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Food Additives

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FOOD ADDITIVES

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FOOD ADDITIVES

"The most frequently discussed food chemistry problem in the popular press today is that of food additives."[1]

The practice of adding"chemicals" to food is a very old one. No doubt it began when man first learned to preserve his meat by putting salt on it. Through the centuries other methods of food preservation were invented.

During the early days of the industrial revolution in England and America there was much trial and error experimentation with materials used to preserve foods or to conceal inferiority by coloring them with dyes that were sometimes highly poisonous.

During the past half century the science of food chemistry has made tremendous progress. The growing, processing, and packaging of food so that it can be transported for thousands of miles and remain in good condition for months or years are among the many wonders of science.

Additives are used for a great many interesting and useful purposes. But, just exactly, what is a food additive?

A food additive is any substance not naturally present in a food but added during its preparation and remaining in a finished product; also in this categroy is any substance naturally present

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[1]Lillian Meyer, Food Chemistry (New York: Reinhold Publishing Corporation, 1960), p. 351.

but with a concentration increased by fortification. Substances or chemicals are added to food to preserve, emulsify, flavor, add nutritive value, color, or achieve other useful, desired purposes. "Americans currently ingest as much as three pounds of additives annually"[2] in these forms.

Nutrient Supplements. These are the vitamins and minerals added to foods to improve nutritive value, and sometimes to replace those removed in processing.

The most common example of this is the supplements found in cereals and other breakfast foods. There has recently been much controversy over this "enrichment" of foods. Many people feel that fortification decisions should be made on consideration of the total diet and the place the fortified food has in it because there is a danger of overfortification. Oil soluble vitamins like A and D can especially cause problems. You must take them in high levels over long periods of time to show any effects but it is possible.

There is already record of problems with Vitamin A in England where, for a while, everything was fortified with Vitamin A. Over something like a year's time, people's fat starting turning yellow. There were no toxic effects but people began to get a jaundiced appearance. "Vitamin D is also a problem because there are a percentage of people sensitive to it."[3]

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[2]David Sanford, "The Chemical Breakfast," New Republic, August 29, 1970, p. 26.

[3]David Sanford, "This Additive Age," New Republic, May 17, 1969, p. 18.

Thiamine, riboflavin, niacin, and iron are added to flour, corn meal, corn grits, macaroni, and noodle products. Vitamin A is added to margarine and Vitamin D to milk. Iodized salt contains added potassium iodide, to furnish iodine necessary to prevent simple goiter. There are, of course, other nutrients which may be added to certain products as dietary supplements.

Nonnutritive Sweeteners. These are the sugar substitutes permitted in foods for people who must restrict their intake of ordinary sweets.

The discovery of a sweetener was far from the mind of Michael Sveda when he picked up a cigarette from the end of his lab bench. He found that it had a strange, sweet taste and decided that it must have come from something he had spilled. He found the answer in some sweet-tasting crystals. Several years later he took the compound to Dupont and in 1949 it was introduced as the first cyclamate sweetener. "Studies showed that these chemicals were at least 30 times sweeter than an equivalent quantity of sugar but were nonnutritive."[4]

Although a more potent nonnutritive sweetener, saccharin, had been in general use for several decades, its consumption was somewhat limited because of a bitter aftertaste that followed ingestion of large quantities. The advent of cyclmates stimulated the development of a number of food products containing cyclamate-saccharin combinations or cyclamates alone and many new industrial

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[4]James Winchester, "How Science Tricks Your Taste," Popular Science, September, 1966, p. 80.

producers were influenced to enter this field.

Thus, during the early 1950's a variety of food products were developed primarily for use in special diets. It was later found that the additive of cyclamates yielded technological advantages in food processing and so the list of cyclamate-containing foods grew. "Yearly production of cyclamates increased nearly fivefold during the early 1960's."[5]

A remarkable rise in consumption of artifidially sweetened products has occurred during the past seven or eight years.

Reacting to the suddenly increased and diversified utilization of artificial sweeteners, the Food and Drug Nutrition Board reevaluated the status of the cyclamates in 1962. "Their report, questioning the use of these sweeteners by the general public, had little impact on the public."[6]

But because of the questions raised, research on the safety of cyclamates by industrial, and univeristy groups was begun. Beginning in 1967 FDA scientists initiated studies of the toxic effects of cyclamates in the chick embryo. By 1969 enough information had been obtained to be reasonably certain that cyclamates produced adverse effects in the chick.

Acting on preliminary evidence, the Commissioner of Food and Drugs requested a review of the findings and further research.

On October 18, 1969 the Secretary of Health, Education, and

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[5]"Artificial Sweeteners," FDA Papers, November, 1969, p. 28.

[6]"A Decision on Cyclamates," FDA Papers, October, 1969, p. 12.

Welfare ordered that cyclamates be removed from the Generally Recognized as Safe list. "This action was taken on the basis of the Delaney Amendment to the Food, Drug, and Cosmetic Act which provides that a food additive must be removed from the market if it is shown to cause cancer when fed to humans or animals."[7]

Cyclamate-containing beverages were removed from the market on January 1, 1970. Other food products, containing lesser amounts of the non-nutritive sweetener, were removed before February 1, 1970.

The FDA is now studying the possibility of transferring cyclamates to drug status to permit their use under medical supervision for persons suffering from diabetes, as well as those suffering from obesity.

Saccharin has been known since 1879. Entirely synthetic and unknown in nature, saccharin provides no calories and has nothing to elevate the diabetic's sugar level. Saccharin was studied under similar procedures as cyclamates and was found to produce no comparable effects.

Preservatives. There are many different types of preservatives, each type being best suited to a particular type of product, or more effective against a particular spoilage organism or chemical change. Preservatives for fatty products, for example, are called antioxidants.

The preservatives used in bread are called mold and rope

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[7]Ibid., p. 13.

inhibitors and antimycotic agents. Those permitted in bread include sodium and calcium propionate, sodium diacetate and lactic acid. Sorbic acid and sodium and potassium sorbates are antimycotic agents for cheese. Still other antimycotics prevent molding of citrus fruits. These are called fungicides because they stop the growth of the mold, or fungus, spores.

Another type of preservative prevents physical or chemical changes which affect color, flavor, texture or appearance. These are called sequestrants. Common sequestrants used in dairy products include sodium, calcium, and potassium salts. A different type of sequestrant is used in the manufacture of soft drinks to remove traces of metals which cause clouding or other undesirable effects.

Other common preservatives are benzoic acid, sulfur dioxide, and of course, sugar, salt, and vinegar.

The Food Additive Law of 1958 also provides that any source of radiation intended for use in producing, manufacturing packaging, preparing, treating, or holding food comes under the jurisdiction of the food additive regulations..

Several regulations have been enacted in response to proposals for various applications of radiation in the inspection, packaging, or treatment of food. One regulates the dose of gamma radiation in the processing of canned bacon, one the dose of electron beams in the preservation of canned bacon.

Several other proposals for regulations involving radiation treatments for various foods have been considered. These include

proposals for irradiation of oranges and strawberries to inhibit spoilage and extend shipping times or shelf life.

"This peaceful application of atomic energy presents possibilities for significant advances in food processing."[8] Applications in food preservation hold promise of improved products for the consumer and the reduction of losses in foods through spoilage and insect devastation.

Emulsifiers. Emulsifiers are used in such foods as bakery products, cake mixes, ice creams, and frozen desserts and confectionery products. They affect characteristics such as volume, uniformity and fineness of grain (bakery goods), ease of emulsification and smoothness (dairy products), and homogeneity and keeping quality (confectionery).

Some common emulsifiers are lecithin, the mono- and diglycerides and propylene glycol alginate.

"Chemists sometimes call the emulsifiers 'surfactants'--short for 'surface active agents.'"[9]

Stabilizers and Thickeners. Smoothness of texture of confectionery, ice cream, and other frozen desserts; uniformity of color, flavor, and viscosity of chocolate milk; "body" of artificially sweetened beverages: these are typical of the purposes for which stabilizers and thickeners are used.

Thickening and stabilizing agents include pectins, vegetable

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[8] "Radiation of Food," FDA Papers, May, 1967, p. 24.

[9] U. S. Department of Health, Education, and Welfare, Facts for Consumers--Food Additives (FDA Publication No. 10. Washington: Food and Drug Administration, 1960), p. 8.

gums, gelatin, and agar agar.

Acids, Alkalies, Buffers, Neutralizing Agents. The degree of acidity or alkalinity is important in many classes of processed foods. The acid ingredient acts on the leavening agent in baked goods, and releases the gas which causes rising. The flavor of many soft drinks is modified by the added acid. Acids contribute flavor to confectionery and help to prevent a "grainy" texture.

Buffers and neutralizing agents are chemicals added to control acidity or alkalinity, just as acids and alkalies may be added directly.

Some common chemicals in this class are ammonium bicarbonate, calcium carbonate and tartaric acid.

Flavoring Agents. Typical of the synthetic flavors used in such products as soft drinks, bakery goods, confectionery, and ice cream are such chemicals as amyl acetate and carvone.

"Essential oils, such as oil of orange and oil of lemon, are natural flavors made by extraction of the fruit rind or other natural product."[10]

Monosodium glutatmate is a seasoning agent made from plant protein. It is a natural ingredient of every protein food, including such foods as beefsteak, cheese, mushrooms and mother's milk. It is also present in the human body, produced in the normal digesting of almost any protein.

MSG has a large role to play in modern day food processing. It restores to food the peak flavor that is reduced in the extended period of processing, shipping, and distributing that

intervenes between harvesting and consumption.

Monosodium glutamate presently heads the FDA's list of "generally recognized as safe" additives. But some scientists think it can cause brain damage in infants and are demanding its ban from baby food. MSG serves no real purpose for babies. "Companies put it in the food to enhance flavor for the benefit of the mother's palate, not the infants."[10]

Although it has not been removed from the market by HEW, MSG has been removed by baby food companies from their products due to the great amount of publicity given to the additive.[11]

Bleaching Agents. Freshly milled flour is yellowish in color and makes a very poor bread. As it ages it whitens and reacts chemically with oxygen in the air, and gradually improves the breadmaking quality.

This aging and bleaching can be speeded up to avoid periods of storage by the adding of oxidizing chemicals.

Some of the permissibile oxidizing and/or bleaching agents are benzoyl peroxide, chlorine dioxide, and chlorine.

There are, of course, other types of additives. Leavening agents, anticaking agents, hardening agents, drying agents, and anti-foaming agents are examples of classes not listed.

SPECIAL CLASSES OF ADDITIVES

The Food Additive Amendment does not cover pesticides used

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[10]"Baby Food," Business World, October 25, 1969, p. 114.

[11]"Monosodium Glutamate: The Myth and the Matter," Food Service, July, 1970, p. 46.

on growing crops, or color used in or on foods; these foods are dealt with by other provisions of the law.

Pesticides. Throughout history man has been concerned with the control of pests affecting his health and welfare. He has constantly sought better means to minimize the diseases and losses of crops and other resources caused by the many forms of animals, insects, and plants classified as pests. His success in controlling pests may be measured by the present attention being directed to the control of the pest control agents. It is reasonable to speculate that more has been written and said, pro and con, about pesticides in food and in other parts of the environment during the past decade than in all previous ages.

The relatively simple pesticide chemicals and other methods used for pest control during the early part of the 20th century have been replaced in less than 25 years by a large number, over 800, of different pesticidal compounds.

The statutory authority for the control of pesticide residues in food began with the Food and Drug Act of 1906. This authority was strengthened generally by the Food, Drug, and Cosmetic Act of 1938, and more specifically in the Pesticide Chemicals Amendment to the Act in 1954.

No pesticide chemical can be legally shipped in interstate commerce without registration by the Department of Agriculture. "For a petitioner to obtain a registration, the chemical must not be injurious to man and animals when used as directed and must

control the pests named on the label without harming the crop being treated."[12] If the use will result in residues on a food or feed crop, the chemical cannot be registered until the Food and Drug Administration has established a safe tolerance for the remaining residues.

The industry or firm promoting the use of the chemical is responsible for obtaining proof that the residues remaining on food are safe for the consumer. Data requirements forming the basis for tolerances are subject to continued review by FDA, which considers new scientific data and advances in the evaluation of safety data.

"The Food and Drug Administration has several programs in progress concerned with pesticide residues. The basic purpose of all of these programs is to insure the safety of the nation's food supply. These programs include a total diet study, as well as research, surveillance, and enforcement programs."[13]

Shipments of foods imported into this country are also sampled and examined. There are no substantial differences in residues in the foods produced in the United States and those imported from other countries.

The Food and Drug Administration also carries out extensive research programs on pesticides. These research programs on pesticides are designed to support and strengthen FDA's capabilities to establish and enforce pesticide residue tolerances. FDA's reserach activities fall into the major

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[12]"Foods and Pesticides," FDA Papers, September, 1968, p. 14.

[13]Ibid., p. 16.

areas of chemical and biological research.

As our information on safety and actual levels of residues in foods expand and changes in agricultural practices in the use of pest control agents occur, we may expect other changes in tolerances. Our tolerance system must keep abreast of the changes if we are to continue to have a safe and adequate food supply.

Food Color Additives. There is no doubt that artificial colors make food more attractive and hence contribute to the pleasure of eating. The Federal Food, Drug, and Cosmetic Act permits the use of safe artificial colors, except where this would result in consumer deception. Artifical color is prohibited if it would make the product appear better than it really is. The presence of artifical color must be declared on the label.

The law also requires that food colors be proved safe before use. But this was not always so. "It was not uncommon for the imported candies of 100 years ago to be colored with poisonous mineral pigments of lead, arsenic, copper, and chromium."[14] Then in 1858 the first organic dye, an aniline dye, was synthesized by William Henry Perkin. This was the beginning of the "coal-tar color" industry, so-called because aniline was made by distillation of coal. These synthetic colors soon replaced the poisonous mineral pigments.

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[14]U. S. Department of Health, Education, and Welfare, FDA Chemistry Project (FDA Publication No. 5 The Identity of Synthetic Color Additives in Foods. Washington: Food and Drug Administration), p. 3.

However, the various illnesses suffered by workers in the dye industry in Germany caused real concern about the safety of any of these new colors for food use. The harmful effects of the coal-tar colors were believed largely due to impurities present, particularly arsenic and lead.

As early as 1907, only one year after the first Federal Food and Drugs Act was passed, food and color manufacturers asked the Government to list the coat-tar colors that could be safely used in foods, and to set up a system of testing or "certification" of every batch of permitted color. The tests were designed to determine whether the color was free of harmful impurities. Seven colors were listed at that time as safe in foods. Foods containing unlisted colors, or colors from uncertified batches, were regarded as "adulterated" and could not be sold.

The voluntary system of color certification was written into the law as compulsory in 1938. The coal-tar colors were getting more Government attention than any other class of food ingredients, at that time.

Then, in the 1950's something happened to bring the safety of food colors into question again. There were two separate outbreaks of poisoning of children from eating highly colored Halloween candy and popcorn. One of the colors was the one then used to color oranges. The other was an orange color used in many different foods.

In each case the amount of color used in the produce was far in excess of that normally used. But, the fact that any amount of these tested colors could cause illness was startling.

This discovery set in motion a chain of events that led to a still stronger color law in 1960 called the "Color Additive Admendments" to the Federal Food, Drug, and Cosmetic Act. This law provided that all of the permitted food, drug, and cosmetic colors be retested for safety using more modern scientific techniques--techniques which had not previously been avilable to the scientific community. The new amendments also gave the FDA the authority to limit the amount of color that may be used. The law applies to all food, drug,and cosmetic colors--not just coal-tar colors.

REGULATION AND PROTECTION

Food and Drug Administration scientists appraising the situation in the mid 1950's knew that several hundred of these additives were being used. They knew also that some of those in use had not been thoroughly tested for safety. "These were in a sort of scientific no'man's land--scientisits did not know whether they were safe or not."[15]

Under the Federal Food, Drug, and Cosmetic Act as it was prior to September 1958, FDA could not stop the use of a chemical simply because it was questionable or had not been adequately tested.

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[15]U. S. Department of Health, Education, and Welfare, Facts for Consumers--Food Additives (Washington: FDA, 1960), p. 3.

It was necessary to be able to prove in court that the chemical was poisonous or deleterious. This is not difficult for chemicals which cause immediate, or acute, illness. But today the big problem which concerns scientists is the long-term effect--what may happen in the body as a result of years, or even a lifetime, of exposure to minute amounts of the chemical. Several years of feeding tests on different kinds of animals are required to appraise these chronic effects. Proving what is poisonous under these circumstances may be very difficult.

While most manufacturers did make tests and consult with FDA about the safety of their products, not all of them did, nor were they required to do so. Obviously, the law had to be changed so as to prevent an untested chemical from being tried out on the public. The danger was not theoretical--it was real.

"The problem of how to protect the consumer from inadequately tested food additives was studied intensively by Congressional committees from 1950 to 1958."[16] From the first, the food and chemical industries, as well as consumers, supported the principle that safety testing should be required by law. The Food Additives Amendment, Public Law 85-929, became law on September 6, 1958. Certain extensions of time were authorized to allow completion of safety tests on specific chemicals already in use, if the public health would not be endangered.

Food and chemical manufactureres are now required to run extensive animal feeding tests on these additives before they

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[16] Ibid., p. 5.

are marketed. Results of these tests must be submitted to the Food and Drug Administration. If FDA scientists are satisfied that the additive may be used safely, a regulation--called an "order"--will be issued permitting its use. This regulation may place a limit, or "tolerance," on the amount which may be used, and will specify any other conditions necessary to protect the public health. If the evidence submitted is not convincing as to safety, the additive will not be permitted. This applies equally to substances added directly to foods, including animal feeds, and to substances likely to contaminate food as a result of some incidental use in food processing. Food packing materials which may be absorbed by the food itself are covered. The law also applies specifically to processes for irradiating foods for preservation; and it covers any residues which may carry over into meat, milk, or eggs as a result of use in animal feeds.

The law specifically states that no additive may be permitted in any amount if the tests show that it produces cancer when fed to man or animls, or by other appropriate test. This part of the law is known as the Delaney Amendment. And it specifies that only the smallest amount necessary to produce the intended effect may be permitted. It prohibits the use of any chemical which would result in consumer deception.

Some of the world's scientific experts on safety of food additives are employed in FDA laboratories. The safety testing procedures they have developed and standardized are used by scientists everywhere.

FDA laboratory researchers are experienced and qualified to evaluate the work of outside research workers who conduct experiments to prove the safety of additives. They are constantly seeking ways to improve public protection by developing faster, more reliable methods that will show whether a substance is safe. For example, one FDA scientist has developed a technique for injecting chemicals into chick embryos in incubated eggs. This technique is being used to accelerate some types of toxicity tests and is providing faster public protection.

FDA scientists are also the nation's experts on methods for detecting and measuring additives and pesticide residues in foods. These methods for policing compliance with the safety rules are the cornerstone of the public health safeguards in the law.

"In order to carry out its responsibility of protecting the health of the American consumer, scientific competency is essential to the Food and Drug Administration."[17] Scientists at headquarters and in the field must use every resource to improve their competency. And FDA must make use of the most advanced analytical techniques and instrumentation.

To help field scientists, FDA turned to the academic community and established its Science Advisors Program.

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[17]"FDA Science Advisors--How They Help Field Scientists," FDA Papers, June, 1967, p. 22.

The program was initiated in May, 1966, with the appointment of an outstanding chemistry professor for eight district laboratories. All seventeen districts, plus the National Drug Testing Center at St. Louis, now have a Science Advisor. All the Science Advisors are on the chemistry faculty of a university within ready commuting distance of the district, and are actively engaged in teaching and research. They are also involved in the direction of graduate study in the field of analytical chemistry or where studies of analytical chemistry are a principal part of the investigation.

The great advantage of the Science Advisor Program is not the specifics which can be enumerated, but rather the overall influence which Advisors bring to bear on the professional development of field scientists, on general upgrading of the scientific climate of District laboratories, and on the stimulus for good research.[18]

In 1968 FDA reached two important milestones in the history of the Food Additives Amendment to the Federal Food, Drug, and Cosmetic Act. The first was the elimination of the petition backlog and the second was new directions for dealing with food additive petitions.

When the Amendment was signed into law the food industry was familiar with FDA, and FDA with the food industry. But this was not so with the packaging industry, nor the radiation industry. In addition, the effect of the law on the animal food industry

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[18] Ibid., p. 23.

could not be fully realized.

Resolutions of problems arising out of this situation were necessary for a beginning. Manufacturers of food packaging materials were permitted to make their own determinations of whether a substance was not a food additive based on an absence of migration from substance to food. Similar temporary solutions were provided for the other industries.

Reduction of the petition backlog, which accumulated early in the history of the Amendment, was not begun successfully until 1966. In that year FDA changed petition hadnling procedures by placing more responsibility on the petitioner for improving his submissions.

FDA has come a long way since the enactment of the law. They are constantly improving procedures, regulations, and protection of the public health. "With the new emphasis on impact of total environment on the living organims, exposure to food additives must be looked at further in the total effect on man."[19]

Most consumers know that the law contains a general requirement that food ingredients be named on the label. Many of the chemicals listed in previous pages, however, and described as commonly used, will not be found in the list of ingredients on labels of foods in which they are used, and consumers will not be familiar with them.

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[19]F. J. McFarland, "A Decade of Regulating Food Additives," FDA Papers, February, 1968, p. 16.

This is not because the chemicals are being clandestinely used or because they are unsafe, or in any way undesirable. And it is not because of any intent to conceal the fact that such chemicals are being used.

One important reason is that the law does not require ingredient declaration on the labels of standardized foods--that is, foods, for which the basic ingredients are set by regulation. Such a regulation is called a Definition and Standard of Identity, and has the effect of law in fixing the composition of the food. Consumers, industry and Government may all participate in the fact-finding process upon which the standard is based. Only safe chemical additives have been permitted in standardized foods.

Since consumers can depend upon basic composition, Congress did not require the main ingredients of standardized foods to be declared on the labels. (However, if the standard permits optional ingredients, the standards regulation itself may require the label declaration of such optional ingredients.) The foods for which standards of identity have been set include several types of bread and rolls, flours, macaroni products, corn meal, chocolate and chocolate products, margarine, evaporated milk, most types of cheese, frozen desserts, tomato ketchup, vanilla flavoring products, and many canned fruits and vegetables. A few other foods have been treated as standardized foods for labeling purposes, pending the actual setting of standards for them.

One other exception to the general requirement for label declaration of ingredients is that flavors, spices, and colors do not have to be individually named, but may be listed simply as flavors, spices, and colors.

And of course pesticide chemicals used on growing crops do not have to be declared.

With these exceptions (and a few other minor ones) chemicals used in foods must be declared on labels by their common or usual names. Frequently, the chemical name is the only "common or usual" name. Chemical names for even the most harmless additives often appear formidable and dangerous to the consumer, simply because they are long and difficult to pronounce. It is important to remember that the declaration of a chemical name on a label is no indication at all that the food is harmful or of inferior quality. "After all, water is hydrogen oxide, and salt is sodium chloride to the chemist."[20]

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[20]U. S. Department of Health, Education and Welfare, Facts for Consumers--Food Additives (Washington: FDA, 1960), p. 14.

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