



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



05903



Distr.
LIMITED

ID/WG.175/25
25 August 1974

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on Minimizing
Pollution from Fertilizer Plants
Helsinki, Finland, 26 - 31 August 1974

/prod. control /
/fert. ind. /

/USA /

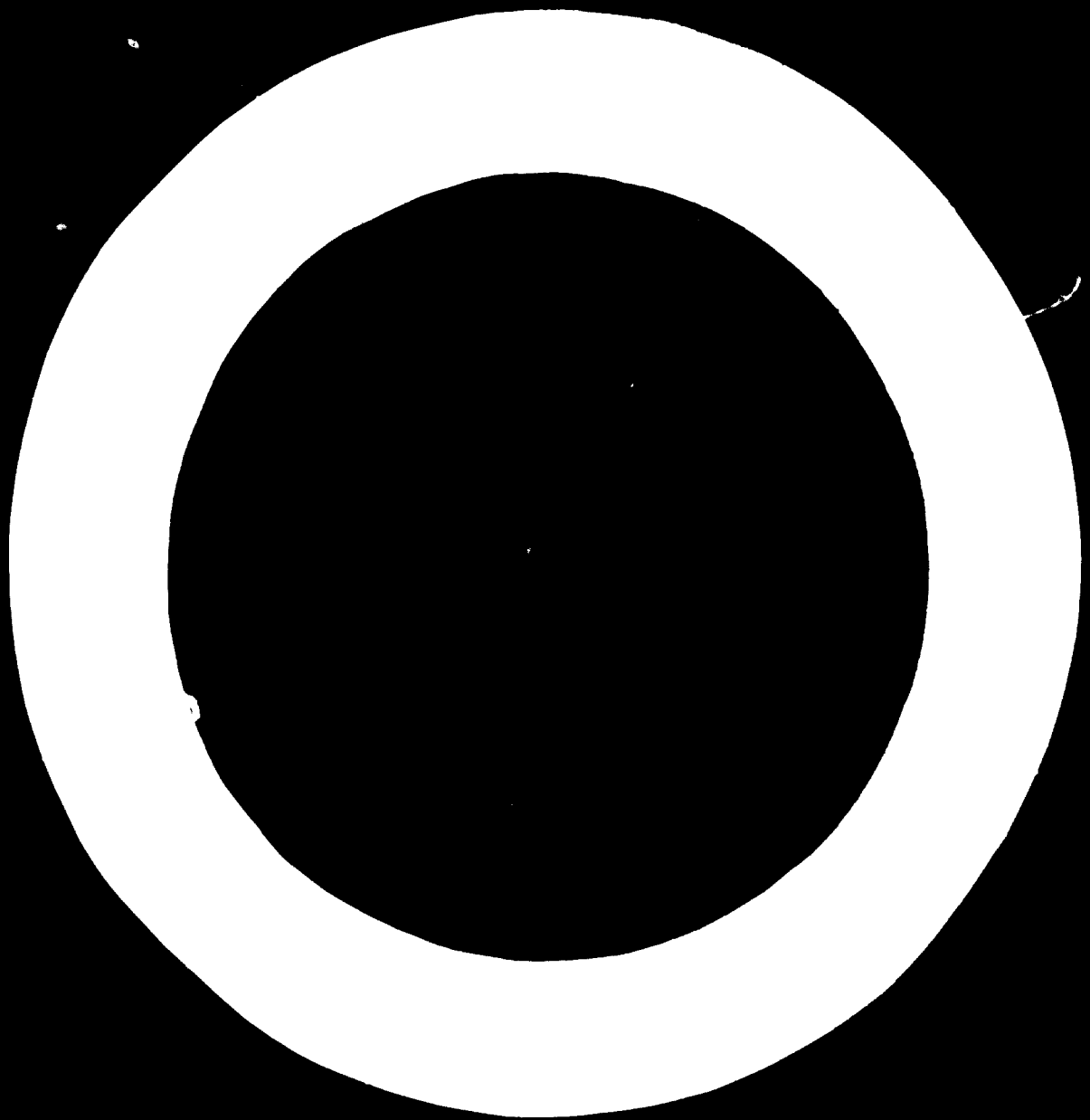
ENVIRONMENTAL REGULATIONS CONFRONTED BY
FERTILIZER PRODUCERS IN THE UNITED STATES ^{1/}

John Reynolds*

* Director, Member Services, The Fertilizer Institute, Washington, D.C., U.S.A.

^{1/} The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.



I. EFFLUENT LIMITATIONS AND GUIDELINES

The U.S. Environmental Protection Agency (EPA) published final effluent discharge limitations for the fertilizer industry on April 8, 1974. Through numerous meetings with EPA and exhaustive committee interaction in response to EPA's proposals, The Fertilizer Institute (TFI) was gratified when EPA promulgated guidelines substantially less stringent than those originally proposed.

EPA originally proposed an unbelievably low level for phosphorus of .05 ppm (Figure 1). This proposal was later revised to 10 ppm with the final limitation being 35 ppm, which is almost as much as the 40 ppm TFI proposed. TFI proposed a level of 20 ppm fluoride compared to the original EPA proposal of 1 ppm and revised proposal of 15 ppm (Figure 2). As far as can be determined, the final level of 15 ppm fluoride can be achieved by all phosphate producers in the U.S.

Similar changes were made to the proposed levels for suspended solids (TSS). Figure 3 shows a final limitation which is 150 per cent higher than EPA's original proposal of 10 ppm.

The final limitations on ammonia nitrogen for the ammonium nitrate subcategory (Figure 4) are about 100 per cent above EPA's revised proposal. A similar increase amounting to about 100 per cent was granted for nitrate

nitrogen (Figure 5). The largest percentage increase (400 per cent) was granted for organic nitrogen from urea plants (Figure 6). In summary, TFI was successful in obtaining final increases over revised proposals of 250 per cent for phosphorus, 67 per cent for suspended solids, about 100 per cent for effluents from the production of ammonium nitrate, and 400 per cent for organic nitrogen discharge from the production of urea. Incidentally, the change for urea marked the first revision of a final promulgated limitation ever approved by EPA.

Why did EPA make such drastic changes? Close cooperation of industry through TFI's Manufacturing Environmental Committee must be given much of the credit, plus EPA's willingness to recognize erroneous conclusions drawn from misinterpreted data. EPA reportedly based their original phosphate proposals on a plant not considered as representative of the majority. Upon investigation, it was determined that this plant achieved abnormally low levels because of upstream dilution. EPA accordingly revised the limit to reflect levels attainable by plants using double liming, a process which will be described in more detail later.

The original proposal for ammonium nitrate was based on a plant that granulates rather than prills. As everyone familiar with the U.S. fertilizer industry knows, most ammonium nitrate is prilled, and the fallout of dust from

the prilling operation ultimately shows up in the plant effluent. Again, EPA revised the numbers upward considerably. In effect, this change exempted nitrate producers from having to install highly complex and expensive ion exchange technology to meet the July 1977 deadline.

The nitric acid limitation is zero discharge. TFI and member firms repeatedly emphasized to EPA that a small cooler-condenser leak can result in substantial nitrogen concentrations in the plant effluent. Yet, EPA remains committed to the no-discharge limitation.

While on the subject of nitric acid and zero discharge, consider a rough calculation of the raw materials and energy required for a large nitrogen complex to achieve zero discharge. Altogether, about 1000 tons of pollutants would have to be removed each year from the plant effluent.

To generate the steam necessary for stripping ammonia and hydrolyzing urea in the effluent, the equivalent of 20,000 tons of coal would be burned annually. Two thousand tons of chemicals would be required to treat the effluent, resulting in 3000 tons of solid waste. About 5000 tons of raw materials would be required to produce the treating chemicals. The energy required to produce the chemicals is included along with the fly ash, SO_2 , NO_x generated by the burning of the coal. The net result is, to remove 1000 tons of pollutants each year would require the use of 27,000 tons of natural resources and produce about

7000 tons of waste material. Obviously, the law of diminishing returns, at least in an environmental sense, would be grossly violated.

Another change in the final guidelines is a "variance provision" whereby a plant "fundamentally different" from those considered in the development of the guidelines may qualify for special discharge allowances. This change resulted from strong objections by industry to the inequities the limitations would impose on the older, smaller installations. It was pointed out that pollution abatement costs per ton of fertilizer produced in the smaller operations are considerably higher than the average. It's a basic fact that the smaller fertilizer operations lack the broad base that large ones have over which to distribute pollution abatement costs.

To be sure the guidelines are adhered to when discharge permits are issued, fertilizer producers must continue to work with EPA at the regional level and with state and local agencies. This is a particularly difficult task since the states usually try to be more stringent than EPA, and the counties try to be tougher than the states. The problem is compounded by the fact that the local agencies are frequently staffed with people having no specific knowledge or understanding, technical or otherwise, of industry's problems.

II. ABATEMENT COSTS

According to TFI's Fertilizer Financial Facts, the U.S. fertilizer industry spent well over \$100 million on pollution control during the period 1968-1973 (Figure 7).

No one can say precisely what the total costs will be to achieve the 1977 and 1983 effluent guidelines. TFI estimates a minimum of \$600 million for the entire industry through 1983. Due to unforeseen occurrences, this figure could easily reach \$1 billion.

By contrast, EPA's cost estimate of \$243 million by 1983 appears quite low because contingency and indirect costs were not included. For technologies generally accepted as operative, such as steam stripping of ammonia and urea hydrolysis, the EPA cost figures are well below those experienced by industry.

In today's world, a discussion of environmental problems is not complete without mention of the energy implications. EPA's effluent guidelines for the fertilizer industry will require enormous expenditures for energy to operate the abatement systems - conservatively speaking - over four times the normal energy consumption level for conventional waste water treatment in other industries.

For example, consider steam stripping of ammonia condensate - an abatement process that will require a capital investment of \$218,000 for a 1000-ton ammonia plant.

Total annual costs for such a plant will be \$244,000, of which \$197,000 are ear-marked for energy to operate the abatement system. Using EPA's own figures, these energy costs amount to about 80 per cent of the annual costs, and about 90 per cent of the capital investment required. Another example is the hydrolysis of urea condensate. For a 1000-ton per day total recycle urea plant, to remove ammonia and organic nitrogen to the level proposed by EPA, a capital investment of \$231,000 is required along with total annual costs of \$199,000 of which \$149,000 are required for energy. Thus, about 75 per cent of the total annual costs are due to energy consumption of the waste water treatment facilities.

III. AIR EMISSION STANDARDS

In order to meet EPA's new source standard of 4 pounds of SO₂ per ton of sulfuric acid produced (100 per cent basis), many of the older, smaller sulfuric acid plants are now being replaced with new double absorption units at an increased capital cost of \$2 million to \$3 million more per plant than required for a single absorption unit. Operating costs for these new units will tack on at least another \$1 per ton of sulfuric acid produced.

Abatement options available for sulfuric acid plants include a molecular sieve, add-on double absorption or alkaline scrubbing processes such as lime, ammonia or caustic, at modification costs ranging from \$1 million to \$5 million.

A conservative estimate of the total cost to the industry for SO₂ abatement over the next few years is approximately \$50 million.

In the nitrogen sector, the new source standard for NO_x is three pounds of nitrogen oxides per ton of nitric acid produced (100 per cent basis). Most states have set a limit for existing plants at between five and 10 pounds per ton. These tight emission standards, coupled with the emergence of urea as a preferred solid nitrogen carrier, have somewhat reduced the rate of construction of new nitric acid plants. The new plants that will be installed have several options available for NO_x abatement. These are catalytic reduction, molecular sieve or adsorption, add-on extended absorption, and the urea process. There has not been sufficient commercial experience to determine the costs of these systems accurately, but a safe assumption would be in the \$1 million to \$2 million range.

In the near future, new source performance standards will be proposed by EPA's Office of Air Programs for six categories of phosphate production. These are wet-process phosphoric acid (.02# F/ton P₂O₅), superphosphoric acid (submerged combustion only) (.01# F/ton P₂O₅), diammonium phosphate (.06# F/ton P₂O₅), granular triple superphosphate production (0.2# F/ton P₂O₅), granular triple superphosphate storage (.0005# F/HR/ton P₂O₅ stored), and run-of-pile triple superphosphate production and storage (0.2# F/ton P₂O₅).

Assuming the states apply these new source standards to existing plants, it is anticipated that, with the exception of superphosphoric acid, the industry can comply without retrofit of existing abatement facilities. With the exception of superphosphoric acid, no serious compliance problems with the new units coming on stream are foreseen. Investments by the industry in wet-process phosphoric acid emission control systems will soon approach \$8 million, with average annual operating costs of about \$2 million. For emission control equipment in DAP plants, U.S. industry's capital investment will soon reach \$60 million with operating costs of about \$6 million per year. Triple superphosphate scrubbing will soon account for approximately \$40 million total investment and require annual operating costs of approximately \$12 million.

Another area of concern is occupational health. Fertilizer plants haven't yet felt the impact of existing legislation. Some fertilizer producers may be in real trouble when government agencies begin to enforce existing occupational health laws on a routine basis.

The Occupational Safety and Health Administration (OSHA) standards specify maximum levels of toxic air pollutants, dust and noise that a worker can be subjected to (Figure 8). The maximum permissible concentration for ammonia and CO is presently 50 ppm. The standard is 2.5

micrograms per cubic meter for fluoride, 25 ppm for nitric oxide, 5 ppm for nitrogen dioxide, and 5 ppm for SO₂. Dust standards, based on 8-hour, time-weighted averages are limited to 10 milligrams per cubic meter for silica, 80 mg per cubic meter for diatomaceous earth, 10 mg per cubic meter for coal dust, and 15 mg per cubic meter for nuisance dust. Noise levels may not exceed 90 decibels for any 8-hour duration in one day. Impact noise is limited to 140 decibels. OSHA ventilation standards require that toxic emissions from open surface tanks be adequately suppressed or ventilated. All air exhaust systems must conform to OSHA standards. No recirculation of air from exhaust systems is permitted.

IV. WATER POLLUTION ABATEMENT TECHNOLOGY FOR PHOSPHATE PRODUCTION

The typical U.S. phosphate complex impounds and recirculates all water which contacts any of the process gas or liquid streams. This recirculated process water supplies essentially all the water needs of the phosphate complex, including slurring of gypsum, process cooling, condensing, and gas scrubbing (with the exception of sulfuric acid and rock grinding). The operation of the system is basically very simple. By-product gypsum is slurried and pumped to above-ground ponds in which the gypsum settles out while the overflow, still warm from the process, drains into large

cooling ponds in which the water temperature is reduced by evaporation. Depending on the processes employed in a particular complex, the impounded water can contain concentrations of up to 9000 ppm of fluoride and over 5000 ppm of phosphorus at a pH of about 1 or 2.

These ponds are enclosed by earthen dams ranging in size from about 100 acres to several hundred acres, depending on plant size and land availability. Gypsum ponds usually have more surface area than the cooling ponds. Since water drains into the cooling pond and is not retained, the gypsum pond is partially dry.

In normal operations, these ponds are totally enclosed systems requiring no effluent discharge at all. Most are designed to have a negative water balance, providing rainfall is not excessive. However, in periods of heavy rainfall, the ponds cannot contain precipitation falling within the impoundment along with the resultant drainage and runoff. Because of surface runoff, it is not uncommon for cooling ponds to rise three to four inches or more following a one-inch rainfall. It is obvious what five to 10 inches of rain over a short period will do to the pond level.

To prevent dike failures, periodic discharge is necessary. This occurs when the minimum freeboard cannot be maintained. When discharge occurs, two stages of lime neutralization are necessary for removal of the fluoride

- 11 -

and phosphate to acceptable levels. Fluorides are present in the water primarily as fluosilicic acid. Phosphates are present mainly in the form of phosphoric acid, along with small amounts of soluble calcium phosphates.

In the first stage, the pH is increased from 1 or 2 up to about 3.5 or 4 by the controlled addition of quicklime or limestone. At this pH level, fluorides will precipitate as calcium fluoride (CaF_2) resulting in a fluoride concentration of 30 to 60 ppm, and a phosphorus concentration of up to 5000 ppm. In the second stage, the water is treated with hydrated lime, again up to a pH of 6 to 8, a level at which the fluoride concentration is reduced to about 15 to 30 ppm, and the phosphorus level comes down to about 35 ppm.

Discharge from the pond is obviously kept to an absolute minimum due to the high cost of lime treating. Treatment costs vary from \$3.00 to \$4.50 per thousand gallons. Annual lime treating costs of \$200,000 are not uncommon.

EPA estimates the magnitude of fluoride emissions from phosphate ponds at about three to five pounds of fluoride per acre per day. This means that a typical pond with an area of 200 acres would emit up to 1000 pounds of fluoride a day from the pond surface, an enormous amount compared to the 100 pounds or so per day emitted from the process stacks. Although considerable effort has been

exerted toward accurate measurement of fluoride emissions from these ponds, no general consensus on their magnitude exists.

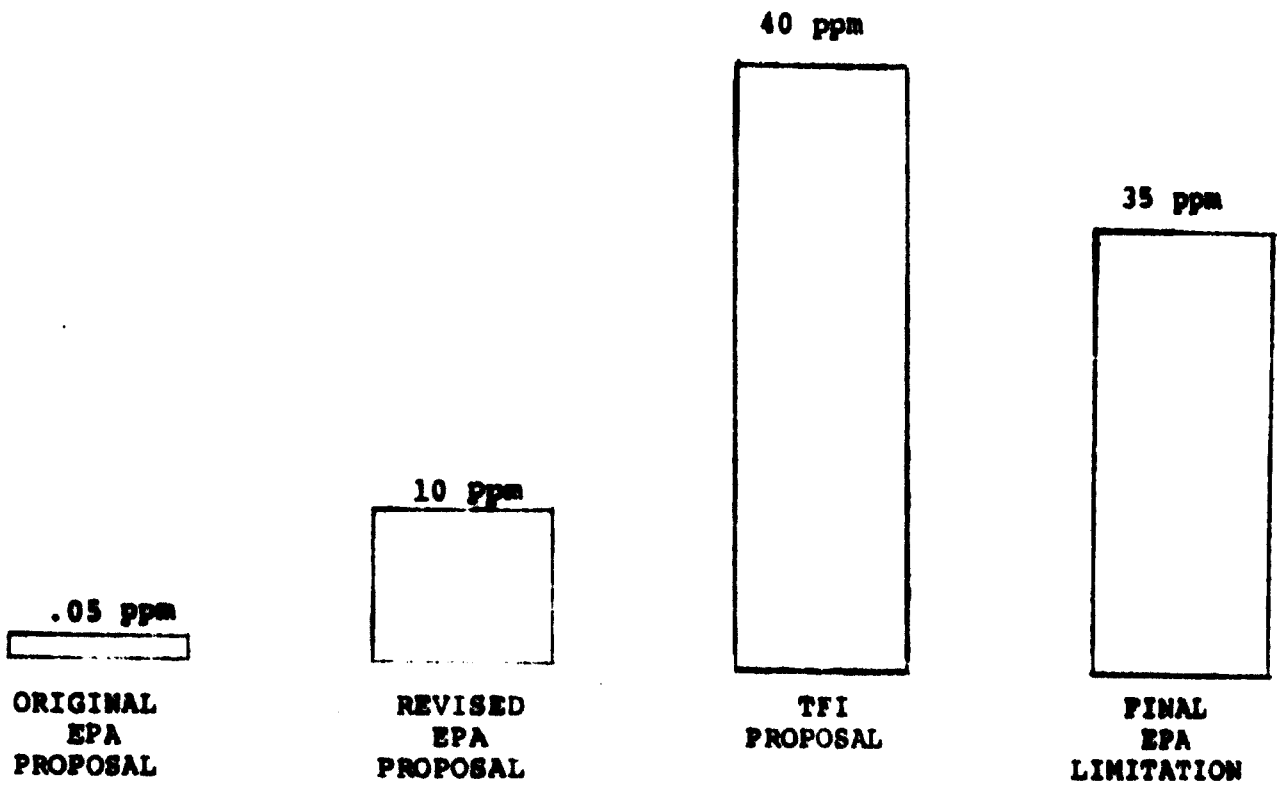
Industry's position on this controversial topic can be summarized briefly as follows:

Since vegetation samples in phosphate-producing areas show fluoride concentrations well within existing standards (40 ppm fluoride), and since adverse environmental impact cannot be proven or substantiated, and since the phosphate companies own over 90 per cent of the land in these areas, and since less than six per cent of the land is used as native pasture, there is no need for further concern about fluoride emissions from this source.

In summary, the U.S. fertilizer industry made substantial accomplishments through liaison with EPA. Many other industries, including some of the inorganic chemical producers, have experienced much less success in getting EPA to budge from their proposals of zero discharge. Everything considered, the fertilizer industry - the farmer and the consumer - have benefited from a cooperative approach.

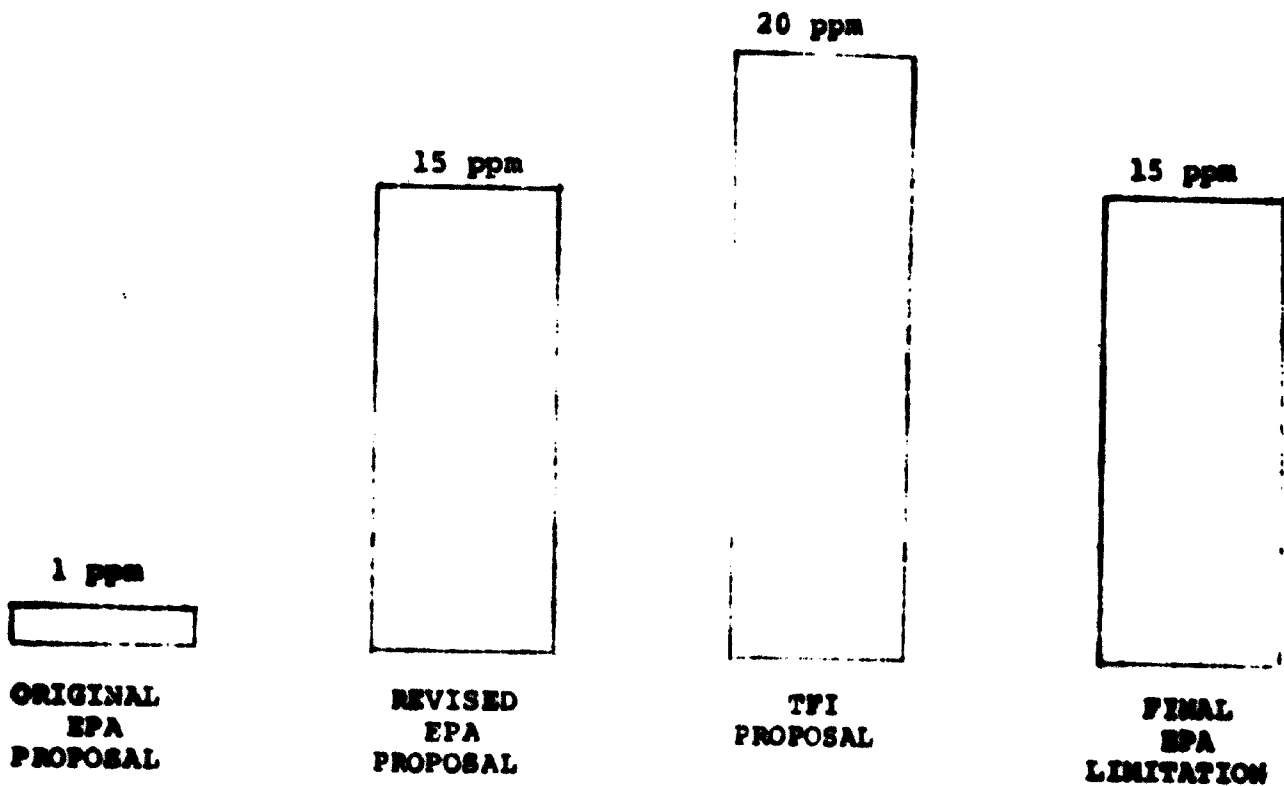
**FIGURE I. 1977 ALLOWABLE DISCHARGE LEVELS -
PHOSPHATE CHEMICAL PLANTS**

TOTAL PHOSPHORUS (as P)

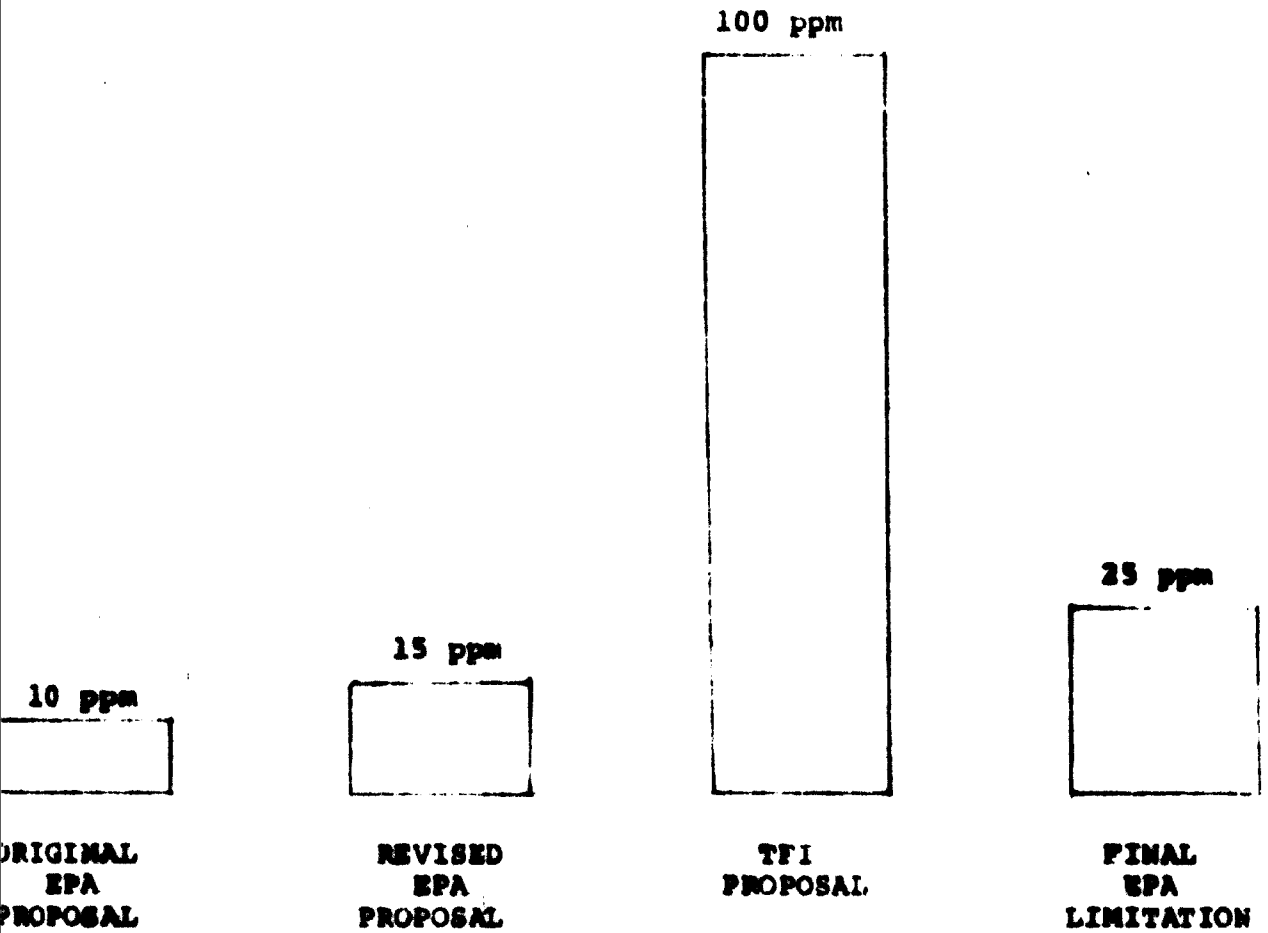


**FIGURE II. 1977 ALLOWABLE DISCHARGE LEVELS -
PHOSPHATE CHEMICAL PLANTS**

FLUORIDE (as F)



**FIGURE III. 1977 ALLOWABLE DISCHARGE LEVELS -
PHOSPHATE CHEMICAL PLANTS
TOTAL SUSPENDED SOLIDS**



**FIGURE IV. 1977 ALLOWABLE DISCHARGE LEVELS -
AMMONIUM NITRATE PLANTS**

AMMONIA NITROGEN

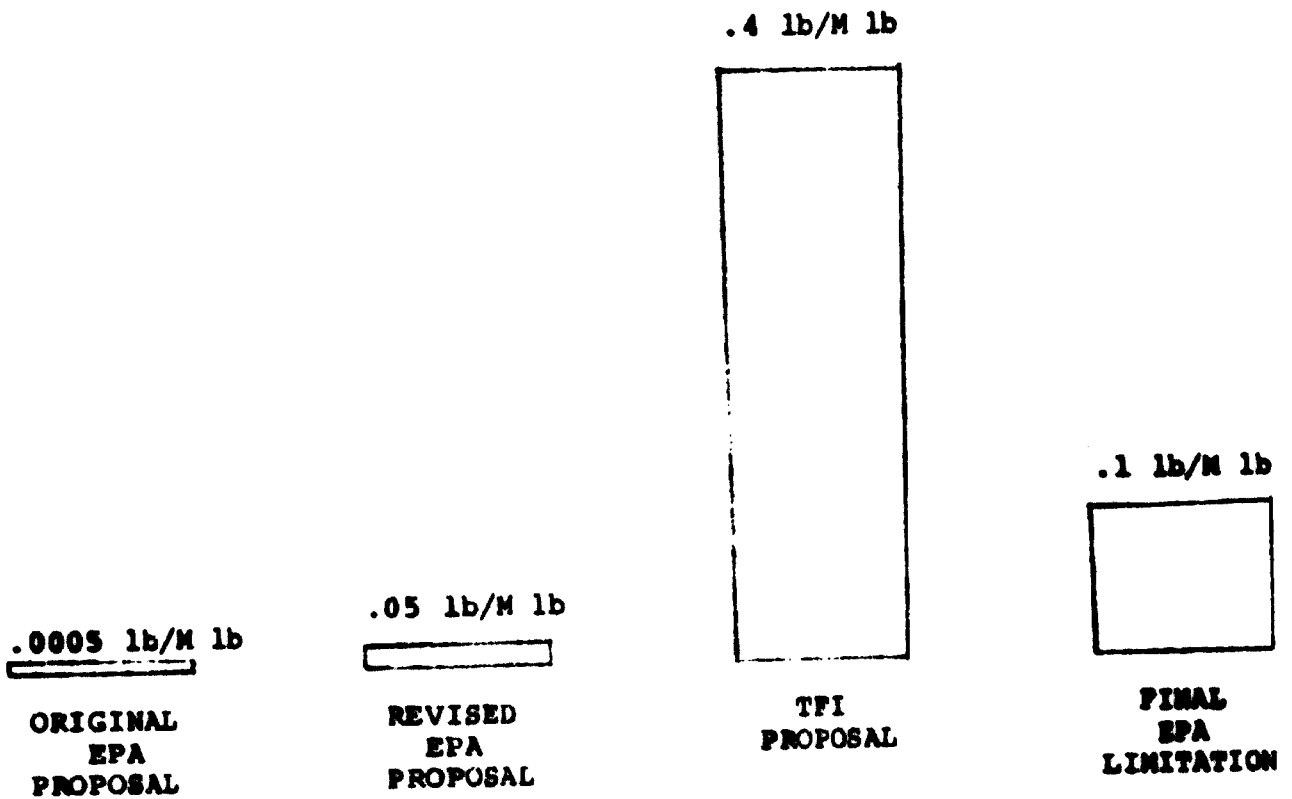


FIGURE V. 1977 ALLOWABLE DISCHARGE LEVELS -
AMMONIUM NITRATE PLANTS

NITRATE NITROGEN

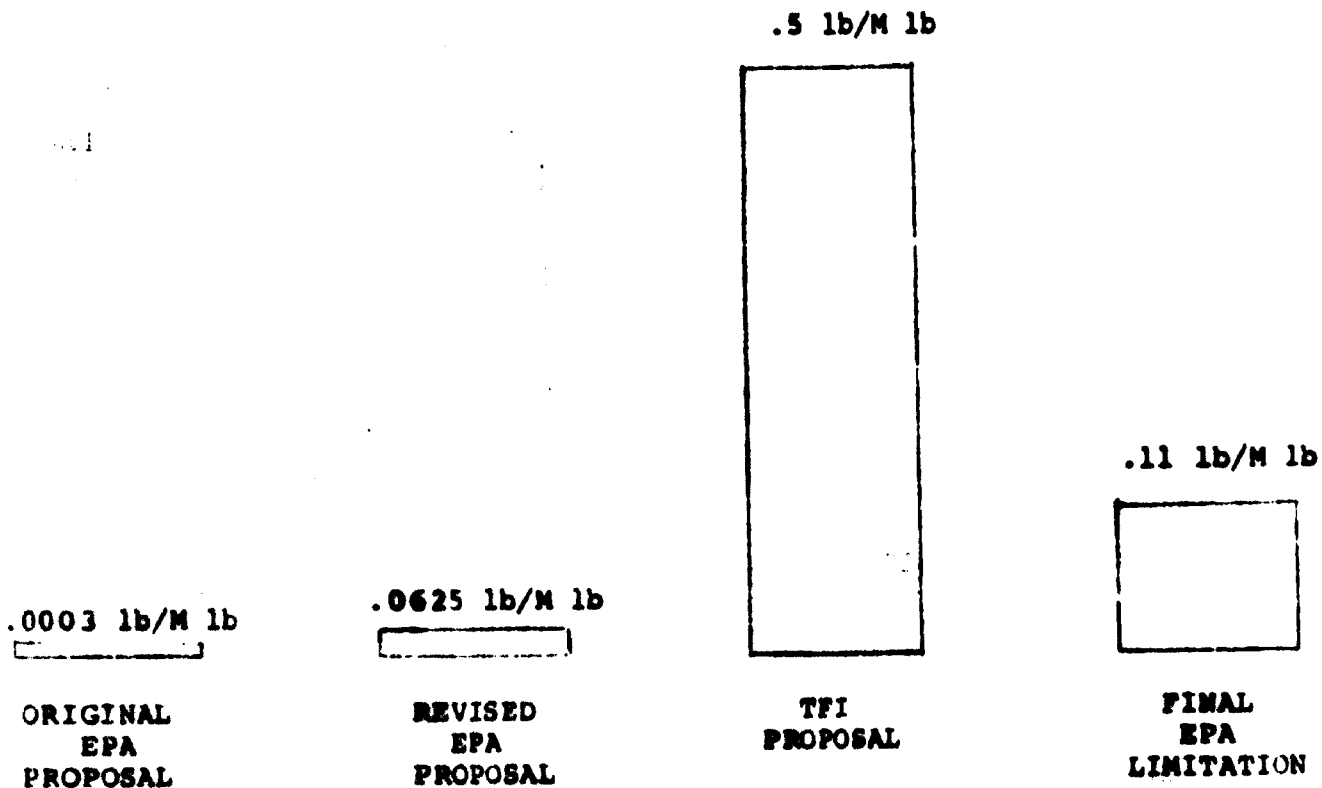


FIGURE VI. 1977 ALLOWABLE DISCHARGE LEVELS -
UREA PLANTS

ORGANIC NITROGEN

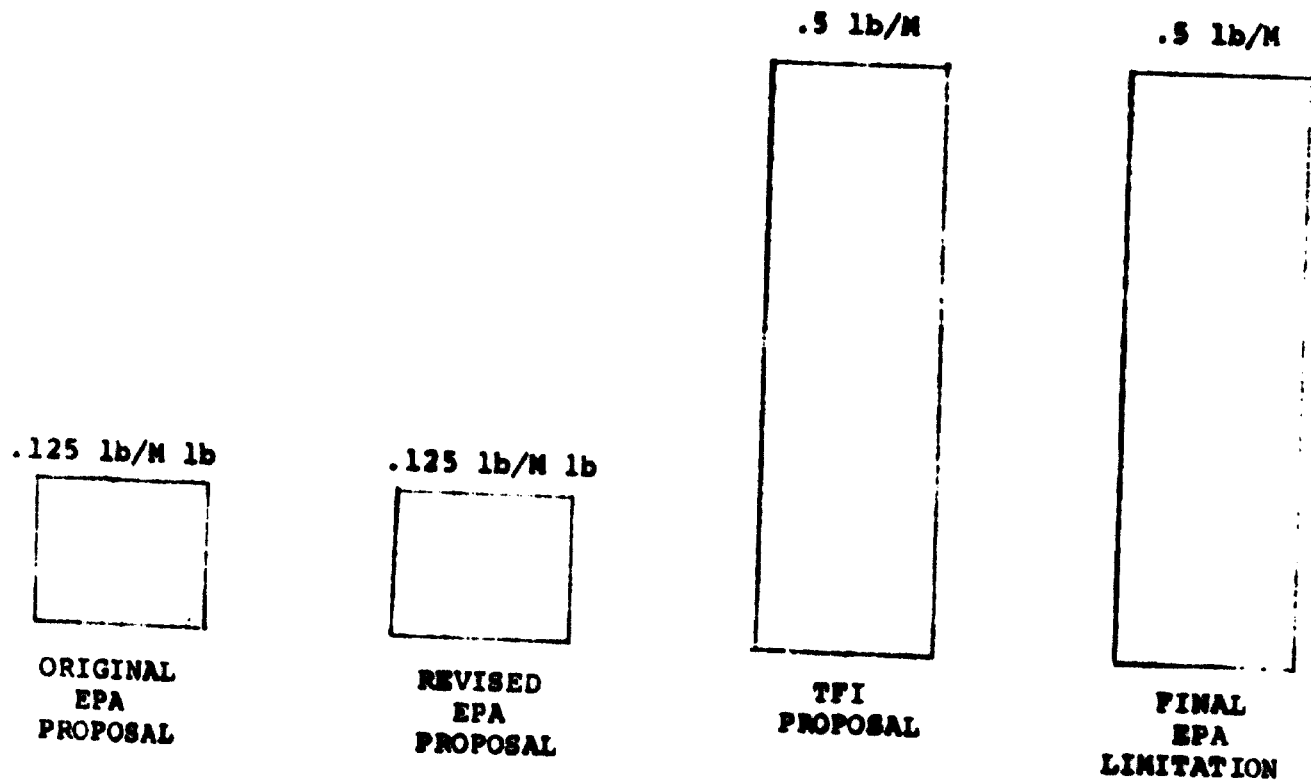


FIGURE VII. FERTILIZER INDUSTRY POLLUTION CONTROL EXPENDITURES

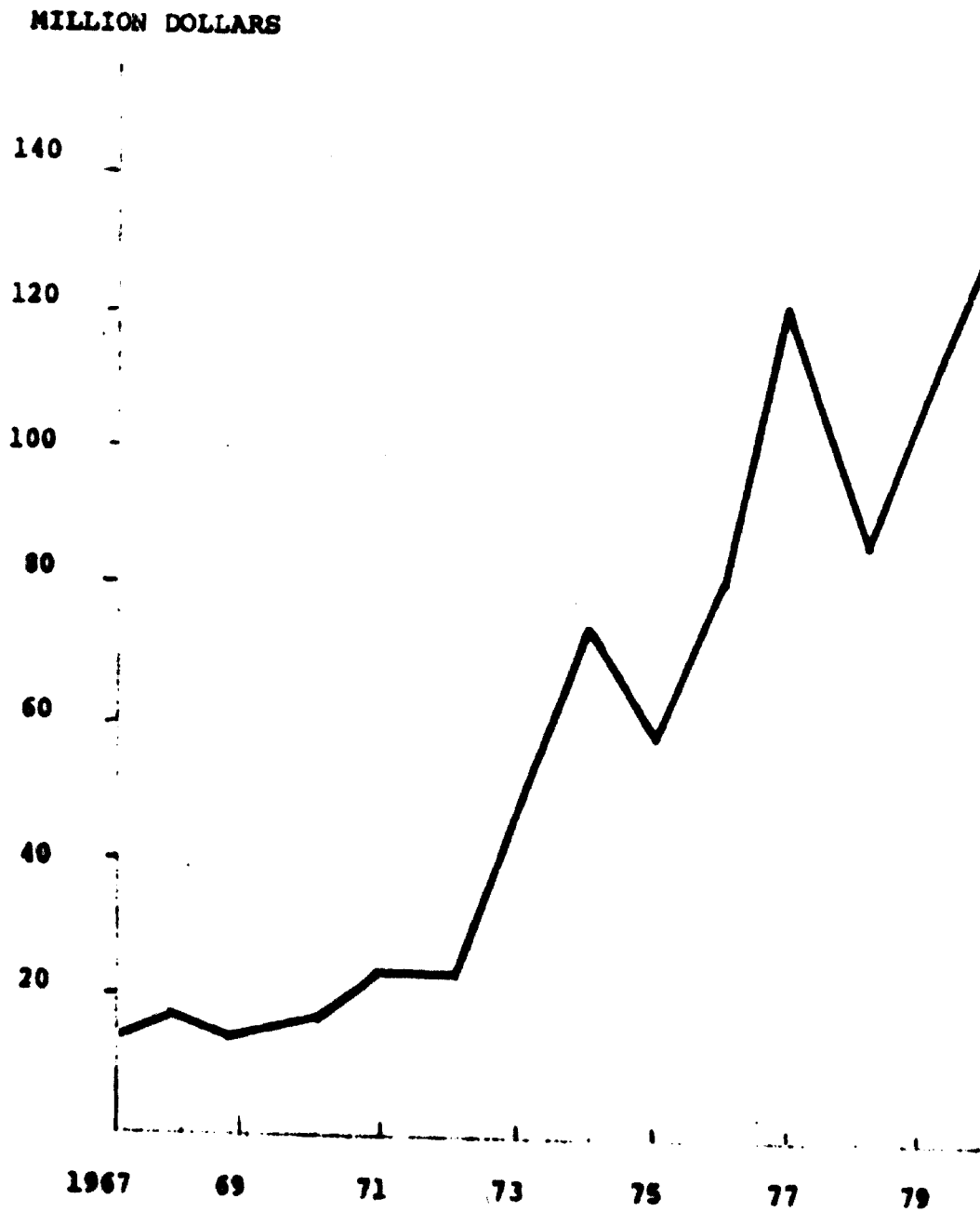
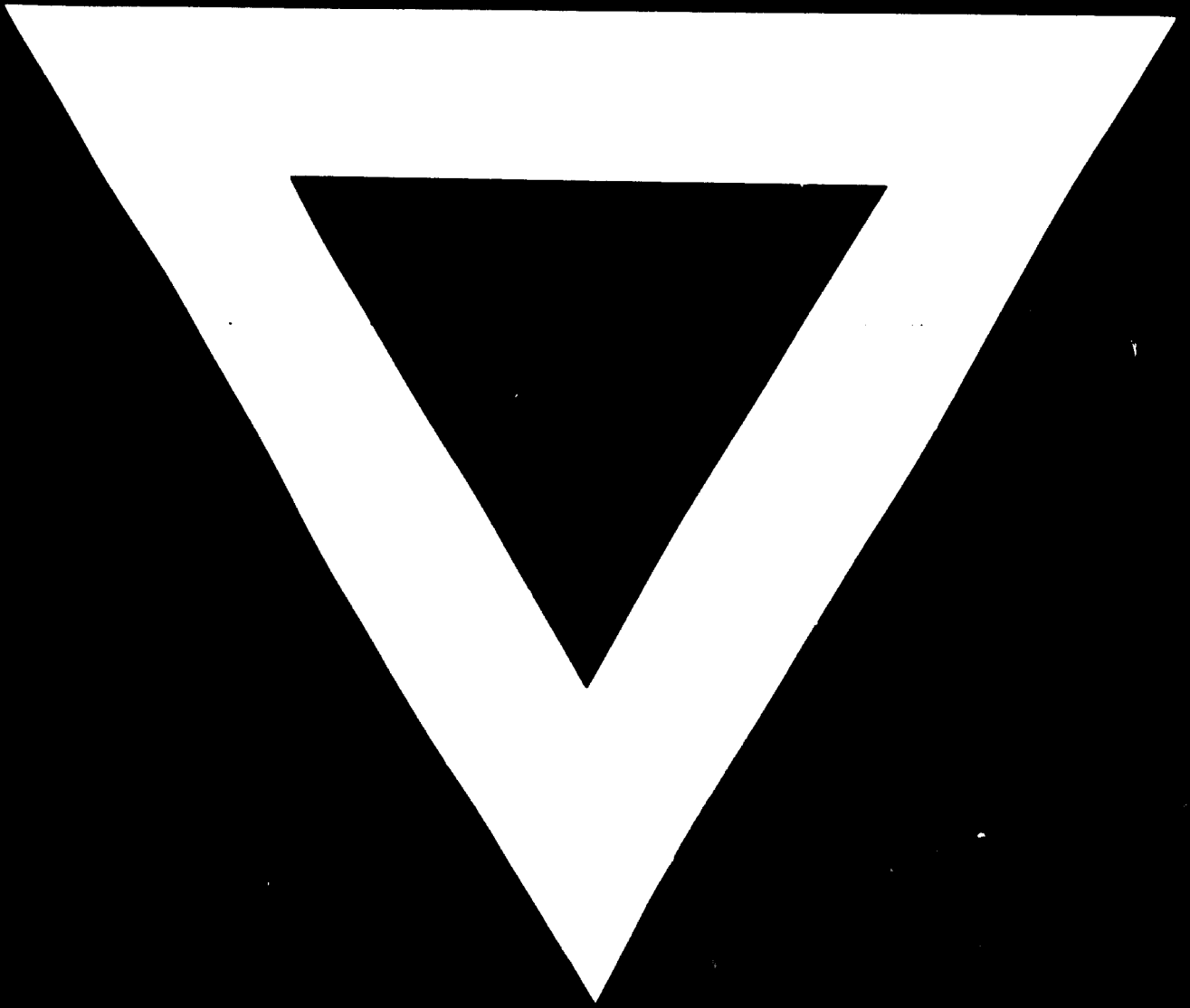


FIGURE VIII. OSHA STANDARDS FOR AIR POLLUTANTS OCCURRING
IN THE FERTILIZER INDUSTRY

(8-hour time weighted averages)

| | |
|---------------------|-----------------------|
| Ammonia | 50 ppm |
| Carbon Monoxide | 50 ppm |
| Fluoride (as F) | 2.5 mg/M ³ |
| Fluoride | 0.1 ppm |
| Nitric Acid | 2 ppm |
| Nitric Oxide | 25 ppm |
| Nitrogen Dioxide | 5 ppm |
| Phosphoric Acid | 1 mg/M ³ |
| Phosphorus (yellow) | 0.1 mg/M ³ |
| Sulfur Dioxide | 5 ppm |
| Sulfuric Acid | 1 mg/M ³ |





75.06.24