Critical Service and Reporting Criteria Using Site Risk Factors

Introducing the RFI *(W.O.E Relative Risk Factor Index)*

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Maybe we have already recognized that categorizing a site's risk factors and knowing how to apply that knowledge can greatly help in developing and implementing a successful water treatment program.

Having a sense of how risky the site is can help in determining things such as:

a. The required **water treatment chemical program**.
b. The **service frequency** by a service provider.
c. Type of **services required** and **qualifications** of the **service engineer**.
d. How to **communicate and coordinate efforts** most effectively between the service provider and the end user client.
e. How and where to set **goals for improvements** or risk reduction.

This assessment process can be created for any water treatment system including:

- Boiler
- Cooling
- Clarification & Wastewater
- Membrane Systems
- Closed Loops
- Specific Processes

We can consider three major categories (**W.O.E.** shown below) that will affect the results as being positive and successful, or prone to problems and poor results:

1. **W**ater Quality & Variability
2. **O**perations & Control
3. **E**quipment Used & System Design

For each system category we can create a list of factors to assess that will help identify the risk as low, medium, or high. This can be quantified as much as possible, or used subjectively, as long as reasons for the ratings can be explained and strategies for improvement created where possible.

With the categorization we can design a water treatment program and communication protocol to optimize results for the given situation and set goals for improvements if required.

An easy to understand index that is called the ***W.O.E Relative Risk Factor Index*** **(RFI for short)** along with a matrix spreadsheet for creating an overall system or site score have been created to help identify and quantify the many contributing factors and to produce a final assessment for a given site as being low, medium, or high risk.

In practice it was intended that this three-digit index could be universally applied in the industry and be consistent when determined by experienced and trained water treatment professionals. Valuable feedback suggested that initially this may be most useful as a tool for assessment and site improvement, and made to be customized by each user for their specific purposes.

There are sites and situations that could more easily be quantified than others. Perhaps into the future, if adapted and applied, a more consistent rating schedule could be developed recognizing that there is much room for development of the Risk Factor Index as a tool to improve water management efforts.

The **RFI** has three digits and each is a rating scale of 1, 2, or 3. First digit applies to **W**ater, Second digit is **O**perations; Third digit is **E**quipment – **W.O.E.**

1 – Low Risk; 2 – Moderate Risk; 3 – High Risk

Example: RFI = 323

This example indicates that the site or system has been assessed as follows:
Water (W.) – High risk water and/or high variability in water quality.
Operations (O.) - Moderate risk operations and control.
Equipment (E.) - High risk around equipment in use or the equipment system design.

(**W**ater: 3, high risk; **O**perations: 2, moderate risk; **E**quipment: 3, high risk)

With a lot more detail used to reach this index example, one possible interpretation of this RFI of 323 and possible strategy could be: We may need a robust chemical treatment program due to the poor water quality or its variability; see if there are ways to improve operations with training and more service time on site; and we might want to make improvements to the equipment or help to get new equipment installed.

It should be noted that the ease or difficulty in moving from a 3 to a 2 or to a 1 could be quite varied depending on each particular situation and reason for the rating. This will best be revealed from the details behind each rating.

What are Successful Outcomes of Water Treatment Programs?

The first step in the process is identifying or labelling what we are assessing. What are desirable outcomes or what is at risk?

Some Possible Successful Outcomes:

1. Meet all safety concerns
2. Efficient plant production, maximize uptime, reduced operating costs
3. Maintaining asset integrity
4. Good, consistent water quality
5. Clean heat exchangers
6. Proper and efficient operation of all boiler pretreatment equipment
7. Clean boilers
8. Acceptably low corrosion
9. High steam purity
10. Minimal clean-in-place requirements for the membrane system
11. Meet wastewater treatment plant water discharge requirements
12. Meet budget or cost goals for chemicals and other OPEX
13. No Legionella or microbiological issues
14. Meet environmental stewardship goals
15. Minimize water and energy consumption
16. Satisfy service and maintenance objectives
17. Establish proper competencies and trainings
18. Meet improvement goals
19. Meet key performance indicators (KPI's)
20. Maintain open and effective communication and planning

What are Some Considerations per W.O.E. Category to Assess a System Risk, to Determine the Overall Site Score, and to Assign the RFI?

Boiler Systems:

W. Water Quality & Variability:

1. Water source (municipal, ground, surface, recycle). A good and consistent municipal supply is generally low risk.
2. Water quality (calcium, alkalinity, TDS, TOC, etc.; consistent or variable).
3. Feedwater: Low risk - 0 to trace hardness, low Fe, low alkalinity; or higher risk - hardness > 1 ppm, Fe > 0.1 ppm, and alkalinity creating high boiler alkalinity or high CO_2 content in steam?
4. Process contamination potential. Are there processes that could contaminate the condensate, boiler, or makeup water?
5. Other relevant information?

O. Operations & Control:

1. Reliability of chemical feed equipment, age, and control consistency.
2. Historical treatment success and results.
3. Ease of access to the site.
4. Relationship with plant personnel.
5. Service frequency requirements to maintain control and effectiveness.
6. Attention by plant personnel, testing, monitoring, necessary adjustments made.
7. Boiler operations and stream production: 24/7 or frequent shut-downs, steady or widely varied steam or makeup loads.
8. Condensate return amount and quality.
9. Proper boiler layup procedures followed.
10. Plant bidding process and pressure on program to minimize cost and service. Can adequate chemical treatment and service be applied?
11. Other relevant information?

E. Equipment & System Design:

1. DA or feedwater heater? DA condition and performance: DO < 10 ppb?
2. Other pretreatment equipment and performance.
3. Steam traps and condensate return equipment condition and performance.
4. Condition, age, and reliability of chemical feed equipment and controllers.
5. Boiler condition and design; clean or dirty; high flux; etc.
6. Other relevant information?

Cooling Systems:

W. Water Quality & Variability:

1. Water source (municipal, ground, surface, recycle). A good and consistent municipal supply is generally low risk.
2. Water quality (calcium, alkalinity, etc.; consistent or variable). Will cycled cooling tower water be highly scale forming or highly corrosive?
3. Is there pH control? If acid is being fed and scale control is dependent on acid, then system is more risky.
4. Effective side stream filtration? If there is a good side-stream multimedia filter or other type providing 5 - 10 micron removal, then clean systems are easier to attain.
5. Area air quality and tower contamination. If the towers are located near areas of dirty air that contaminates the water, then this creates higher risk.
6. Process contamination potential. Are there processes that could contaminate the cooling tower water and create water treatment issues?
7. Other relevant information?

O. Operations & Control:

1. Reliability of chemical feed equipment, age, and control consistency.
2. Historical treatment success and results.
3. Ease of access to the site.
4. Relationship with plant personnel.
5. Service frequency requirements to maintain control and effectiveness.
6. Attention by plant personnel, testing, monitoring, adjustments.
7. Biological control history.
8. Plant bidding process and pressure on program to minimize costs and services. Can adequate chemical treatment and service be applied?
9. Other relevant information?

E. Equipment & System Design:

1. HVAC, or other applications with high skin temperatures? (Chillers are generally low risk, but processes such as air compressors, or high heat processes increase scale potential and corrosivity).
2. Heat exchanger types & designs: Do chillers have rifled tubes or are there plate and frame exchangers? Both require lows TSS and good MB control.
3. Automation (accuracy of cycle control and saturation indices or ratios).
4. Condition, age, and reliability of controllers.
5. Condition of the systems (clean and passivated or deposits and corrosion).
6. Cooling tower design and condition.
7. Other relevant information?

Clarification and Wastewater:

W. Water Quality & Variability:

1. Water source (lake, river, recycle, etc.).
2. Water constituents (TSS, TDS, TOC, COD, pH, metals, biological, etc. Normal, minimum, and maximum of each constituent).
3. Is there adequate equalization of flows and constituents?
4. Are all possible contamination sources known and accounted for?
5. What are water temperature variations?
6. Other relevant information?

O. Operations & Control:

1. Reliability of chemical feed equipment, age, and control consistency.
2. Historical treatment success and results.
3. Ease of access to the site.
4. Relationship with plant personnel.

5. Service frequency requirements to maintain control and effectiveness.
6. Attention by plant personnel, testing, monitoring, and adjustments.
7. Are treatment processes quality and flow based?
8. Do jar testing results duplicate plant treatment?
9. Plant bidding process and pressure on program to minimize costs and service. Can adequate chemical treatment and service be applied?
10. Other relevant information?

E. Equipment & System Design:

1. Do the equipment, flow, and mixing allow completion of necessary reactions?
2. Are there adequate redundancies and spare equipment and parts?
3. Are the processes adequately automated or are there high labor requirements?
4. Condition, age, and reliability of system controls.
5. Are sensors accurate and calibrated as required?
6. Can unit operations be easily isolated or diverted as needed?
7. Other relevant information?

Membrane Systems:

W. Water Quality & Variability:

1. Water source (municipal, ground, surface, recycle). Good and consistent ground or municipal supply are generally low risk.
2. Water constituents (calcium, alkalinity, etc.; consistent or variable). Will concentrated RO water be highly scale forming? Dependency on scale control chemicals makes it more risky.
3. Is there pH control? If acid is being fed and scale control is dependent on acid, the system is more risky.
4. Is there a potential for microbiological contamination and high nutrient loading?
5. Is the SDI low and consistent?
6. Process contamination potential. Are there processes that could contaminate the cooling tower water and create water treatment issues?
7. Other relevant information?

O. Operations & Control:

1. Reliability of chemical feed equipment, age, and control consistency.
2. Historical treatment success and results.
3. How often do the machines stop and start, and is there proper pre-flush and post-flush?
4. Ease of access to the site.
5. Relationship with plant personnel.
6. Service frequency requirements to maintain control and effectiveness.
7. Attention by plant personnel, testing, monitoring, and adjustments.

8. Can the RO's be shut down and cleaned when trigger points call for a clean-in-place (CIP)?
9. Plant bidding process and pressure on program to minimize costs and service. Can adequate chemical treatment and service be applied?
10. Other relevant information?

E. Equipment & System Design:

1. Is there an N+1 or greater design (redundancy and surplus capacity)?
2. Is there internal recycle of concentrate? Recycle increases risk.
3. Are spare membranes stored on site or readily available?
4. Is there good automation (accuracy of control of flows and recovery rates)?
5. Condition, age, and reliability of process controls.
6. Condition of the systems.
7. Proper flux design and operating flux for the given water quality.
8. Good and convenient CIP system?
9. Other relevant information?

Spreadsheets for each type of system are used to create the RFI and to create an overall site score such as shown below:

Site Name:	
Location:	
System Name:	

RFI	*(W.O.E. Relative Risk Factor Index)*
121	1st Digit is **Water**; 2nd **Operations**; 3rd **Equipment**
	1 - Low Risk; 2- Moderate Risk; 3 - High Risk

Overall Site Score on 1 to 3 Scale:

	Risk Factor:	Assigned Number:
By Site or System	Low	1
	Medium	2
	High	3
Final Score Risk Rating:	Low	<1.5
	Medium	1.5 - 2.5
	High	>2.5

Insert "x" for risk rating for each of the categories"

Cooling System	Low Risk	Medium Risk	High Risk	Score
Water Quality & Variability	x			1
Operations & Control		x		2
Equipment & System Design	x			1
			Average Score	1.3

Strategies for Risk Management and Abatement:

It may be advantageous to have multiple people involved in the process of risk assessment to gain different perspectives from varying levels of expertise.

Site assessments should probably also be made on some level of regularity since the risk factors can change over time.

Once the systems or sites are assessed and the relative risks identified and recognized, the real value then is in creating a fitting strategy to reduce the risk of failure and to make improvements going forward. It is also advisable to establish a properly informed client along with open communications.

A menu of options and strategies can be developed and referenced as a starting baseline of options along with more site-specific strategy discussions.

Menu of Some Possible Site Strategies:

1. Begin or improve upon remote monitoring capabilities.
2. Change service frequency or duration of visits.
3. Provide higher qualified service provider or supplement service with backup support. Provide site visits by managers, technical experts, or those with needed specific skills, etc.
4. Locate a better water source if possible such as drill a well.
5. Improve pretreatment process or equipment to improve water quality and reliability.
6. Create better plant control with better on-site automation.
7. Develop better testing or more valuable testing as required. Composite sampling where it is useful; lab testing as required; more accurate procedures, etc.
8. Select or design proper chemical treatment to best reduce inherent risks such as better polymer selection, best and required dosages, broader LSI range, better inhibitors, etc. (Get an appropriately robust treatment chemistry for each treated process).
9. Create redundancies and adequate supplies where appropriate for improved reliability. (Spare parts; alternative chemistries if needed for certain situations; spare membranes, etc.).
10. Provide duel feed systems such as primary feed and trim feed where it could improve control and reliability.
11. Provide more training along with written standard operating procedures (SOP's).
12. Know possible contamination possibilities with response plans. Have contingency procedures in place for upsets or abnormal situations.
13. Provide temporary or full-time operators or operating support.
14. Create priorities list of improvements to make.
15. Regular formal technical reviews.
16. Create partnerships with other businesses or people where beneficial.
17. Consider temperature extremes for all process and the impact on processes and water treatment programs. Have freeze protection in place where appropriate.
18. Learn and help improve plant politics and cooperation level between all people, departments, and shifts.
19. Know operations on 24/7 basis and how they may differ based upon time or shift. What is the plant operating schedule?
20. Are there proper shutdown, start-up, and storage procedures? (Many of system failures occur during these periods or during upsets and not during normal operations). Consider the unforeseen and be prepared to them.

21. Have a thorough knowledge of the cleanliness of all systems (deposits, corrosion, biofilm, deposits, etc.) and how that effects the various programs and results. Dirty or corroded versus clean and passivated greatly impacts treatment success.
22. Site history is important. If certain programs in the past failed, know why. If past programs were successful, should they be continued?
23. What is the plant safety history and is it safe now and going forward?
24. Establish site key performance indicators (KPI's); have good tracking of KPI's; and create strategies to successfully meet them.
25. Establish excellent information and communication strategies to keep all well informed on a timely basis and to foster a cooperative vendor/client partnership type relationship:
    a. Remote monitoring with alarms to multiple people.
    b. Real time reports showing KPI's and high-risk areas.
    c. Client is well aware of risks and consequences.
    d. Open coordination with plant management, production, operations, maintenance, purchasing, and service provider.
    e. Regular training and in person or virtual meetings with frequent progress and situation reviews.

Conclusion:

A method can be used to more formally assess a system or site by doing a detailed investigation around three critical categories of water quality & variability, operations & control, and equipment & system design. The goal is to know the relative level of risk of achieving or not achieving desirable outcomes.

With adequately skilled water treatment professionals, a **Risk Factor Index (RFI)** can be determined and used as a tool to develop appropriate treatment strategies, improvement plans, and communications protocols.