UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 28 1974

OFFICE OF
ENFORCEMENT AND GENERAL COUNSEL

MEMORANDUM

n-74-3

TO : All Regional Permit Branch Chiefs

FROM : Chemist, Permit Assistance Branch

SUBJECT: Application of Electroplating Guidelines to NPDES Permits

Summary and Introduction

This memorandum is written to help explain the application of Electroplating Guidelines to writing NPDES permits. It is considered that the guidelines are essentially formulated on the use of effluent flow X treated pollutant concentration logic. The effluent flow is rated and used on a flow per area plated basis. A generalized approach is given to understanding what is meant by area plated in the guidelines and three possible methods of calculation of area plated to obtain pollutant limits are outlined. Finally, it is suggested that a direct total flow X concentration calculation be made to assure reasonableness of assigned permit limits.

The Electroplating Guidelines, Phase I, covering the copper, nickel, chromium and zinc subcategories were issued in the Federal Register on March 28, 1974. During that same month, the final version of the Effluent Guideline Division support documentation for these guidelines were published as EPA Report 440/1-74-003-a. In recent months there have been three workshops on the subject cosponsored by Effluent Guidelines Division and the Permit Assistance and Evaluation Division; they were held in Washington, D. C., Boston, Massachusetts, and Philadelphia, Pennsylvania and all were well attended by invited, interested, State and Regional permit writing personnel. Specifically, the subject matter of the meetings emphasized the justification of the guidelines as well as their application to permit writing. Significantly, the latter was explained by use of a number of different examples. Apparently, most if not all of the attendees' questions were answered to their satisfaction during these meetings.

Unfortunately, the diverse nature of the Electroplating Industry makes it extremely difficult, if not impossible to write down a discrete, concise set of rules and examples to follow for the facile writing of permits. The essential problem is that it is absolutely necessary to correctly determine the total area plated as required by the guidelines to obtain the basis of production for the plant.

This memorandum is written in response to Regional requests I am still receiving at this point in time for assistance in helping to properly interprete the application of these guidelines. On this subject matter, I have had numerous discussions with Carl Schafer and participated in all of the Effluent Guideline Division technical working group meetings. The contents are based on these experiences as well as my own considerations and I hope will clarify the picture enough to better expedite permit preparation.

I. Underlying Premises and/or Assumptions

(a) Justification of the actual guideline limitations themselves and the use of area as the unit-of-production base is not the subject of this memorandum. It must now be accepted as the Law and all permits covered by these guidelines must be written accordingly.

(b) The treatment model is that of a common treatment plant wherein the involved metals are coprecipitated and removed by settling, clarification and/or filtration.

(c) The area plated is directly proportional to water use. Essentially, the entire volume of process water used by an electroplating plant is for rinsing the plated part after each separate or individual operation. The explanation of what is meant by a bona fide operation has been confusing, if not misleading. In my opinion, it should mean any form of metal finishing step that is followed by a rinsing procedure requiring approximately the same amount of rinse water used after a specific plating step. Certain metal pre-plating steps such as acid-alkaline cleansing (or pickling) and on-line plating steps such as the so-called metal "strike" may or may not require the usual amount of rinse water, if any at all, after the specific treatment step. It is essential that the permit writer establish this through appropriate dialogue during the permit writing process with the discharger. In this regard, a rule-of-thumb is, the cleaning steps preceding plating are bona fide operations and are to be counted as such, whereas the usual "strike" is not.

(d) The guideline limits are given in terms of mg or lbs of pollutant per unit area plated (m^2 or ft^2). However, the logic is based on the product of total flow into the treatment plant X treatment concentration for each pollutant, in view of the treatment model expressed in Item (b), above. This means that for each pollutant, the following relationships hold (for purposes of clarity, we shall use the metric system only, hereafter).

$$\text{Guideline Limitation: } L/m^2 \times mg/L = mg/m^2 \quad (1)$$

In Equation (1) the term L/m^2 actually represents either the total flow in liters into the common treatment plant divided by the total area plated or else, ideally, this ratio would be equal to the ratio of amount of rinse water used for a particular plating operation divided by the area plated during that operation. The element of <u>time</u> is considered constant throughout these discussions and, therefore, its actual amount is irrelevant. Expressed analytically,

$$L \text{ (single operation})/m^2 \text{ (single operation)} = L \text{ (total flow)}/m^2 \text{ (total area plated)} \quad (2)$$

Therefore;

$$m^2 \text{(total area plated)} = m^2 \text{ (single operation) X No of Operations} \quad (3)$$

Since the guideline limitation in mg/m^2 is based on flow x concentration logic as expressed in Equation (1), in order to obtain mg as required for each pollutant in the permit (on a daily basis) the following calculation must be used for each pollutant:

$$m^2 \text{ (total area plated) X } mg/m^2 \quad (4)$$

This means that as long as there is a common treatment plant, coefficient <u>m^2(total area plated)</u> in Equation (4) is common to all pollutants.

The above description applies to a single metal finishing line, representing a number of separate operations in series. When there is more than one line and regardless of whether or not these additional lines plate at at similar rates or plate different objects with different metals, the total area plated and total accompanying water use (if necessary) is calculated for that line separately. Finally, and assuming the effluent from all plating lines enter the same treatment plant concurrently, the total area plated for all lines are summed up arithmetically to arrive at the grand total <u>m^2</u> term used in Equation (4). If necessary, the total effluent volume entering the treatment plant is arrived at in the same manner.

Since the effluent limitations are fundamentally based on flow X concentration logic, then it can readily be seen that the m^2 (total area plated) term in Equation (4) is the same for all pollutants in a complex plating plant regardless of how many operations a particular pollutant is involved in, in the different plating lines. Thus, assuming the pollutant is zinc, whether or not it is plated in one or more different plating lines in the same complex plating plant does not matter in itself; what really counts, is that it is the total number of operations involved, summed up in the manner described above, that determines the m^2 (total area plated) term in Equation (4). Significantly, what this really means is that a plant plating zinc in a solely single plating step (one operation) winds up getting only one-fifth the total daily allowance of zinc that a plant plating the same amount of zinc (geometric area being the same) and plating four other metals (total of five operations) in a single line, would get. This is due to the precipitation step being concentration limited; therefore, the magnitude of the final effluent is directly related to water usage.

II. Methods for Obtaining Total Area Plated

For purpose of emphasis, it is now repeated that each guideline parameter expressed as mg/m^2 must be multiplied by the same total area plated figure determined for the particular plant.

This figure, in terms of a calendar day rate can be obtained by the various alternative methods to be discussed. It should be possible to use at least two alternative methods as a check on the reliability of the approach. These methods will now be discussed.

(a) Geometric: The particular plant in question is likely to be a captive shop that plates a common part of fixed geometry. The plant knows the area plated for each part. Then, the total area plated daily to be used for permitting purposes is:

Geometric Area Plated per Part X No. of Parts X No. of Operations (5)

Needless to say, the average job shop that plates sundry shaped parts on a day to day basis is not likely to have such data.

(b) Electrochemical: The principle involved is the application of Faraday's Law. The pertinent Law, actually the second of Faraday's two laws on electrolysis states, in effect, that the quantity of electricity required to liberate (or deposit) one gram equivalent weight of a substance is 96,500 coulombs (ampere-second). Expressed mathematically

$$W = \frac{Ite}{96,500} \qquad (6)$$

Wherein

W = weight of metal deposited in grams
I = amperes flowing in plating line
t = seconds (time duration of plating)
e = gram equivalent weight of the metal plated

The gram equivalent weight of each metal can be obtained from handbooks; however, in order to obtain the true W, one must multiply the right-hand term in Equation (4) by the known plating efficiency. Suggestions are given in the above referenced EPA document or else, the plant must give its own certified estimate of its plating efficiency.

Next, it is necessary to convert from W, the weight of metal plated out to area by dividing by density of the plating (certified plant estimate), to derive the volume of the plating. Knowing the thickness of the plating (certified plant estimate), it would then be possible to readily obtain the area plated if a simple flat piece is involved. If the geometry of the plated part is complex, then it is necessary to estimate the area from the basic rules of solid geometry which are available from standard handbooks.

It is my considered opinion, that once having gone through all of these calculations, calculated area plated may still be off by two or three times. If several metals are plated in the same line, then possibly some direct averaging could be applied to derive the best representative area. It is important to note that the electrochemical approach gives the geometric area plated per operation in a particular plating line. In order to obtain the total area plated per plating line, it is necessary to multiply the geometric area plated per operation as calculated from Faraday's Law (this may require average if several metals are plated per line and their respective geometric areas are calculated individually) by the total number operations involved in that plating line.

In certain cases, such as when hollow cylinders are involved and only the outside of the cylinder gets plated, the geometric area plated must be multiplied by two, if both the unplated inside and plated outside get rinsed. This is due to the fact that the inside of the cylinder may be non-conductive, but nevertheless gets exposed to electrolyte.

In summary, it is important to note that the permitter must approach his estimation of area plated by this method very cautiously and must be especially cognizant of pitfalls in the plater's own estimate of area plated by this method, i. e., the plater himself, especially if it is a job shop, may be incapable of performing this type of calculation reliably for any one of a number of reasons. In the past, he has not had to do so since this has been a labor-based pricing type of industry for the most part.

(c) Assumed Water Use-Area Plated Ratio: According to information received from Effluent Guidelines Division, a liberal water use per unit area plated per operation is

$$200\ L/m^2 \quad (7)$$

This would apply to a plant that does not exercise particularly good water conservation and could be readily established by a casual plant visit by the permitter. Then, for each plating line, the following calculation could be performed to obtain total area plated:

$$\frac{L\ \text{(total flow per line)}}{\frac{200L}{m^2}\ \text{(area plated per operation)}} = m^2\ \text{(total area plated per line} \quad (8)$$

$$m^2\ \text{(line 1)} + m^2\ \text{(line 2)} + \ldots = m^2\ \text{(total area plated)} \quad (9)$$

Finally, total area plated could be substituted in Equation (4) to yield the allowed pollutant limit in the permit. If a plant is exercising good water conservation practice, the figure of 160 L/m^2 (area plated per operation) would be a more judicious choice in this calculation.

(d) Direct Flow times Concentration Method: This approach should be used as a final check as to whether or not the assigned pollutant limitations seem reasonable. The total flow would be multiplied by the suggested BPCTCA concentrations in the above referenced document i. e., 0.5 mg/l for the heavy metals. If the plant is using excessive water, these limitations would naturally be expected to be higher than those obtained by the area-based calculations. On the other hand, if the plant is using good or normal water conservation, the pollutant limitations should check out quite well with those of the other methods. Needless to say, anything suspicious should lead to a reinvestigation of the estimated total area plated.

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