4.5 APPROACHES TO QUANTIFYING EXPOSURES

An initial requirement for exposure assessment is an understanding of the presence (or absence) of an agent and its concentrations and distribution, including any fluctuations over time. Guidance on sampling and analysis of environmental media is summarised in Chapter 8.

Accurate and useful exposure assessment requires a detailed understanding of both the strengths and weaknesses of the exposure assessment techniques, and the specific exposure factors used in the assessment. Considerable effort needs to be made to accurately characterise the population or individuals for whom the exposure assessment is relevant.

> *Direct measurement of the exposures of the (potentially) affected population provides the best exposure data but this is not always available or practicable and default exposure factor data are often required.*
>
> (Langley 1993a p. 90)

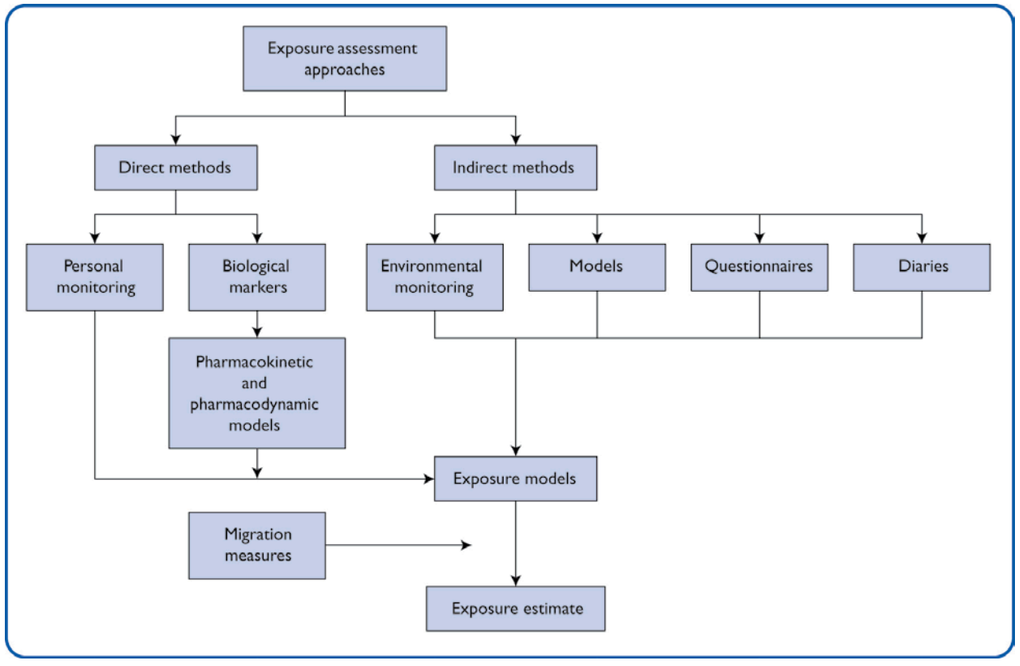
Figure 21 outlines the integration of direct and indirect measurements of exposure. Most EHRA processes rely on indirect estimation of exposure, using environmental monitoring data and models to quantify chemical transport through the identified exposure pathways. Chapter 13 outlines further information on the use of modelling in exposure assessment.

4.5.1 Measurement of exposure

Accurate and useful exposure assessment requires a detailed understanding both of the strengths and weaknesses of the exposure assessment techniques, and the specific exposure factors used in the assessment.

Direct measurement of the exposures of the (potentially) affected population provides the best exposure data, but this is not always available or practicable (except perhaps at the Tier 3 level) and default exposure factor data is often required.

Figure 21: Components of exposure assessment



Adapted from: National Academy of Sciences (NAS) 1991.

4.5.2 Determinants of exposures

The principal determinants of the level of exposure are:

- concentration of the agent in the relevant medium
- exposure duration
- exposure frequency
- exposure fluctuations (continuous or intermittent)
- whether exposure pathways are completed or potential.

Monitoring environmental media can provide useful indications of exposure levels, providing there is a strong correlation between environmental media levels of exposure and personal doses.

A powerful method of direct exposure assessment is using biomarkers as part of a biological monitoring process, but this approach has its limitations. The role of biomonitoring is discussed in Chapter 14.

4.5.3 Quantification of exposure

The quantification of exposure can be done in three ways:

- The exposure can be measured at the point of contact (the outer boundary of the body) while it is taking place, measuring both exposure concentration and time of contact and integrating them (point of contact measurement).
- The exposure can be estimated by separately evaluating the exposure concentration and the time of contact, then combining this information (scenario evaluation).
- The exposure can be estimated by dose, which in turn can be reconstructed from internal indicators (biomarkers, body burden, excretion levels) after the exposure has taken place.

Each of these methods is a separate entity using different information, and so each one can be useful in verifying or validating the results of other methods (ATSDR 1992).

Commonly, chemical levels will be measured at the point of release to the environment, as this is likely to be the point where concentrations are highest and so it will be the easiest to measure. Such data may also be available from monitoring required by regulation. More information is provided in Chapter 8.

It is important to have a good understanding of the strengths and weaknesses of the sampling design and the analytical methods used in any measurement.

An understanding of transport and fate models for the agent(s) in question is also important. Transport and fate will be affected by (Fiksel & Scow 1983):

- environmental exposure medium (e.g. air, surface water, soil, groundwater or biota)
- geographic scale (e.g. global, national, regional or local)
- pollutant source characteristics (e.g. continuous, intermittent or instantaneous releases from industrial, residential and commercial point or area sources)
- the nature of the risk agent (e.g. whether it is a specific agent or group of agents)
- the receptor population (e.g. humans, animals, plants, micro-organisms and habitats, as well as specific sub-populations exposed to high levels of the agent or who are particularly sensitive to exposure)
- exposure routes (e.g. ingestion, dermal contact or inhalation)
- environmental conditions (e.g. pH, presence of organic matter, clay content, temperature and meteorological)
- the time frame (e.g. retrospective, current or prospective).

Modelling may be used to estimate the concentration that people may be exposed to when measurement is not practical or possible in the time frame required. See Chapter 13

The initial release of a chemical may be modelled for facilities that are yet to be built. These will be based on the engineering of the facility and the way chemicals are to be used.

Measured data for the release of a chemical from a facility may be available but models may commonly be used to describe the transport of the chemical away from the point of release, such as air dispersion models, or to describe the fate of the chemical in the environment through consideration of half-lives, effect of organic carbon or other characteristics.

In developing sampling plans for chemical agents and assessing exposure, an understanding of the movement of chemical agents within and between environmental compartments and the effects of environmental partitioning will be necessary (see Section 4.9.1).