American Membrane Technology Association

America's Authority in Membrane Treatment

Planning and Procurement for Membrane Plants

Overview

This fact sheet will cover the basic planning, piloting, procurement and construction of various membrane systems such as: Seawater and brackish water Reverse Osmosis, EDR, Nanofiltration, Ultrafiltration, Microfiltration as well as Integrated Membrane Systems (IMS).

Critical and major decision factors, including capital costs, operation and maintenance costs as well as life cycle cost approaches are discussed. Feed water quality assessments, piloting needs, project phasing, project schedule allocations, permitting needs and challenges, and other planning tools and needs are also discussed. The advantages and disadvantages of various procurement methods of delivery, such as design/bid, design/ build, and pre-purchase are highlighted.

Project Implementation Phases

Membrane system implementation is similar to any other water treatment project in terms of phases, however it is unique in terms of the degree of detail and the procurement steps.

A typical project implementation will have the following phases:

Phase 1: Feasibility Study
Phase 2: Conceptual Design
Phase 3: Detailed Design
Phase 4: Bidding Period
Phase 5: Construction
Phase 6: Functional Testing and Commissioning
Phase 7: Startup Phase
Phase 8: Project Closeout

During Phase 1, the project water quality goals and plant capacity is set. Then, with assistance from membrane manufacturers and/or specialty consultants, a critique of various technologies is conducted to assess feasibility and cost effectiveness of membrane options. Many utilities can complete this phase with their own staff. It is crucial to give a yes or no to membranes in this phase. Remember, membranes may not be the best option for all types of waters and in every application.

For Phase 2, advice from a specialized consultant is a must. This is when layouts and conceptual design are done to evaluate membrane options. This is also the last practical and cost effective phase to go back to feasibility study if membrane is not found to be the best alternative. Following this phase, it would be very costly to change the treatment technology and it will have a significant impact on the project schedule. A detailed water quality investigation and if required, piloting is done in this phase to verify membrane applicability, type of systems to use, as well as setting design parameters for the next phase. Depending on the piloting requirements and periods, this phase could take as little as 2-3 months to over a year, if seasonal water quality changes are substantial. If a pilot study is required, a detailed test protocol should be prepared to not only evaluate various manufacturers, but also use it as a basis for O&M cost evaluation. It is highly recommended to prepare this test protocol with guidance from the permitting agencies and make them a part of the decision process as stakeholders. The conclusion of this phase should be what type of membrane to use and who the manufacturers are. If manufacturers were invited to pilot test, you must ensure that they are being evaluated in a fair and open environment. Test protocol is the key evaluation tool. It is also recommended to get manufacturers involved early in the draft test protocol so there are no surprises and they won't take exceptions later. Remember if you are doing this for the first time, they have done pilots side-by-side for a couple of decades!

Before starting Phase 3, all design parameters, plant capacity, reliability and redundancy factors, stand-by provisions, temperature and water quality considerations must be established. These will then become the design basis for the specialty consultant. Phase 3 is essentially local engineers working with specialty consultants to perform detail designs to prepare the bidding documents while the local engineer is focusing on the site work, building, incoming power, etc. The specialty consultant is doing detail design and layout for the process equipment and setting the bidding requirements for the membrane system. Depending on the project schedule and local requirements, typically three major submittals are prepared; 20%-30%, 60%-70% and 100% design. It is critical to establish the type of

procurement, short list manufacturers and identify all key process needs during the 20%-30% phase. Even with the same membrane technology, the system layout, process needs and power/ chemical requirements are very different.

Phase 4 is the most complex phase in membrane system implementation. There are many different methods of bidding membrane systems, each with its own advantages/disadvantages. Please refer to the procurement section of this paper.

The success of Phase 5 depends on Phase 3 and 4. The single most important factor becomes how detailed the bid document is and who is responsible for what material/ equipment, as well as testing and guarantees.

For Phases 6 and 7, typically each entity focuses on their scope, except the overall controls, which should be one entity taking charge.

Phase 8 is preparing as builts, final O&M manuals and each entity completing their punch lists. The specialty consultant can be of great assistance to compile all O&M and shop drawings and provide comprehensive operator training on the overall plant process, while each supplier provides detailed training of individual components.

Bidding Documents

The bid documents, regardless of whether it is one, two or sometimes three package, should follow the following guidelines:

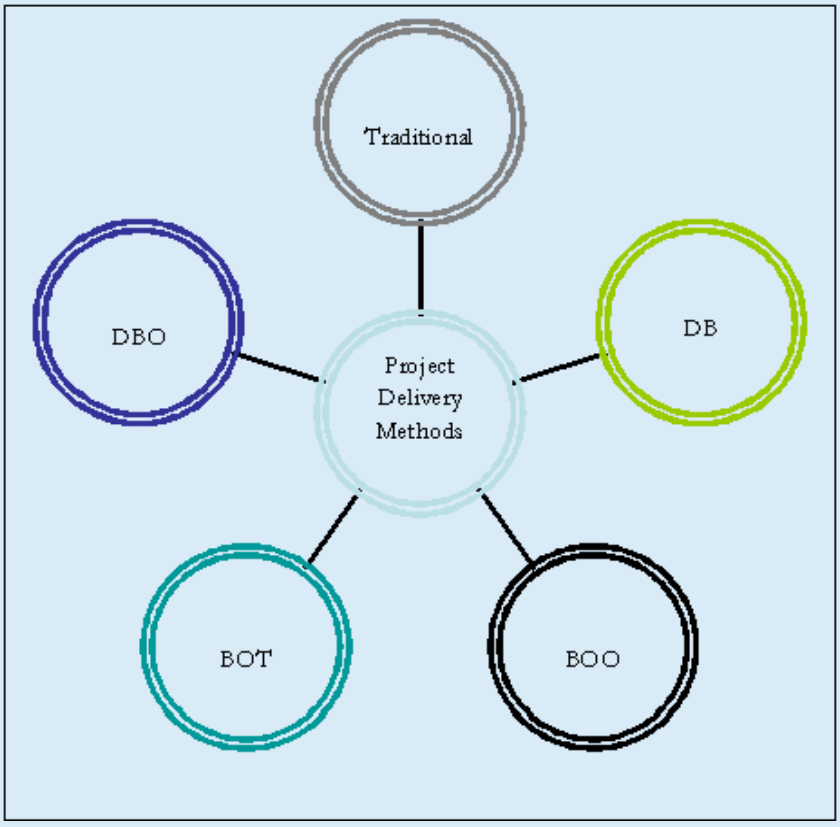
- Be very detailed as far as requirement, but have flexibility for design improvements and specifics of each manufacturer. Design creativity will produce a better final product and in many cases, reduced cost.
- Stay away from generic, ambiguous and meaningless language.
- Avoid forcing factors over which the parties do not have any control.
- Do not try to force unrealistic contract periods.
- Define payment structure, payment terms and invoicing requirements. Remember most OEM's can not afford to pay for all the components and wait until project completion to get paid. There is nothing wrong with paying for pre-purchased and stored material if well documented and liability and insurances are defined.
- Avoid risk-shifting in contract languages and do not put unreasonable and uninsurable risks on any of the entities. Remember any risk must be shared and you and your consultants are part of the team with your own share.

Procurement Options

There are many ways of procuring membrane systems, each with its unique advantages/disadvantages. Compared to conventional treatment facilities or membrane filtration, large seawater desalination plants are better suited to take advantage of the alternative project delivery methods. Their size, permitting, construction schedule and private financing needs makes them well suited for DBB, BOO and BOT delivery methods. During the last ten years, over 50% of large seawater desalination plants have utilized private financing with alternative project delivery methods. The following is a list of popular project delivery methods, although sometimes combinations of methods are used.

Type I: Conventional Design/Bid/ Build (DBB)

IA: Parallel general or prime contractors, where one entity is controlling the site work, infrastructure, building tanking, etc. Another is installing the membrane system and process/control components. This method only works if the process prime contractor is required to hire a qualified OEM and has direct contact with the owner.



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Advantages:

- Owner deals with one entity for warranty issues
- Each contractor is directly accountable for their own contracts and to the owner

Disadvantages:

- Administration of two contracts
- Careful division of scope is required
- Some finer-pointing could arise
- Some mark-up is added by the process prime contractor

IB: Single prime contractor with assigned OEM or Manufacturer. This type works well with NF/RO projects and not so well with MF/ UF projects, especially larger projects. Regardless of the technology, the qualifications of the OEM and/or manufacturer needs to be well defined with no exceptions allowed. Do not allow post-bid shopping. Any alterations need to be defined with bid price obtained to do a fair comparison. For MF/UF life cycle, cost must be included as well as a guaranteed price for membrane replacement. Remember 70%-80% of the total water cost is O&M.

Advantages:

- Administer only one contract
- Less division of work is required

Disadvantages:

- All communication and warranties are through GC, which means a layer is added for warranty claims
- GC typically adds a mark-up
- Some responsibility questions may arise

IC: Single contractor with "Black Box" spec for equipment. This is the worst type of membrane system procurement and should be avoided. This may work well for a pump or belt press, but it has been proven over and over that it does not work for membrane systems.

Type II: Design/Build (DB)

This is a popular procurement method for large projects, especially overseas. Some utilities and/or states in the US may not allow this method. It works well if the documents define the minimum standards, but leave the innovation and creativity to the DB team. If you want to specify everything down to the nuts/bolts, and even color choices, then Type II is not for you, you should use Type I method.

Advantages:

- Involves the OEM and manufacturers in the early stages of design
- Selection is narrowed down to pre-qualified teams
- Owner may get quality and cost benefits from innovations

Disadvantages:

- Owners may feel they are left out
- If documents don't define the minimum standards, you may end up with less than the minimum quality product

Type III: Design/Build/Operator/ Transfer (BOOT)

This is not common in the US, except for very large projects. This works well for private utilities or entities who are not interested in the process, just the end product (water).

Advantages:

- One entity for everything
- BOOT team may assist in financing

Disadvantages:

- Owner has no control over design and shape of the final plant

Type IV: Construction Management (CM at Risk)

This is typical for some large projects in the US. Unfortunately, most of the CM companies are not true contractors; they don't have shovels and backhoes!

Advantages:

- One point of contact with one warranty
- CM acts as GC (typically more professional)

Disadvantages:

- Another layer of markup
- Owner essentially has no control over design

Summary

In summary, the optimum choice of contracting method depends on the project budget allocation, type of contracts allowed in your jurisdiction, size and type of membrane system and several other factors, as discussed. The list of advantages/disadvantages may help decision makers to find the most optimum method for their customized needs.

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

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