8.2 Resources

The resources required to undertake measurements include the laboratory or other workplace, appropriate staff, measurement or other equipment, and supplies. All contribute to the reliability of the measurement data and must be included in the quality assurance programme.

The **workplace** should be designed to allow tasks to be carried out in appropriate, well-defined areas. Fittings should be made of materials which are compatible with the tests being performed. For example, it may be necessary to take account of magnetic fields, high voltages or chemical contamination. In many cases atmospheric factors such as cleanliness, temperature or humidity may affect the reliability of results. It is then important to keep systematic records and, where appropriate, install adequate environmental control. The required conditions should also be specified in the documentation of the test procedure.

The knowledge, experience and attitude of **staff** undertaking measurements can have a major effect on the reliability of results. Attitude is often overlooked, but for many measurement methods obtaining consistent results is dependent on having staff who are alert to problems and take pride in their work. Clearly, it is impracticable and unnecessary for all measurements to be performed by highly qualified scientists or engineers. Nevertheless it is essential that every measurement procedure has a designated responsible officer who is scientifically answerable for the data and fully understands the procedure. The responsible officer should be appropriately qualified and be experienced in the area of work, with first-hand experience of the test procedure. The responsible officer need not necessarily have managerial responsibility for the facility although this is often the case, particularly in smaller organisations. Staff acting under instruction from the responsible officer must be fully trained and experienced in the correct use of instrumentation or other equipment. It is essential that they understand the general principles of quality assurance, including the importance of following a method exactly as described and how to act on quality control data. No member of staff should be allowed to produce results without close supervision until they have been adequately trained and have demonstrated their ability to produce data of sufficiently high quality. A record of their relevant qualifications, training and experience must be kept, including proven ability to perform to a designated standard. Relevant records of staff competence should be archived with the measurement results. In larger organisations it is useful for staff to maintain a training portfolio which they take with them from job to job.

Complex **equipment and instrumentation** is now an integral part of most measurement procedures. As such, assuring its correct operation must

be a major element of the quality system. The widespread use of solid-state electronics and elaborate data-processing facilities makes it increasingly difficult for the measurement scientist or engineer to identify and understand many possible sources of unreliable results. Hence quality assurance activities should begin even before the equipment is purchased. Those responsible will need to consider the most appropriate specification, ensure that the proposed purchase fully meets it, and check on the supplier's own attention to quality. Performance to specification must be confirmed by appropriate tests, both after installation and regularly thereafter, and records maintained. These specification tests should be devised by those responsible for the measurements and take into account the type of work undertaken. The frequency with which they are carried out will depend on both the nature of the work and characteristics of the equipment such as instrument drift. Equipment found to be out of specification should not be used until corrective action has been undertaken. Except in very small organisations the quality system will need to make formal provision for taking equipment out of use and authorising its reinstatement. Similarly, the system will need to specify requirements for routine maintenance and calibration, ideally carried out according to manufacturers' instructions. Records of these activities should be kept, ideally in association with archived data. Wherever possible, calibrations should be traceable to a recognised national or international organisation. This is a requirement of most regulatory or certification bodies.

All measurement facilities require consumable **supplies**, ranging from electricity through water and various gases to complex chemical reagents. Similar requirements apply to those noted above for equipment; a specific level of quality must be specified, regular checks made and records kept. Checks should be made to confirm that items from new batches or new suppliers are consistent with those used previously. Even inadequate electricity supplies, for example mains spikes or fluctuating voltages, can seriously affect the reliability of measurement data. Where chemicals and solvents are used, it is essential that adequate checks be made for problems such as deterioration or contamination. If this is to be achieved by reliance on the supplier, then checks for authenticity and integrity should be made by the user. The quality of many chemicals and some other supplies will deteriorate with time. Hence the quality assurance system must include appropriate precautions, for example labelling with preparation and expiry dates or regular checks of critical parameters. It may be necessary to store some supplies under carefully controlled conditions. In this case regular checks should be made of the relevant conditions, such as temperature, and records maintained.

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