

Executive Summary

In the research report of project 1668 (*Volume 1: Research Report (WRC Report 1668/1/09)*), the identification of technical and non-technical problems and challenges experienced at water treatment plants led to the development of comprehensive diagnostic tools which spell out the step-by-step procedures and corrective actions needed to ensure the supply of safe water to non-metropolitan communities. These diagnostic tools for technical and non-technical compliance of water treatment plants were developed to perform an assessment of a water treatment plant and establish compliance with water quality standards and management norms.

Diagnostic tool for technical compliance – In this diagnostic tool, a detailed assessment of technical treatment plant measurements includes design aspects, quality control, process control, plant monitoring, maintenance aspects and risk management. The quality of the final water is measured against the specifications of South African National Standard (SANS) 241. For every area of non-compliance, the causes and/or underlying problems are identified and flagged for further attention and action. Corrective and preventative measures are then proposed for each of these causes and problems, and re-measurement of the total program is then undertaken to eliminate or manage these issues.

Diagnostic tool for non-technical compliance – This tool is used to perform an audit of the management components that play an important role in the sustainability of a water treatment plant. The assessment focuses on management issues and practices, human resources, the financial aspect, the communication systems in place, safety, health and environmental quality as well as community involvement and awareness. Problem areas that are identified during the assessment are then flagged and corrective measures proposed. A report is then sent to the authorities, and compliance re-assessed by performing a new re-measurement from the first step involving the human resources assessment. In this way, the problems resulting in non-compliance can be eliminated or addressed and preventative measures put in place, so as to ensure that these challenges can be managed effectively by the plant manager or supervisor.

The diagnostic tools were evaluated through on-site visits to 45 small water treatment plants in Eastern Cape, KwaZulu-Natal, Mpumalanga and Western Cape. The test mostly focused on quality control, process control and plant monitoring. This was due to the fact that most process controllers on duty during the visits were not able to provide the required information. However, most of the information regarding the non-technical aspects of the plants was obtained during workshops.

Step-wise procedures for performing a compliance assessment of water treatment plants

Compliance assessment using the technical diagnostic tool

The technical diagnostic tool developed during this study chronicles technical compliance assessments. It also shows corrective actions to be taken in cases of anomalies and can be used as a scoring guide. The essence of the technical diagnostic tool is to make information on the various aspects of the assessments widely available in order to canvass better understanding of the step-by-step procedures required for the eventual supply of safe water.

For the water treatment plant measurement, a detailed assessment of design, operational monitoring, compliance monitoring, plant monitoring, maintenance monitoring and risk management practices should be undertaken.

- *Assessment of design and operational monitoring practices* – The design should be assessed in terms of the availability and functioning of the mixing, flocculation, sedimentation, and filtration equipment. In each case, the mixing equipment should be checked for the duration and intensity of mixing, including accurate dosage of chemicals, whereas the flocculation equipment should be checked for the type and rapidity of floc formation, the condition of the dosing system, the calibration of the dosing rate including the availability of a backup dosing pump and the maintenance of flocculation equipment. The assessment of the sedimentation equipment should consider whether parameters such as short circuiting, retention time, settling velocity, maintenance work and sludge and backwash-water disposal are within acceptable standards. Filtration should be checked for the effectiveness of valves, filter nozzles, filtration rate, length of filter and the requirement of chlorine to prevent algae growth of lime and to increase pH and removal of metal, as well as whether turbidity of filtered water falls within the recommended limits.
- *Assessment of plant and final water monitoring practices* – Information on daily activities in water treatment plants should be obtained for the purpose of prompt identification of deviations or anomalies. Such information should include operating practices, measurement of flow rate, lime and alum doses, measurement and interpretation of turbidity, pH, temperature, chlorine dose and the state of the filters. Information may be obtained during a tour of the plant as well as interviews with process controllers and plant superintendants. In obtaining information, inspection of infrastructure and equipment noting unusual noises or smells is important. Process controllers are required to take notes of irregular observations in the plant logbook for eventual action by the plant manager or supervisor. Information on final water quality must also be obtained and recorded from various sampling points in terms of the concentration of free chlorine residual and the presence or absence of faecal indicator bacteria.
- *Assessment of maintenance practices* – Critical issues to be considered when assessing maintenance practices are the availability of spare-parts and back-up services, communication lines and facilities between the plant and management, suppliers and service providers, availability and ease of access to funds for maintenance, and accessibility to plant by motor vehicles (e.g. delivery trucks).
- *Assessment of risk management practices* – A Risk based approach for the identification of hazards from the catchment to the point of consumption including mitigation strategies must be established. All relevant measurements such as the quality of settled and filtered water and the quality of final water at the point of treatment and the point of use should comply with SANS 241.
- *Documenting and scoring of problem areas* – For all cases mentioned above, a listing and description of all the problem areas, including implications and consequences emanating from the problems, must be documented in order of priority. The scoring of the problem areas on the scale of one to five should be reflected as indicated below.

1	Insignificant Consequence
2	Minor Consequence
3	Moderate Consequence
4	Major Consequence
5	Catastrophic Consequence

- *Corrective and preventative measures for technical compliance* – Once the scoring is completed, corrective and preventative measures must be actioned and subsequent re-measurement performed by repeating the whole technical assessment, with emphasis on problem areas identified, and a continuation of the repeat process until full compliance is achieved. As guidance, a list of corrective and preventative measures for some of the most common problems experienced at water treatment plants is provided in this document.

Compliance assessment using the non-technical diagnostic tool

The non-technical compliance assessment should be predicated on management issues that are vital for the sustainability of water treatment plants. The assessment should therefore target such management issues and practices as human and financial resources, communication systems, community involvement and awareness, health, safety and environmental factors. The essence of the non-technical diagnostic tool is to make information on the various aspects of the assessments widely available in order to canvass better understanding of the management conditions required for the eventual supply of safe water.

- *Audit of management issues* – The management issues should emphasise plans for preventative strategies for drinking water management, recruitment of plant personnel, in-service training and job description as well as a comprehensive funding strategy. Tactical plans should emphasise strategies for maintenance and asset management, communication and general oversight of the plants during emergencies. The operational plan typifies the monitoring of attendance of process controllers including the use of a clock-in-system, an arrangement for substitute personnel when any of the operators is ill, absent or away on other official business. This plan should also specify the job requirements and responsibilities of supervisors and process controllers.
- *Audit of management practices* – Issues around management practices are: assessment of local and international management practices, assessment of personnel at the plant, qualification, training needs and career development including the assessment of working conditions of staff and classification of the plant. The understanding and implementation of local and international best practices are useful. Assessment of personnel should entail information on shift workers including guidelines/rules for their deployment. The relevant qualifications in relation to job fit and conditions of service including salaries and medical aid schemes are also critical issues for consideration. Other pertinent incentives should consist of the following: leave, retirement and pension benefits, strategies for in-service training and career advancement, conflict management as well as management and payment of overtime. Information on the type and category of classification of the plants must be readily available.

- *Audit of financial systems* – This includes assessment of financial, information sharing and procurement systems and should specify adequacy of funds for maintenance and overtime, communication channels between the financial and water care sections, meetings held and how decisions are taken and whether the minutes of meetings are freely available. The procurement system should be judged in terms of transparency, honesty and the involvement of the water section in the adjudication of tenders.
- *Audit of communication systems* – The audit of communication systems should encompass internal and external communication systems in terms of the effectiveness of communication channels between management and lower level process controllers, between management and municipalities or departments and consumers.
- *Audit of safety, health and environmental quality* – **These parameters should be assessed in terms of strategies in place to ensure normal operations during incidents and emergencies including** chlorine leaks, as well as the safety of process controllers on duty. Availability and accessibility of fire extinguishers must be guaranteed. Control measures that identify risks and mitigation strategies as well as plans to improve the quality of the working environment in order to enhance service delivery must be a source document.
- *Community involvement and awareness* are important factors in ensuring the supply of safe drinking water. Consequently, interface of water management staff and local communities is necessary to address community concerns in all their ramifications.
- *Documenting and scoring of problem areas* – For all cases mentioned above, a listing and description of all the problem areas including implications and consequences emanating from the problems must be documented in order of priority. The scoring of the problem areas on the scale of one to five should be reflected as indicated above.
- *Corrective and preventative measures for non-technical compliance* – The corrective measures and preventative measures are then initiated at the plant, and as soon as all these have been completed, re-measurement is conducted by repeating the whole technical compliance assessment, but this time concentrating on the problem areas that were identified during the first assessment, and establishing whether compliance has now been achieved/restored. This process is continued until all the problem areas have been eliminated and there is full compliance. A list of practical corrective and preventative measures for non-technical issues is highlighted in this document.

Scored and weighted system for technical and non-technical compliance

The overall compliance rating of a water treatment plant will be based on a scoring system according to the identified criteria and norms in this document. This is carried out separately for technical compliance and non-technical compliance to ensure rapid assessment of whether the main problems at the treatment plant (if applicable) lie within the technical or non-technical (management) area.

Because certain compliance criteria are more important than others, a weighting system is used whereby weight is given to each of the compliance sections. These weights should be determined by a panel of water treatment experts and regulation authorities, and should be

revised on a regular basis and when necessary. The proposed weight systems for technical and non-technical compliance are provided in this document.