

TERMS OF REFERENCE FOR R&D PROJECT

Food and Agriculture Department

Water Purification Systems Sectional Committee, FAD 30

1 TITLE OF THE PROJECT

Study on effective technologies/methodologies available for removal of fluoride from water for drinking purposes.

2 BACKGROUND

2.1 Fluorine is a common element widely distributed in Earth's crust and exists in the form of fluorides in several minerals, such as fluorspar, cryolite, and fluorapatite. Traces of fluorides are present in many waters, with higher concentrations often associated with groundwater. High fluoride concentrations can be found in many parts of India. Fluoride may be an essential element for humans; however, fluoride can also hurt tooth enamel and lead to mild dental fluorosis. Elevated fluoride intakes can have more severe effects on skeletal tissues. Skeletal fluorosis (with adverse changes in bone structure) may be observed when drinking water contains 3–6 mg of fluoride per litre, particularly with high water consumption. Several epidemiological studies are available on the possible association between fluoride in drinking water and cancer. A range of treatment technologies are available for both large and small supplies. Different methods for small supplies are favored in different countries based on bone charcoal, contact precipitation, activated alumina, and clay.

2.2 Fluoride contamination in groundwater is a persistent public health issue, particularly in rural and semi-urban regions of India. The Indian Standard IS 12742:1989, developed over three decades ago, provides guidance on defluoridation of drinking water using chemical treatment methods, specifically the Nalgonda technique. IS 12742 may be downloaded from the BIS website by following the link: https://standardsbis.bsbedge.com/BIS_searchstandard.aspx?Standard_Number=IS+12742&id=3417. While this method has been historically significant, the standard is now outdated need to be revised to reflect the technological advancements, field experiences, or policy developments that have emerged since its publication. Moreover, while the Ministry of Jal Shakti's Handbook on Drinking Water Technologies which can be accessed through the link https://ejalshakti.gov.in/MISC/InnovationProvenTech_Rep_W.aspx acknowledges a diverse set of proven solutions. The standard also needs to address India's geographically diverse fluoride contamination and offer guidance for region-specific or population-based system designs. A comprehensive R&D project is essential for the following reasons:

- **Health Impact:** Fluorosis cases continue to rise, warranting improved intervention methods and more targeted deployment strategies.

- **Technological Gaps:** Emerging technologies like electrocoagulation or nano-filtration require field validation and cost-benefit analysis.
- **Variability in Fluoride Levels:** Regional differences in contamination make uniform solutions ineffective.
- **Socioeconomic Constraints:** High operational and maintenance costs make certain methods unviable for low-income communities.

3 OBJECTIVE

The objective of this study is to comprehensively analyze and assess the various available technologies and practices for defluoridating drinking water. The study will focus on collecting technical information related to the methodologies, design parameters, and operational considerations essential for fluoride removal. It aims to evaluate the feasibility and cost-effectiveness of the adaptability of different technologies. Furthermore, the study aims to generate context-specific protocols suited to various plant sizes, level of fluoride contamination and geographic challenges.

4 SCOPE

4.1 Study of existing literature on research publications, international/national/ regional guidelines & standards related to defluoridation of water for drinking purposes.

4.2 Primary survey in locations with different geographical and climatic factors to understand the best practices, relevant technologies, and methodologies for defluoridation of water for drinking purposes.

4.3 Stakeholder consultation for the development of an all-inclusive guide based on the study conducted for defluoridation of water for drinking purposes.

5 RESEARCH METHODOLOGY

5.1 Undertake a thorough literature review as per **4.1** and prepare a summary report.

5.2 Collect information on various plants (both rural and urban) in the country that defluoridate water for drinking purposes and the methodologies used by them.

5.3 Identify the geographical sites of fluoride contamination to map the extent of the contamination, with a discussion on endemic concentration ranges. This will facilitate the recommendation on suitable treatment technologies.

5.4 Sampling plan:

- (i) Conduct a primary survey among stakeholders (minimum 15) involved in the defluoridation of water for drinking purposes to understand the best practices being employed in the country.
- (ii) Conduct onsite visits to a minimum of 10 different locations (identified in **5.3**) in the country for the detailed study.

5.5 Study relevant technologies and methodologies used for their design, operation and performance-based criteria covering fluoride removal efficiency, operational costs, energy consumption, maintenance frequency, residual waste management, and community acceptance to enable objective evaluation and informed technology selection.

5.6 Evaluate the performance of existing treatment plants, and comparison of emerging technologies with prevalent ones, with emphasis on effectiveness, operational sustainability and economic viability.

5.7 Identify the challenges and recommend practices to mitigate these challenges, and apply modern-day technology.

5.8 Based on the detailed literature review, stakeholder consultations, and on-site visits, prepare an all-inclusive guide on various technologies, methodologies, and protocols recommended for defluoridation of water for drinking purposes based on the geographical location, level of fluoride contamination and the size of the plant.

6 EXPECTED DELIVERABLES

Detailed project report of the work done, in hard copy and digital formats, as per the scope specified under **4**, with the following as appendices:

- a) Database on various defluoridation methods of water for drinking purposes in different locations of the country.
- b) Research findings collected through the secondary and primary study, including Questionnaires (from the survey) and field-specific empirical data/ information on technologies and methodologies employed. Discussion and visit reports are to be appended to the project report.
- c) Working draft of standard covering comprehensive guidelines on various technologies, methodologies, and protocols vis-à-vis the geographical location, level of fluoride contamination and capacity/size of the plant, which are recommended for defluoridation of water for drinking purposes.

7 TIMELINE AND METHOD OF PROGRESS REVIEW

7.1 Timeline for the project is 6 months from the date of award of the project.

7.2 Stages of review:

Stage	Timeline
Stage I: Review of the literature (published research, international/ regional guidelines & standards) and collection of information on various plants in the country for defluoridation of water for drinking purposes and their methodologies. Conduct a primary survey among stakeholders (minimum 15) involved in the defluoridation of water for drinking purposes to understand the best practices being employed in the country.	2 months
Submission of mid-term report	End of 2 nd month
Stage II: On-site visits at different country locations. Study and evaluation of various technologies, methodologies and protocols <i>vis-a-vis</i> geographical location, level of fluoride contamination and capacity/size of the plant.	3 rd to 5 th month
Stage III: Draft report and working draft submission – The Sectional Committee will evaluate the draft report and working draft and provide feedback/recommend changes if required.	6 th month

At the end of the 6th month, the project allottee is to submit the final project report incorporating recommendations/feedback from the Committee.

Note: The timelines above are indicative, and the time will be calculated starting from when the project leader receives the sanction letter.

8 SUPPORT FROM BIS

8.1 Access to Indian and International Standards.

8.2 Letters from BIS to concerned stakeholders for support in the research project.

9 NODAL OFFICER

Ms Disha Zanwar, Scientist-C/ Deputy Director and Member Secretary FAD 30 , BIS, may be contacted at fad-wps@bis.gov.in for any queries on the research project.