Foundry Waste Disposal Guideline
November 12, 1985

Introduction

Under the authority of IAC 4-4-9, the following foundry waste disposal guideline was developed. The State is in the process of incorporating the contents of this guideline into the new Solid Waste Rule. The State realizes the foundry industry's economic burden of manditory disposal of all foundry waste at sanitary landfills under the current Rule. The State would like to help alleviate this burden by implementing this guideline, which contains alternative site types for foundry waste disposal, during the interim rule revision/adoption period.

This document is a guideline and is meant to have some flexibility. A waste or a site may not fit the exact waste type or site type descriptions found on the proceeding pages but it comes close. Should this be the case, the generator or site owner may demonstrate to the Board that the deviation, from the recommendations contained in this guideline, will not cause a potentially harmful effect on the environment. If the intent of the guideline is followed and the demonstration is adequate, the Board may consider allowing the deviation.

Foundry waste that is deposited in landfills is composed of many foundry waste components generated from individual foundry waste process unit operations. Component foundry waste examples include slag, green sand, cupola, cleaning room waste, sulfur dioxide core butts, finishing sand, baghouse dust, and air cleaner sludge to name a few. For materials with similar characteristics or if other materials have been added to the foundry waste, this guideline shall be applied on a case by case basis.

In the course of preparing this guideline, staff investigated the requirements of a number of other States. Requirements varied widely. California indicated that foundry waste is considered to be a hazardous waste and requires disposal at a hazardous waste site. North Carolina requires that industrial wastes and sludges that test at greater than 10 times drinking water standards be treated or chem-fixed. Ohio excludes foundry waste which tests less than 30 times drinking water from the definition of solid waste and does not regulate it.

The guideline presented here sets forth different site requirements which are based on leaching test results. Material which tests at less than drinking water (or other) standards is allowed to go to a site for which the main requirements are that the material not be placed within standing water where the standing water reflects the water table or sinkholes and not be within 500 feet of a usable, potable/irrigation well. Materials which leach greater amounts are required to have increasing thicknesses of clay liners, frequency of cover, and groundwater monitoring.

One of the references used in developing this guideline was "Leachate and Groundwater Quality in and Around Ferrous Foundry Landfills and Comparisons to Leach Test Results" by Blaha, Boyle, Ham, Kunes, Nichol, and Stanforth (January, 1985). Based on their study of fourteen foundry landfills, four major conclusions can be drawn from this reference and they are listed below.

Point 1: Foundry landfills are contributing some parameters to the groundwater occasionally at fairly high concentrations. The three major offending parameters cited are manganese, iron, and fluoride. The first two elements are secondary drinking water parameters; the third element is a primary drinking water parameter. The study found manganese exceeded drinking water standards in more than half of all samples at each landfill studied with lysimeters. It exceeded drinking water standards by ten times at all foundry landfills at the 95% cumulative frequency level. Iron exceeded drinking water standards in more than half of all samples of four foundries tested. At the 95% cumulative frequency, iron exceeded drinking water standards at each landfill studied often by factors greater than ten times the drinking water standard. In three of the the test cases, the drinking water standard for flouride was exceeded by more than fifty percent. Drinking water standards were violated more often by secondary drinking water parameters than by primary drinking water parameters.

Point 2: Results of groundwater samples from wells near and on the landfills studied reflect a high degree of variablility in parameter concentrations. It was pointed out in the study that the landfill is very nonhomogeneous with regard to waste composition and that wells reflect local rather than general conditions. As noted in the first paragraph of this policy, there are so many components to foundry wastes that it would be very feasible for one area of the landfill to have the majority of one waste component present and a short distance away another waste component dominate. It is necessary environmentally to know how foundry waste components might behave in a landfill environment. In order to get an accurate picture of the foundry waste, analytical component testing should be done.

Point 3: The two types of analytical batch leaching tests to analyze leachate components were the EP or acid test and the AFS or water test. As stated on page 4 of the AFS study, "In most cases the the EP test underpredicted parameter concentrations found in field leachate. ...the AFS test often underestimated groundwater concentrations of very soluble redox sensitive parameters such as iron and manganese". The study reports that the EP test appears to be a slightly better predictor than the AFS test at both the fifty and ninety five percent cumulative frequency levels. Perhaps the reason for the better test results is due to sample pH and concentration in the testing situation. Only six of the fourteen foundries cited in the AFS report presented composite EP, AFS, and field test results. Using these six foundries, staff evaluated how well the EP test would predict the waste catagory for the actual field leachate by the waste type guidelines set forth in this document. The EP test correctly placed the test parameter into the same field leachate waste type 73% of the time. The staff study results indicate that the EP test is a fairly

good indicator of the parameters that would be found in the field but it is not always accurate. Based on these findings, staff believes there should be some safety factor in site requirements. It should be noted that, of the six foundries studied, none of the foundry wastes fell into waste type A, B or D. All of the foundries fell into waste category C. Consistently iron and manganese were the parameters which caused the higher waste type rating.

Point 4: Organic material is present in foundry waste. Based on EPA's Development Document for Effluent Limitations Guidelines for the Foundries (Metal, Molding, and Casting) Point Source Category, there are many chemicals that can be used in the foundry process including acrylic resins, foundry coke, epoxy resins, phenolic resins, catalysts, alkyd resin binders, degreasers and charcoal to name a few. Possible components generated from using any or all of these chemicals include cyanide, phenol, benzene, toluene, naphthalene, nitrosamine, formaldehyde, ethylene dichloride, trichloroethylene and polychloroethylene. It can be seen that foundry processing chemicals can generate organic wastes. The AFS study reported on TOC levels (page 145). The report states that "Although no drinking water standard presently exists for TOC, high levels of TOC can be considered undesirable in groundwater". The AFS study reports that the average TOC level in the leachate from each foundry landfill was below 50 mg/liter. In comparison, raw sewage has a TOC range between 80 and 290 mg/liter based on EPA's Development Document for Effluent Limitation Guidelines and Standards for the Foundries (Metal, Molding and Casting) Point Source Category. The TOC for foundry sand is in the same general range as the TOC for raw sewage and therefore may have the potential of being harmful. Special attention is paid to testing for phenols in this policy since the AFS study reported that phenolic compounds are widely used in the foundry industry and are very water soluble. The AFS study also reports on page 145 that "Phenolic compounds were found in foundry landfill unsaturated zone samples in concentrations up to .44 mg/liter (or about 1.5 times the drinking water standard)". With so many types of chemicals used in the foundry industry coupled with documented cases of high levels of organics in foundry landfill wastes, it is necessary environmentally to test foundry waste for levels of organic compounds and in particular the level of phenolic compounds.

Point 5: The current testing structure used in this guideline is to perform the EP Toxicity Test and the water leach test for waste classification purposes. The EP Toxicity Test is used for the eight primary metals and the water test is used for the remaining parameters. On July 18, 1985 RMT gave a presentation of their foundry waste disposal guideline ideas to the State and the Association of Indiana Foundries. One of the main ideas of their waste testing structure is to initially check for hazardous wastes by performing the EP Toxicity test method on the eight primary metals. If the waste is nonhazardous, the water leach test would be done for waste classification purposes on all parameters including the eight primary metals. One of RMT's supporting arguments in favor of this procedure is that water leaching tests often overestimated groundwater concentrations of primary drinking water metals based on the AFS study.

Staff feels that the AFS field leachate results give a more accurate indication of potential contamination from waste than groundwater results. Field leachate results may be higher than the groundwater concentrations for a site in question, but it is in the environment's favor that comparisons using the field leachate results are made. Infiltration that enters the landfill must eventually exit the waste boundries as field leachate. Groundwater parameter concentrations are variable based on many factors including the specific site, location, depth of the well, and how long the waste has been in place to contribute to groundwater parameter concentrations. The AFS study even points out on page 85 that "...Groundwater contamination, in summary, was generally localized and several wells were needed to evaluate the impact of waste on groundwater." Thus, placement of test parameters into either the EP Toxicity or water leach test procedure is based on results from the AFS study utilizing the EP test, the water leach test and the 95% cumulative frequency field leachate results for this policy. Each test parameter is generally placed into the test procedure where the parameter leached closest to the .95% field leachate results. This cumulative frequency level adds a margin of safety to the tests in the environment's favor. Specific exceptions to this trend are iron and manganese as documented later on in this policy. Staff made a comparison between the water test and the EP Toxicity test results with respect to predicting the .95 field leachate results for the EP toxic metals. Results indicate, for the primary metals where the field leachate results tested greater than drinking water standards, in 80% of the cases neither the EP nor the AFS tests showed detectable concentrations. In the remaining 20% of the cases, the EP Toxic test most accurately predicted leachate concentration. Thus, only the EP Toxic Metals will be tested under the EP Toxic Test for waste classification and the water leach test will be used for the remaining parameters.

Staff does not favor using the EP Toxicity test to establish a hazardous/nonhazardous status and then using the water leach test for waste classification purposes. The AFS study represents only ductile and grey iron foundries and the leaching results for these foundries are typically quite low. However, there are other types of foundries in Indiana. One brass foundry in particular leached 22.3, 42.4 and 2.0 mg/l lead using the EP Toxicity test and only leached lead at .036 mg/l with a pH of 9.8, .014 mg/l with a pH of 9.7 and .0008 mg/l with a pH of 9.6 respectively using the water leaching test. Based on this brass foundry information, the following hypothetical situation could very likely occur depending on the leaching conditions at the site. A waste could leach 4.9 ppm lead using the EP Toxicity Test -- only .1 ppm away from a hazardous waste classification, and leach .02 ppm lead using the water leach test -- a value within the A Type range. Assuming all other water leach parameters are within the A range, the waste could theoretically be placed anywhere with minimal restrictions. Consequently, it could be placed in an environment simulating conditions of the EP Toxicity test rather than the water leach test. For example, it could

be subject to leaching by rainfall which is more acidic than the water leach test. A Ball State University professor has done some work on the pH of rainfall in Indiana and some of the rainfall is not basic in nature. As an example, the pH of the rainfall in Grant County is 3.96 on the average. Since the waste is so close to the hazardous waste limit, it should be placed in a sanitary landfill environment for maximum security. Staff feels this policy should not be written to potentially favor such situations as the above example demonstrates.

At some point in time, a decision may be made to deposit foundry waste at a municipal landfill instead of a monofill. If the waste is classified as Type A, B or C, it may be deposited at any municipal landfill. Should the waste be classified as a Type D, the State will consider it a Special Waste and the waste must be permitted by the State as such. The reason behind this decision follows. At the present time, not all of Indiana's municipal landfills meet Site Type I requirements. The State feels it needs to reserve the right to require placement of a Type D waste into a designated municipal landfill that does meet the necessary requirements for maximum environmental protection.

Waste Type: Statistically Allowable Contaminant Concentrations

Initially, all generators must statistically establish that each individual waste stream is not a characteristic or listed hazardous waste. The characteristic hazardous waste tests are ignitability, corrosivity, reactivity, and the EP Toxicity Test for the eight metals listed under the "EP Toxicity Method" heading below. Please refer to Attachment I for the necessary quality control and quality assurance for the sampling procedure and the EP Toxicity Test.

All generators will perform analytical tests to determine waste type. The waste type shall be tested as stated under the Generator Waste Requirements. Based on the results of these tests and the following table, the waste type can be found. For most of the parameters, Waste Type A corresponds to drinking water standards. For copper and zinc, Staff was concerned that drinking water standards were insufficently protective of aquatic life. As an illustration, EPA's recommendation to protect freshwater aquatic life is 5.6 ug/l as a 24-hour average for copper and 47 ug/l as a 24-hour average for zinc. In setting standards for these two parameters, Staff has utilized one one-hundredth of California hazardous waste limits. Since no Federal standard exists, the limit for nickel is also equal to one one-hundreth of the California hazardous waste limit. Cyanide and sulfide limits are cited on pages 435 and 452 respectively of the EPA Development Document for Effluent Limitations Guideline and Standards for the Foundries (Metal, Molding and Casting) Point Source Category. For iron and manganese, secondary drinking water parameters, Waste Type A corresponds to average concentrations found in Indiana groundwater. According to the Water Division of the Department of Natural Resources, typical iron and manganese concentrations in Indiana groundwater are .5 to 2.5 ppm for iron and .05 ppm for manganese. Manganese concentrations are known to be higher in Indiana river valleys. Iron and manganese demonstrate lower leaching results under basic conditions according to the AFS study. Staff thought that there might be a problem with testing mercury, cyanide and sulfide to the limits proposed in this policy. Checks with the Indiana State Board of Health's Water Laboratory confirmed that the proposed limits are within feasible testing ranges. The Water Laboratory can perform tests on mercury and cyanide to .0001 and .005, ppm respectively. These limits are below the policy standards. Waste Types B, C, and D are 10, 25, and 100 times the concentrations of Waste Type A respectively.

The results of the initial EP Toxicity Test to determine if the waste is hazardous may also be used to classify the waste. The laboratory may be using a higher detection limit than is necessary to classify a waste as potential Type A, B, or C. Generators need to make sure the laboratory that is performing the initial EP Toxicity sample analysis is aware of the lower waste classification limits and can handle testing for these lower limits adequately.

EP Toxicity Method Parameter	Concentrations (ppm)			
	Type A***	Type B***	Type C	Type D
Arsenic	0.05	0.5	1.25	5.0
Barium	1	10	25	100
Cadmium	0.01	0.1	0.25	1.0
Chromium	0.05	0.5	1.25	5.0
Lead	0.05	0.5	1.25	5.0
Mercury	.002	.02	.05	.2
Selenium	0.01	0.1	0.25	1.0
Silver	0.05	0.5	1.25	5.0

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Leaching Method

Parameter	Concentrations (ppm)			
	Type A***	Type B***	Type C	Type D
Chlorides	250	2,500	6,250	*
Copper	.25	2.5	6.25	*
Cyanide, Total	.2	2	5	*
Fluoride	2.4	24.	60.	*
Iron	1.5	15	*	*
Manganese	.05	.5	*	*
Nickel	.2	2	5	*
Phenols	.3	3.	7.5	*
pH	6.0 - 9.0	5 - 10	4 - 11	*
Sodium	250	2,500	6,250	*
Sulfate	250	2,500	6,250	*
Sulfide, Total	1****	5	12.5	*
TDS	500	5,000	12,500	*
Zinc	2.5	25	62.5	*
**				

* Testing is not required.

** Generators must submit a comprehensive list of all organic additives used in process unit operations, comparable to material safety data sheets. If trade names are given to additives, it is the generator's responsibilty to contact the manufacturer about supplying the State with the chemical ingredient listing that makes up the trade-named chemical and have the manufacturer contact the Board with the proper information. The Board reserves the right to require TOC and/or other organic testing be done.

*** May be used for road deicing, construction fill and other uses as approved by the Board.

**** If detection limit problems exist, please consult the Division of Land Pollution Control's Technical Staff for guidance.

Site Type Requirements

The landfill type shall be determined based on the following requirements for each category I through IV. Facility requirements shall be equivalent to the requirements for sanitary landfills stated in 330 IAC 4 with the following changes:

For all sites, a setback of 500 feet from active usable, potable and/or irrigation wells shall be observed unless a waiver including written consent of the well owner is provided. For Site Types III and IV, there is no required setback to dwellings. For Site Types I and II, there is a 600 foot setback to any dwelling unless written consent of the occupant and owner of the dwelling is obtained. For Site Types III and IV, the setback to property boundaries is 50 feet unless a waiver including written consent of the adjacent landowner and occupant is obtained. For Site Types I and II, the setback to property boundaries is 50 feet. Facility applications shall show property boundaries and shall state whether any active, potable/irrigation wells exist within 500 feet of the disposal area.

For all sites, if re-sampling results indicate that the waste should be going to a site with more stringent requirements, then the results of further testing shall be submitted within 30 days. If further testing continues to indicate the waste is not acceptable, then disposal shall cease unless further approved by the Board. Under such conditions, the Board may require that monitoring wells be installed at Type III and IV Sites even if disposal is discontinued.

For all Type Sites:

Rules 3-4(a), (j)(i), (viii), (x), (xi), (xii), (xiv), (xvi), (xviii), (xix), (xx), (xxiii), (xxiv), (xxvi), (xxvii), and (xxv) shall be omitted.

Rule 3-4(j)(iv) shall be changed to: "Thickness and frequency of intermediate cover to be applied."

Rule 3-4(j)(vi): replace the word "daily" with "intermediate".

For Type IV Sites:

Rules 3-4(c), (d), (e), (f), (g), (h), (i), (j)(ix) and j(iv) shall be omitted.

For Type III Sites:

If soils maps and well logs indicate a sufficient barrier between the waste and water user, then Rules 3-4(h)(i, ii, iii) shall be omitted. Rules 3-4(c), (i), (e), (g), (d)(i) and (j)(ix) shall be omitted. Submit (d)(ii) and (iii) with a scale of 1 inch equals 100 feet.

The first sentence of Rule 5-6(a) shall be changed to: "For Type II, and I Sites, groundwater monitoring wells shall be installed and sampled quarterly during site operation. Generally the groundwater is monitored quarterly for a period of five years from the closure date. Once the site has been closed and monitored for two and one half years, a request for permission to reduce testing for the remaining two and one half years can be submitted to the Board for approval. If no request is made sampling frequency remains quarterly. For the initial analysis, the following list contains general groundwater parameters that need to be tested: As, B, Ba, Cd, Cl, COD, Cr, Cu, Cyanide, Fl, Fe, Mn, Ni, Pb, pH, phenols, hardness, TDS, Zn, Se, sulfate, sulfide, and TOC. Based on the initial groundwater test results and waste analyses, each site's parameter listing for quarterly analysis will generally consist of some range between one and all of the above initial test parameters."

Rule 5-6(c) shall be changed to "For Type IV Sites, material shall not be placed into sinkholes or into standing water where the standing water reflects the water table". For Type I, II, and III Sites, a barrier of soil, either undisturbed, constructed, or a combination thereof, shall

be maintained between the deposited material and the aquifer. This barrier shall consist of soil with a permeability of less than 10^{-6} cm./sec. and the following minimum thicknesses. Liner thicknesses may be increased due to Cation Exchange Capacities less than 10 milliequivalents per 100 grams or decreased due to lack of groundwater resources in the area.

A minimum thickness of five (5) feet or three (3) feet if the waste is demonstrated to have an in-place permeability of less than 10^{-6} cm./sec. for Type III Sites.

A minimum thickness ranging between five (5) feet and ten (10) feet dependent upon the in-place permeability of the waste and other factors for Type II Sites.

A minimum thickness of fifteen (15) feet or ten (10) feet if the waste is demonstrated to have an in-place permeability of less than 10^{-6} cm./sec. for Type I Sites.

Rule 5-13 shall be changed to :

"Cover Applications"

Frequency

(a) An intermediate cover of at least six (6) inches of soil shall be applied to all exposed material at the following minimum frequency:

For Type IV Sites, there shall be no minimum cover frequency.
For Type III Sites, the minimum frequency shall be yearly.
For Type II Sites, the minimum frequency shall be monthly. If the material is demonstrated to have an in-place permeability of less than 10^{-6} cm./sec. the minimum frequency may be reduced to yearly.
For Type I Sites, the minimum frequency shall be daily.

For site types II, III, and IV, if the site is in violation of Air Pollution Regulations and/or Board Representatives find and document evidence of visible foundry waste deposits from wind or water beyond the site property then a six inch daily cover shall be applied until a plan to control dispersal is submitted and approved by the Board.

(b) For Type IV Sites, no final cover is required if the site will support vegetation. For Type I, II and III Sites, when any portion of the site reaches within two feet of final elevation, a final cover, not less than two feet in depth, shall be applied. For all Sites, vegetation shall be established unless special provisions for land use are made with the Board. Except for Type IV Sites, the final cover shall have a slope of not less than 2 percent and be without depressions to cause ponding of water. The maximum slope of the final cover shall not exceed 33%. The projected erosion rate for Type II, III, and IV Sites shall be less than 5 tons per acre per year.

Type of Cover Material

Type A material, a mixture of Type A material and soil or soil may be used as cover for Site Type III if the proposed cover will support vegetaion. Type A material, a mixture of Type A material and soil or soil may be used as cover for Site Type II if the proposed cover will support vegetation and is shown to have a hydraulic conductivity less than or equal to 10^{-6} cm/second. For Type I Sites, only compacted soil may be used.

Site And Waste Requirements For New Permits And Amendments To Add Volume

For new permits and amendments for additional volume, the following table determines which sites can handle which types of waste. The site number directly across from the waste type in question and any larger site number are the sites that can handle the type of waste in question. Thus Waste Type A can be disposed of in sites I through IV whereas type D can only be disposed in site I. Similiarly, a site I can handle Waste Types A thru D whereas site type III can handle waste types B and A.

Waste Type	Site Requirements Type
A	IV
B	III
C	II
D	I

Permit Renewals

Require sampling of each generator's waste either by the landfill or generator(s) to determine that each waste stream's composite sample does not exceed the concentration levels for Waste Type D. Renew permits with existing conditions (unless changes are warranted based on problems at the site). Add monitoring wells and sampling unless the waste is shown to be Type A or B. All results must be submitted for review before a renewal is issued.

Sampling Frequency

Initial sampling and resampling whenever the foundry process or additives change shall be conducted in a manner necessary to establish that the upper confidence limit for each parameter value is less than the Allowable Contaminant Concentrations for the Waste Type using the statistical sampling methodology specified in SW-846. Resampling shall occur at two year intervals before each renewal utilizing a composite sample of each waste stream for Site Types I, III and IV and utilizing an overall composite waste sample for Site Type II. Renewal sampling may be decreased based on lack of variability noted in previous sampling and other factors.

Generator Waste Requirements

After it has been established that the waste is nonhazardous, for disposal in Site Types I, III and IV, the sampling and testing must be performed on a "waste stream specific" basis, meaning that if a generator disposes of multiple waste streams, there is a need to sample and test each particular waste stream. The "Waste and Sampling Description" section should be performed for each waste stream 1) initially on all random samples from each waste stream and 2) at two year intervals on one stream composite sample obtained from mixing random samples from each waste stream. For disposal in Site Type II, generators may composite waste streams, for the water leach parameters, in proportions reflecting waste generation percentages for analysis purposes. No blatant mixing of non-waste material for the purposes of falling into a lower waste classification will be tolerated. Composite testing procedures shall follow the "Waste and Sampling Description" section initially and at two year intervals.

If a generator's waste stream is found to contain other parameters that are detrimental to the environment, not including those required to be tested for under this proposal, it is proper for the applicant to be required to test for said parameter(s). All applications and testing waiver requests must be accompanied by the following statement signed by the generator or his authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of permit denial or revocation, civil penalty, and imprisonment.

The "Allowable Contaminant Concentrations" section is a list of parameter concentrations and levels that must not be exceeded statistically by any parameter from any particular waste stream.

Waste and Sampling Description

See Attachment I for information regarding quality control and quality assurance for sampling and testing procedures.

Leaching Method

Sampling for the Water Leach Test must be performed in accordance with Attachment I. These parameters must be tested on the extract obtained by the Leaching Method found in Attachment II. Test all parameters found in the Leaching Method list under the Waste Type heading found in this policy. Along with the parameter results, report the QA/QC information in accordance with Attachment I.

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