following:

Public Comments and Responses

The following is a list of the substantial issues raised during the public comment period, with responses, in accordance with Title 14-120-4 of LRAPA's *Rules and Regulations*.

1. Request for Public Hearing and Extensions to the Public Comment Period: The Oregon Toxics Alliance requested a public hearing in a letter dated 12/7/06. Several requests were made to extend the public comment period. Greg Slowik requested another public hearing in an e-mail on 3/29/07.

Response: The public comment period began on November 17, 2006. Based on the request for a public hearing, the hearing was arranged and held on February 12, 2007. Based on multiple requests for continuance following the public hearing, the public comment period was extended to March 13, 2007. No additional extensions or hearings were granted in accordance with Title 34-130-5 of LRAPA's *Rules and Regulations*.

2. Additional Offsite Impact Considerations: A total of eight (8) comments expressed concerns about air quality impacts of hydrogen fluoride (HF), most notably on vegetation, but also concerning multiple pathway risks (risks resulting from pollutants deposited in soil or water and/or risks resulting from interaction with other pollutants). More than one of the commenters cited quantitative concentrations at which adverse impacts on certain plant species and/or foraging animals could be expected.

Response: LRAPA requested that Hynix re-examine the offsite impacts including the next level of air dispersion modeling. Hynix performed the modeling and the offsite impact analysis. The results are summarized in Table 4.2 of this report. The modeling results described in Section 4. of the Review Report indicate no significant offsite impact.

HF is not a suitable candidate for multiple pathway risk analyses based on its physical/chemical properties, according to Bruce Hope, Toxicologist for the Oregon Department of Environmental Quality (ODEQ). This assertion is supported by the ODEQ's work in establishing the ambient benchmarks for toxic pollutants. HF breaks down readily and forms bonds with most other elements. Its defining element, fluorine, is pervasive in nature in many forms. Therefore, establishing the origin of fluoride compounds is difficult.

3. Adequacy of Emissions Controls: A total of ten (10) comments expressed concern relating to emissions control technology at Hynix and questioned what emissions control measures are used at comparable plants. Additionally, more than one commenter suggested that the frequency of stack testing is inadequate.

Response:

Control Systems -- Hynix uses five (5) packed-bed wet scrubbers to control acid emissions, including HF. This type of system has been used to meet Best Available Control Technology (BACT) requirements. Additionally, the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Semiconductor Manufacturing requires scrubbers as maximum available control technology. Although **Hynix is not subject** to this federal rule because its HF emissions are not great enough, the scrubber systems at Hynix are consistent with the requirements of the NESHAP.

Test Frequency – The purpose of testing is to demonstrate compliance with emission limits and to ensure the effective operation of the control equipment. The permit requires testing every five (5) years. This is more frequent testing than that required by the semiconductor NESHAP rule (the NESHAP requires testing to be performed only at start-up or within six (6) months of the effective date of the rule). The following *comparable facilities/permits* section provides further information on the adequacy of the testing requirements.

Additionally, in response to public comment, LRAPA added permit requirements for semiannual testing and the establishment of optimal scrubber parameters that must be included, and followed by operators, in the facility's maintenance and operation (M & O) plan.

Comparable Facilities/Permits -- As a comparison to similar operations, the LRAPA gathered the following information:

- LRAPA contacted the Oregon Department of Environmental Quality (ODEQ) concerning the air quality permit for the Intel integrated circuit plant in Hillsboro, Oregon. Based on the Intel permit and conversations with ODEQ, systems for controlling HF and other acids at Hynix are similar to the packed-bed wet scrubbers at Intel. Hynix systems and requirements appear to be at least as effective/stringent as the ODEQ permit requirements for Intel.
- LRAPA contacted the Bay Area Air Quality Management District (BAAQMD), which regulates several semiconductor manufacturers. In an e-mail follow-up on 3/19/07, a permit engineer said that HF is not heavily regulated; scrubbers are used as control devices, but not required by permit. HF emissions are not quantified by the BAAQMD because they are controlled by scrubbers and believed to be negligible. The HF emissions at Hynix are controlled at least as well as comparable facilities regulated by the BAAQMD.
- LRAPA contacted the Puget Sound Clean Air Agency (PSCAA) in Washington State. This jurisdiction has a single, but inactive, semiconductor manufacturing facility (Microchip Technology Incorporated). The construction permit for this facility cites requirements similar to those in the Hynix permit. The PSCAA construction permit conditions limit emissions of HF to no more than 4.86 tons per year. Wet scrubbers are required for controlling HF. Hynix systems and requirements appear to be comparable to those of the PSCAA permit for Microchip Technology Incorporated.
- LRAPA contacted the Virginia Department of Environmental Quality (VDEQ) concerning a semiconductor manufacturer in Manassas, VA (Micron Technology, Inc.). The permit includes emission limits for HF, and requirements to control these emissions with wet packed bed scrubbers. The permit does not require testing of the scrubbers. No offsite

impact analysis was performed for this facility. Hynix systems and requirements appear to be at least as effective/stringent as the VDEQ permit requirements for Micron Technology, Inc.

- LRAPA contacted the Idaho Department of Environmental Quality (IDEQ) concerning a semiconductor manufacturer in Nampa, ID, near Boise (Micron Technology, Inc.). IDEQ stated that this facility is subject to the federal NESHAP for semiconductor manufacturers. Micron Technologies uses wet scrubbers to control HF. Hynix systems and requirements appear to be at least as effective/stringent as the IDEQ permit requirements for Micron Technology, Inc.

4. Concerns Based on Toxic Effects: A total of 254 comments expressed varying degrees of concern and/or opposition relating to the proposed increase in emissions, several on the basis of toxic effects, particularly health effects. A few commenters suggested a link between cancer and HF exposure.

Response: In Section 4 of the Review Report, LRAPA examined the potential human health impact of offsite HF concentrations given the proposed emissions level. This analysis showed no significant adverse impact. Additional dispersion modeling was performed by Hynix to further examine offsite impacts, most notably impacts on vegetation. The modeling results indicate no adverse impacts on human health or vegetation.

LRAPA considered the specific HF concentrations provided by Dr. Paul Engelking and others. Hynix performed additional air dispersion modeling to further examine the concern regarding offsite impacts cited in these comments (See results of Tables 4.1 and 4.2).

The Hynix permit review, specifically the dispersion modeling and risk analysis, pertains to non-cancer risk. The scientific evidence has not established a link between HF exposure and cancer.

5. HF Emissions and Greenhouse Gases: One (1) comment expressed concern that emissions of both HF and PFC (perfluorocarbons, greenhouse gases) be minimized, rather than lowering PFC at the cost of raising HF.

Response: Hynix has expressed its intention to lower its use of fluorinated compounds in general. The company described its intention to continuously look for ways to better control HF emissions, such as point-of-use control devices, when feasible, and to maintain all of its emissions control systems. Hynix also acknowledges increased production over the years. The company explained that market forces constantly necessitate changes in the types of products made. Additionally, the IPCC made a recent change in the method for calculating PFC's, which also effects HF emissions determinations. Such a change in methodology changes the emissions determinations based on better scientific understanding.

6. Testing and Minimizing Emissions: One (1) comment expressed concern that Hynix be held to the "absolute minimum output of all potentially harmful emissions," and that LRAPA not "rely on Hynix to do the only stack tests."

Response: The impact of HF emissions at the level proposed by Hynix has been reviewed by LRAPA (see Section 4 of the Review Report). This review includes air dispersion modeling and the results indicate no significant offsite health risk at the maximum proposed HF emission rate at Hynix.

As part of the permit renewal requirements, Hynix will be required to perform a stack test to demonstrate compliance with the permitted HF emission rate limit. LRAPA requires Hynix to submit a source test plan and receive approval in advance of any testing. An independent, professional, testing firm that adheres to the required test procedures must perform the testing. The test plan must demonstrate that the procedures, sampling and laboratory analysis will follow the methods in the Oregon DEQ (ODEQ) *Air Quality Source Sampling Manual*. LRAPA representatives observe source tests to ensure adherence to testing requirements and operating requirements during testing.

Before accepting reported test results, LRAPA evaluates the raw data, operating parameters, calculations and laboratory analyses to ensure testing meets the terms prescribed by the ODEQ *Air Quality Source Sampling Manual*. The LRAPA monitoring staff that reviews the test plans and results has expertise in performing and evaluating source tests. Hence, the compliance determination relies not on Hynix, but on LRAPA observation and review of the test data.

Testing oversight and LRAPA approval of test plans are also requisite to the semiannual testing that Hynix must perform on the scrubbers.

7. Emissions, Emissions Control and Safety: One (1) comment expressed concern about emissions of perfluorocarbons (PFCs), the overall emissions quantities, and the potential adverse impact on the area surrounding Hynix.

Response: Although LRAPA does not regulate PFCs, this class of compounds contributes to global warming and Hynix uses a method of calculating PFCs in the course of determining emissions of HF. The determination of both HF and PFC emissions relate to the “fate” of available gaseous fluorine. This determination is made using a segment of a document published by the Intergovernmental Panel on Climate Change (IPCC) -- *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. This document provides a means of determining greenhouse gas formation from available fluorine. The methodology attributes a fraction of the available fluorine to greenhouse gases and the balance is assumed to form HF. Because Hynix uses a method of calculating HF that includes PFC quantities, these quantities are included in the annual reports. For reporting year 2005, Hynix estimated emissions of 19.7 tons of PFCs.

8. Alternatives to HF for Electrochemical Etching: One (1) comment provided literature citing alternative materials suitable for etching in the course of semiconductor production.

Response: The referenced research, which cites etching alternatives in the liquid phase, was passed to Hynix personnel for their consideration. HF emissions at Hynix result from gas-phase processes, however. Additionally, HF gas is not a raw material at Hynix, but is formed when gases such as NF_3 and CH_4 dissociate and provide available fluorine for the formation of HF. These emissions are routed through the scrubber control system.

9. Monitoring Near the Hynix Plant: One (1) comment suggested monitoring should be performed near Hynix.

Response: Hynix performed further dispersion modeling to better address offsite impacts of HF emissions. Dispersion modeling is the standard of analysis for review of permitting situations of this kind. It is approved by and discussed extensively by the U.S. EPA for the review of permitted sources of air emissions. (See preferred/recommended models at http://www.epa.gov/scram001/guidance_permit.htm.)

10. Support for Hynix: One (1) comment expressed support for Hynix and its economic contribution to the community. One commenter also suggested that actual emissions measurements should be taken and possibly further measures taken to control emissions.

Response: The permit includes periodic stack testing to measure emissions from Hynix. LRAPA has added monitoring requirements pertaining to scrubber operation to ensure the effective control of acid emissions, including HF.

11. Hynix Comments: Hynix submitted written comments on February 28, 2007. In the comments, Hynix described the reasons for the request for increased HF emissions. In summary, production has increased, accounting in part for the request. Secondly, the determination of the fate of fluorine, specifically how much of it becomes HF versus greenhouse gases, has changed recently, thereby elevating the amount attributed to HF.

Hynix also commented that additional testing, beyond what is specified in the permit, must have justification. The comments outlined the scrubber control systems and the measures taken to ensure continued scrubber effectiveness.

Hynix disagrees with the alleged vegetative damage, specifically damage to lichens, as attributable specifically to the HF emissions from its operations. Hynix argued that lichen damage is associated with general urban pollution, but not with a specific stressor. The condition of lichen, they stated, is an unreliable basis for analysis.

LRAPA Response: LRAPA has considered the concerns expressed relating to the effective operation of control systems. The agency intends for any permit, including that of Hynix, to include requirements that ensure control system effectiveness. Hynix has conducted additional dispersion modeling as discussed in Section 4 of the Review Report.

12. Biological Monitoring: One (1) comment called for monitoring to examine biological impacts. Several similar comments were made suggesting soil and/or water sampling and monitoring. In its written comments, the Oregon Toxic Alliance (OTA) suggested such monitoring. The OTA stated, "LRAPA should require Hynix to perform in situ biological monitoring. This is necessary to determine whether the HF emitted by Hynix thus far has damaged the vegetation and animals of the wetlands west and southwest and to the forested areas to the south of the facility. The updated information would establish a new baseline to evaluate any future detrimental effects of HF emissions." The OTA continued, "Furthermore, Dr. Paul Engelking, an LRAPA advisory board member, gave testimony on HF's damage to vegetation. LRAPA should give his testimony foremost consideration."

Response: The topic of adverse impacts of HF and fluorides on plant species was considered and discussed within LRAPA, and with Hynix. Dr. Engelking's comments were given considerable attention by LRAPA for the additional review of the offsite emissions impact on vegetation. Hynix performed additional dispersion modeling to better clarify the offsite impacts (see Section 4 of the Review Report).

13. Transport, Handling and Storage of HF: One (1) comment expressed concerns relating to how HF is delivered to the Hynix site, how it is stored, what effect the proposed HF emissions increase will have on these aspects, and the possibility of an industrial accident.

Response: LRAPA has no direct authority in the areas of materials transport, handling and storage. However, LRAPA would expect to be notified in the event of an incident resulting in excess emissions. As explained in Section 18 of the Review Report, Hynix is not subject to the federal requirements pertaining to accidental release under Title 40 CFR 60.130.

14. Reduction of PFC Emissions: One comment from Mr. Fred Hamlin asked about methods of realizing a 10% decrease in PFCs as directed by the World Semiconductor Council. Mr. Hamlin stated, "How are other plants making this reduction to comply with the 2010 deadline?"

Response: As mentioned, LRAPA does not have authority to regulate PFCs. However, the Semiconductor Industry Association, with which Hynix is affiliated, has agreed to a 10% reduction in PFCs by 2010. More information on this and other semiconductor industry issues can be found at: <http://www.sia-online.org>.

Summary of LRAPA Actions Based on Public Comments

Below are the key LRAPA actions taken based on public comments. For a more complete description of the LRAPA's responses to comments, considerations of comments, as well as related details, see Sections 4 and 20 of the Review Report.

1. Toxic Impacts: To address the concerns regarding offsite impacts of HF, LRAPA asked Hynix to examine vegetative impacts, including performance of more refined dispersion modeling. LRAPA reviewed the available literature, particularly that provided by Dr. Paul Engelking. Studies were identified in which HF impacts on plant species were examined, and threshold concentrations established. This further work allowed for comparison of modeling results to more stringent ambient air standards to protect plant species. No such standard for HF exists in the state of Oregon. However, standards for HF that cover vegetative impacts were identified from other air quality jurisdictions in North America. The full description of considerations and actions taken on this comment, including modeling results and discussion of these results, is given in Section 4 of the Review Report.
2. Adequacy of Emissions Controls: This issue encompasses control systems, test frequency and the operation of comparable semiconductor manufacturing facilities, all of which are discussed in Section 3 of this document.

Conclusion: LRAPA expanded the permit conditions to further monitor continued effective operation of the scrubber control systems in response to public comments (see permit Conditions 25, 26 and 27). Based on the Federal NESHAP for semiconductor facilities and the review of comparable permitting of semiconductor facilities in other jurisdictions, the requirements of the Hynix permit provide comparable stringency to ensure effective control of emissions. In addition to testing all pollutants once during the permit, the permit limits require Hynix to test for HF emissions on at least two (2) scrubbers on a semiannual basis. The scrubbers will be tested on a rotating basis. The semiannual testing plan and units selected for testing are subject to LRAPA approval.

In addition, permit conditions have been added that require HF emissions be assessed on at least a semiannual basis. Further, within six (6) months of permit issuance, the permit conditions require Hynix to have quarterly production recordkeeping in place to track and forecast its compliance status with the annual HF limits.

3. New Source Review (NSR): As explained in Section 3 of the Review Report, LRAPA found upon re-examination of the regulatory issues that NSR does not apply. Therefore the review report and permit were changed to reflect this determination.
4. Additional Limitations and Requirements: In the course of considering public comments, LRAPA found merit in adding semi-annual testing requirements and emission tracking for hydrogen fluoride (HF). These requirements are found in permit Conditions 27 and 31.

5. Biological Testing: As described in the 3rd paragraph of the above comment, Section **Error! Reference source not found.**, LRAPA is continuing its pursuit of the details surrounding possible studies of lichens as an indicator of HF emissions near Hynix. A botanist who has worked with the U.S. Forest Service has proposed an initial area assessment of lichens near Hynix as Phase 1 of such a study. The field work was completed in August of 2007, with a report describing the findings to follow. The report is expected to include recommendations addressing the merits of further study and analysis.

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