



NATIONAL
**ANIMAL
NUTRITION**
PROGRAM

FEED COMPOSITION

Part Per Million, Part Per Billion

Feed ingredients contain nutrients

Diets are created with feed ingredients to deliver nutrients required by animals. Knowledge of feed nutrient composition informs how much of each ingredient to include in animal diets. Some nutrients, like minerals and vitamins, are described as “micro-nutrients.” The relatively low concentration of these nutrients in the diet, along with relatively low requirements for these nutrients by the animal, means they may be expressed using units that include part per million or part per billion. Even within the mineral category, some are provided a relatively high concentration (termed ‘macro-minerals’), but many are at low concentrations (termed ‘micro-minerals’).

“A part or amount in relation to a whole”

Part per million (noun)

Unit of proportion; one (1) part per one million (1,000,000) parts; accompanies a specific number indicated by the acronym **ppm**

Part per million expressed as a fraction or number:

$$\frac{1 \text{ mg}}{1,000,000 \text{ mg}} = \frac{1 \text{ mg}}{1,000 \text{ g}} = \frac{1 \text{ mg}}{1 \text{ kg}} = 1 \text{ ppm}$$

Part per billion (noun)

Unit of proportion; one (1) part per one billion (1,000,000,000) parts; accompanies a specific number indicated by the acronym **ppb**

Part per billion expressed as a fraction or number:

$$\frac{1 \text{ } \mu\text{g}}{1,000,000,000 \text{ } \mu\text{g}} = \frac{1 \text{ } \mu\text{g}}{1,000 \text{ g}} = \frac{1 \text{ } \mu\text{g}}{1 \text{ kg}} = 1 \text{ ppb}$$

Operations with smaller and smaller concentrations

Sorghum grain (selected from the NANP Feed Composition Databases) contains:

$$39.42 \text{ ppm iron (as-fed)} = \frac{39.42 \text{ mg iron}}{1 \text{ kg as-fed}}$$

The amount of iron contained within 1701 kg (as-fed) of sorghum grain, dry is:

$$1,701 \text{ kg as-fed sorghum grain} \times 39.42 \text{ ppm} = \frac{39.42 \text{ mg iron}}{1,701 \times 1 \text{ kg as-fed}} =$$
$$67,053.42 \text{ mg iron (as-fed)} \times \frac{1 \text{ g}}{1,000 \text{ mg}} = 67.1 \text{ g iron (as-fed)}$$

Example #1: Animal Feeding

Nutrient amount in relation to animal's requirement

For adult cats at maintenance, the recommended daily allowance of thiamin (NRC, 2006) is:

$$\frac{5.6 \text{ mg thiamin}}{1 \text{ kg dry matter}} = 5.6 \text{ ppm thiamin (dry matter-basis)}$$

The daily metabolizable energy (ME) intake of 5-kg body mass adult cat at maintenance (NRC, 2006) is:

$$\frac{100 \text{ kcal ME}}{1 \text{ kg BW}} \times 5^{0.67 \text{ kg}} = 294 \text{ kcal ME}$$

The dry matter intake of an adult cat consuming a diet containing 4,000 kcal ME/kg DM (NRC, 2006) will be:

$$294 \text{ kcal ME} \times \frac{1 \text{ kg DM}}{4,000 \text{ kcal ME}} = 0.074 \text{ kg dry matter}$$

The daily intake of thiamin (mg) necessary to satisfy the recommended daily allowance for adult cats at maintenance is:

$$\begin{aligned} 5.6 \text{ ppm thiamin (dry matter basis)} &= \frac{5.6 \text{ mg thiamin}}{1 \text{ kg dry matter}} \times 0.074 \text{ kg dry matter} \\ &= 4.144 \text{ mg thiamin} \end{aligned}$$

Example #2: Feed Manufacturing

Ingredient amount in relation to whole batch

A finished formula requires 100 ppm Zn (as-fed) as zinc oxide (78% Zn). Two-ton (4,000 lbs) batch of the formula:

$$4,000 \text{ lbs} \times \frac{1 \text{ kg}}{2.205 \text{ lbs}} = 1,814.06 \text{ kg formula diet (conversion to kg for ease of calculation)}$$

requires addition of:

$$1,814.06 \text{ kg} \times 100 \text{ ppm Zn} = 1,814.06 \text{ kg} \times \frac{100 \text{ mg Zn}}{1 \text{ kg}} = 181,406 \text{ mg Zn}$$

$$181,406 \text{ mg Zn} \times \frac{100 \text{ mg zinc oxide}}{78 \text{ mg Zn}} = 232,572 \text{ mg zinc oxide}$$

$$232,572 \text{ mg zinc oxide} \times \frac{1 \text{ g}}{1,000 \text{ mg}} = 232.6 \text{ g zinc oxide}$$