

ENVIRONMENTAL CONTAMINANTS ENCYCLOPEDIA

BENZO(B)FLUORANTHENE ENTRY

July 1, 1997

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Like a library or most large databases (such as EPA's national STORET water quality database), this document contains information of variable quality from very diverse sources. In compiling this document, mistakes were found in peer reviewed journal articles, as well as in databases with relatively elaborate quality control mechanisms [366,649,940]. A few of these were caught and marked with a "[sic]" notation, but undoubtedly others slipped through. The [sic] notation was inserted by the editors to indicate information or spelling that seemed wrong or misleading, but which was nevertheless cited verbatim rather than arbitrarily changing what the author said.

Most likely additional transcription errors and typos have been added in some of our efforts. Furthermore, with such complex subject matter, it is not always easy to determine what is correct and what is incorrect, especially with the "experts" often disagreeing. It is not uncommon in scientific research for two different researchers to come up with different results which lead them to different conclusions. In compiling the Encyclopedia, the editors did not try to resolve such conflicts, but rather simply reported it all.

It should be kept in mind that data comparability is a major problem in environmental toxicology since laboratory and field methods are constantly changing and since there are so many different "standard methods" published by EPA, other federal agencies, state agencies, and various private groups. What some laboratory and field investigators actually do for standard operating practice is often a unique combination of various standard protocols and impromptu "improvements." In fact, the interagency task force on water methods concluded that [1014]:

It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...

No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

Differences in field and laboratory methods are also major issues related to (the lack of) data comparability from media other than water: soil, sediments, tissues, and air.

In spite of numerous problems and complexities, knowledge is often power in decisions related to chemical contamination. It is therefore often helpful to be aware of a broad universe of conflicting results or conflicting expert opinions rather than having a portion of this information arbitrarily censored by someone else. Frequently one wants to know of the existence of information, even if one later decides not to use it for a particular application. Many would like to see a high percentage of the information available and decide for themselves what to throw out, partly because they don't want to seem uninformed or be caught by surprise by potentially important information. They are in a better position if they can say: "I knew about that data, assessed it based on the following quality assurance criteria, and decided not to use it for this application." This is especially true for users near the end of long decision processes, such as hazardous site cleanups, lengthy ecological risk assessments, or complex natural resource damage assessments.

For some categories, the editors found no information and inserted the phrase "no information found." This does not necessarily mean that no information exists; it

simply means that during our efforts, the editors found none. For many topics, there is probably information "out there" that is not in the Encyclopedia. The more time that passes without encyclopedia updates (none are planned at the moment), the more true this statement will become. Still, the Encyclopedia is unique in that it contains broad ecotoxicology information from more sources than many other reference documents. No updates of this document are currently planned. However, it is hoped that most of the information in the encyclopedia will be useful for some time to come even with out updates, just as one can still find information in the 1972 EPA Blue Book [12] that does not seem well summarized anywhere else.

Although the editors of this document have done their best in the limited time available to insure accuracy of quotes as being "what the original author said," the proposed interagency funding of a bigger project with more elaborate peer review and quality control steps never materialized.

The bottom line: The editors hope users find this document useful, but don't expect or depend on perfection herein. Neither the U.S. Government nor the National Park Service make any claims that this document is free of mistakes.

The following is one chemical topic entry (one file among 118). Before utilizing this entry, the reader is strongly encouraged to read the README file (in this subdirectory) for an introduction, an explanation of how to use this document in general, an explanation of how to search for power key section headings, an explanation of the organization of each entry, an information quality discussion, a discussion of copyright issues, and a listing of other entries (other topics) covered.

See the separate file entitled REFERENC for the identity of numbered references in brackets.

HOW TO CITE THIS DOCUMENT: As mentioned above, for critical applications it is better to obtain and cite the original publication after first verifying various data quality assurance concerns. For more routine applications, this document may be cited as:

Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese, and W. Basham. 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed within the Federal Government as an Electronic Document (Projected public availability

on the internet or NTIS: 1998).

Benzo(b)fluoranthene (Benzofluoranthene, 3,4-; CAS number 205-99-2)

Brief Introduction:

Br.Class: General Introduction and Classification Information:

Benzo(b)fluoranthene is a high-molecular-weight, 5-ring Polycyclic Aromatic Hydrocarbon PAH and an EPA Priority Pollutant [680,634]. benzo(b)fluoranthene is an EPA-classified carcinogen for regulatory purposes [446].

Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and soil and onto crops. Benzo(b)fluoranthene is also found in creosote [880].

Of all estimated environmental releases of benzo(b)fluoranthene, 97% are to air. Of the remaining 3%, approximately equal amounts of benzo(b)fluoranthene are released to water and land [880].

At this time (1990), benzo(b)fluoranthene has been found at 46 out of 1,177 sites on the National Priorities List (NPL) of hazardous waste sites in the United States [880].

Benzo(b)fluoranthene is included on the expanded scan list used by the Geochemical and Environmental Research Group (GERG) Laboratory at Texas A&M [828]. This list includes most of the PAHs recommended by the NOAA's National Status and Trends program [680].

On many hazardous substances lists. If one pound is released to the environment within a 24-hour period, EPA must be notified [881].

Br.Haz: General Hazard/Toxicity Summary:

The heavier (4-, 5-, and 6-ring) PAHs (like this one) are more persistent than the lighter (2- and 3-ring) PAHs and tend to have greater carcinogenic and other chronic impact potential [796].

Acute toxicity is rarely reported in humans, fish, or wildlife, as a result of exposure to low levels of a single PAH compound such as this one. PAHs in general are more frequently associated with chronic risks. These risks include cancer and often are the result of exposures to complex mixtures of chronic-risk aromatics (such as PAHs, alkyl PAHs, benzenes, and alkyl benzenes),

rather than exposures to low levels of a single compound (Roy Irwin, National Park Service, Personal Communication, 1996, based on an overview of literature on hand). See also "PAHs as a group" entry.

People may be exposed to benzo(b)fluoranthene from environmental sources such as air, water, and soil and from cigarette smoke and cooked food. Typically, exposure for workers and the general population is not to benzo(b)fluoranthene alone, but to a mixture of similar chemicals [880].

No information has been found about specific levels of benzo(b)fluoranthene that have caused harmful effects in people after breathing, swallowing, or touching the substance [880].

According to one source, pertinent data regarding lethality and decreased longevity in humans or experimental animals following inhalation, oral, or dermal exposure to benzo(b)fluoranthene could not be located in the available literature [880]. According to the same source, no information is available on the systemic effects of benzo(b)fluoranthene in humans or experimental animals following inhalation, oral, and dermal exposures. And although the carcinogenic PAHs as a group have an immunosuppressive effect, specific effects of benzo(b)fluoranthene on the immune system have not been reported [880].

PAH effects on humans tend to be chronic effects (like cancer) rather than acute effects (see "PAHs as a group" entry for more details).

Additional human health issues related to this topic have been summarized by ATSDR [767]. Due to lack of time, no information from this ATSDR document has yet been incorporated into this entry.

Br.Car: Brief Summary of Carcinogenicity/Cancer Information:

EPA 1996 IRIS classification information [893]:

Evidence for classification as to human carcinogenicity, weight-of-evidence classification:

Classification: B2; probable human carcinogen

BASIS: Based on no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal (i.p.) or subcutaneous

(s.c.) injection, and skin painting.

HUMAN CARCINOGENICITY DATA: None. Although there are no human data that specifically link exposure to benzo(b)fluoranthene to human cancers, benzo(b)fluoranthene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke (U.S. EPA, 1984, 1990; IARC, 1984).

ANIMAL CARCINOGENICITY DATA: Sufficient.

The International Agency for Research on Cancer (IARC) has determined that benzo(b)fluoranthene is possibly carcinogenic to humans [788]. The Department of Health and Human Services (DHHS) has determined that benzo(b)fluoranthene may reasonably be anticipated to be a carcinogen [788]. Finally, EPA has determined that benzo(b)fluoranthene is a probable human carcinogen [788,881].

No data are available in humans. Sufficient evidence of carcinogenicity in animals. OVERALL EVALUATION: Group 2B: The agent is possibly carcinogenic to humans. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. S7 58 (1987) [609].

Phototoxicity to *Daphnia magna* (zooplankton) has been documented for a related compound benzo(k)fluoranthene [887]. However, no specific information could be found on carcinogenicity or phototoxicity of benzo(b)fluoranthene.

Relative (equivalency factor) oral carcinogenic potency value compared to Benzo(a)pyrene (BAP, which is ranked 1.0): The factor for Benzo(b)fluoranthene compared to BAP is 0.1 [EPA, 1993, Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons]. Although the information is based on mouse skin painting studies, until better guidance is available, this relative oral carcinogenic potency value may be used in superfund site human risk assessments in conjunction with the oral carcinogenic slope factor for Benzo(a)pyrene found in EPA's IRIS database [893] (Stan Smucker, EPA Region 9, personal communication, 1996).

It is known that the metabolism of alternant PAHs (such as benzo[a]pyrene, benz[a]anthracene, chrysene, and dibenz[a,h]anthracene) differs from nonalternant PAHs (such as benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[j]fluoranthene, and indeno[1,2,3-c,d]pyrene) [881].

Therefore, the metabolism of benzo[b]fluoranthene can be discussed as a model for nonalternant PAH metabolism [881]. Nonalternant PAHs, in contrast to several alternant PAHs, do not appear to exert their genotoxic effect primarily through the metabolic formation of simple dihydrodiol epoxides [881]. In the case of benzo[b]fluoranthene, there is evidence to suggest that metabolism to the dihydrodiol precursor to its bay-region dihydrodiol does occur [881]. Rather than this metabolite being converted to its dihydrodiol epoxide; however, it appears to be extensively converted to its 5-hydroxy derivative [881]. It is the further metabolism of this phenolic dihydrodiol to 5,9,10-trihydroxy-11,12-epoxy-9,10,11,12-tetrahydrobenzo[b]fluoranthene that has been linked to the genotoxic activity of benzo[b]fluoranthene in mouse skin [881]. In the case of benzo[j]fluoranthene, two potentially genotoxic metabolites have been identified [881]. These are the trans-4,5- and 9,10-dihydrodiols of benzo[j]fluoranthene [881]. It is the conversion of trans-4,5-dihydro-4,5-dihydroxybenzo[j]fluoranthene to anti-4,5-dihydroxy-5,6a-epoxy-4,5,6,6a-tetrahydrobenzo[j]fluoranthene that is principally associated with DNA adduct formation in mouse skin [881].

Br.Dev: Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

According to one source, pertinent data regarding the reproductive and developmental toxicity of benzo(b)fluoranthene in humans or experimental animals following inhalation, oral, or dermal exposure could not be located in the available literature [880].

There is inadequate evidence that benzo(b)fluoranthene is active in short-term genetic assays. Further studies are needed in order to evaluate the genotoxic potential of benzo(b)fluoranthene [880].

3,4-Benzofluoranthene was dissolved in corn oil and injected singly or in various combinations into the yolk sacs of fertile chicken eggs and incubated for 21 days. It was injected at levels of 0-10 ug. The hatchability of the eggs decreased as the levels increased. [Reno F et al; Toxicol Appl Pharmacol 8 (2): 351 (1966) [609].

Additional human health issues related to this topic have been summarized by ATSDR [767]. Due to lack of time, no information from this ATSDR document has yet been incorporated into this entry.

Br.Fate: Brief Summary of Key Bioconcentration, Fate, Transport, Persistence, Pathway, and Chemical/Physical

Information:

The heavier (4-, 5-, and 6-ring) PAHs, like this one, are more persistent than the lighter (2- and 3-ring) PAHs [796].

Summary Environmental Fate/Exposure [609]:

Release of benzo(b)fluoranthene is most likely to result from the incomplete combustion of a variety of fuels including wood and fossil fuels. Plants may produce benzo(b)fluoranthene. When released to water, adsorption to suspended sediments is expected to remove most of the benzo(b)fluoranthene from solution. Photolysis and photo-oxidation of the benzo(b)fluoranthene which remains in solution is expected to occur but adsorbed benzo(b)fluoranthene is expected to resist these processes. Volatilization and biodegradation of dissolved benzo(b)fluoranthene may also occur. Bioconcentration in fish may occur; however microsomal oxidase, an enzyme capable of rapidly metabolizing polynuclear aromatic hydrocarbons, is present. Release to the soil may result in some biodegradation. Due to the anticipated strong adsorption of benzo(b)fluoranthene to the soil, volatilization, photolysis and leaching to groundwater are not expected to be significant. Benzo(b)fluoranthene in the atmosphere is likely to be adsorbed to particulate matter, and will be subject to wet and dry deposition. Benzo(b)fluoranthene in the vapor phase will react with photochemically generated, atmospheric hydroxyl radicals with an estimated half-life of 1.00 day. Photolysis of vapor phase benzo(b)fluoranthene will be rapid, but the adsorbed compound may not photolyze significantly. Benzo(b)fluoranthene is a contaminant in air, water, sediment, soil, fish, and other aquatic organisms and food. Human exposure results primarily from air. (SRC) .

Synonyms/Substance Identification:

2,3-benzfluoranthene [366]
2,3-benzofluoranthene [366]
2,3-benzofluoranthrene [366]
3,4-benz(e)acephenanthrylene [366]
3,4-benzfluoranthene [366]
3,4-benzofluoranthene [366]
B(b)Fu [366]
B(b)F [609]
Benz(e)acephenanthrylene [366]

Benzo(e)fluoranthene [366]

Molecular Formula:

C20-H12 [366]

Associated Chemicals or Topics (Includes Transformation Products):

See also individual entry:

PAHs as a group

Metabolism/Metabolites [366]:

The 1,2- & 11,12-dihydrodiols as well as the 4-(or 7-), 5-(or 6-)monohydroxy derivatives of benzo(b)fluoranthene have been detected as metabolites. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V32 149 (1983).

The metabolism by rat liver 9000x g supernatant of benzo(b)fluoranthene was investigated. The major metabolites were identified by comparison to synthetic samples as 5- and 6-hydroxybenzo(b)fluoranthene. The principal dihydrodiol metabolite formed under these conditions was trans-11,12-dihydro-11,12-dihydroxybenzo(b)fluoranthene, which was identified by comparison to the synthetic compd. 1,2-dihydro-1,2-dihydroxybenzo(b)fluoranthene was identified by its mass spectrum. No evidence was obtained for the formation of 7b,8-dihydro-7b,8-dihydroxybenzo(b)fluoranthene or trans-9,10-dihydro-9,10-dihydroxybenzo(b)fluoranthene. [Amin S et al; Carcinogenesis 3 (2): 171-4 (1982).

The effects of fluorine substitution on benzo(b)fluoranthene DNA adduct formation and tumorigenicity in mouse epidermis were investigated. Fluoro derivatives studied included 1-, 6-, 7-, 8-, 9- and 11-fluoro benzo(b)fluoranthene as well as 1,9- and 6,9-difluorobenzo(b)fluoranthene. Each compound was applied topically to mice and hydrocarbon/DNA adduct formation was assessed using the ³²P-post-labelling technique. All of the fluorinated compounds bound to DNA to a lesser extent than benzo(b)fluoranthene. Among the fluorinated compounds, the greatest binding was observed from 8-fluorobenzo(b)fluoranthene. Lowest levels of hydrocarbon/DNA adduct formation from the fluoro derivatives were observed for 1-, 7-, 11-, and 6,9-difluorobenzo(b)fluoranthene. The tumor-initiating activities on mouse skin of 7-, 9- and 11-fluorobenzo(b)fluoranthene were determined. All three compounds were significantly less tumorigenic than

benzo(b)fluoranthene. The results of this study are discussed with respect to possible mechanisms of metabolic activation of benzo(b)fluoranthene. [Weyand EH et al; Chem Biol Interact 71 (2-3) 279-90 (1989).

The metabolism of benzo(b) fluoranthene was investigated in mouse epidermis, and the potential role of the benzo(b)fluoranthene 9,10-diol and other benzo(b)fluoranthene metabolites as proximate carcinogens of benzo(b)fluoranthene was assessed. Metabolites of tritium labeled benzo(b)fluoranthene formed in vitro using rat S9 were identified by their ultraviolet spectra and retention times in high pressure liquid chromatography. The major metabolites were the 4, 5, and 6-hydroxy benzo(b)fluoranthenes. Minor metabolites included the 12-hydroxy benzo(b) fluoranthene, a 1,2-diol, and a 11,12-diol; the 9,10-diol was not detected. Data on the further metabolism of the 9,110-diol were consistent with its being converted to 5 and 6-hydroxy 9,10-diols. The metabolism of tritium labeled benzo(b)fluoranthene in mouse skin was investigated at 1 to 8 hours treatment. The major metabolites were phenols. Tumor initiating activity was tested on mouse skin for groups of 25 albino female mice. In addition to benzo(b) fluoranthene, only the 9,10-diol showed high tumorigenic activity. /It was/ concluded that although the 9,10-diol is the only known dihydrodiol of benzo(b)fluoranthene with tumorigenic activity on mouse skin, there is no evidence to support its presence in mouse epidermis as a metabolite of benzo(b)fluoranthene. [Geddle JE et al; Carcinogenesis 8 (1): 1579-84 (1987)].

Water Data Interpretation, Concentrations and Toxicity (All Water Data Subsections Start with "W."):

W.Low (Water Concentrations Considered Low):

No information found.

W.High (Water Concentrations Considered High):

No information found.

W.Typical (Water Concentrations Considered Typical):

The benzo(b)fluoranthene concentration range in surface waters of the Atlantic region of Canada was <0.003 ug/L [754]. (NOTE: value is based on 61 samples taken in 1980-81.)

Water Concentrations [609]:

SURFACE WATER: Bellevue, WA - 1% samples pos, 2

ug/l(1). Benzo(b,k)fluoranthene isomers were 190-1008 ng/g in suspended sediments from the Niagara River at Niagara-on-the-Lake(2). Great Britain - 3.76-339.12 ng/l in four rivers used or intended for use as public water supply and 16.17-76.8 ng/l in water from rivers not intended for public water supply(3). Great Britain - <3-5 ng/l(3). Great Britain raw water (flowing into water treatment plants) - 5-139 ng/l(3). Great Britain - Tamar Estuary, water, 9.3 ng/l, suspended sediments, 871 ng/g(4). Benzo(b)fluoranthene was detected but not quantified in water samples taken in Ontario(5) and in water samples taken in water surrounded by industry in Japan(6). BbF was 6600 ng/l in samples of surface water contaminated with road runoff(3). [(1) Cole RH et al; J Water Pollut Cont Fed 56: 898-908 (1984) (2) Kuntz KW; Toxic Contaminants in the Niagara River, 1975-82 Burlington, Ontario Technical Bulletin No 134 (1984) (3) Crane RI et al; A Survey of Polycyclic Aromatic Hydrocarbon Levels in British Waters Medmenham UK: A Water Research Centre TR-158 (1981) (4) Readman JW et al; Est Coastal Shelf Sci 14: 369-89 (1982) (5) Katz M et al; pp 121-9 in Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment Afghan BK, Mackay D eds Plenum Press NY (1980) (6) Shinohara R et al; Environ Intern 4: 163-74 (1980).

DRINKING WATER: Netherlands - 0.003 ug/l avg, 0.045 ug/l maximum(1). Great Britain - < 0.5-1 ng/l (2). Benzo(b)fluoranthene was detected but not quantified in drinking water from an unspecified source(3). [(1) Kraybill HF; NY Acad Sci Annals 298: 80-9 (1977) (2) Crane RI et al; A Survey of Polycyclic Aromatic Hydrocarbon Levels in British Waters Medmenham UK: Water Research Centre TR-158 (1981) (3) Kool HJ et al; Crit Rev Env Control 12: 307-57 (1982).

GROUNDWATER: Netherlands - 3 ug/l maximum(1). Benzo(b)fluoranthene (BbF) was detected but not quantified in samples of groundwater contaminated with coal-tar wastes(2). Benzo(b)fluoranthene was < 1-4 ng/l in water from various groundwater distribution systems(3). [(1) Zoeteman BCJ et al; Sci Total Environ 21: 187-202 (1981) (2) Rostad CE et al; Chemosphere 14: 1023-36 (1985) (3) Crane RI et al; A Survey of Polycyclic Aromatic Hydrocarbon Levels in British Waters Medmenham UK: Water Research Centre TR-158 (1981).

RAIN/SNOW: Rain water - 4.4-14.6 ng/l(1). Benzo(b)fluoranthene was detected but not quantified in liquid and particulates from precipitation in Norway(2). [(1) IARC; Polynuclear

Aromatic Compounds Part 1 32: 147-62 (1983) (2)
Lunde G et al; Organic Micropollutants in
Precipitation in Norway SNSF Project FR-9/76
(1977).

Effluents Concentrations [609]:

Sewage effluent in Japan contained 26.0 ng/l benzo(b)fluoranthene(1). Sewage effluents (United Kingdom) - 9.9-40.85 ng/l(3). Combined residues of benzo(b,j,k)fluoranthene isomers were found in sediments from the effluent channel from a coking plant in an unspecified location at 23 ug/g dry weight(2). Benzo(b)fluoranthene in treated wastewater effluents from a variety of industries were as follows(4). Coil coating - 30 samples, 3.33% pos, 10 ug/l maximum; foundries - 1 sample, 100% pos, 6 ug/l maximum; nonferrous metals manufacturing 42 samples, 2.4% pos, ND-12 ug/l, 0.5 ug/l avg; timber products processing 9 samples, 33.3% pos, 10-2500 ug/l, 10 ug/l avg(4). [(1) Akiyama T et al; J UOEH 2: 285-300 (1980) (2) Griest WH; pp 173-83 in Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment Plenum Press NY, NY (1980) (3) Crane RI et al; A Survey of Polycyclic Aromatic Hydrocarbon Levels in British Waters Medmenham UK: Water Research Centre TR-158 (1981) (4) USEPA; Treatability Manual Vol 1 Treatability Data USEPA-600/2-81-001a (1981).

Domestic effluent: 0.036-0.202 ppb; Sewage (high percentage industry): 0.525-0.87 ppb; Sewage during dry weather: 0.039 ppb. [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 250.

W. Concern Levels, Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and Other Water Benchmarks:

W. General (General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or General Aquatic Biota):

Canada's Interim Assessment Criterion for benzo(b)fluoranthene is 0.01 ug/L [656].

NOTE: a) For most of the organic chemical parameters in [656], criteria are based on analytical detection limits; b) criterion is considered "Interim" since complete supporting rationale do not exist.

EPA Water Quality Criteria:

Freshwater Acute Criteria: None Published
[446,689,893,928].

Freshwater Chronic Criteria: None Published
[446,689,893,928].

Acute Marine Criteria: 3.0E+2 ug/L LEC (Lowest
effects concentration in the literature [893],
Reference: 45 FR 79318 (11/28/80)

Marine Chronic Criteria: None Published
[446,689,893,928].

W.Plants (Water Concentrations vs. Plants):

No information found.

W.Invertebrates (Water Concentrations vs. Invertebrates):

No information found.

W.Fish (Water Concentrations vs. Fish):

No information found.

W.Wildlife (Water Concentrations vs. Wildlife or Domestic
Animals):

No information found.

W.Human (Drinking Water and Other Human Concern Levels):

EPA 1996 (IRIS) Water Quality Criteria [893]:

Maximum Contaminant Level Goal: 0 mg/L
Proposed 1990 see 55 FR 30370 [893].

Maximum Contaminant Level (MCL): Value: 0.0002
mg/L Proposed 1990; Reference: 55 FR 30370
(07/25/90).

Ambient Water Quality Criteria for Human
Health considering Water & Fish routes of
exposure: 2.8E-3 ug/liter (10⁻⁶ or E-06) Risk
Level for Carcinogens).

Previous reference to same concentration
for Human Health (10⁻⁶ Risk Level for
Carcinogens): Published Criteria for
Water and Organisms: 0.0028 ug/L [689].

Ambient Water Quality Criteria for Human Health considering Only Fish Route of exposure: $3.11\text{E-}2$ ug/liter (10^{-6} or E-06) Risk Level for Carcinogens).

Previous reference to same concentration for Human Health (10^{-6} Risk Level for Carcinogens): Published Criteria for Organisms Only: 0.0311 ug/L [689].

NOTE: Discussion: For the maximum protection from the potential carcinogenic properties of this chemical, the ambient water concentration should be zero. However, zero may not be obtainable at this time, so the recommended criteria represents a E-6 estimated incremental increase of cancer over a lifetime. The values given represent polynuclear aromatic hydrocarbons as a class.

Before citing a concentration as EPA's water quality criteria, it is prudent to make sure you have the latest one. Work on the replacement for the Gold Book [302] was underway in March of 1996 and the IRIS database is updated monthly [893].

EPA Region 9 Preliminary remediation goal for tap water (PRG): $9.2\text{E-}02$ ug/l [868].

The levels of polynuclear aromatic hydrocarbons in ambient water which may result in an incremental cancer risk of $1\text{X}10^{-5}$, $1\text{X}10^{-6}$, and $1\text{X}10^{-7}$ over an individual lifetime are estimated to be 28.0 ng/l, 2.8 ng/l, and 0.28 ng/l, respectively (for ingestion of both contaminated water and contaminated aquatic organisms). On the basis of the consumption of aquatic organisms alone, the corresponding levels in ambient water are estimated to be 311.0 ng/l, 31.1 ng/l, and 3.11 ng/l, respectively, based on benzo(a)pyrene as the model PAH /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft) p.C-121 (1980)] [366,880].

NOTE: The attempt to develop a drinking water criterion for polynuclear aromatic hydrocarbons (PAH) as a class is hindered by several gaps in the scientific data base: (1) The PAH class is composed of numerous

compounds having diverse biological effects and varying carcinogenic potential. A "representative" PAH mixture, has not been defined. (2) The common practice of using data derived from studies with benzo(a)pyrene to make generalizations concerning the effects of environmental PAH may not be scientifically sound. (3) No chronic animal toxicity studies involving oral exposure to PAH mixtures exist. (4) No direct human data concerning the effects of exposure to defined PAH mixtures exist. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft) p.C-118 (1980)] [366].

The warm water- and cold water sport fish community human cancer criteria for benzo(b)fluoranthene in Wisconsin public water supplies are each 0.023 mg/L [881].

The warm water- and cold water sport fish community human cancer criteria for benzo(b)fluoranthene in Wisconsin non-public water supplies are each 0.1 mg/L [881].

W.Misc. (Other Non-concentration Water Information):

No information found.

Sediment Data Interpretation, Concentrations and Toxicity (All Sediment Data Subsections Start with "Sed."):

Sed.Low (Sediment Concentrations Considered Low):

No information found.

Sed.High (Sediment Concentrations Considered High):

Benzo(b)fluoranthene was detected in 96.3 % of urban-bay samples from the Puget Sound area. The mean concentration was 2253 ug/kg dry weight (ppb), while the median concentration was 700 ug/kg (ppb) [852].

NOTE: The above values are not normalized for total organic carbon (TOC) content.

Analyses of sewage sludges from 50 publicly owned treatment works by the U.S. Environmental Protection Agency (1985): The mean concentration of benzo(b)fluoranthene was 1.76 ppm (dry weight) [347].

Sed.Typical (Sediment Concentrations Considered Typical):

Benzo(b)fluoranthene was detected in 84.4 % of non-urban-bay samples from the Puget Sound area. The mean concentration was 1451 ug/kg dry weight (ppb), while the median concentration was 249 ug/kg (ppb) [852].

NOTE: The above values are not normalized for total organic carbon (TOC) content.

Sediment/Soil Concentrations [609]:

SEDIMENT: Sagamore Lake, NY - 360-1 ng/g dry weight (0-75 cm deep), Woods Lake, NY - 1800-8 ng/g dry weight (0-84 cm deep)(1). Maine - Penobscot Bay surficial sediments, 17-1000 ppb dry weight(2). Washington - 32-35 ng/g dry sediment(3). Great Britian - Tamar Estuary, 475 ng/g (dry weight)(4). Norway - Saudafjord, 21.0-8212.1 ppb dry weight (0-2 cm), 40.0-4678.3 ppb dry weight (2-4 cm), 5.7-2853.2 ppb dry weight (4-6 cm), 4.0-2907.9 ppb dry weight (6-8 cm)(5). Unspecified benzofluoranthenes were 2440 + or - 270 ng/g sediment wet weight in samples from the Duwamish River Delta in Seattle, WA(6), and from 100-3000 + or - 1800 ng/g dry weight in sediment samples from four sites in Washington(7). Benzo(b)fluoranthene was detected but not quantified in sediments from the Elizabeth River in Virginia(8). Deposition rates of unspecified benzofluoranthenes to sediments in Washington were shelf - 0.9-37 ng/sq cm year, 12 ng/sq cm year avg; midshelf - 8.1-37 ng/sq cm year, 19 ng/sq cm year avg; and slope - 0.1-4.4 ng/sq cm year, 1.8 ng/sq cm year avg(3). SOIL: Benzo(b)fluoranthene isomers were 30-110 and 25-35 ppb in dried forest soil samples taken from south of Darmstadt and near Lake Constance, West Germany, respectively(9). [(1) Tan YL, Heit M; Geochim Cosmochim Acta 45: 2267-79 (1981) (2) Johnson AC et al; Marine Environ Res 15: 1-16 (1985) (3) Prahl FG et al; Environ Sci Technol 18: 687-93 (1984) (4) Readman JW et al; Est Coastal Shelf Sci 14: 369-89 (1982) (5) Bjorseth A et al; Sci Total Environ 13: 71-86 (1979) (6) Varanasi U et al; Environ Sci Technol 19: 836-41 (1985) (7) Malins DC et al; Carcinogenesis 6: 1463-69 (1985) (8) Merrill EG, Wade TL; Environ Sci Technol 19: 597-603 (1985) (9) Verschueren K; Handbook of Environmental Data on Organic Chemicals. 2nd ed Von Nostrand Reinhold NY p 250 (1983).

Sed. Concern Levels, Sediment Quality Criteria, LC50 Values, Sediment Quality Standards, Screening Levels, Dose/Response Data and Other Sediment Benchmarks:

Sed.General (General Sediment Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Sediment Concentrations Versus Mixed or General Aquatic Biota):

AET: The apparent effects threshold (AET) concentrations for benzofluoranthenes (as a group) in sediments proposed for Puget Sound ranged from 3.2 mg/kg dry weight (microtox) to 9.9 mg/kg dry weight (benthic) [416]. Although the authors of the Puget Sound AETs have cautioned that Puget Sound AETs may not be appropriate for comparison with data from other geographic areas, so few concern levels for this chemical have been published that the proposed Puget Sound concern level is included in this text as a reference item.

NOTE: Even lower concentrations of this PAH may be of concern related to its contribution to "total or total carcinogenic PAH" sums (see "PAHs as a group" entry).

St. Lawrence River Interim Freshwater Sediment Criteria for for benzofluoranthenes (as a group), 1992. No effect level: 300 ug/kg dry weight [761].

Sed.Plants (Sediment Concentrations vs. Plants):

No information found.

Sed.Invertebrates (Sediment Concentrations vs. Invertebrates):

No information found.

Sed.Fish (Sediment Concentrations vs. Fish):

No information found.

Sed.Wildlife (Sediment Concentrations vs. Wildlife or Domestic Animals):

No information found.

Sed.Human (Sediment Concentrations vs. Human):

No information found.

Sed.Misc. (Other Non-concentration Sediment Information):

No information found.

Soil Data Interpretation, Concentrations and Toxicity (All Soil Data Subsections Start with "Soil."):

Soil.Low (Soil Concentrations Considered Low):

No information found.

Soil.High (Soil Concentrations Considered High):

Concentrations of PAH's in bioassay earthworms and bioassay soil from 15 sites at the Times Beach Confined Disposal Facility in Buffalo, N.Y. (1987): The mean concentration of benzo(b)fluoranthene in the soil was 2.6 ppm and the range was 0.25-5.6 ppm (dry weight). The mean concentration of benzo(b)fluoranthene in the earthworm was 0.83 ppm, the range was 0.15-5.4 ppm (ash-free dry weight) [347].

Analyses of sewage sludges from 50 publicly owned treatment works by the U.S. Environmental Protection Agency (1985): The mean concentration of benzo(b)fluoranthene was 1.76 ppm (dry weight) [347].

Soil.Typical (Soil Concentrations Considered Typical):

No information found.

Soil.Concern Levels, Soil Quality Criteria, LC50 Values, Soil Quality Standards, Screening Levels, Dose/Response Data and Other Soil Benchmarks:

Soil.General (General Soil Quality Standards, Criteria, and Benchmarks Related to Protection of Soil-dwelling Biota in General; Includes Soil Concentrations Versus Mixed or General Soil-dwelling Biota):

Canada's Interim Assessment Criterion for benzo(b)fluoranthene in soil is 0.1 ug/g dry weight [656].

NOTE: a) "Interim" means complete supporting rationale do not exist; b) for most of the organic parameters in [656], criteria are based on analytical detection limits and are intended to provide general guidance only for the protection of both human and environmental health [656].

Canada's Interim Remediation Criteria for benzo(b)fluoranthene in soil for three different land-uses (ug/g dry weight) [656]:

Agricultural = 0.1

Residential/Parkland = 1
Commercial/Industrial = 10

NOTE: a) "Interim" means complete supporting rationale do not exist; b) if contaminant concentrations exceed the criterion for a current or anticipated land use at a site, then the need for further investigation and/or remediation exists; c) criteria are relevant to protection of both human and environmental health [656].

Soil.Plants (Soil Concentrations vs. Plants):

No information found.

Soil.Invertebrates (Soil Concentrations vs. Invertebrates):

Concentrations of PAH's in bioassay earthworms and bioassay soil from 15 sites at the Times Beach Confined Disposal Facility in Buffalo, N.Y. (1987): The mean concentration of benzo(b)fluoranthene in the soil was 2.6 ppm and the range was 0.25-5.6 ppm (dry weight). The mean concentration of benzo(b)fluoranthene in the earthworm was 0.83 ppm, the range was 0.15-5.4 ppm (ash-free dry weight) [347].

Soil.Wildlife (Soil Concentrations vs. Wildlife or Domestic Animals):

No information found.

Soil.Human (Soil Concentrations vs. Human):

EPA 1996 National Generic Soil Screening Level (SSL) designed to be conservative and protective at the majority of sites in the U.S. but not necessarily protective of all known human exposure pathways, land uses, or ecological threats [952]:

SSL = 0.9 mg/kg for ingestion pathway [952].

SSL = 0.2 to 5 mg/kg for protection from migration to groundwater at 1 to 20 Dilution-Attenuation Factor (DAF) [952].

EPA 1995 Region 9 Preliminary remediation goals (PRGs) [868]:

Residential Soil: 0.61 mg/kg wet weight
Industrial Soil: 2.6 mg/kg wet weight

NOTE:

1) Values are based on a one-in-one million cancer risk.

2) PRGs focus on the human exposure pathways of ingestion, inhalation of particulates and volatiles, and dermal absorption. Values do not consider impact to groundwater or ecological receptors.

3) PRGs for residential and industrial landuses are slightly lower concentrations than EPA Region III RBCs, which consider fewer aspects (more limited to ingestion pathway) [903].

EPA 1955 Region 3 Risk Based Criteria (RBC) to protect from transfers to groundwater:

4 mg/Kg dry weight [903].

See also [656] information in Soil.General section above.

Soil.Misc. (Other Non-concentration Soil Information):

No information found.

Tissue and Food Concentrations (All Tissue Data Interpretation Subsections Start with "Tis."):

Tis.Plants:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Plants:

No information found.

B) Body Burden Residues in Plants: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

Plant Concentrations [609]:

Benzo(b)fluoranthene (BbF) occurs in leaves of higher plants as follows: Beech - green, 62 ug/kg; yellow, 374 ug/kg. Oak - green, 62 ug/kg; yellow, 292 ug/kg. Tobacco - green, 32 ug/kg, yellow, 126 ug/kg. These are dry weight values(1). Residues of other polynuclear aromatic hydrocarbons (PAH) were not detected in higher plants exposed to carefully filtered air, however, suggesting that polycyclic aromatic hydrocarbons presence in higher plants may not be due to

biosynthesis(1). Algae (various species) - Norway, various sites, 31-431 ug/kg benzo(b)fluoranthene dry weight(2). [(1) Sims RC, Overcash MR; Res Rev 88: 1068 (1983) (2) Knutzen J, Sortland B; Water Res 16: 421-8 (1982).

In the Sahelian countries coloquint seed tar is used in traditional medicine. A condensate from the seed of Citrullus colocynthis was obtained in a camel nomad settlement. It contained a large number of polycyclic aromatic hydrocarbons, including benzo(b)fluoranthene. [Habs M et al; J Cancer Res Clin Oncol 108 (1): 154-6 (1984).

... /It has been reported/ that the increased concn of benzo(b)fluoranthene in the soil caused an increase in its concn in summer wheat & rye growing in the soil. [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume II. EPA-440/4-79-029b. Washington, D.C.: U.S.Environmental Protection Agency, December 1979.,p. 97-11.

Tis.Invertebrates:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Invertebrates:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Invertebrates:

No information found.

C) Body Burden Residues in Invertebrates: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

Details of benzo(b)fluoranthene content (ug/kg or ppb) in whole body samples of mussels) from Snug Harbor, Alaska, an area heavily oiled by the Exxon Valdez Crude Oil, 4/15/89 [971]:

Note: Concurrent measurements of water quality, as well as equilibrium partitioning estimates of water quality based on concentrations in fish and mussels, both confirm that PAH concentrations did not exceed water quality criteria at the time these

concentrations were measured in mussel tissues [971]. These values are wet weight (Jerry Neff, Battelle Ocean Sciences, Duxbury, MA, personal communication 1996):

benzo(b)fluoranthene: 27.4 ug/kg = ppb

Concentrations of PAH's in bioassay earthworms and bioassay soil from 15 sites at the Times Beach Confined Disposal Facility in Buffalo, N.Y. (1987): The mean concentration of benzo(b)fluoranthene in the soil was 2.6 ppm and the range was 0.25-5.6 ppm (dry weight). The mean concentration of benzo(b)fluoranthene in the earthworm was 0.83 ppm, the range was 0.15-5.4 ppm (ash-free dry weight) [347].

See also Tis.Fish, C) section below.

Tis.Fish:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Fish (Includes FDA Action Levels for Fish and Similar Benchmark Levels From Other Countries):

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Fish:

No information found.

C) Body Burden Residues in Fish: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No detections of this compound were made in certain samples of Exxon Valdez fish [971].

The benzo(b)fluoranthene concentration in mosquitofish with extremely elevated total PAH concentrations (60.79 mg/kg) was 3.5 mg/kg [201].

Fish/Seafood Concentrations [609]:

Lake Erie - 3 sites, stomach contents of bottom feeders, 3.24-17.0 ng/g wet weight(1); Oregon (Yaquina Bay) - oysters, 0.25-5.1 ppb (wet weight) (remote site), 2.5 ppb avg; 10.4-24.4 ppb (wet weight) (site proximal to industry), 18.0 ppb avg 1979-80(2). Oregon (Coos Bay) - softshell clams, 0.9-2.3 (remote site), 1.5 ppb avg; 10.5-14.8 ppb (site proximal to industry), 12.1 ppb avg, 1978-

79(3). South Carolina - 0.3-3.2 ppb (wet weight) avg in summer, no benzo(b)fluoranthene (BbF) was detectable in the spring(4). Maryland - oysters, 0.3 ppb (low pollution), 1.2 ppb (area approved for oyster harvesting), 2.2 ppb (closed areas)(5). Norway - Saudafjord, mussels, 1653-56509 ppb dry weight(6). Norway - common mussel, 16-176 ug/kg dry weight, periwinkle, 3-30 ug/kg dry weight, common limpet, 48-90 ug/kg dry weight(7). Japan (Moyagi Prefecture) - mussel, 0.83-1.94 ppb, oyster, 2.17 ppb, corb-shell, 1.37 ppb, shortneck clam, 0.82-1.87 ppb(8). England - fish, 0.03-0.33 ppb, 0.13 ppb avg(9). Holland (1976-78) - < 0.1-0.7 ppb(10). Unspecified benzofluoranthenes were < 4.3-< 16 ng/g dry weight in liver and < 4.8 ng/g in muscle of English sole obtained from Washington(11). Benzo(k,b)fluoranthene isomers were ND-1.0 ug/g dry weight in oysters taken from a variety of locations around the USA(12). [(1) Maccubbin AE et al; Bull Environ Contam Toxicol 34: 876-82 (1985) (2) Mix MC, Schaffer RL; Marine Environ Res 9: 193-209 (1983) (3) Mix MC, Schaffer RL; Marine Pollut Bull 14: 94-7 (1983) (4) Marcus JM, Stokes TP; Bull Environ Contam Toxicol 35: 835-44 (1985) (5) Howard JW, Fazio T; J Assoc Off Anal Chem 63: 1077-1104 (1980) (6) Bjorseth A et al; Sci Total Environ 13: 71-86 (1979) (7) Knutzen J, Sortland B; Water Res 16: 421-8 (1982) (8) Takatsuki K et al; J Assoc Off Anal Chem 68: 945-9 (1985) (9) Dennis MJ et al; Food Chem Toxicol 21: 569-74 (1983) (10) Vaessen HAMG et al; Toxicol Environ Chem 4: 379-87 (1985) (11) Malins DC et al; Carcinogenesis 6: 1463-9 (1985) (12) Pittinger CA et al; Environ Toxicol Chem 4: 379-87 (1985).

Tis.Wildlife: Terrestrial and Aquatic Wildlife, Domestic Animals and all Birds Whether Aquatic or not:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Wildlife, Domestic Animals, or Birds:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Wildlife, Birds, or Domestic Animals (Includes LD50 Values Which do not Fit Well into Other Categories, Includes Oral Doses Administered in Laboratory Experiments):

No information found.

C) Body Burden Residues in Wildlife, Birds, or Domestic Animals: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Human:

A) Typical Concentrations in Human Food Survey Items:

See also Tis.Fish, C) section above.

Food Survey Results [609]:

Benzo(b)fluoranthene residues were as follows in food samples collected in the United Kingdom. Cereals - 0.17-0.29 ppb, 0.23 ppb avg; meat - 0.02-0.06 ppb, 0.04 ppb avg; oils and fats - 0.11-2.28 ppb, 0.92 ppb avg; fruits and sugar - 0.04-0.1 ppb, 0.06 ppb avg; root vegetables - 0.02-0.1 ppb, 0.05 ppb avg; other vegetables - 0.03-0.56 ppb, 0.16 ppb avg; beverages - ND (0.01 ppb)-0.02 ppb, 0.006 ppb avg(1). Holland (1976-78) - potato products - 11 samples, < 0.1-0.9 ppb; vegetables - 11 samples, < 0.1-1.4 ppb; meat and egg products - 11 samples, < 0.1-1.0 ppb(2). Federal Republic of Germany - kale, 10 samples, 6.8-21.9 ppb, 13.9 ppb avg(2). Benzo(b)fluoranthene has been detected in broiled and smoked food at up to 15.1 ug/kg and in oils and margarine at up to 14.5 ug/kg(3). [(1) Dennis MJ et al; Food Chem Toxicol 21: 569-74 (1983) (2) Vaessen HAMG et al; Toxicol Environ Chem 7: 297-324 (1984) (3) IARC; Polynuclear Aromatic Compounds Part 1 32: 147-62 (1983).

In gas-broiled fish 0.1 to 1.2 ug/kg could be found ... while smoked or dried fish could contain as much as 37 ug/kg. In heavily smoked ham or bacon 3.6 to 15.1 ug/kg were found ... & in fresh sausages 0.4 ug/kg & in grilled or fried sausages 6.3 ug/kg have been detected. Benzo(b)fluoranthene has also been reported in smoke of gas- or electric-broiled fish. In olive oil, plant cooking fat, plant oil & coconut oil, concn ranged from 0.1 to 4 ug/kg ... & in margarine from 2.6 to 14.5 ug/kg, the concn being reduced by treatment with activated charcoal & steam. In fat, the

concn could be reduced by controlled laboratory heating & in oils by frying. Extremely black roasted coffee contained 1.2 to 2.1 ug/kg, & up to 3.0 ug/kg were found in malt coffee, substitute coffee & soluble coffee powder. In whisky 0.05 ug/l could be detected in only one ... of 15 brands. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V3 73 (1973).

Levels of benzo(b)fluoranthene found in foods: Fresh sausages 0.4 ug/kg; grilled or fried sausages: 6.5 ug/kg; heavily smoked ham or bacon: 3.6-15.1 ug/kg; gas-broiled fish: 0.1-1.2 ug/kg; smoked fish: up to 37 ug/kg; margarine or mayonnaise: 2.6-14.5 ug/kg; coconut oil, olive oil, plant cooking fat, plant oil: 0.2-4 ug/kg; roasted or black coffee: 1.2-2.1 ug/kg; soluble coffee powders: up to 30 ug/kg; whiskey: 0.05 ug/l. /From table/ [Health & Welfare Canada; Polycyclic Aromatic Hydrocarbons p.29-30 (1979) Report No. 80-EHD-50.

Seafood & agricultural products contain polycyclic aromatic hydrocarbons (PAHs) because of their sedimentation from air & subsequent penetration into water systems. Crude coconut oil, heavily smoked ham, roasted coffee, tea, & charcoal-broiled meat contain polycyclic aromatic hydrocarbons in concn up to 20 to 40 ug/kg. /Polycyclic aromatic hydrocarbons/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 953.

B) Concentrations or Doses of Concern in Food Items Eaten by Humans (Includes Allowable Tolerances in Human Food, FDA, State and Standards of Other Countries):

For risk to human adults eating fish, separate carcinogenic and non-carcinogenic risk-based fish tissue concentrations were calculated [903]. The following EPA Region III fish tissue risk-based concentration (RBC) benchmark utilizes the lower of the two (carcinogenic) concentrations, rounded to two significant figures [903]: 0.0043 mg/Kg wet weight.

Oral slope factor: 7.3E-01 mg/kd-d [868]. The slope factor is the result of application of a low-dose extrapolation procedure and is presented as the risk per mg/kg/day. The unit risk is the quantitative estimate in terms of either risk per ug/L drinking water [893].

C) Body Burden Residues in Humans: Typical, Elevated, or of Concern Related to the Well-being of Humans:

Body Burdens [609]:

Benzo(b)fluoranthene was detected at 0.2 ng/mg skin lipid (median concn) in samples taken from roofing workers exposed to polycyclic aromatic hydrocarbons (PAH) as a component of coal tar pitch & the asphalt roofing material. The presence in skin oil provides evidence of continued body burden after leaving the workplace. [Wolff MS et al; Chemosphere 11 (6): 595-9 (1982)].

Twelve polycyclic aromatic hydrocarbons (PAH) (including benzo(b)fluoranthene) have been analyzed in blood collected from roofing workers. In six serum samples, the polycyclic aromatic hydrocarbon were below the limit of detection (1-60 pg/ml). [Wolff MS et al; Chemosphere 11 (6): 595-9 (1982)].

Milk Concentrations [609]:

England - 0.006-0.02 ppb, 0.01 ppb avg(1). [(1) Dennis MJ et al; Food Chem Toxicol 21: 569-74 (1983)].

Tis.Misc. (Other Tissue Information):

No information found.

Bio.Detail: Detailed Information on Bioconcentration, Biomagnification, or Bioavailability:

During the Exxon Valdez spill, bioconcentration explained the buildup of PAHs in tissues better than biomagnification; most accumulation was of an equilibrium partitioning nature across the gills rather than from the food chain [971]. Immature fish seem to have higher bioconcentration of PAHs than adults, perhaps because their PAH breakdown systems are not fully developed and at times perhaps because of a higher percentage of lipid tissues (yolk tissues, etc) [971] (confirmed by Jerry Neff, Battelle Ocean Sciences, Duxbury, MA, personal communication 1996).

Bioconcentration factor, log BCF: 5.15 for microorganisms in

water; 4.00 for *Daphnia magna* [848].

Concentrations of PAH's in bioassay earthworms and bioassay soil from 15 sites at the Times Beach Confined Disposal Facility in Buffalo, N.Y. (1987): The mean concentration of benzo(b)fluoranthene in the soil was 2.6 ppm and the range was 0.25-5.6 ppm (dry weight). The mean concentration of benzo(b)fluoranthene in the earthworm was 0.83 ppm, the range was 0.15-5.4 ppm (ash-free dry weight) [347].

Bioconcentration [609]:

No data concerning the bioconcentration of benzo(b)fluoranthene (BbF) in aquatic organisms were available. The high estimated log octanol/water partition coefficient (6.124(1)) of BbF suggests that it will bioconcentrate appreciably in aquatic organisms. The presence of microsomal oxidase in fish(2) suggests, however, that polynuclear aromatic hydrocarbons, including BbF, will not bioconcentrate in fish due to the anticipated rapid metabolism of these compounds. [(1) GEMS; Graphical Exposure Modeling System CLOGP3 (1986) (2) Santodonato J et al; Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Lee SD, Grant L eds; Pathotox Publ Park Forest South IL (1981).

Interactions:

Information from HSDB [366]:

Microsomal oxidation of benz(a)anthracene (baa) in rat liver has been shown to occur at various positions (1,2-, 3,3-, 5,6-, 8,9- and 10,11-position). The carcinogenic risk by baa is significantly incr through the induction of enzymes responsible for the formation of ultimate carcinogens. Results indicate that these enzymes are induced by several environmentally relevant polycyclic aromatic hydrocarbons as benzofluoranthenes and other polycyclic aromatic hydrocarbons (pah) occurring in particulate matter, automobile and other environmental matrices. Benzofluoranthenes induced the oxidation at the 3,4-position forming the precursor of the ultimate carcinogen of baa. [Jacob j et al; the influence of polycyclic aromatic hydrocarbons as inducers of monooxygenases on the metabolite profile of benz(a)anthracene in rat liver microsomes; cancer lett (shannon, irel) 14 (2): 175-85 (1981)].

The synergistic actions of individual polycyclic aromatic hydrocarbons (PAH) containing up to 1 to 7 rings have been studied /for their effect/ on the mutagenicity of benzo(a)pyrene. Synergistic effect was observed with benzo(b)fluoranthene. It was concluded that the synergistic effects of hydrocarbons probably occur at the

level of the enzymatic system of activation of polycyclic aromatic hydrocarbon. [hermann m; mutat res 90: 399-409 (1981)].

The potencies of various xenobiotics for induction of monooxygenases and their influence on the rat liver microsomal metabolite profile of the environmentally relevant weak carcinogen, chrysene, was determined. Among the widely distributed chemicals, ... as well as polycyclic aromatic hydrocarbons and their heterocyclic analogues, benzo(b)fluoranthene, ... was found to be a potent inducer, stimulating the formation of the proximate, and ultimate carcinogen of chrysene. [Jacob J et al; Cancer Lett 34 (1): 91-102 (1987)].

The effects of environmental contaminants and/or xenobiotics on the rat liver microsomal cytochrome p450 system were studied in rats. ... Pretreatment of rats with ... benzo(b)fluoroanthene ... induced the p450 isoenzymes in such a way that the primary metabolite of chrysene, 1,2-dihydroxy-1,2-dihydroxchrysene, was converted to chrysene dihydrodiolepoxide [Silverman BD, Lowe JP; Chem-Biol Interact 47 (3): 289-92 (1983)].

Fraction F20, which in other studies was the most tumorigenic neutral fraction of cigarette smoke condensate was separated into refined subfractions for identification of polynuclear aromatic hydrocarbons (PAH) & for bioassay on mouse skin. Results supported the concept that polycyclic aromatic hydrocarbon in cigarette smoke must interact with other components in order to exert tumorigenic effect. /Polynuclear aromatic hydrocarbons/ [Akin FJ et al; j nat cancer inst 57 (1): 191-5 (1976)].

Uses/Sources:

See also Chem.Detail section below for benzo(b)fluoranthene concentrations in various petroleum products.

Major Uses [609]:

Research chemical

U.S. Production [609]:

There is no commercial production ... of this compound.

Artificial Sources [366]:

/Benzo(b)fluoranthene/...has been identified in...cigarette smoke...gasoline exhaust...emissions from

the burning of various types of coal...emission from oil-fired heating...broiled & smoked food...& oils & margarine. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work).,p. V32 148 (1983)].

Product of incomplete combustion (of carbon containing materials); component of fossil fuels.

Tumorigenic agents identified in particulate phase of tobacco smoke: benzo(b)fluoranthene--0.3 Ug/100 cigarettes. /From table/ [Searle, C. E. (ed.). Chemical Carcinogens. ACS Monograph 173. Washington, DC: American Chemical Society, 1976. 356].

Polycyclic aromatic hydrocarbons can be found in gases from premixed flame and fuel combustion. [Prado G et al; Formation of polycyclic aromatic hydrocarbons in premixed flames. Chemical analysis and mutagenicity; Chem Anal and Biol Fate: Polynucl Aromat Hydrocarbons, Int Symp 5th: 189-98 (1981)].

Human exposure to benzo(b)fluoranthene occurs primarily through the smoking of tobacco, inhalation of polluted air & by ingestion of food & water contaminated by combustion effluents. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work).,p. V32 150 (1983)].

Forms/Preparations/Formulations:

No information found.

Chem.Detail: Detailed Information on Chemical/Physical Properties:

Information from ATSDR [880] (unless referenced otherwise):

Solubility in water: 14 ug/L at 25 degrees C [366].

Insoluble (sic, actually "relatively insoluble") in water [366].

Solubility in organic solvents: slightly soluble in benzene and acetone

Solubility in biological fluids: unknown

Vapor pressure:

5x10(-7) mm Hg (20 C)

Partition coefficients:

Octanol-water (Kow): 1.15x10(6)
Log Kow: 6.06; 6.50 [848]; 6.57 [754]; 5.80 [971].

Soil-organic carbon-water (Koc): 5.5x10(5)
Sorption partition coefficient (log Koc): 5.74 [848].

Henry's law constant:

1.22x10(-5)

Molecular weight: 252.32 g/mol

Color: colorless

Odor: unknown

Melting point: 167-168 C

Boiling point: 481 degrees C [848].

Density: unknown

Benzo(b)fluoranthene concentrations in South Louisiana crude and Kuwait crude were <0.5 and <1 mg/kg (ppm), respectively [177].

Benzo(b)fluoranthene occurs in crude oil at a concentration of 7.4 mg/kg and in gasolines at concentrations of 0.19-1.34 mg/kg [847].

Benzo(b)fluoranthene content (mg/kg or ppm) in one fresh sample of Exxon Valdez Crude Oil [971]: 6 mg/kg = ppm

Benzo(b)fluoranthene content in one fresh sample of NSFO (Fuel Oil 5, Chuck Rafkind, National Park Service, Personal Communication, 1996): 11.0 ng/mg (ppm)

Benzo(b)fluoranthene content in one sample of groundwater subjected to long term contamination of NSFO (Fuel Oil 5), possibly mixed with some JP-4, motorgas, and JP-8, Colonial National Historical Park Groundwater Site MW-10 (Chuck Rafkind, National Park Service, Personal Communication, 1996): 399.2 ng/L (ppt)

NOTE: the above two PAH concentrations were analyzed by a GC/MS/SIM NOAA protocol [828] modified with methylene chloride extraction for use with water samples (Guy Denoux, Geochemical and Environmental Research Group, Texas A&M University, personal communication 1996).

Benzofluoranthenes concentration in Used Engine Oil: 46.0 ppm [519; Reprinted with permission from Environmental Toxicology and Chemistry, Volume 12, Upshall, C., J.F. Payne and J. Hellou. Induction of MFO enzymes and production of bile metabolites in rainbow trout (*Oncorhynchus mykiss*) exposed to waste crankcase oil. Copyright 1992 SETAC].

Benzo(b)fluoranthene is found at a volume of 3.9% in unleaded, premium unleaded, and leaded gasolines [796].

Fate.Detail: Detailed Information on Fate, Transport, Persistence, and/or Pathways:

Half-life in surface water: 8.7 to 720 hours, based on estimated aqueous photolysis half-life [848].

Half-life of benzo(b)fluoranthene in groundwater is 17,280 to 29,280 hours, based on unacclimated aqueous aerobic biodegradation half-life [848].

Half-lives in soil [848]: 294 days for Kidman sandy loam soil; 211 days for McLaurin sandy loam soil; 42 weeks; 9.2 years.

The half-life of benzo(b)fluoranthene also has been estimated to be 610 days in terrestrial environments [866].

One study showed how biodegradation of PAHs was related to molecular weight. The 5-ring PAHs like benzo(b)fluoranthene decreased slowly over a period of years [815].

Environmental Fate [609]:

TERRESTRIAL FATE: Oily sludge was repeatedly applied to soil in lab. After 1280 days, 79.4% of the added benzo(b)fluoranthene (BbF) remained. An unspecified portion of this degradation was attributed to biodegradation(1). Very strong adsorption of BbF to soil is expected. Leaching to groundwater and volatilization are, therefore, expected to be slow, relatively insignificant processes(SRC). [(1) Bossert I et al; Appl Environ Microbiol 47: 763-7 (1984).

AQUATIC FATE: Volatilization, photolysis and photooxidation of dissolved benzo(b)fluoranthene (BbF) may occur, but most benzo(b)fluoranthene is expected to be adsorbed to sediments, so these other fate processes are not expected to be significant(SRC). Bioconcentration of benzo(b)fluoranthene may be significant, although fish can rapidly metabolize polynuclear aromatic hydrocarbons by the action of microsomal oxidase(1). [(1) Santodonato J et al; Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Lee SD, Grant L eds; Pathotox Publ Park Forest South IL (1981).

ATMOSPHERIC FATE: An atmospheric half-life of 1.00 day was estimated for the reaction of vapor phase benzo(b)fluoranthene (BbF) with photochemically generated hydroxyl radicals(1,SRC). Adsorbed BbF will not react with hydroxyl radicals at this rate. Vapor phase benzo(b)fluoranthene is expected to directly photolyze at a rapid rate in the atmosphere, but the adsorbed compound may not do so(SRC). [(1) GEMS; Graphical Exposure Modeling System. Fate of Atmospheric Pollutants (FAP) Data Base. Office of Toxic Substances. USEPA (1986).

Biodegradation [609]:

No data were available concerning the biodegradation of benzo(b)fluoranthene, (BbF) but experiments have shown that other four- and five-ring polynuclear aromatic compounds undergo cometabolism(1). Benzo(b)fluoranthene may, therefore, also be subject to co-metabolism, but as a sole carbon source, benzo(b)fluoranthene is not expected to biodegrade(SRC). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983).

Abiotic Degradation [609]:

The half-life values for the reaction of a thin film of liquid benzo(b)fluoranthene (BbF) with ozone were 52.7, 10.8 and 2.9 hr for ozone concentrations of 0.19, 0.70 and 2.28 ppm, respectively(1). The photolysis half-life of BbF irradiated with 290-400 nm light in the absence of ozone was 8.7 hr (1). The half-life values when benzo(b)fluoranthene was irradiated at these wavelengths in the presence of ozone were 4.2, 3.6 and 1.9 hr for ozone concentrations of 0.19, 0.70 and 2.28, respectively(1). The temperature was not specified(1). Rapid photolysis of benzo(b)fluoranthene not adsorbed to sediments is expected(SRC). Photolysis in the presence of oxygen will likely produce quinone(2). [(1) Lane DA, Katz M; Adv Environ Sci Technol 8: 137-54 (1977) (2) Graedel TE; Chemical Compounds in the Atmosphere Academic Press NY, NY p 130 (1978).

Soil Adsorption/Mobility [609]:

Using a water solubility of 0.0012 mg/l(1), a log soil-sorption coefficient (Koc) of 5.88 was estimated for benzo(b)fluoranthene (BbF)(2,SRC). A Koc of this magnitude suggests that BbF will be immobile in the soil(3). Leaching to groundwater is, therefore, expected to be very slow; BbF is also expected to partition to sediments(SRC). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. McGraw-Hill NY pp 4-9 (1982) (3) Kenaga EE; Ecotox Env Safety 4: 26-38 (1980).

Volatilization from Water/Soil [609]:

Using a water solubility of 0.0012 mg/l(1) and a vapor pressure of 5.0×10^{-7} mm Hg(1), the half-life values for the volatilization of benzo(b)fluoranthene (BbF) from streams, rivers and lakes were estimated. The Henry's Law constant was estimated to be 1.38×10^{-4} atm cu m/mol. The wind velocity was assumed to be 3 m/s, the current velocities of the streams, rivers and lakes 2, 1 and 0.1 m/s, respectively, the depths of the lakes 50 m and that

of the streams and rivers 1 m. The half-life values were 10.24 hr, 14.47 hr and 5586.28 hr (232.8 days) for the streams, rivers and lakes, respectively(2, SRC). These values apply strictly to dissolved benzo(b)fluoranthene, and any process which limits the free solubility of benzo(b)fluoranthene such as adsorption to sediments or biota, will increase these half-lives(SRC). Volatilization from soil is not expected to be significant(SRC). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds. McGraw-Hill NY p 15-21 (1982).

Pharmacokinetics [609]:

Absorption, Distribution and Excretion:

Polynuclear aromatic hydrocarbons (PAH), some of which are potent carcinogens, are common environmental pollutants. The transport processes for these hydrophobic compounds into cells and between intracellular membranes are diverse and are not well understood. A common mechanism of transport is by spontaneous desorption and transfer through the aqueous phase. From the partitioning parameters, we have inferred that the rate limiting step involves solvation of the transfer species in the interfacial water at the phospholipid surface. Transfer of 10 polycyclic aromatic hydrocarbons ... out of phosphatidylcholine vesicles has been examined. Our results show that the molecular volume of the polycyclic aromatic hydrocarbons is a rate-determining factor. Moreover, high performance liquid chromatography (HPLC) data confirms the hypothesis that the rate of transfer is correlated with the size of the molecule and with the partitioning of the molecule between a polar and hydrocarbon phase. The kinetics and characteristics of the spontaneous transfer of carcinogens are likely to have a major impact on the competitive processes of polycyclic aromatic hydrocarbon metabolism within cells. /Polynuclear aromatic hydrocarbons/ [Plant AL et al; Chem-biol Interact 44 (3): 237-46 (1983).

It has been observed that polynuclear aromatic hydrocarbons (PNAs) are highly soluble in adipose tissue and lipids. Most of the PNAs taken in by mammals are oxidized & the metabolites excreted. Effects of that portion remaining in the body at low levels have not been documented. /Polynuclear aromatic hydrocarbons/ [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985. 741.

The waxy surface of some plant leaves and fruits can

concentrate polyaromatic hydrocarbons through surface adsorption. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons p.C-11 (1980).

Laboratory and/or Field Analyses:

Recommended detection limits:

Most of the PAH methods which have been commonly used historically for routine monitoring, including PAH parent compound standard methods:

EPA 8270 (8270 includes several PAH parent compounds along with a long list of other organics) for solid waste/RCRA applications [1013], and

EPA NPDES method 610 as specified in 40 CFR Part 136 (method 610 includes 16 PAH parent compounds) [1010],

EPA method 625 for Base/Neutral Extractables (method 625 includes several PAH parent compounds along with a long list of other organics) as specified in 40 CFR Part 136 [1010],

are all inadequate for generating scientifically defensible information for Natural Resource Damage Assessments [468]. These standard EPA scans do not cover important alkyl PAHs and do not utilize low-enough detection limits. When biological effects, ecological risk assessment, damage assessment, or bio-remediation are being considered, detection limit should be no higher than 1-10 ng/L (ppt) for water and 1 ug/kg (ppb) dry weight for solids such as tissues, sediments, and soil.

Note: Utilizing up to date techniques, many of the better labs can use detection limits of 0.3 to 1 ppb for tissues, sediments, and soils. When no biological resources are at risk, detection limits for solids should nevertheless generally not be above 10 ppb. One reason that low detection limits are needed for PAHs is that so many of the criteria, standards, and screening benchmarks are in the lower ppb range (see various entries on individual PAHs).

In the past, many methods have been used to analyze for PAHs [861,1010,1013]. However, recent (1991) studies have indicated that EPA approved methods used for oil spill assessments (including total petroleum hydrocarbons method 418.1, semivolatile priority pollutant organics methods 625 and 8270, and volatile organic priority pollutant methods 602, 1624, and 8240) are all inadequate

for generating scientifically defensible information for Natural Resource Damage Assessments [468]. These general organic chemical methods are deficient in chemical selectivity (types of constituents analyzed) and sensitivity (detection limits); the deficiencies in these two areas lead to an inability to interpret the environmental significance of the data in a scientifically defensible manner [468].

For risk, damage assessment, drinking water, or to determine if biodegradation has occurred, the NOAA expanded scan for PAHs and alkyl PAHs [828], or equivalent rigorous and comprehensive scans. (such as SW-846 method 8270 modified for Selective Ion Mode detection limits and an equivalent list of parent compound and alkyl PAH analytes), are recommended.

If a Park Service groundwater investigation at Colonial National Historical Park performed in response to contamination by Fuel Oil 5 had utilized EPA semi-volatile scan 8270 or any of the other typical EPA scans (625, etc.) all of which only include parent compounds and typically utilize detection limits in the 170-600 ppb range, the false conclusion reached would have been that no PAHs were present in significant (detection limit) amounts. This false negative conclusion would have been made because the parent compound PAHs present constituted only 7.6% of the PAHs detected in groundwater by the expanded scan [828], and the highest concentration found for any parent compound was 8.4 ppb, far below the detection limits used on the older standard EPA scans. Utilizing the NOAA protocol expanded scan [828], it was determined that 92.4% of the total concentration values of the PAHs detected in groundwater were alkyl PAHs, and that all 39 PAHs and alkyl PAHs were present. Of course, all 39 PAHs were also present in the fresh product, in much higher concentrations, and also having alkyl compounds with the highest percentage of higher values compared to parent compounds (see Chem.Detail section in separate "PAHs as a group" entry for more details).

In a similar vein, if the Park Service sediment investigation at Petersburg National Historical Battlefield (see Chem.Detail section in separate "PAHs as a group" entry; this study was performed in response to contamination by Diesel) had utilized EPA semi-volatile scan 8270 or any of the other typical EPA scans (625, etc.), all of which only include parent compounds and often utilize detection limits no lower than the 170-600 ppb range, the false conclusion reached would have been that only one PAH was present in significant (detection limit) amounts. This false negative conclusion would have been made because the parent compound PAHs present constituted only 2.4% of the PAHs detected in sediments, and the highest concentration found for any parent compound except pyrene was 85.5 ppb, far below the detection limits used on the older standard EPA scans. Pyrene was 185 ppb, which would have been non-detected on many of the EPA scans, but not all. However, utilizing the NOAA protocol expanded scan [828], it was determined that 97.6% of total quantity of PAHs detected in sediments were alkyl PAHs, and that all 39 PAHs and alkyl PAHs were present in these sediments.

When taking sediment samples for toxic organics such as PCBs, PAHs, and organochlorines, one should also routinely ask for total

organic carbon analyses so that sediment values may be normalized for carbon. This will allow comparison with the newer EPA interim criteria [86,127]. TOC in sediments influences the dose at which many compounds are toxic (Dr. Denny Buckler, FWS Columbia, personal communication).

In some cases (where the expanded scans are too expensive) an alternative recommendation is that one screen sediments with a size-exclusion high-performance liquid chromatography (HPLC)/fluorescence method. The utility and practicality of the HPLC bile and sediment screening analyses were demonstrated on board the NOAA R/V Mt. Mitchell during the Arabian Gulf Project. Estimates of petroleum contamination in sediment and fish were available rapidly, allowing modification of the sampling strategy based on these results [522].

Variation in concentrations of organic contaminants may sometimes be due to the typically great differences in how individual investigators treat samples in the field and in the lab rather than true differences in environmental concentrations. This is particularly true for volatiles and for the relatively lighter semi-volatiles such as the naphthalene PAHs, which are so easily lost at various steps along the way. Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable. In fact, as mentioned in the introductory disclaimers, the interagency task force on water methods concluded that [1014]:

It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...

No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

As of 1997, the problem of lack of data comparability (not only for water methods but also for soil, sediment, and tissue methods) between different "standard methods" recommended by different agencies seemed to be getting worse, if anything, rather than better. The trend in quality assurance seemed to be for various agencies, including the EPA and others, to insist on quality assurance plans for each project. In addition to quality control steps (blanks, duplicates, spikes, etc.), these quality assurance plans call for a step of insuring data comparability [1015,1017]. However, the data comparability step is often not given sufficient consideration. The tendency of agency guidance (such as EPA SW-846 methods and some other new EPA methods for bio-concentratable substances) to allow more and more flexibility to select options at various points along the way, makes it harder to insure data comparability or method validity. Even volunteer monitoring programs are now strongly encouraged to develop and use quality assurance project plans [1015,1017].

At minimum, before using contaminants data from diverse

sources, one should determine that field collection methods, detection limits, and lab quality control techniques were acceptable and comparable. The goal is that the analysis in the concentration range of the comparison benchmark concentration should be very precise and accurate.

It should be kept in mind that quality control field and lab blanks and duplicates will not help in the data quality assurance goal as well as intended if one is using a method prone to false negatives. Methods may be prone to false negatives due to the use of detection limits that are too high, the loss of contaminants through inappropriate handling, or the use of an inappropriate methods such as many of the EPA standard scans. This is one reason for using the NOAA expanded scan for PAHs [828]; or method 8270 [1013] modified for Selective Ion Mode (SIM) detection limits (10 ppt for water, 0.3 to 1 ppb for solids) and additional alkyl PAH analytes; or alternative rigorous scans. These types of rigorous scans are less prone to false negatives than many of the standard EPA scans for PAH parent compounds (Roy Irwin, National Park Service, Personal Communication, 1997).

For a much more detailed discussion of the great many different lab and field methods for PAHs in general, see the entry entitled PAHs as a group (file name starting with letter string: PAHS). There the reader will find much more detailed discussions of lab methods, holding times, containers, comparability of data from different methods, field sampling methods, quality assurance procedures, the relationship of various methods to each other, the various EPA standard methods for various EPA programs, the pros and cons of various methods, and additional documentation concerning why many standard EPA methods are inadequate for certain applications. A decision tree key for selecting the most appropriate methods for oil or oil products spills is also provided in the lab section of the PAHs entry. Due to the length of these discussions, they are not repeated here (see PAHs entry).