MBRC San Antonio 2015 attachment A To replace version on pages 148 – 163 of the 2015 AAFCO OP (print version)

AAFCO METHODS FOR SUBSTANTIATING NUTRITIONAL ADEQUACY OF DOG AND CAT FOODS

This section contains the minimum testing methods for the substantiation of nutritional adequacy claims, calorie content claims, and procedures for establishing pet food product families referenced in AAFCO Model Pet Food and Specialty Pet Food Regulations PF2, 4, 7, 8, 9 and/or 10. These methods represent minimum requirements. Companies may choose, or may need, to perform additional testing to substantiate their claims.

AAFCO Dog and Cat Food Nutrient Profiles

Introduction

The original Canine and Feline Nutrition Expert Subcommittees convened in 1990 were charged by the chair of the AAFCO Pet Food Committee to establish practical nutrient profiles for both dog and cat foods based on commonly used ingredients. These subcommittees established the "AAFCO Dog Food Nutrient Profiles" and the "AAFCO Cat Food Nutrient Profiles" that appeared in the Official Publication of the AAFCO in 1992 and 1993, respectively. The profiles were reviewed in 1994/95 and updates to the maximum concentrations for vitamin A in dog foods were implemented in 1996.

The National Research Council (NRC) in 2006 updated its published *Nutrient Requirements of Dogs* and *Nutrient Requirements of Cats* in a single publication that combined recommendations for both species.[1] In 2007 the AAFCO Pet Food Committee again formed Canine and Feline Nutrition Expert Subcommittees and charged these subcommittees with the task of revising the AAFCO Nutrient Profiles in consideration of the information in the 2006 NRC *Nutrient Requirements of Dogs and Cats* (2006 NRC). In addition, the subcommittees considered information in the NRC *Mineral Tolerance of Animals Second Revised Edition, 2005* (2005 *Mineral Tolerance of Animals*).[2] Finally, the subcommittees also reviewed and considered the recommended nutrient concentrations for dog and cat food products as published in February 2008 by the European Pet Food Industry Federation (Federation Europeenne de l'Industrie des Alimentis pour Animaux Familiers (FEDIAF)), titled *F.E.D.I.A.F. Nutritional Guidelines for Complete and Complementary Pet Food for Cats and Dogs*, (FEDIAF Guidelines) that are roughly the European-equivalent to the AAFCO Dog and Cat Food Nutrient Profiles.[3]

The AAFCO Dog and Cat Food Nutrient Profiles were designed to establish practical minimum and some maximum nutrient concentrations for dog and cat foods, formulated from commonly used, non-purified, complex ingredients. The concentrations differ from minimum nutrient requirements traditionally developed by the NRC Committee on Animal Nutrition. Many of the NRC minimum nutrient requirements are based on research with purified diets and/or highly bioavailable nutrient sources that are not practical to use in commercial dog and cat foods. Therefore, unlike the previous NRC publications *Nutrient Requirements of Dogs* in 1985[4] and *Nutrient Requirements of Cats* in 1986,[5] the *Nutrient Requirements of Dogs and Cats* in 2006 contained two additional listings of nutrient concentrations for adequate intake and recommended allowance (RA) in addition to minimum requirements. The concentrations for RA's of nutrients in the 2006 NRC are at least equal to, or greater than, concentrations for adequate intakes and minimum requirements, respectively, and are defined as "the concentration or amount

of a nutrient in a diet formulated to support a given physiological state." When appropriate, the RA takes into consideration the bioavailability of the nutrient. Thus, the Canine and Feline Nutrition Expert Subcommittees of 2007 primarily used the RA in the 2006 *Nutrient Requirements of Dogs and Cats* in evaluating whether revision was needed to one or more of the minimum recommended concentrations in the profiles. Values for specific nutrient concentrations were added or modified where indicated and supported by recent scientific publications, practical experience, or unpublished data.

The AAFCO Dog and Cat Food Nutrient Profiles have been criticized and faulted for not explicitly indicating the apparent nutrient digestibility, sometimes called nutrient availability or bioavailability, required to make the listed concentrations adequate for meeting the animal's daily requirements. When a minimum requirement has been established for a particular nutrient, the expected apparent digestibility to meet the minimum requirement for that nutrient at the recommended concentration listed in an AAFCO Nutrient Profile can be calculated using the formula:

((minimum requirement) x (its apparent digestibility in the diet(s) used to establish the minimum requirement) / (recommended concentration in the AAFCO Profile)) x 100.

In the above formula, the minimum requirement is expressed in the same units as in the AAFCO Nutrient Profile and digestibility is expressed in decimal equivalents. As an example, the NRC lists the minimum crude protein requirement for puppies to be met by formulas containing 18% crude protein on a dry matter basis with the digestibility of the protein sources estimated to be near 100%. The 2012 AAFCO Dog Food Nutrient Profile for Growth and Reproduction recommends the minimum crude protein concentration of dry matter to be 22.5%. Therefore, the expected apparent digestibility for crude protein in a diet formulated to meet the AAFCO Dog Food Nutrient Profile for Growth and Reproduction is at least 80% [(18 x (1.00)/22.5) x 100].

For nutrients known to be essential, but that lack sufficient data to establish a minimum requirement, the typical digestibility for the nutrient in ingredients and food matrices similar to those used to establish the apparent amount to fulfill the animal's need for the nutrient should be ensured. The 2006 *Nutrient Requirements of Dogs and Cats* discusses average or typical apparent digestibility for such nutrients when explaining how a RA was set. As an example, for adult dogs there is no established minimum requirement for iron, although iron is considered essential for adult dogs. In setting the RA of 30 mg/kg in dietary dry matter for adult maintenance, the NRC subcommittee considered the apparent digestibility of iron to be 20%. However, the explanatory text in the publication notes that measured apparent digestibility of iron in the scientific literature has ranged from close to 100% to less than 10%, and is affected by numerous factors such as the specific source of iron, the concentration of other specific minerals or other ingredients in the diet, as well as the iron status of the animal.

The specific example for iron can be generalized to most essential minerals, and demonstrates the impossibility that any list of concentrations can invariably ensure that all nutrient requirements are fulfilled in all diet formulas without additional considerations. As stated for the previous editions of the AAFCO Dog and Cat Food Nutrient Profiles, formulating a product according to the Profiles is only one part of a nutritionally sound, scientific development that must consider all other aspects of the product. The fact that a dog or cat food is formulated to meet a specific AAFCO Profile should not deter or discourage the manufacturer from conducting appropriate feeding trials to further confirm and ensure the diet is nutritionally adequate for its intended use.

Indications regarding expected nutrient availability from some ingredient sources are given in footnotes. It is important to read the footnotes to the tables as they contain information critical to many of the recommended concentrations. Additionally,

manufacturers must make allowances to nutrient concentrations prior to processing to account for losses during processing and subsequent storage. The recommended concentrations in the Profiles are those expected to be present at the time the formula is consumed by the animal.

The established profiles are the "AAFCO Dog Food Nutrient Profiles" and "AAFCO Cat Food Nutrient Profiles" as the terms are applied in AAFCO model pet food regulations referring to nutritional adequacy. Under these model regulations, dog and cat foods substantiated for nutritional adequacy by reference to the AAFCO Dog and Cat Food Nutrient Profiles for a designated life stage(s) must be formulated to contain at least the minimum concentrations of nutrients specified in the Profiles, and, for some nutrients, not more than any maximum concentration listed for that specific nutrient in the Profiles as shown in this section. Products with their nutritional adequacy substantiated by AAFCO Feeding Protocols are not mandated to meet the minimum or maximum concentrations listed in the Profiles. Additionally, snacks, treats or products intended for intermittent or supplemental feeding only are not mandated to meet the concentrations in the Profiles unless their labeling references the Profiles.

The AAFCO Dog and Cat Food Nutrient Profiles and the AAFCO Feeding Protocols are the only methods recognized by AAFCO for substantiating the nutritional adequacy of "complete and balanced" dog or cat foods. If a product is substantiated by a feeding trial and does not meet the AAFCO Dog or Cat Food Nutrient Profiles, the label cannot reference the Profiles. An unqualified reference to an AAFCO Dog or Cat Food Nutrient Profile is an implied guarantee that the product contains the minimum concentrations for all nutrients in the profile and no more than any maximum concentration listed for a specific nutrient in the profile.

Minimum and some maximum nutrient concentrations were established in the Profiles for two categories; growth and reproduction (gestation/lactation), and adult maintenance. Maximum nutrient concentrations were established for nutrients where the potential for overuse or toxicity is of concern and likely to occur if attention is not paid to the concentrations of those nutrients. The absence of a maximum concentration should not be interpreted to mean that nutrients without a specific maximum content are safe at any concentration. Rather, it reflects the lack of information in dogs and cats on toxic concentrations of that nutrient. Establishing a maximum concentration implies safety below that concentration for long term consumption and to set a maximum arbitrarily might prove worse than no maximum at all.

The nutrient concentrations are expressed on a dry matter (DM) basis and at a specified caloric density. Diets should be corrected for caloric density as indicated below. Reference to the concentrations of nutrients on a product label in the guaranteed analysis must be expressed in the same units and order as given in the AAFCO Dog or Cat Food Nutrient Profiles. For the purposes of determining metabolizable energy (ME), use the methods specified in Model Regulation PF9.

AAFCO DOG FOOD NUTRIENT PROFILES
BASED ON DRY MATTER [a]

Nutrients	**Units DM Basis**	**Growth & Reproduction Minimum**	**Adult Maintenance Minimum[b]**	**Maximum**
Crude Protein	%	22.5	18.0	
Arginine	%	1.0	0.51	
Histidine	%	0.44	0.19	
Isoleucine	%	0.71	0.38	

Leucine	%	1.29	0.68	
Lysine	%	0.90	0.63	
Methionine	%	0.35	0.33	
Methionine-cystine	%	0.70	0.65	
Phenylalanine	%	0.83	0.45	
Phenylalanine-tyrosine	%	1.30	0.74	
Threonine	%	1.04	0.48	
Trytophan	%	0.20	0.16	
Valine	%	0.68	0.49	
Crude Fat [c]	%	8.5	5.5	
Linoleic acid	%	1.3	1.1	
alpha-Linolenic acid	%	0.08	ND[d]	
Eicosapentaenoic + Docosahexaenoic acid	%	0.05	ND[d]	
(Linoleic + Arachidonic):(alpha-Linolenic + Eicosapentaenoic + Docosahexaenoic) acid Ratio				30:1
Minerals				
Calcium	%	1.2	0.5	2.5 (1.8)[e]
Phosphorus	%	1.0	0.4	1.6
Ca:P ratio		1:1	1:1	2:1
Potassium	%	0.6	0.6	
Sodium	%	0.3	0.08	
Chloride	%	0.45	0.12	
Magnesium	%	0.06	0.06	
Iron [f]	mg/kg	88	40	
Copper [g]	mg/kg	12.4	7.3	
Manganese	mg/kg	7.2	5.0	
Zinc	mg/kg	100	80	
Iodine	mg/kg	1.0	1.0	11
Selenium	mg/kg	0.35	0.35	2
Vitamins & Other				
Vitamin A	IU/kg	5000	5000	250000
Vitamin D	IU/kg	500	500	3000
Vitamin E [h]	IU/kg	50	50	
Thiamine [i]	mg/kg	2.25	2.25	
Riboflavin	mg/kg	5.2	5.2	
Pantothenic acid	mg/kg	12	12	
Niacin	mg/kg	13.6	13.6	
Pyridoxine	mg/kg	1.5	1.5	
Folic acid	mg/kg	0.216	0.216	
Vitamin B_{12}	mg/kg	0.028	0.028	

Choline	mg/kg	1360	1360	

[a] Presumes a caloric density of 4000 kcal ME/kg, as determined in accordance with Regulation PF9. Formulations greater than 4000 kcal ME/kg should be corrected for energy density; formulations less than 4000 kcal ME/kg should not be corrected for energy. Formulations of low-energy density should not be considered adequate for reproductive needs based on comparison to the Profiles alone.

[b] Recommended concentrations for maintenance of body weight at an average caloric intake for dogs of a given optimum weight.

[c] Although a true requirement for crude fat per se has not been established, the minimum concentration was based on recognition of crude fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability, and to supply an adequate caloric density.

[d] ND – Not Determined. While a minimum requirement has not been determined, sufficient amounts of omega-3 fatty acids are necessary to meet the maximum omega-6:omega-3 fatty acid ratio.

[e] The maximum of 1.8% is applicable to formulas that may be fed to large size puppies (those weighing 70 pounds or greater as mature lean adults). For other life stages, including non-large size growth formulas, the maximum calcium is 2.5% DM.

[f] Average apparent digestibility for iron associated with recommended minimums is 20% of that consumed. Because of very poor apparent digestibility, iron from carbonate or oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration for iron.

[g] Because of very poor apparent digestibility, copper from oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration for copper.

[h] It is recommended that the ratio of IU of vitamin E to grams of polyunsaturated fatty acids (PUFA) be $\geq$ 0.6:1. A diet containing 50 IU of vitamin E will have a ratio of $\geq$ 0.6:1 when the PUFA content is 83 grams or less. Diets containing more than 83 grams of PUFA should contain an additional 0.6 IU of vitamin E for every gram of PUFA.

[i] Because processing may destroy up to 90% of the thiamine in the diet, allowances in formulation should be made to ensure the minimum nutrient concentration for thiamine is met after processing.

AAFCO DOG FOOD NUTRIENT PROFILES
BASED ON CALORIE CONTENT

Nutrients	**Units per 1000 kcal ME**	**Growth & Reproduction Minimum**	**Adult Maintenance Minimum[a]**	**Maximum**
Crude Protein	g	56.3	45.0	
Arginine	g	2.50	1.28	
Histidine	g	1.10	0.48	
Isoleucine	g	1.78	0.95	
Leucine	g	3.23	1.70	
Lysine	g	2.25	1.58	
Methionine	g	0.88	0.83	
Methionine-cystine	g	1.75	1.63	
Phenylalanine	g	2.08	1.13	

Phenylalanine-tyrosine	g	3.25	1.85	
Threonine	g	2.60	1.20	
Tryptophan	g	0.50	0.40	
Valine	g	1.70	1.23	
Crude Fat [b]	g	21.3	13.8	
Linoleic acid	g	3.3	2.8	
alpha-Linolenic	g	0.2	ND[c]	
Eicosapentaenoic + Docosahexaenoic acid	g	0.1	ND[c]	
(Linoleic+Arachidonic):(alpha-Linolenic+Eicosapentaenoic+ Docosahexaenoic) acid Ratio				30:1
Minerals				
Calcium	g	3.0	1.25	6.25 (4.5)[d]
Phosphorus	g	2.5	1.00	4.0
Ca:P Ratio		1:1	1:1	2:1
Potassium	g	1.5	1.5	
Sodium	g	0.80	0.20	
Chloride	g	1.10	0.30	
Magnesium	g	0.15	0.15	
Iron [e]	mg	22	10	
Copper [f]	mg	3.1	1.83	
Manganese	mg	1.8	1.25	
Zinc	mg	25	20	
Iodine	mg	0.25	0.25	2.75
Selenium	mg	0.09	0.08	0.5
Vitamins & Others				
Vitamin A	IU	1250	1250	62500
Vitamin D	IU	125	125	750
Vitamin E [g]	IU	12.5	12.5	
Thiamine [h]	mg	0.56	0.56	
Riboflavin	mg	1.3	1.3	
Pantothenic acid	mg	3.0	3.0	
Niacin	mg	3.4	3.4	
Pyridoxine	mg	0.38	0.38	
Folic acid	mg	0.054	0.054	
Vitamin B_{12}	mg	0.007	0.007	
Choline	mg	340	340	

[a] Recommended concentrations for maintenance of body weight at an average caloric intake for dogs of a given optimum weight.

[b] Although a true requirement for crude fat per se has not been established, the minimum concentration was based on recognition of crude fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability, and to supply an adequate caloric density.

[c] ND – Not Determined. While a minimum requirement has not been determined, sufficient amounts of omega-3 fatty acids are necessary to meet the maximum omega-6:omega-3 fatty acid ratio.

[d] Maximum of 4.5 g Ca/1000 kcal ME is applicable to formulas; that may be fed to large size puppies (those weighing 70 pounds or greater as mature lean adults). For other life stages, including non-large breed growth formulas, the maximum calcium is 6.25 g Ca/1000 kcal ME.

[e] Average apparent digestibility for iron associated with recommended minimums is 20% of that consumed. Because of very poor apparent digestibility, iron from carbonate or oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration for iron.

[f] Because of very poor apparent digestibility, copper from oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration for copper.

[g] It is recommended that the ratio of IU of vitamin E to grams of polyunsaturated fatty acids (PUFA) be $\geq$ 0.6:1. A diet containing 50 IU of vitamin E will have a ratio of $\geq$ 0.6:1 when the PUFA content is 83 grams or less. Diets containing more than 83 grams of PUFA should contain an additional 0.6 IU of vitamin E for every gram of PUFA.

[h] Because processing may destroy up to 90% of the thiamine in the diet, allowances in formulation should be made to ensure the minimum nutrient concentration for thiamine is met after processing.

CHANGES TO AND RATIONALE FOR NUTRIENT CONCENTRATIONS - DOG FOODS

CALORIC DENSITY

The 2007 AAFCO Canine Nutrition Expert Subcommittee (CNES) chose to set the presumed caloric density for dog food products at 4000 kcal metabolizable energy (ME) per kilogram (kg) dry matter (DM) for both the nutrient concentrations per kg DM and the nutrient amounts per 1000 kcal ME in order to be consistent with the presumed caloric density used in the 2006 *Nutrient Requirements of Dogs and Cats*[1] and in the current AAFCO Cat Food Nutrient Profiles. Prior to the 2012 revisions to the Profiles, the presumed caloric density for dog foods was set at 3500 kcal ME/kg DM for nutrient concentrations per kg DM and at 4500 kcal ME/kg DM for nutrient amounts per 1000 kcal ME, although mathematical conversion between the two tables was accomplished using 3500 kcal/kg DM as the caloric density. The presumed caloric density is not a minimum or a maximum content that a product must meet to reference the profile, but it does dictate the factor used to convert between expressions of nutrient content per kg DM versus per 1000 kcal ME and the minimum concentrations of required nutrients in complete and balanced products. Because the denominator for converting from concentrations per kg DM to amounts per 1000 kcal ME has increased from 3.5 to 4.0, values in the per 1000 kcal ME table in some instances may appear less than corresponding values listed prior to 2012 even though DM concentrations may not have changed or even increased slightly. Corrections to amounts of nutrients in formulations differing in caloric density from the presumed value of 4000 kcal ME/kg DM are discussed below.

PROTEIN

The minimum concentration of protein for growth and reproduction was increased slightly from 22% to 22.5% DM consistent with the RA for growth established by the 2006 NRC.[1] The minimum concentration in the AAFCO Dog Food Nutrient Profile for Adult Maintenance was not changed from the previous value of 18%.

The CNES established minimum recommended amounts for the essential amino acids methionine and phenylalanine consistent with the RA proposed by the NRC in addition to the previous minimum recommended amounts of methionine plus cystine

and phenylalanine plus tyrosine. The CNES felt it prudent to include specific minimums for methionine and phenylalanine because although some, or all, of the requirement for cystine and tyrosine can be met from excess methionine and phenylalanine, respectively, the reverse is not true. Some of the previous recommendations for dietary concentrations of essential amino acids in the Dog Food Nutrient Profile for Adult Maintenance (i.e., histidine, lysine, threonine and tryptophan) were greater than the corresponding RA in the 2006 NRC and the CNES elected to retain the previously recommended amounts for these amino acids in the current Dog Food Nutrient Profile for Adult Maintenance.

Minimum concentrations of some essential amino acids in the Dog Food Nutrient Profile for Growth and Reproduction were increased, usually to match the NRC RA for growth (i.e., arginine, leucine, methionine, methionine-cystine, phenylalanine-tyrosine and valine). Although the NRC RA for total crude protein during lactation is essentially identical to the RA for growth (22.0% versus 22.5%), several of the RA for essential amino acids during lactation are greater than the RA for growth. In some cases (i.e., histidine, isoleucine, lysine, phenylalanine, and threonine) the difference was small and the CNES elected to set the recommended amount in the Growth and Reproduction Profile at the larger NRC RA for lactation. For other essential amino acids (i.e., leucine and valine) the RA proposed by the NRC for lactation is substantially more than the RA for growth, and in the case of leucine and valine the concentrations are equal to, or greater than, the corresponding RA for the cat during lactation, an obligate carnivore with protein requirements generally greater than those for the dog. The NRC ad hoc committee indicated that it set the RA based on, "lowest concentrations of each of the essential amino acids from digestible protein in commercial dry expanded diets that have been shown to sustain normal gestation and lactation for bitches."[1] The CNES chose not to increase the recommended concentrations for leucine and valine to those of the NRC RA for lactation based on lack of documented problems with the previous concentrations in the AAFCO Dog Food Nutrient Profile for Growth and Reproduction and the relative disparity in the RA between canine versus feline protein requirements. The CNES did not elect to change the tryptophan concentration in the Dog Food Nutrient Profile for Growth and Reproduction for two reasons. The CNES had access to feeding studies and a publication showing that the minimum requirement for tryptophan in Labrador retriever puppies was less than the current concentration in AAFCO Dog Food Nutrient Profile for Growth and Reproduction and that the tryptophan concentration of 0.2% DM already provided approximately a 25% safety margin.[6] The CNES was also aware that it was nearly impossible to formulate a product at the minimum protein concentration to contain more than 0.2% tryptophan on a DM basis from typical ingredients without including crystalline tryptophan in the formula.

Insufficient data were available to demonstrate detrimental effects of high protein intake in the normal dog to allow for any definitive maximum concentrations for protein or amino acids to be established. The CNES is aware of the findings regarding excess lysine at some concentration between 2.0% and 4.0% lysine/kg DM to produce depression in growth of puppies and clinical signs associated with arginine deficiency when arginine is present at 0.4% DM, and that FEDIAF has established a concentration of 2.8% lysine in DM as a maximum.[3,7] However, this information was available prior to the establishment of the original AAFCO Nutrient Profiles and did not result in a maximum lysine content being established by the 1990 Expert Subcommittee. Furthermore, the 2007 CNES notes that the minimum recommended arginine content for growth and reproduction is 2.5 times the concentration of 0.4% arginine/kg DM required to produce the noted adverse effects in combination with lysine at more than 2.0%/kg DM.

FAT/FATTY ACIDS

The CNES increased the minimum recommended amount for total fat in the AAFCO Dog Food Nutrient Profiles by 0.5% to 8.5% for Growth and Reproduction and 5.5% for Adult Maintenance. These concentrations are consistent with the RA for total fat in the 2006 NRC and the FEDIAF Guidelines. The CNES also increased the minimum recommended linoleic acid concentration in the Growth and Reproduction Profile from 1.0% to 1.3% and in the Adult Maintenance Profile from 1.0% to 1.1%, again consistent with the RA in the 2006 NRC. The CNES did not set a minimum recommended concentration for arachidonic acid in either profile, but did establish minimum recommended concentrations for some fatty acids in the n-3 (omega-3) series in the Growth and Reproduction Profile, specifically, alpha-linolenic acid at 0.08%, and the combination of eicosapentaenoic plus docosahexaenoic acids at 0.05%, of DM. Because the scientific evidence to date indicates that these n-3 fatty acids are needed for the development of the nervous and visual systems during fetal and neonatal life stages, the CNES did not feel there was scientific justification for setting minimum recommended concentrations for n-3 fatty acids for adult maintenance. A recommendation in a comment to list quantities of alpha-linolenic acid and eicosapentaenoic plus docosahexaenoic acids for adult maintenance as being not determined (ND) was accepted by the AAFCO Pet Food Committee.

The CNES did not establish maximum concentrations for fat or fatty acids despite the NRC listing a safe upper limit (SUL) for total crude fat, linoleic acid, and the combination of eicosapentaenoic plus docosahexaenoic acids. The CNES felt it likely that insufficiencies in other nutrients will occur in a conventional formula before an inclusion of 33% crude fat in DM is reached. Also, although some differences in delayed hypersensitivity reactions were noted in studies cited by the NRC as the basis for setting the SUL for eicosapentaenoic plus docosahexaenoic acids, the 2007 CNES noted that those differences are not unequivocally undesirable or detrimental.[8,9] The CNES did elect to set a maximum for the ratio of the sum of linoleic plus arachidonic acids to the sum of alpha-linolenic, eicosapentaenoic, and docosahexaenoic acids at 30:1 given the modulating effects of n-3 fatty acids on n-6 metabolism and the predominant contribution of these fatty acids to the n-6 and n-3 fatty acid contents, respectively, in conventional dog food formulas.

CALCIUM & PHOSPHORUS

The CNES decreased the recommended minimum concentration of calcium and phosphorus in the Adult Maintenance Profile by 0.1% to 0.5% and 0.4%, respectively. The current recommended minimum concentrations are 0.1% more than the RA for calcium and phosphorus on a DM basis for adult maintenance in the 2006 NRC but consistent with the concentrations in the FEDIAF Guidelines. The CNES recommended that the calcium and phosphorus in growth formulas for the large breed or large size dogs (those breeds typically attaining lean adult body weights of 70 pounds or more) be allowed to decrease to 0.9% and 0.75%, respectively, while still being judged to meet the Growth and Reproduction Nutrient Profile. However, based on comments and a publication[10] demonstrating that some diets containing 0.88% to 1.04% Ca on a DM basis (2.2 to 2.6 g Ca/1000 kcal ME) when fed to medium or large breed puppies produced inhibited growth in 10-week growth studies compared to diets containing between 1.3 to 1.8% Ca, the AAFCO Pet Food Committee elected to keep the minimum recommended calcium and phosphorus concentrations in the Growth and Reproduction Nutrient Profile at 1.2% and 1.0%, respectively, for all dog food products that substantiate nutritional adequacy based on being formulated to meet the nutrient content of the Dog Food Nutrient Profile for Growth and Reproduction.

Because of concerns for excess calcium to produce detrimental effects in growing dogs of large and giant breeds,[11-13] the 2007 CNES deemed that additional restriction to

the maximum limit for calcium was warranted for large size growth formulations and lowered the maximum calcium concentration to 1.8% DM for these products. The CNES did not believe it necessary to decrease the previous maximum calcium concentration of 2.5% for adult dogs or growing dogs of small or moderate size breeds, and retained the maximum of 2.5% for the adult maintenance products as well as gestation/lactation products and growth products for small and moderate size breeds of dogs. The AAFCO Pet Food Committee discussed and considered the proposal at length for having two maximum calcium concentrations applicable to different products. The Pet Food Committee notes that unless a product's labeling restricts the product to specific breeds, products bearing an All Life Stages claim based on the product being formulated to meet the AAFCO Dog Food Nutrient Profile for Growth and Reproduction should not contain more than 1.8% calcium on a DM basis. The CNES retained the maximum phosphorus concentration of 1.6% DM for both profiles, as well as the minimum and maximum values of 1:1 and 2:1, respectively, for the calcium to phosphorus ratio.

OTHER MACROMINERALS

POTASSIUM

The 2007 CNES elected to retain the recommended minimum potassium concentration at 0.6% DM for both Profiles. Although the RA in the 2006 NRC and some concentrations in the FEDIAF Guidelines are less than 0.6% DM for potassium, the CNES felt that the potassium concentration did not warrant changing especially given that potential toxicosis of potassium was not a practical concern. Thus, a maximum concentration for potassium was not established.

SODIUM & CHLORIDE

The 2007 CNES did not change the minimum recommendation for sodium or chloride in the Growth and Reproduction Nutrient Profile as the values are slightly above the 2006 NRC RA. The 2007 CNES made an editorial increase in the recommended minimum concentrations for sodium and chloride in the Adult Maintenance Nutrient Profile to match the 2006 NRC RA. For sodium the increase was from 0.06% to 0.08% DM and for chloride from 0.09 to 0.12% DM. The recommended minimum concentrations for sodium and chloride in both dog food nutrient profiles continue to reflect the 1:1.5 sodium to chloride ratio of salt previously used by the 1990 CNES to justify recommended chloride concentrations. As noted by the 1990 CNES, because palatability and food consumption would decline due to excess sodium before adverse health effects were observed, setting a maximum concentration for sodium was not of practical concern.

MAGNESIUM

The 2007 CNES increased the minimum recommended concentration for magnesium from 0.04 to 0.06% in Adult Maintenance and Growth and Reproduction Nutrient Profiles to match the 2006 NRC RA for adult maintenance and peak lactation, respectively. The 2007 CNES deleted the maximum recommended concentration for magnesium due to lack of data specific to dogs in both the 2006 NRC and the 2005 *Mineral Tolerances of Animals*. The only comment regarding maximum magnesium content in the 2006 NRC was that a SUL for magnesium in the diets of dogs was greater than 1.7% DM.

MICROMINERALS

IRON

The 2007 CNES made an editorial change to the minimum concentration for iron in the Growth and Reproduction Nutrient Profile to make the concentration consistent with a presumed caloric density of 4000 kcal ME/kg DM which makes the recommended concentration consistent with the RA from the 2006 NRC and the FEDIAF Guidelines

for same life stages. The 2007 CNES decreased the recommendation for adult maintenance from 80 to 40 mg/kg DM based on considerations that the RA of the 2006 NRC was 30 mg/kg DM and the FEDIAF Guidelines concentration was 36 mg/kg DM. The 2007 CNES deleted the maximum concentration for iron based on one scientific and one practical regulatory consideration. First, the 2006 NRC indicated that appropriate data for setting a SUL for iron in dog foods are not available. The previous maximum concentration was stated to be based on tolerance data in swine. The 2005 *Mineral Tolerance of Animals* indicated that the listed tolerance of 3000 mg/kg DM for swine needed to be confirmed by long-term studies and all other tolerances for iron listed in that publication are 6 times less than 3000 mg/kg DM. Second, the implied safety of a maximum concentration presumes some amount of apparent digestibility and, as noted above, the apparent digestibility of iron in any given diet or combination of ingredients can vary from less than 10% to near 100%. Some sources of iron are considered unavailable and used for their technical effects (i.e., color) on the product and not for their nutrient contribution of iron to the animal. Such unavailable sources will still contribute iron to an analytical result for determining product content, and thus a maximum concentration set for available sources of iron might prohibit use of unavailable sources for coloring, whereas a maximum concentration set for unavailable colorants might permit use of unsafe amounts of available sources on the basis of analytical content. Thus, the 2007 CNES elected to delete the previous maximum of 3000 mg/kg DM and not list any other value as a maximum for iron. Manufacturers should note that iron is toxic at some amount greater than the recommended quantities, but the exact amount is unknown for dogs.

COPPER

The minimum concentration for copper in the Adult Maintenance Nutrient Profile was not changed from the previous amount of 7.3 mg/kg DM, the concentration being consistent with that of the FEDIAF Guidelines and slightly more than the 2006 NRC RA of 6.0 mg/kg. The 2007 CNES increased the minimum recommended concentration in the Growth and Reproduction Nutrient Profile to 12.4 mg/kg DM, consistent with the 2006 NRC RA for peak lactation and slightly more than FEDIAF Guidelines and the NRC RA for growth. Because of poor bioavailability, the use of copper oxide as a nutritional source is excluded.[14] The 2007 CNES deleted the copper maximum concentration for many of the same science-based reasons cited above for deleting the maximum for iron content.

MANGANESE

The minimum concentration for manganese in the Adult Maintenance Nutrient Profile was not changed from the previous amount of 5.0 mg/kg DM, the amount being slightly more than the 2006 NRC RA of 4.8 and slightly less than the FEDIAF Guidelines of 5.6 mg/kg DM. The 2007 CNES increased the minimum recommended concentration in the Growth and Reproduction Nutrient Profile to 7.2 mg/kg DM, consistent with the 2006 NRC RA for peak lactation and slightly more than FEDIAF Guidelines concentrations and NRC RA for growth.

ZINC

The 2006 NRC RA for zinc in growth, reproduction, and adult maintenance formulations was less than the previous concentration in the Dog Food Nutrient Profiles of 120 mg/kg DM and the 2007 CNES decreased the recommended minimum concentration to 100 mg/kg DM in the Growth and Reproduction Nutrient Profile and to 80 mg/kg DM in the Adult Maintenance Nutrient Profile consistent with the 2006 NRC RA and FEDIAF Guidelines concentrations. Both the 2005 *Mineral Tolerance of Animals* and the 2006 *Nutrient Requirements of Dogs and Cats* state there is not enough data available to set a tolerance or SUL for zinc in dog foods. The 2007 CNES elected to delete the previous maximum concentration of 1000 mg/kg DM that was based on the

maximum tolerance concentration recommended for swine rations. The CNES noted that the swine tolerance of 1000 mg/kg DM was the greatest concentration for any tolerance for zinc listed in the 2005 *Mineral Tolerance of Animals.*

IODINE

The 2006 NRC RA for iodine in dog foods is 0.88 mg/kg DM. The FEDIAF Guideline concentrations range from 0.9 to 1.5 mg/kg DM. In considering the basis for these various recommended concentrations the 2007 CNES felt a recommended minimum concentration of 1.0 mg/kg to be prudent and adequate to support adult maintenance as well as growth and reproduction.

The 2007 CNES revised the maximum concentration for iodine based on the following considerations. Although neither the 2005 *Mineral Tolerances for Animals* nor the 2006 *Nutrient Requirements of Dogs and Cats* established a tolerance or SUL for iodine in diets for dogs, both publications cite data that indicate a commercial formulation containing 5.6 mg iodine/kg diet had adverse effects on thyroid function.[15,16] FEDIAF also notes these studies, but faulted the studies for using a diet deficient in calcium, phosphorus and potassium, and fed in excessive quantities. The 2008 FEDIAF Guidelines indicate a maximum concentration for iodine of 11 mg/kg DM when other minerals are within acceptable concentrations and the products are fed in appropriate quantities. The tolerances for iodine in the 2005 *Mineral Tolerances of Animals* that have been established for various species range from 5 mg/kg DM in diets for horses to 400 mg/kg DM in diets for swine. Given that the NRC tolerance for horses is 10 times less than the general maximum concentration of 50 mg iodine/kg DM recommended by AAFCO, the 2007 CNES felt the value of 50 mg/kg DM to no longer be appropriate for setting a maximum concentration for iodine in dog foods. The 2007 CNES acknowledges that additional studies may allow further refinement of a maximum amount of iodine in foods for dogs, but until such data are available the CNES felt it prudent to adopt the FEDIAF position and set 11 mg iodine per kg DM as the maximum concentration of iodine in dog foods.

SELENIUM

The recommended minimum concentration of selenium was increased to 0.35 mg/kg DM in Adult Maintenance and Growth and Reproduction Nutrient Profiles consistent with the 2006 NRC RA for selenium. The 2007 CNES notes there is a difference between added selenium and total selenium content. The approval of food additives for addition of selenium to animal feeds limits the total amount of selenium that may be added to feed to 0.3 mg/kg from all approved sources on an as-fed basis (90% DM feeds), roughly equivalent to 0.333 mg/kg on a DM basis. The recommended minimum concentration of 0.35 mg selenium/kg DM in dog foods is the sum of selenium from all ingredients in the product, both approved food additives used specifically to add selenium to the product, as well as selenium contained as a constituent of other ingredients. As there is generally more than 0.05 mg selenium/kg DM in ingredients used to supply protein and fat to typical pet food formulations, the 2007 CNES believes the limitation of 0.3 mg selenium/kg DM from approved selenium additives will not hinder a manufacturer's ability to meet the minimum recommended concentration of 0.35 mg selenium/kg DM.

Both the 2006 NRC and the 2005 *Mineral Tolerance of Animals* state no data are available upon which to establish a SUL or tolerance for selenium in diets for dogs. Both NRC publications cite the fifth edition of *Trace Elements in Human and Animal Nutrition* published in 1986 for information indicating a dietary concentration of 5 mg/kg DM resulted in toxicity in dogs.[17] The 2007 CNES acknowledges the NRC has indicated in the years since the publication of the first edition of *Mineral Tolerance of Domestic Animals* set a tolerance of 2.0 mg of selenium per kg DM for all species in 1980 that the value has been challenged as an underestimate of the true tolerance for several species,

and that during 1980 to 2005 greater tolerances for selenium have been established for some species. Although the true tolerance for dogs may be greater than 2, but less than 5, mg selenium/kg DM, the 2007 CNES believes it to be prudent to retain the maximum concentration for selenium at 2.0 mg/kg DM until such time as empirical data permit a greater and more definitive maximum to be established.

VITAMINS

The 2007 CNES did not believe there were data sufficient to change any of the recommended minimum concentrations for the fat soluble vitamins or the maximum concentration for vitamin A. The 2007 CNES decreased the maximum vitamin D concentration in consideration of the SUL and maximums set by the 2006 NRC and FEDIAF Guidelines based on the studies conducted by Tryfondidou et al.[18,19] The maximum vitamin D concentration was reduced to 3000 IU/kg DM (750 IU/1000 kcal ME) which is 6 times the recommended minimum concentration and 1000 IU/kg less than the amount shown to produce disruption of endochondrial ossification in growing Great Dane puppies. The 2007 CNES noted that the 2006 *Nutrient Requirements of Dogs and Cats* had not established a SUL for vitamin E based on there being no information on vitamin E toxicity in dogs, and so deleted the maximum concentration for vitamin E in the Dog Food Nutrient Profiles. The 2007 CNES increased the minimum concentrations of thiamine, riboflavin and pyridoxine consistent with the RA of the 2006 NRC. For pantothenic acid, niacin, folic acid, vitamin B_{12} and choline, the 2007 CNES elected to set the recommended concentrations in the AAFCO Dog Food Nutrient Profiles equal to the 2006 NRC adequate intake (AI) recommendation based on indications that the AI already provided a margin of safety above the minimum requirements for these compounds.

AAFCO CAT FOOD NUTRIENT PROFILES
BASED ON DRY MATTER [a]

Nutrients	**Units DM Basis**	**Growth & Reproduction Minimum**	**Adult Maintenance Minimum[b]**	**Maximum**
Crude Protein	%	30.0	26.0	
Arginine	%	1.24	1.04	
Histidine	%	0.33	0.31	
Isoleucine	%	0.56	0.52	
Leucine	%	1.28	1.24	
Lysine	%	1.20	0.83	
Methionine	%	0.62	0. 20	1.5
Methionine-cystine	%	1.10	0.40	
Phenylalanine	%	0.52	0.42	
Phenylalanine-tyrosine	%	1.92	1.53	
Threonine	%	0.73	0.73	
Tryptophan	%	0.25	0.16	1.7
Valine	%	0.64	0.62	
Crude Fat [c]	%	9.0	9.0	
Linoleic acid	%	0.6	0.6	
alpha-Linolenic acid	%	0.02	ND[d]	

Arachidonic acid	%	0.02	0.02	
Eicosapentaenoic + Docosahexaenoic acid	%	0.012	ND[d]	
Minerals				
Calcium	%	1.0	0.6	
Phosphorus	%	0.8	0.5	
Potassium	%	0.6	0.6	
Sodium	%	0.2	0.2	
Chloride	%	0.3	0.3	
Magnesium [e]	%	0.08	0.04	
Iron [f]	mg/kg	80	80	
Copper (extruded) [g]	mg/kg	15	5	
Copper (canned) [g]	mg/kg	8.4	5	
Manganese	mg/kg	7.6	7.6	
Zinc	mg/kg	75	75	
Iodine	mg/kg	1.8	0.6	
Selenium	mg/kg	0.3	0.3	
Vitamins & Others				
Vitamin A	IU/kg	6668	3332	333300
Vitamin D	IU/kg	280	280	30080
Vitamin E [h]	IU/kg	40	40	
Vitamin K [i]	mg/kg	0.1	0.1	
Thiamine [j]	mg/kg	5.6	5.6	
Riboflavin	mg/kg	4.0	4.0	
Pantothenic acid	mg/kg	5.75	5.75	
Niacin	mg/kg	60	60	
Pyridoxine	mg/kg	4.0	4.0	
Folic acid	mg/kg	0.8	0.8	
Biotin [k]	mg/kg	0.07	0.07	
Vitamin B_{12}	mg/kg	0.020	0.020	
Choline	mg/kg	2400	2400	
Taurine (extruded)	%	0.10	0.10	
Taurine (canned)	%	0.20	0.20	

[a] Presumes an energy density of 4000 kcal ME/kg as determined in accordance with Regulation PF9. Formulations greater than 4000 kcal ME/kg should be corrected for energy density; formulations less than 4000 kcal ME/kg should not be corrected for energy. Formulations of low-energy density should not be considered adequate for growth or reproductive needs based on comparison to the Profiles alone.

[b] Recommended concentrations for maintenance of body weight at an average caloric intake for cats of a given optimal weight.

[c] Although a true requirement for crude fat per se has not been established, the minimum concentration was based on recognition of crude fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability, and to supply an adequate caloric density.

[d] ND – Not Determined.

[e] If the mean urine pH of cats fed *ad libitum* is not below 6.4, the risk of struvite urolithiasis increases as the magnesium content of the diet increases.

[f] Because of very poor bioavailability, iron from carbonate or oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration.

[g] Because of very poor bioavailability, copper from oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration.

[h] Add 10 IU Vitamin E above the minimum concentration for each gram of fish oil per kilogram of diet.

[i] Vitamin K does not need to be added unless the diet contains more than 25% fish on a dry matter basis.

[j] Because processing and specific ingredients may destroy up to 90% of the thiamine in the diet, allowances in formulation should be made to ensure the minimum nutrient concentration is met after processing.

[k] Biotin does not need to be added unless the diet contains antimicrobial or anti-vitamin compounds.

AAFCO CAT FOOD NUTRIENT PROFILES
BASED ON CALORIE CONTENT

Nutrients	**Units per 1000 kcal ME**	**Growth & Reproduction Minimum**	**Adult Maintenance Minimum[a]**	**Maximum**
Crude Protein	g	75	65	
Arginine	g	3.10	2.60	
Histidine	g	0.83	0.78	
Isoleucine	g	1.40	1.30	
Leucine	g	3.20	3.10	
Lysine	g	3.00	2.08	
Methionine	g	1.55	0.5	3.75
Methionine-cystine	g	2.75	1.00	
Phenylalanine	g	1.30	1.05	
Phenylalanine-tyrosine	g	4.80	3.83	
Threonine	g	1.83	1.83	
Tryptophan	g	0.63	0.40	4.25
Valine	g	1.55	1.55	
Crude Fat [b]	g	22.5	22.5	
Linoleic acid	g	1.40	1.40	
alpha-Linolenic acid	g	0.05	ND[c]	
Arachidonic acid	g	0.05	0.05	
Eicosapentaenoic + Docosahexaenoic acid	g	0.03	ND[c]	
Minerals				
Calcium	g	2.5	1.5	
Phosphorus	g	2.0	1.25	
Potassium	g	1.5	1.5	
Sodium	g	0.5	0.5	
Chloride	g	0.75	0.75	

Magnesium [d]	g	0.20	0.10	
Iron [e]	mg	20.0	20.0	
Copper (extruded) [f]	mg	3.75	1.25	
Copper (canned) [f]	mg	2.10	1.25	
Manganese	mg	1.90	1.90	
Zinc	mg	18.8	18.8	
Iodine	mg	0.45	0.15	
Selenium	mg	0.075	0.075	
Vitamins & Others				
Vitamin A	IU	1667	833	83325
Vitamin D	IU	70	70	7520
Vitamin E [g]	IU	10	10	
Vitamin K [h]	mg	0.025	0.025	
Thiamine [i]	mg	1.40	1.40	
Riboflavin	mg	1.00	1.00	
Pantothenic acid	mg	1.44	1.44	
Niacin	mg	15	15	
Pyridoxine	mg	1.0	1.0	
Folic acid	mg	0.20	0.20	
Biotin [j]	mg	0.018	0.018	
Vitamin B_{12}	mg	0.005	0.005	
Choline	mg	600	600	
Taurine (extruded)	g	0.25	0.25	
Taurine (canned)	g	0.50	0.50	

[a] Recommended concentrations for maintenance of body weight at an average caloric intake for cats of a given optimal weight.

[b] Although a true requirement for crude fat per se has not been established, the minimum concentration was based on recognition of crude fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability, and to supply an adequate caloric density.

[c] ND – Not Determined.

[d] If the mean urine pH of cats fed *ad libitum* is not below 6.4, the risk of struvite urolithiasis increases as the magnesium content of the diet increases.

[e] Because of very poor bioavailability, iron from carbonate or oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration.

[f] Because of very poor bioavailability, copper from oxide sources that are added to the diet should not be considered in determining the minimum nutrient concentration.

[g] Add 10 IU Vitamin E above the minimum concentration for each gram of fish oil per kilogram of diet.

[h] Vitamin K does not need to be added unless the diet contains more than 25% fish on a dry matter basis.

[i] Because processing and specific ingredients may destroy up to 90% of the thiamine in the diet, allowances in formulation should be made to ensure the minimum nutrient concentration is met after processing.

[j] Biotin does not need to be added unless the diet contains antimicrobial or anti-vitamin compounds.

CHANGES TO AND RATIONALE FOR NUTRIENT CONCENTRATIONS - CAT FOODS

CALORIC DENSITY

The 2007 AAFCO Feline Nutrition Expert Subcommittee (FNES) retained the presumed caloric density for cat food products at 4000 kcal ME/kg DM for both the nutrient concentrations per kg DM and the nutrient amounts per 1000 kcal ME. As discussed below and in the footnotes to the Tables of the AAFCO Cat Food Nutrient Profiles, products with a caloric density greater than 4000 kcal ME/kg should have nutrient concentrations corrected for energy density. Nutrient concentrations in products with energy densities less than 4000 kcal ME/kg should not be corrected.

PROTEIN

The 2007 FNES did not change the minimum concentrations of crude protein in the Cat Food Nutrient Profiles, the current values being equal to or greater than the corresponding 2006 NRC RA and FEDIAF Guidelines.[1,3] The FNES made modifications to concentrations for some essential amino acids to bring the recommended concentrations in line with the RA in the 2006 NRC and the FEDIAF Guidelines. Minor increases between 0.02 to 0.04% in amounts of histidine, isoleucine and leucine were made in the Growth and Reproduction Profile. The amount for methionine and methionine plus cystine was decreased for adult maintenance. Significant increases were made to the recommended phenylalanine and phenylalanine plus tyrosine concentrations to bring the recommendations in line with the RA in the 2006 NRC which are based on studies establishing the requirements for maximum nitrogen retention and black hair color.[20,21]

Because of work showing an adverse effect of high concentrations of methionine, the maximum concentration of 1.5% was retained.[22] The FNES also set a maximum of 1.7% for tryptophan based on the work of Herwill and the recommendations in the 2006 NRC and FEDIAF Guidelines.[1,3,23]

FAT/FATTY ACIDS

The 2007 FNES retained the minimum recommended concentrations of crude fat at 9% DM and at 0.02% for arachidonic acid. The minimum concentration for linoleic acid was increased to 0.6% in both Cat Food Nutrient Profiles consistent with the corresponding 2006 NRC RA and FEDIAF Guidelines. Similar to the CNES, the FNES established minimum recommended concentrations for some fatty acids in the n-3 (omega-3) series in the Growth and Reproduction Profile, specifically, alpha-linolenic acid at 0.02%, and the combination of eicosapentaenoic plus docosahexaenoic acids at 0.012%, of DM. The FNES notes that the NRC[1] stated no requirement for alpha-linolenic acid in adult cats had been demonstrated and that although a theoretical argument could be made for the adult cat to require eicosapentaenoic plus docosahexaenoic acids on a similar order of magnitude as arachidonic acid given the low delta-6 desaturase activity in the species, no objective data were available to support the establishment of any required concentrations. Although the FNES did not feel there was scientific justification for setting minimum recommended concentrations for n-3 fatty acids for adult cats, a recommendation in a comment to list quantities of alpha-linolenic acid and eicosapentaenoic plus docosahexaenoic acids for adult maintenance as being not determined (ND) was accepted by the AAFCO Pet Food Committee.

MINERALS

The 2007 FNES increased the recommended concentrations for copper in canned formulas in the Growth and Reproduction Nutrient Profile and for iodine and selenium in both Cat Food Nutrient Profiles. The recommended copper concentration in canned

products for growth and reproduction was increased from 5.0 to 8.4 mg/kg DM to match the 2006 NRC RA for gestation and lactation.

For iodine the 2007 FNES increased the recommended concentration in the Growth and Reproduction Nutrient Profile to match the 2006 NRC RA and the FEDIAF Guidelines. The recommended concentration of iodine for adult maintenance was increased based on the work of Wedekind *et al*. and corresponds to the amount recommended in the FEDIAF Guidelines.[24]

The 2007 FNES increased the recommended concentrations for selenium in the Cat Food Nutrient Profiles from 0.1 to 0.3 mg/kg to match the recommendations of the 2006 NRC RA and the FEDIAF Guidelines. The 2007 FNES elected to delete the maximum recommended amount of zinc from the Cat Food Nutrient Profiles noting that the 2006 NRC indicated the safe upper limit of zinc for cats was > 600 mg/kg DM for at least short periods of time and that the swine tolerance of 1000 mg/kg DM was the greatest concentration for any tolerance for zinc listed in the 2005 *Mineral Tolerance of Animals*. The FNES retained the recommended concentrations set by the 1990 FNES for all other minerals in the Cat Food Nutrient Profiles.

VITAMINS & OTHERS

The 2007 FNES decreased the recommended minimum concentrations for vitamins A and D in the Cat Food Nutrient Profiles based on the 2006 NRC RA. The 2007 FNES increased the maximum concentration for vitamin D in the Cat Food Nutrient Profiles based on the work of Sih *et al*. and the SUL in the 2006 NRC.[25]

The 2007 FNES increased the recommended concentration of vitamin E to more closely coincide with the recommendations of the 2006 NRC and the FEDIAF Guidelines. The recommended concentration of vitamin K in diets containing 25% or more DM derived from fish was unchanged from previous values consistent with the FEDIAF Guidelines.

Recommended concentrations of thiamine and pantothenic acid in the Cat Food Nutrient Profiles were increased to match the 2006 NRC RA. The recommended concentrations of the remaining water soluble vitamins and for taurine were unchanged from the previous values, several being equal or greater than the 2006 NRC RA (riboflavin, niacin, pyridoxine, folic acid and taurine) with previous recommended concentrations for biotin, vitamin B12 and choline being between the 2006 NRC AI and RA.

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Correcting for Moisture Content

The values given in the Profiles are listed in terms of dry matter (DM). However, the values listed in the guaranteed analysis on dog and cat food labels are given on an "as is" or "as fed" (AF) basis, and values reported from laboratories may be given on either an AF or DM basis. The difference between a value reported on a DM basis versus an AF basis is proportional to the moisture (water) content of the food. The greater the moisture content of a food, the greater the food's DM values for nutrients would be compared to the corresponding AF values. This discrepancy makes direct comparison between the guaranteed analysis values on a food label and the Profile table values impossible without first correcting one or the other set of values so that both are on an equal-moisture basis.

One method of correcting for moisture is the adjustment of the values listed in the guaranteed analysis or reported from a laboratory on an AF basis to a DM basis before comparing with the Profile values. This is done by dividing each AF value by the proportion of DM in the food [(100 - % moisture)/100]. The examples shown below use the guaranteed analysis values, but these adjustments are equally valid for actual laboratory results reported on an AF basis.

Example A1: A Dry Dog Food Making a Growth Claim
Moisture-Adjusted Guaranteed Analysis Values

Nutrient	Guaranteed Analysis Values	Dog Food Nutrient Profile Minimum Values for Growth	Moisture - Adjusted Guaranteed Analysis Values	Moisture-Adjusted Guaranteed Analysis vs. Profile Values
Crude Protein:	min. 21%	22.5%	23.3%	OK
Crude Fat:	min. 8%	8.5%	8.9%	OK
Crude Fiber:	max. 4%		4.4%	
Moisture:	max. 10%	0%	0%	
Calcium:	min. 1.1%	1.2%	1.2%	OK
Phosphorus:	min. 0.9%	1.0%	1.0%	OK

Directly comparing the guaranteed values in Example A1 for crude protein, crude fat, calcium, and phosphorus to the minimum values for growth given in the Dog Food Nutrient Profile indicates this food would appear to be deficient. However, this comparison is not valid, because the values for the food are listed on a 10% moisture (90% DM) basis, but the Profile values are given on a 0% moisture (100% DM) basis. To put both sets of values on an equal-moisture basis, the guaranteed values were adjusted to 100% DM by dividing each value by the proportion of DM in the food (0.90). With this correction, it becomes apparent that the moisture-adjusted guaranteed analysis values of the reported nutrients do, in fact, meet the minimum recommended concentrations of the Dog Food Nutrient Profile for Growth and Reproduction.

As an alternative method to converting the guaranteed values to a DM basis, the Profile values can be adjusted to match the moisture content of the food. This can be achieved by simply multiplying each Profile value by the proportion of DM in the food (0.9 in example A1). Such calculations yield the following:

Example A2: A Dry Dog Food Making a Growth Claim
Moisture-Adjusted Profile Values

Nutrient	Guaranteed Analysis Values	Dog Food Nutrient Profile Minimum Values for Growth	Moisture-Adjusted Profile Values for Growth	Guaranteed Analysis vs. Moisture-Adjusted Profile Values
Crude Protein:	min. 21%	22.5%	20.25%	OK
Crude Fat:	min. 8%	8.5%	7.65%	OK
Crude Fiber:	max. 4%			
Moisture:	max. 10%	0%	10%	
Calcium:	min. 1.1%	1.2%	1.08%	OK
Phosphorus:	min. 0.9%	1.0%	0.9%	OK

Correcting for Energy Density

The values given in the Profiles presume an energy density of 4000 kcal ME/kg DM. Some dog and cat foods will have energy densities close to this amount. However, many products may have DM energy densities considerably greater than the presumed values. When these more energy-dense products are fed, the dog or cat will require less of the food to meet its caloric requirements. Under these circumstances, the concentrations of the other nutrients in the food should be increased proportionately, so that the dog or cat will receive the needed amount of each nutrient in the smaller amount of food. Therefore, when the energy density of the dog or cat food exceeds 4000 kcal ME/kg DM the nutrient concentrations should be corrected for caloric content before valid comparisons to the appropriate AAFCO Nutrient Profile are made.

Conversely, products could be much lower in energy density than 4000 kcal ME/kg DM. Theoretically, a lower concentration of the other nutrients should be required, assuming that the dog or cat is allowed, and able, to consume enough of the product to meet its caloric needs and that those caloric needs are typical for the average dog or cat of the specific life stage. Because this assumption does not always hold true, the nutrient content should not be decreased in less energy-dense products, that is, the nutrient concentrations in such products should not be corrected for energy density. In fact, if the food is intended to supply significantly fewer calories in somewhat smaller amounts of food than typically consumed by the average weight and specific life stage of the animal, the concentrations of some nutrients per 1000 kcal ME may need to be increased compared to amounts listed in the tables to ensure the animal is provided adequate amounts of those essential nutrients in the quantity of food containing the targeted consumption of daily calories. Furthermore, unless a product meeting the definition for a "lite" or "low calorie" product as specified in Model Regulation PF10 has successfully passed the appropriate AAFCO Feeding Protocols, the product should not be considered adequate for growth or reproduction, regardless of the concentrations of the other nutrients.

The first step in correcting for energy density is to determine the actual energy density of the food. The determination should be done in accordance with Model Regulation PF9. After determining the energy density of the food, the nutrient values can be converted to a per 4000 kcal ME/kg DM or a per 1000 kcal ME basis and compared to the values in the appropriate AAFCO Nutrient Profile.

Example B1: A Canned Cat Food Making a Growth Claim:
Moisture and Energy Adjusted Guaranteed Analysis Values

Nutrient	Guaranteed Analysis Values	Moisture - Adjusted Guaranteed Analysis Values	Moisture & Energy-Adjusted Guaranteed Analysis Values	Growth & Reproduction Cat Food Profile Values per kg DM	Status of Energy Adjusted Guaranteed Analysis vs. Profile Values
Crude Protein:	min. 9%	36%	32.1%	30.0	OK
Crude Fat:	min. 7%	28%	25.0%	9.0	OK
Crude Fiber:	max. 1%				
Moisture:	max. 75%	0%	0%		
Ash:	max. 2%				
Calcium:	min. 0.25%	1.0%	0.89%	1.0	Low
Phosphorus:	min. 0.2%	0.8%	0.71%	0.8	Low
Energy:[a]	1120 kcal ME/kg AF	4480 kcal ME/kg DM	4000 kcal ME/kg DM	4000 kcal ME/kg DM	

[a] Energy = (3.5 x g Crude Protein) + (8.5 x g Crude Fat) + (3.5 x g Nitrogen Free Extract[b] (CHO))
= (3.5 x 90) + (8.5 x 70) + (3.5 x 60) = 1120

[b] % Nitrogen Free Extract = 100- (% Crude Protein + % Crude Fat + % Crude Fiber + % Moisture + % Ash)

A cursory examination of the values listed in the guaranteed analysis compared to the minimum values given in the Cat Food Nutrient Profiles expressed as per kg DM containing 4000 kcal ME revealed that a direct comparison would not be valid. Because the food in Example B1 was 75% moisture (25% DM), the major reason for the discrepancy was likely due to water content. By first dividing the guaranteed values by the proportion of DM (0.25), the moisture-adjusted guaranteed values were derived. Comparing these corrected values with the Profile values, this food appeared to meet the minimums for a growth claim.

However, in this example, direct comparison of the moisture-adjusted guaranteed values with the Profile values was premature. The high DM crude fat content of the food compared to the Profile value (25% vs. 9.0%) was an indication that the food was probably more energy-dense than the Profile value of 4000 kcal ME/kg DM. When calculated, in fact, it was found to be 4480 kcal ME/kg DM (1120 kcal ME/kg AF). Therefore a second adjustment to account for the differences in energy density was warranted. This was achieved by dividing each moisture-adjusted guaranteed value by 4480 (the DM energy density of the food) and then multiplying the result by 4000 (the standard energy density). This second manipulation revealed that the energy-adjusted guaranteed analysis values for the calcium and phosphorus were, in fact, below minimum concentrations for growth.

As demonstrated with the moisture correction methods above, an alternative to correcting the values of the food to meet the Profile energy density is correcting the Profile values to meet the food's energy density. Below, each Profile value was divided by 4000, and the result was multiplied by the appropriate value for energy density (1120 in this example).

Example B2: A Canned Cat Food Making a Growth Claim: Energy Adjusted Profile DM Values

		Cat Food Nutrient		

Nutrient	Guaranteed Analysis Values	Profile Minimum Values for Growth	Energy Adjusted Profile Values	Guaranteed vs. Energy Adjusted Profile Values (Columns 2 vs. 4)
Crude Protein:	min. 9%	30.0%	8.4%	OK
Crude Fat:	min. 7%	9.0%	2.5%	OK
Crude Fiber:	max. 1%			
Moisture:	max. 75%			
Ash:	max. 2%			
Calcium:	min. 0.25%	1.0%	0.28%	Low
Phosphorus:	min. 0.2%	0.8%	0.22%	Low
Energy	1120 kcal ME/kg AF	4000 kcal ME/kg DM	1120 kcal ME/kg AF	

Note that although the energy-adjusted minimum for crude fat calculated out to be 2.5%, a much higher concentration of crude fat (in this case 7%) predefined the higher energy density and dictated the need for energy adjustment in the first place. Because for the most part a higher concentration of crude fat predetermines what the higher energy density will be, the energy-adjusted Profile minimum value for crude fat should always be met and will often be grossly exceeded.

The last method for correcting for energy density is to convert the guaranteed values for the food to a per 1000 kcal basis, and to compare these values with those listed in the appropriate Profile based on Calorie Content. This is accomplished by dividing the AF values in the guaranteed analysis by the AF energy density (1120 kcal ME/kg in this example) and then multiplying the result by 1000 kcal ME/kg. The result is the values appearing in the fourth column of Example B3 below with the conclusion being identical to that reached in Examples B1 and B2 above.

Example B3: A Canned Cat Food Making a Growth Claim:
Energy Adjusted Guaranteed Analysis Values

Nutrient	Guaranteed Analysis Value	Amount per kg (1000 g) As-Fed	Product Amount per 1000 kcal ME	Profile Amount per 1000 kcal ME	Status
Crude Protein	9%	90 g	80.4 g	75	OK
Crude Fat	7%	70 g	62.5 g	22.5	OK
Crude Fiber	1%	10 g			
Moisture	75%	750 g			
Ash	2%	20 g			
Calcium	0.25%	2.5 g	2.2 g	2.5	Low
Phosphorus	0.20%	2.0 g	1.9 g	2.0	Low
Nitrogen Free Extract (CHO)[a]	(8%)	60 g			
Energy[b]		1120 kcal			

[a] % Nitrogen Free Extract = 100- (% Crude Protein + % Crude Fat + % Crude Fiber + % Moisture + % Ash)

[b] Energy = (3.5 x 90) + (8.5 x 70) + (3.5 x 60) = 1120