

TRAINING NEEDS ASSESSMENT FOR AN OPERATION IN A JUICE
PROCESSING PLANT

By

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ABSTRACT

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Training is an important function in an organization when the base of the operations is dependent upon certain employees to perform key tasks (Brinkerhoff & Gill, 1994). A training need exists when employees lack the necessary knowledge and skills to perform an assigned task in a simple manner. If an employee lacks knowledge, skills, or abilities to do their job, the proper knowledge and skills must be provided to them.

Company X is a 24 hour, seven days a week juice processing facility. They depend on the operators to carry out the specific duties and tasks of the operation to benefit the needs of the company. This study looked at the Microfiltration and Reverse Osmosis process to determine if

there is a need to identify a standardized approach to future training.

This study focused on the 28 operators of this process and by using a stratified sample, created a DACUM and survey to determine if there was a lack of knowledge, skills, or abilities in the MF and RO operation.

The objectives of this study are:

1. Identify the duties and tasks for effective MF and RO operation;
2. Identify the importance of each duty and task for consistent operation;
3. Identify if there is a deficit in knowledge, skills, and abilities in the current associates responsible for this operation;
4. Propose implementations to increase KSAs in the MF and RO operation; and
5. Offer suggestions on how to implement a standardized training program for the MF and RO operation.

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1. The world will not be handed to you on a silver platter.
2. You can never let anyone convince you to give up anything that will make you a better person.
3. You must take care of your responsibilities and work hard to get where you need to be.
4. Never depend on anyone else to take you where you want to go.
5. The world does not stop and wait for you when you fall down, so keep your chin up, find the opportunity in every challenge, and learn from your mistakes.

So many times, I believed that I was at the point where I knew as much as I needed to know in life. Now I have learned that no matter what chapter of any book that you are writing, each day has the potential for a new beginning..

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CHAPTER ONE

INTRODUCTION

Training is an important function in an organization when the base of the operations is dependent upon certain employees to perform key tasks (Brinkerhoff & Gill, 1994).

A training need exists when employees lack the necessary knowledge and skills to perform an assigned task in a simple manner. If an employee lacks knowledge, skills, or abilities to do their job, the proper knowledge and skills must be provided to them.

When employees are not performing their job correctly, it is because they do not know how to, they are somehow prevented from doing it correctly, or they are not motivated to carry out the duties and tasks. Companies put time and effort into their training programs to avoid these problems.

Microfiltration and Reverse Osmosis are two important operations in a juice processing facility. Microfiltration (MF) is a process that filters juice for clarification. When the juice passes through the MF membranes, it is divided into two streams. The clarified juice is one stream that continues into the Reverse Osmosis (RO) process. The other stream contains insoluble solids that are put to drain as a waste product.

Reverse Osmosis is the second part of the filtration process. The RO membranes filter the juice further, also producing two separate streams. One stream is concentrated juice that is ready to be blended. The other stream is essentially water that is stored and reused for cleaning or elsewhere in the process.

At Company X, 28 employees operate this critical process 24 hours a day and seven days a week. Each associate was trained one of several different ways, depending on when he or she was hired. Over the past seven years, Company X has experienced several changes. They strive to alleviate some of the stress of change by implementing four hours of training every pay period.

This study will conduct a training needs assessment (TNA) on the Microfiltration and Reverse Osmosis system and identify a standardized approach to training in the future. After all, how well employees remain focused on their job performance while operating the MF and RO will ultimately contribute to the needs of an organization (Brinkerhoff & Gill, 1994).

Statement of the Problem

A Training Needs Assessment (TNA) will be conducted on the Microfiltration and Reverse Osmosis operation to determine if all of the operators have been trained on the necessary skills in order to perform this job correctly and consistently.

Purpose of the Study

This study is essential to determine if there is a lack of knowledge, skills, or abilities in operating the MF and RO due to the many different training methods used for each employee at this juice processing facility and to determine if there is a need for additional training.

Significance of the Study

Currently, there is not a standardized method in place to train operators on the MF and RO. Each individual was trained according to the knowledge, skills, and abilities (KSAs) of another operator that works in that area. On-the-job training was used because it is the most common and least expensive form of training. This is when an individual learns how to perform the tasks of the job right at the workstation by someone who already possessing these skills. There are a few disadvantages to this type of training. The noise level at Company X could be a physical

constraint and information that is not heard may be misinterpreted or lost in the training process.

On-the-job training may also create safety issues and lower the quality standards of the process being taught. Some of the tasks involve working with chemicals and present other hazards, which can be dangerous to a trainee if they cannot clearly hear the instructions.

The Current Best Methods, which are the standard operating procedures used by Company X, have not been revised for the past six years, leaving no written resources to turn to when problems arise. During this period, two additional MF and RO systems have been installed and the chemicals used for cleaning have changed quite significantly. Over the past three years, turnover and expansions have also created significant change.

A TNA is important to establish a baseline for the basic knowledge and skills needed to operate the MF and RO optimally. The researcher and a knowledgeable group of operators will develop a curriculum (DACUM) that outlines the duties and tasks necessary in this operation. A standard method of training is also needed to improve job performance, which will ultimately improve the bottom line of the company.

Research Objectives

1. Identify the duties and tasks needed to effectively operate the MF and RO.
2. Identify the importance of each duty and task for consistent operation.
3. Identify where there is a deficit in knowledge, skills, and abilities in the current associates that operate the MF and RO
4. Propose implementations to increase KSAs in the MF and RO operation.
5. Offer suggestions on how to implement a standardized training program for the MF and RO operation.

Limitations

There are nine juice-processing facilities in the cooperative being studied. Only one of these juice-processing plants will be assessed in this study. The reason of doing a TNA in only one facility is that not every juice plant has the same team-driven setup with such a diverse number of operators. Other facilities may use different cleaning chemicals, and the set-up of the equipment may be different.

At the time of this study, there are some newer employees in the juice cluster. Not all employees have been trained in the MF and RO operation. This limits the

researcher in collecting valuable information from all 28 operators.

Definition of Terms

Microfiltration (MF) -A pressure driven, cross-flow filtration process used in conjunction with semi-permeable membranes. Filtration occurs through a semi-permeable membrane that allows small molecules such as water, sugar, salts, and small molecular weight materials to pass through the membrane, but holds back larger molecules such as suspended solids, etc. (Santo, 1993).

Reverse Osmosis (RO) -A pressure driven cross flow filtration process used in conjunction with semi-permeable membranes. Filtration occurs through a semi-permeable membrane that allows small molecules such as water to pass through the membranes, but holds back larger molecules such as salts, etc. (Santo, 1993).

Training Needs Assessment (TNA) - A process of determining gaps between what is and what should be in terms of organizational or individual performance, and setting priorities for closing those gaps (Clark, 1995).

Knowledge, Skills and Abilities (KSAs) -An understanding of principles related to a particular subject with the physical activity developed because of training and the

general capacity needed for performing that activity with understanding (Johnson, 1999).

Current Best Method (CBM) -Documented, concise, systematic work instructions that assure a process, system, or operation is maintained in a state of control using the best methods, materials, technologies or practices available. These instructions assure the work is completed in a uniform, consistent manner to achieve a common result (North, 1996).

DACUM -Developing a curriculum: An occupational analysis involving the employees having a reputable performance record in that job function that analyzes job duties and tasks needed for successful operation (Norton, 1999).

Subject Matter Experts (SME) -An individual who possesses abundant knowledge, familiarity and a strong performance record in a specific job function (Holton III, Bates, Naquin, 2000).

CHAPTER TWO

REVIEW OF LITERATURE

Organizations often experience rapid changes within the operation. Many times training needs are discovered on a reactive approach and after a problem already exists. New problems arise out of new hires, promotions, transfers, appraisals, rapid expansion, changes, or the introduction of new technologies (Clark, 2000). Training becomes the resolution to the problems only when the cause is a lack in skills needed to perform the job effectively (Noonan, 1994). Company X has experienced most of these issues in the seven years of its existence.

Historical Perspective

Company X was a spin-off from a pilot plant in the cooperative testing a low cost juice extraction process. It began operation in August 1993. Sixteen employees were hired to run this juice process.

The sixteen associates were divided among four teams. These first sixteen were trained in a classroom setting on a wide variety of topics for 10 weeks before the juice processing operation began. Four of the sixteen learned to run the MF and RO operation by a specialist from the MF and RO membrane manufacturer, and by an engineer that was

involved in the MF and RO operation in the pilot plant. These two subject matter experts (SMEs) were also available on site for the start-up of the equipment. The four trained employees that ran the MF and RO had an operating manual available that contained flow charts and detailed instructions when any problems would arise.

The first expansion took place at the facility in early 1995. A by-product was produced using the meat and skins of the fruit after the juice had been extracted. This opened up 32 new positions in the plant. All the p.m. associates had an opportunity to move to the day shifts. This put most of the experience on days and all new hires on nights.

All associates with the MF and RO responsibility would receive another round of classroom training by the membrane manufacturer and the corporate SME. For some of the operators, it was their first time receiving any type of formal training. When they began operation, they would receive hands-on training from the associates already familiar with the MF and RO.

With the success of the new product made from the meat and skin of the fruit, a second expansion took place in early 1997 to double the size of the plant. Two additional MF and RO systems were installed. Fifty-two more process

associates were hired, 25% of those would learn the juice processing operation, including the MF and RO.

Training was done the same way: in the classroom with the membrane manufacturer and the corporate SME. The employees were thus able to get some hands-on experience. They learned from the experienced associates. This time, all of the senior associates were required to remain on nights for one year to ensure that the new associates were thoroughly trained before they had the opportunity to move to a day shift.

One difference in this training was that the flow charts and manuals were now outdated and never replaced with current ones. That resource was no longer available to the MF and RO operators.

A third expansion took place in the spring of 2000. There was no necessity to hire additional associates except to cover the positions created by the wave of high turnover. A large employer who moved into town and began operations during this expansion created a majority of this turnover. Approximately 40% of the MF and RO operators were replaced with new hires.

The only training offered at this time was a four-hour troubleshooting class from the membrane manufacturer SME. Many of the new associates did not benefit from this

training because they had no knowledge of the operation. Any available co-worker in their cluster trained the new associates strictly by OJT.

Now that the facility has stabilized, one of the goals of the organization is to standardize training and operations of the MF and RO. A concern lies with the fact that every operator runs this equipment his or her own way.

With the completion of a Training Needs Assessment, CBMs can be updated, training can be standardized, and operations can become more consistent between individuals and the four teams.

Crossflow Membrane Technology

Crossflow separation technology is a filtration process using thin, semi-permeable membranes that are designed to provide an exceptionally fine level of separation to a liquid product (Santo, 1993). There are four types of filtration systems available that use this technology, depending on the level of separation needed. These four systems are microfiltration, ultrafiltration, nanofiltration, and reverse osmosis. The sizes of the pores in the membranes determine how much is filtered out and will be most beneficial to the organization.

Microfiltration has the largest pores while reverse osmosis has the smallest, providing the finest level of separation.

The term crossflow is used because the surface of the filter splits the product stream into two effluents; one is the permeate stream and the other is the concentrate stream. The product stream flows parallel to the membrane. The concentrate stream contains particles that are too large to pass through the pores of the membrane so it bounces back, away from the module. The permeate contains the particles that are small enough to pass through the pores of the membrane, creating a second stream (Paulson, 1995).

Water purification, manufacturing process separation, and waste treatments are the three categories of crossflow separation technology. For one of these three reasons, hundreds of applications have become commercialized. Organizations and suppliers have been testing this process for approximately four decades (Misra, 1998).

The use of crossflow filtration for water purification purposes include: feeding boilers, removing microbials, rinsing bottles and cans, spot free car wash rinses, pulp and paper rinses, bottled water, reconstituting food and juices, and kidney dialysis, to name a few.

Manufacturing process separations are used in food and beverage industries, as well as other types of manufacturers. Some of these uses include: juice and milk concentration, beverage flavor enhancement, maple syrup preconcentration, glycol and glycerin recovery, medicine and vitamin purification, and blood fractionation.

The waste treatment industry is becoming more widely recognized for its reduction of hazardous material waste by using crossflow separation technology. Other uses are for tertiary sewage recovery for reuse, oil field "produced water" treatment and commercial laundry water and heat reuse.

As more organizations become aware of the cost benefit ratio of this technology, it is becoming more widely used. New applications are being tested and developed on a daily basis (Paulson, 1995).

Filtration technology is usually operated by the use of a PC-based control system using a software program called Wonderware (Freeman & Marty, 1997). The filtration systems also require certain clean-in-place systems and specific cleaning procedures. The filtration membranes are sensitive to operating pressures, temperatures, pH ranges, and chemical compatibility.

If the membranes are subjected to pressures outside of their operating capacity, it causes the membranes to compress. Over a period of time, multiple compressions will lower the permeation (flux) rate. This also means a shorter life span of the membranes.

Temperature is less of a critical factor in the filtration process. The importance lies in the recommendations of the manufacturer because of the different materials that the membranes are made of. The temperature can have some effect when using chemicals in reducing the life of the membranes.

Membranes are vulnerable to the acidity or basicity of product and chemicals running through them. Any product or chemical that is above the acceptable pH level for the membrane will shorten its life and increase costs in replacing fouled membranes.

A large area of concern is the chemical compatibility of microfiltration and reverse osmosis membranes. Certain chemicals, especially chlorine, can easily damage the material that the membranes are made of. Membranes lack resistance to harsh chemicals. Maintaining the proper chemical parts per million (ppm) during cleaning is essential to avoid damaging the interior of the membrane, which will shorten the life span.

Training for operating a crossflow filtration system is a critical issue due to the complex operating issues and cleaning procedures. If the process is misunderstood or done improperly, the membranes will foul causing decreased productivity and increased cost for the organization (Paulson & Jondahl, 1998).

The Microfiltration Process

Microfiltration membranes have three to five times larger pore openings than ultrafiltration, nanofiltration, and reverse osmosis (Jacangelo et al, 1998). Company X uses an MF module that has a .3-micron pore opening. This process is used to clarify the juice.

Under low pressure, approximately 80 pounds per square inch (psi), the raw juice is fed into the MF modules. It is separated into two streams, concentrate and permeate. The first stream, called concentrate, is the larger particles that could not pass through the membranes. These suspended solids are recycled back through the membranes for the duration of the run, to obtain optimal filtration. When the run is over, the minimal amount of suspended solids are put to drain as waste.

The permeate is the stream containing the juice with sugars, salts, and other dissolved solids that are small enough to pass through the pores of the MF membrane. This

stream is the clarified juice that moves on to the Reverse Osmosis process (Santos, 1993).

Reverse Osmosis

Reverse Osmosis provides the finest level of filtration. Because the pores are so small, the juice has to be pushed through the membranes with a higher amount of pressure, approximately 550 psi (Santos, 1993).

Just like the MF process, two streams are produced from the product stream as the juice is pushed through the membranes. These two streams are also called concentrate and permeate. The difference in the RO process however, is the opposite of the MF process. The concentrate is the juice that is stored for later use and the permeate is the waste product.

The RO membranes act as a barrier to the dissolved sugars, salts, and dissolved solids that are larger than 100 molecular weight pore size. This stream becomes concentrated into triple strength juice. This juice is the final product processed at Company X. It is chilled and stored in large tanks until it is shipped to one of the other plants in the cooperative for blending.

The second stream, the permeate, has the smallest particles that are able to pass through the membranes. This stream is essentially filtered water. Company X is able to

reuse this water elsewhere in the process. This eliminates wastewater and saves the company money in disposing it.

Purpose of a Training Needs Assessment

It has been discussed that training is not always the answer for operational deficiencies. There may be other factors both internally and externally, which can cause problems. External factors could be faulty equipment or an adverse environment. An internal factor would include a deficit of knowledge, skills, or abilities. A lack of KSAs represents a training need (Herbert & Doverspike, 1990). At Company X, a TNA is being conducted to determine if there is a problem with internal or external factors.

During the process of a Training Needs Assessment, the skill levels of the tasks being performed by operators are identified (Clark, 2000). At the conclusion of a TNA, there will be clues as to what the real problem is, external or internal. An organization can also use the results of the TNA throughout the course of business, possibly with some modifications along the way, for developing job descriptions, training purposes, performance appraisals, and evaluating pay scales.

Identifying current job skills and comparing them with the requirements of the job can also measure performance gaps. As stated by Rossett (1992), "A training needs

assessment may address any or all of the following purposes; 1) optimal performance, 2) actual performance, 3) how key sources feel, 4) what is causing a problem, and 5) solutions to close the gaps between optimal and actual performance.”

Training programs are not always successful because they do not focus on the true needs of the employees. Training needs that can easily be identified would benefit both the employee and the organizational goals (Holton III et al, 2000). When an operator’s KSAs are expanded, measurable value is added to the organization, no matter what type of product or service the organization produces.

After an employee is trained on the important functions of his or her job, it will continually contribute to the needs and strategies of the organization, as long as they can remain focused on the objectives (Brinkerhoff & Gill, 1994). This can be accomplished by keeping training up to pace with the changes of the business.

Duties and Tasks Associated with a TNA

A task is a function outlaying the logical steps to perform a duty. By identifying all of the duties and tasks required to perform a job, performance can be critiqued and measured to gain an understanding of the process.

One technique of analyzing jobs is called the DACUM technique. This stands for developing a curriculum. The DACUM technique produces a list of duties, tasks, and KSAs of performing a job. The researcher can use this tool to develop a survey to assess the employees that operate the MF and RO. When comparing all of the individual KSAs, discrepancies can be identified (Herbert & Doverspike, 1990). After constructing a performance measure for each of the tasks, a critical step towards achieving training goals has been accomplished.

Summary

A TNA is an important step in determining the training needs of an organization. Inadequate or incomplete training is most likely to promote performance deficiencies (McGehee & Thayer, 1961). This tool is used as one of the effective keys to implement effective training programs in an organization.

At Company X, a TNA will be the beginning process of learning the level of KSAs the operators possess and how much of the microfiltration and reverse osmosis process they understand.

Researchers are studying the crossflow separation technology in many different organizations with different needs to optimize cost savings and efficiency. Company X

has used this process for seven years in this facility and has had success with microfiltration and reverse osmosis for the purpose intended. Areas that need more research are membrane fouling, the impact of operational variables on membrane fouling, and the study of predicting membrane fouling (Jacangelo et al, 1998). These studies could all be considered at Company X if the operators are all performing the procedures correctly. When everybody is performing tasks differently, it brings too many variables into the process.

When organizations experience change, it is crucial that they stay on top of training needs, especially when employees transfer, new employees are hired, and new equipment is introduced on a continual basis.

CHAPTER THREE

RESEARCH METHODS

Introduction

With the multiple changes of equipment and associates, standardization has been one of the goals of this organization. The researcher will assess the training needs of the MF and RO operation, develop a DACUM using duties and tasks, identify the KSAs of the associates, and propose implementations of standardization and a training program for this area of responsibility.

This chapter will explain the research design, population and sample, and the instrumentation used in this study.

Purpose of the Study

This study is essential to determine if there is a lack of knowledge, skills, or abilities in operating the MF and RO due to the many different training methods used for each employee at this juice processing facility. It will also determine if there is a need for additional training.

Research Objectives

1. Identify the duties and tasks needed to effectively operate the MF and RO.
2. Identify the importance of each duty and task for consistent operation.

3. Identify where there is a deficit in knowledge, skills, and abilities in the current associates that operate the MF and RO.
4. Propose implementations to increase KSAs in the MF and RO operation.
5. Offer suggestions on how to implement a standardized training program for the MF and RO operation.

Research Design

To gain a historical perspective on how the operation evolved in the facility and how the operators were trained, the researcher collected information from four process associates who have been involved in the MF and RO operation since the 1993 start-up. With each expansion, a number of associates were added to the operation. It was important to look at how everyone had been trained over the past seven years to gain an understanding of why there may be deficiencies in the knowledge and skill levels of the operators.

All of the duties and tasks of the operation were identified by creating a DACUM and then put into survey form. The associates used the survey to rate their personal knowledge, skills, and abilities in operating the MF and RO systems. The results of the survey will indicate to the researcher any training needs on the MF and RO operation.

At the conclusion of this study, if training needs exist, the DACUM will provide a basis to create updated CBMs and standardized training checklists.

Population and Sample

This facility is a 24-hour, seven days a week facility. There are four teams of 28 people each to cover the operations. Each team contains five clusters that cover a different area of responsibility. The cluster that is responsible for juice operation consists of seven associates on each of the four teams. Thus, there are 28 total MF and RO operators. Each MF and RO operator will be included in the study. Since the sample size is relatively small, it is important to gain insight from everyone that operates this equipment.

Instrumentation

A DACUM (Appendix A) was created by a stratified sample of MF and RO operators to identify all of the duties and tasks associated with this operation. Each individual that participated in the DACUM process had a level two competency level and three years of MF and RO operating experience. The membrane manufacturer and corporate SME, who had been involved in the training process since the start-up of the MF and RO operation at Company X, reviewed the DACUM for accuracy.

A survey was developed by using the data created in the DACUM (Appendix B). All of the associates in the juice operation cluster were asked to participate in this study. Each operator was asked to rate his or her knowledge, skill, and ability level on tasks located under the following duty headings on the survey:

1. Operating the Microfiltration process;
2. Operating the Reverse Osmosis process;
3. Possessing troubleshooting skills;
4. Displaying basic chemical usage;
5. Utilizing basic operating skills.

The same two SMEs that reviewed the DACUM assessed the survey for accuracy.

The results of the survey will show if there is a deficit of KSAs and possibly identify an inconsistency in operation by individuals and by teams.

Survey Administration

A cover letter (Appendix C) was e-mailed to all of the MF and RO operators on June 22, 2001 at Company X. This letter explained the study and the importance of each individual's participation.

On June 25, 2001, the survey was distributed in each operator's personal mailbox at work. There was a follow-up letter (Appendix D) and a human subject consent form

attached to each survey asking them to return the completed survey to the training mailbox by July 9, 2001.

Data Analysis

All 28 surveys were returned. The researcher entered the survey data and analyzed it by using Microsoft Excel 2000. The frequency, percentage, mean, and standard deviation were calculated. After reviewing the results of the tabulated data, conclusions and recommendations can be proposed in areas where there is a lack of KSAs and inconsistency in the operation.

Limitations

With some of the operators not having any experience or training on the MF and RO at the time of the study, there is an assumption that a small percentage of results will automatically show a deficit in KSAs.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

The purpose of this study was to perform a TNA on the MF and RO operation at Company X to determine if there is a lack of KSAs between the numerous operators. A DACUM was produced by a group of operators that had the most experience with the company operating the MF and RO. A survey was developed using the duties and tasks developed in the DACUM and distributed to all twenty-eight operators.

All twenty-eight MF and RO operators completed the survey by rating his or her competency level on the necessary tasks of this operation. The researcher analyzed the data file created from the survey using Microsoft Excel 2000. Frequency and percentages were calculated based on the KSA level response given for each individual task on the survey. Mean and standard deviation were calculated on the total response for each task listed.

This chapter will show the results of the data gathered on operating the MF, operating the RO, possession of troubleshooting skills, displaying basic chemical usage, and utilizing basic skills in this area of responsibility.

Each operator rated his or her level of competency for each task. They rated themselves as a level three if they

were competent at the task and could teach it to others. A level two meant that they had performed the task before, but would need help to perform it again. A level one response meant they had never learned how to perform the task.

Operate the Microfiltration Process

The total number of respondents was 28. Table 1 represents the data gathered on operating the microfiltration process.

Table 1. Operating the MF process

Task	Rating	Frequency	Percentage	Standard	
				Mean	Deviation
Prepare process swings	3	26	92.86%	2.89	0.42
	2	1	3.57%		
	1	1	3.57%		
Start the MF process	3	24	85.71%	2.89	0.42
	2	2	7.14%		
	1	2	7.14%		
Record process data	3	25	89.29%	2.86	0.45
	2	2	7.14%		
	1	1	3.57%		
Monitor process operation	3	24	85.71%	2.86	0.48
	2	2	10.71%		
	1	2	3.57%		
Perform batchdown	3	24	85.71%	2.82	0.57
	2	2	7.14%		
	1	2	7.14%		
Monitor diafiltration	3	24	85.71%	2.79	0.57
	2	2	7.14%		
	1	2	7.14%		
Put unit into pumpdown	3	24	85.71%	2.79	0.57
	2	2	7.14%		
	1	2	7.14%		

Shutdown the MF	3	24	85.71%		
	2	2	7.14%		
	1	2	7.14%	2.79	0.57
Make swings for CIP	3	26	92.86%		
	2	1	3.57%		
	1	1	3.57%	2.89	0.42
Verify CIP timers	3	23	82.14%		
	2	1	3.57%		
	1	4	14.29%	2.68	0.72
CIP MF unit	3	24	85.71%		
	2	2	7.14%		
	1	2	7.14%	2.79	0.57
Calculate water-flux	3	19	67.86%		
	2	6	21.43%		
	1	3	10.71%	2.57	0.69
Lay-up MF unit	3	21	75.00%		
	2	3	10.71%		
	1	4	14.29%	2.57	0.79

For operating the MF units, it was found that many of the associates have strong KSAs in the basic functions such as preparing swings for both process and CIP, starting the process, and monitoring and recording process data.

Two areas that present concern is calculating the water-flux and laying up the Microfiltration unit.

The results were consistent in showing that two operators have not been trained on operating the MF process and one to two operators have not been completely trained or are not quite confident in their KSAs.

Operating the Reverse Osmosis Process

Table 2 represents the data gathered from the twenty-eight associates on operating the RO process.

Table 2. Operating the RO process

Task	Rating	Frequency	Percentage	Mean	Standard Deviation
Prepare process swings	3	26	92.86%	2.89	0.42
	2	1	3.57%		
	1	1	3.57%		
Start the RO process	3	24	85.71%	2.79	0.57
	2	2	7.14%		
	1	2	7.14%		
Record process data	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Monitor process operation	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Shutdown RO process	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Make swings for CIP	3	26	92.86%	2.89	0.42
	2	1	3.57%		
	1	1	3.57%		
CIP RO unit	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Calculate water-flux	3	20	71.43%	2.64	0.62
	2	6	21.43%		
	1	2	7.14%		
Sanitize RO modules	3	25	89.29%	2.79	0.63
	2	0	0.00%		
	1	3	10.71%		
Lay-up RO unit	3	22	78.57%	2.64	0.73
	2	2	7.14%		
	1	4	14.29%		

The results of the survey indicate that the operators are comfortable in their KSAs in the basic procedures

needed to run the RO process. Scores were consistent in areas such as preparing swings for both process and CIP, starting the process, monitoring and recording process data, and shutting down the RO process.

The two areas that showed a lack of KSAs is in calculating the water flux and laying up the RO units. The results are consistent with those in operating the MF units.

There is also an indication in this section that two operators have not been trained on the MF and RO operation and one to two operators are in the process of being trained and are not quite comfortable in his or her KSAs in this area.

Possessing Troubleshooting Skills

Table 3 represents the data gathered on possessing and utilizing troubleshooting skills on the MF and RO process.

Table 3. Possessing troubleshooting skills

Task	Rating	Frequency	Percentage	Mean	Standard Deviation
Identify Alarms	3	19	67.86%	2.61	0.63
	2	7	25.00%		
	1	2	7.14%		
Low system productivity/MF	3	19	67.86%	2.54	0.74
	2	5	17.86%		
	1	4	14.29%		
Low feed pressure/MF	3	19	67.86%	2.54	0.74
	2	5	17.86%		
	1	4	14.29%		
High feed pressure/MF	3	18	64.29%	2.46	0.79
	2	5	17.86%		
	1	5	17.86%		
High feed temperature/MF	3	18	64.29%	2.57	0.63
	2	8	28.57%		
	1	2	7.14%		
Malfunctioning valve/MF	3	11	39.29%	2.21	0.74
	2	12	42.86%		
	1	5	17.86%		
High permeate turbidity/MF	3	15	53.57%	2.36	0.78
	2	8	28.57%		
	1	5	17.86%		
High permeate solids/MF	3	17	60.71%	2.46	0.74
	2	7	25.00%		
	1	4	14.29%		
Low system productivity/RO	3	18	64.29%	2.54	0.69
	2	7	25.00%		
	1	3	10.71%		

Low feed pressure/RO	3	19	67.86%		
	2	5	17.86%		
	1	4	14.29%	2.57	0.74
High feed temperature/RO	3	15	53.57%		
	2	9	32.14%		
	1	4	14.29%	2.39	0.74
High retentate solids/RO	3	13	46.43%		
	2	8	28.57%		
	1	7	25.00%	2.21	0.74
Malfunctioning valve/RO	3	11	39.29%		
	2	12	42.86%		
	1	5	17.86%	2.21	0.83
CIP system problems	3	16	57.14%		
	2	9	32.14%		
	1	3	10.71%	2.46	0.74

Possessing troubleshooting skills is an area where operators lack KSAs. Roughly, 65% of the operators understand how to correct problems such as high and low system productivity, low feed temperatures and pressures on both the MF and RO, and high feed temperatures on the MF. Approximately the same percentage of operators are able to identify the alarms and correct the problem associated to it.

The lowest areas of KSAs lie within troubleshooting malfunctioning valves on both the MF and RO, turbidity problems on the MF, high feed temperatures on the RO, and troubleshooting high retentate solids on the RO. Results also show that the number of associates able to identify and correct problems with the CIP system are lower than the average in this survey.

Display Basic Chemical Usage

Table 4 represents the data gathered on displaying basic chemical usage skills for this operation.

Table 4. Display basic chemical usage

Task	Rating	Frequency	Percentage	Mean	Standard Deviation
Operate the quantum unit	3	24	85.71%	2.86	0.36
	2	4	14.29%		
	1	0	0.00%		
Utilize dosing system	3	13	46.43%	2.11	0.92
	2	5	17.86%		
	1	10	35.71%		
Wear PPE	3	27	96.43%	2.96	0.19
	2	1	3.57%		
	1	0	0.00%		
Pause a CIP cycle	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Hold a CIP cycle	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Abort a CIP cycle	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
CIP 1000 series tanks	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
CIP 2000 series tanks	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
CIP 4000 series tanks	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
CIP 5000 series tanks	3	25	89.29%	2.82	0.55
	2	1	3.57%		
	1	2	7.14%		
Verify CIP quality via swabs	3	26	92.86%	2.82	0.55
	2	1	3.57%		
	1	1	3.57%		

Acknowledge CIP expiration	3	24	85.71%		
	2	1	3.57%		
	1	3	10.71%	2.75	0.65
CIP system problems	3	16	57.14%		
	2	9	32.14%		
	1	3	10.71%	2.46	0.74

According to the results, displaying basic chemical usage is one of the strongest areas of competency in the MF and RO operators. There is a great abundance of KSAs in wearing PPE, cleaning-in-place the tanks necessary for operation, pausing, holding, and aborting a CIP cycle, verifying CIP quality, and understanding the expiration time of a CIP.

The one area showing the least amount of KSAs is with the chemical dosing system. Only a small percentage of operators have an understanding of it.

The results again show that two associates have not been trained to operate the MF and RO and one associate that is still in training.

Utilize Basic Skills

Table 5 represents the data gathered on the operators using basic skills that are needed for MF and RO operation.

Table 5. Utilizing basic skills

Task	Rating	Frequency	Percentage	Mean	Standard Deviation
Update documentation	3	21	75.00%	2.61	0.74
	2	3	10.71%		
	1	4	14.29%		
Change MF modules	3	22	78.57%	2.75	0.52
	2	5	17.86%		
	1	1	3.57%		
Change RO modules/seals	3	18	64.29%	2.54	0.69
	2	7	25.00%		
	1	3	10.71%		
Update MF module map	3	19	67.86%	2.54	0.74
	2	5	17.86%		
	1	4	14.29%		
Update RO module map	3	18	64.29%	2.5	0.75
	2	6	21.43%		
	1	4	14.29%		
Understand glycol system	3	9	32.14%	2.14	0.71
	2	14	50.00%		
	1	5	17.86%		
Monitor juice chiller	3	22	78.57%	2.68	0.67
	2	3	10.71%		
	1	3	10.71%		
Verify biopectinase pump	3	23	82.14%	2.71	0.66
	2	2	7.14%		
	1	3	10.71%		
Interpret PS/PC document	3	15	53.57%	2.46	0.64
	2	11	10.71%		
	1	2	14.29%		
Identify faulty pumps	3	21	75.00%	2.61	0.74
	2	3	10.71%		
	1	4	14.29%		

Change out bad pumps	3	10	35.71%		
	2	12	42.86%		
	1	6	21.43%	2.14	0.76
Check seal water tank	3	22	78.17%		
	2	2	7.14%		
	1	4	14.29%	2.64	0.73
Change well water filters	3	11	39.29%		
	2	12	42.86%		
	1	5	39.29%	2.21	0.74
Perform conductivity test on RO	3	9	32.14%		
	2	12	42.86%		
	1	7	25.00%	2.07	0.77

Utilizing basic skills represents a number of responsibilities pertinent to the MF and RO operation, but are not interrelated as the tasks in the other categories were. This explains the variances under this category.

The categories showing strength in KSAs include changing MF modules, monitoring the juice chiller, checking the seal water tank, and ability to identify faulty pumps. Operators are also more knowledgeable in changing MF modules and updating the module maps than they are on changing RO modules and updating the RO module maps.

Areas of opportunity to increase KSAs are with gaining a better understanding of the glycol system, interpreting the PS/PC document for the MF and RO operation, changing out bad pumps, learning about the well water filters and how it affects the CIP operation, and performing a conductivity test on the RO.

Discussion

A few of the surveys came back with skills listed in the other sections. These skills that the operators thought were pertinent to operation but not listed on the survey include: pumping juice between feed tanks (as a troubleshooting skill), understanding air pressure and the effects on the valves, utilizing PC skills, and understanding Sattop valves (all under utilizing basic skills). These tasks are all important in every production area at Company X. With the exception of pumping juice between the feed tanks during a crisis situation, the skills listed in the other sections are not inclusive to the MF and RO operation.

According to the results of the survey, the operators are knowledgeable with the basic operation of the MF (total mean of 2.78) and with the RO (total mean of 2.79). Displaying basic chemical skills is where the respondents had the highest KSA level (total mean of 2.78). There appears to be a deficit of KSAs with troubleshooting skills (total mean of 2.45) and with the basic skills of the MF and RO process (total mean of 2.31).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

The final chapter of this research displays the major findings, conclusions, and recommendations for further study by the researcher.

Restatement of the Problem

A training needs assessment will be conducted on the Microfiltration and Reverse Osmosis operation at Company X to determine if all of the operators have been trained on the necessary skills in order to perform this job correctly and consistently.

This research will look at the current training situation and recommend solutions to increase the KSAs of the operators and make recommendations on how to standardize the current training program.

Research Objectives

1. Identify the duties and tasks needed to effectively operate the MF and RO;
2. Identify the importance of each duty and task for consistent operation;
3. Identify where there is a deficit in knowledge, skills, and abilities in the current associates that operate the MF and RO;

4. Propose implementations to increase KSAs in the MF and RO operation;
5. Offer suggestions on how to implement a standardized training program for the MF and RO process.

Summary of Methodology

There were two types of instruments used in this study. The first was a DACUM (Appendix A) that highlighted the major tasks associated with the MF and RO process. Secondly, a survey (Appendix C) was developed using the tasks in the DACUM. The survey was given to each of the 28 MF and RO operators. Each operator was asked to rate his or her KSA level on each task. A rating of three meant that the operator knows the task well enough to teach it. A rating of two indicated that they had performed the task but would need help to perform it again. A designated one rating by the respondents was for a task that was never learned. The response rate was all 28 surveys (100%).

Significant Findings

1. Operating the MF system has a total mean of 2.78. A majority of the surveys indicated that the associates operate at a level three, however there were a couple of tasks that fell below that average. These include calculating the water flux and laying-up the MF unit.

2. Operating the RO system produced a total mean of 2.79. Again, most of the associates were confident in their operation skills except for calculating the water flux and laying-up the RO unit.
3. Troubleshooting skills is an area that lacks KSAs. The total mean was 2.45 and the results indicated that in every area except two, there is a lack of KSAs. The strongest troubleshooting skills are in identifying alarms and troubleshooting high feed pressure on the RO. The scores were weak in all other areas.
4. Basic chemical usage had a total mean of 2.78. All of the operators were confident in their KSAs in this area with the exception of utilizing the chemical dosing system. This system is not in use but was tried during a short period of time. Not everybody had the opportunity to utilize this task.
5. Utilizing basic skills contained a variety of tasks that are important to the daily operation of the MF and RO. This section produced the lowest score with a total mean of 2.45. The strongest areas of application changing MF modules, monitoring the juice chiller operation, verifying the biopectinase pump operation, and checking the seal water tank. Areas that illustrate a lack of KSAs are in understanding the glycol system, changing out bad

pumps, changing well water filters, and performing a conductivity test on the RO.

Conclusions

One of the limitations of the study indicates that some of the operators may not have been trained on the MF and RO process. The results of the survey imply that this is likely to be only two operators of the 28 (7%).

Taking the results of the survey into consideration, there is a need to develop a standardized method of training to optimize the performance of the MF and RO operation. The survey also indicates that not all of the operators have learned all of the tasks thoroughly enough to perform the job correctly and consistently.

The lack of KSAs are most likely caused by the new hires after the significant turnover, rapid expansions, and the introduction of new technologies without the proper training techniques in place at Company X (Clark, 2000).

Occasionally, there are problems encountered with the equipment that can cause performance deficiencies, but with a deficit of KSAs in the operators, it is difficult to differentiate internal and external factors (Herbert & Doverspike, 1992). If the KSA levels were solid within all of the operators, an external factor could be quickly identified and resolved.

Recommendations for Company X

The following recommendations for Company X will be based on the objectives of this study:

Objective 1. *Identify the tasks and duties needed to effectively run the MF and RO operation.*

This objective was accomplished with the creation of the DACUM (Appendix A). A group of operators with a level two competency as well as three years of experience in operating the MF and RO participated in this process. It is recommended that Company X use this DACUM to create individualized training checklists outlining all of the sequential steps needed to complete each task. This will keep the necessary KSAs current with the job requirements of operating the MF and RO (Rossett, 1992).

Objective 2. *Identify the importance of each duty and task for consistent operation.*

This process was also completed with the creation of the DACUM. The group that created the DACUM put each task into order of importance for consistent operation. The order was verified by the corporate SME and the membrane manufacturer SME who validated the DACUM and the survey. The researcher recommends that the DACUM be revisited periodically to keep it current. As minor changes occur on

a continual basis, this will ensure the reliability of available resources.

Objective 3. *Identify where there is a deficit in knowledge, skills, and abilities in the current associates that operate the MF and RO.*

The current KSAs were identified with the survey process. Each operator identified his or her comfort level in performing each task. It is recommended to compile a list of the tasks that scored statistically low and have training sessions on these tasks. A separate session is recommended for extensive training on troubleshooting skills for the MF and RO operation. The researcher suggests that both classroom and OJT training be completed to strengthen the confidence level in the operators performance of these KSAs.

Objective 4. *Propose implementations to increase KSAs in the MF and RO operation.*

Currently, the MF and RO operators become a level one and level two operators once they are signed off on being competent in this operation. The problem with this is the verification of the operators KSAs that is signing off the other operator. Statistically, there are areas shown to have real weaknesses. The researcher concludes that these skills need to be re-examined in all of the operators.

The recommendation for this objective is to involve all of the operators in updating the CBMs. Training sessions involving all of the MF and RO operators to create a consensual operating procedures will serve as a resource for increasing KSAs in all of the current and future operators. These CBMs also need to be updated periodically as frequent changes have been the trend at Company X.

Objective 5. *Offer suggestions on how to implement a standardized training program for the MF and RO process.*

As recommended for objective 1, training checklists should be produced on all of the tasks for operating the MF and RO with the steps included. All of the current operators need to be accountable for each job function. Keeping records of the training check-sheets and revisiting them on occasion to make sure they are updated can also produce benchmarks in operating stability. Use the training checklists for new operators to guarantee the consistency and comprehensiveness of training. Enhancing job performance ultimately enhances the bottom line of the organization (Brinkerhoff & Gill, 1994).

Recommendations for future study:

In completing this study, the researcher recommends that the following be considered for future study at Company X:

1. Complete a TNA on each duty included in the MF and RO operation. Break the tasks down into steps and survey the KSA level on each step. Intricate details may be missed on a broad study and impossible to know if the operators are performing the steps consistently.
2. Study the historical data on the operation of the MF and RO units to determine if there is indications of errors that may have created any problems that were missed by the operators. Track any noticeable trends.
3. Study the CIP historical data for each MF and RO unit to determine if the parameters are being followed for pressures, temperatures, pH levels, and chemical compatibility. Any noticeable trends of fouling or a decrease in flux may indicate a problem with internal or external issues that need to be addressed.

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Appendix A

APPENDIX A

DACUM for the MF and RO

A. Operate the Microfiltration Process			
	A.1 Prepare Process Swings	A.2 Start Microfiltration Process	A.3 Record Process Data
A.4 Monitor Process Operation	A.5 Perform Batchdown	A.6 Monitor Diafiltration	A.7 Put Unit in Pumpdown
A.8 Shutdown MF	A.9 Make swings for CIP	A.10 Verify CIP timers	A.11 Clean-in-place the MF unit
A.12 Calculate Water Flux	A.13 Lay-up MF unit		

B. Operate the Reverse Osmosis Process			
	B.1 Prepare Process Swing	B.2 Start the RO Process	B.3 Record Process Data
B.4 Monitor Process Operation	B.5 Shutdown RO process	B.6 Make swings for CIP	B.7 Perform Clean-in-Place
B.8 Calculate Water Flux	B.9 Sanitize RO modules	B.10 Lay-up RO unit	

APPENDIX A

DACUM for the MF and RO

C. Possess Troubleshooting Skills	C.1 Identify Alarms	C.2 Troubleshoot low system productivity on MF	C.3 Troubleshoot low feed pressure on MF
C.4 Troubleshoot high feed pressure on MF	C.5 Troubleshoot high feed temperature on MF	C.6 Troubleshoot mal-functioning valve on MF	C.7 Troubleshoot high permeate turbidity on MF
C.8 Troubleshoot high permeate solids on MF	C.9 Troubleshoot low system productivity on RO	C.10 Troubleshoot low feed pressure on RO	C.11 Troubleshoot high feed pressure on RO
C.12 Troubleshoot high feed temperature on RO	C.13 Troubleshoot high retentate solids on RO	C.14 Troubleshoot mal-functioning valve on RO	C.15 Troubleshoot CIP system problems

D. Display Basic Chemical Usage	D.1 Operate the chemical Quantum unit	D.2 Utilize chemical dosing system	D.3 Wear Proper Personal Protective Equipment
D.4 Pause a CIP cycle	D.5 Hold a CIP cycle	D.6 Abort a CIP cycle	D.7 CIP 1000 series tanks
D.8 CIP 2000 series tanks	D.9 CIP 4000 series tanks	D.10 CIP 5000 series tanks	D.11 Verify CIP Quality
D.12 Acknowledge CIP expiration time			

APPENDIX A

DACUM for the MF and RO

E. Utilize Basic Skills	<i>E.1</i> Update Documentation	<i>E.2</i> Change MF modules	<i>E.3</i> Replace RO modules and seals
<i>E.4</i> Update MF module maps	<i>E.5</i> Update RO module maps	<i>E.6</i> Understand Glycol System	<i>E.7</i> Monitor Juice Chiller operation
<i>E.8</i> Verify Biopectinase Pump operation	<i>E.9</i> Interpret PS/PC Document	<i>E.10</i> Identify Faulty Pumps	<i>E.11</i> Change out bad pumps
<i>E.12</i> Check Seal Water Tank	<i>E.13</i> Change Well Water Filters	<i>E.14</i> Perform Conductivity Test on RO	

Appendix B

APPENDIX B

June 5, 2001

Company X
Mr. Larry Wildflower
One Company X Drive
<city name>, Massachusetts 02XXX

Dear Larry,

As you are well aware, the Microfiltration and Reverse Osmosis operations are important to this company. Change has been a major factor here at the <company location> plant and through the forwarding of our paperwork, you have probably noticed the fluctuation in our productivity.

I have been working on a training needs assessment for this area to identify the knowledge, skills, and abilities of our operators. I know this study will show where the operators have great strength, but I am hoping it will produce areas of opportunity to improve our productivity.

Since you have been actively involved in the setup and training of the MF & RO system here in <company location>, I would like to involve you in this project. I realize that you are quite busy with your own job responsibilities, but if you could review a couple of documents for me and provide feedback, it would be greatly appreciated.

I have enclosed a DACUM that has been produced by our top operators that is a spreadsheet listing the pertinent duties and tasks of the MF & RO operation. Please look this over and let me know if there are any areas that can be changed to get a better picture of the process.

There is also a survey attached which was made directly from the DACUM. You will find the same information on that. I will revise the DACUM and survey if you have some recommendations for me. Once again, I appreciate any feedback that you would provide. Thank you.

Sheri Shockey
Company X
<City name>, WI 54XXX
(608)XXX-XXXX

enclosures

June 5, 2001

Company Y
Mr. David Buick
850 Main Street
<city name>, Massachusetts 01XXX

Dear Dave,

As you are well aware, the Microfiltration and Reverse Osmosis operations are important functions of our operation at Company X. Change has been a major factor here at the <company location> plant and through your training sessions; you have probably noticed the fluctuation in our knowledge, skills, and abilities to operate this equipment.

I have been working on a training needs assessment for this area to identify the knowledge, skills, and abilities of our operators. I know this study will show where the operators have great strength, but I am hoping it will produce areas of opportunity to improve our productivity.

Since you have been actively involved in the setup and training of the MF & RO system here in <company location>, I would like to involve you in this project. I realize that you are quite busy with your own job responsibilities, but if you could review a couple of documents for me and provide feedback, it would be greatly appreciated.

I have enclosed a DACUM that has been produced by our senior operators. It is a spreadsheet listing the significant duties and tasks of the MF & RO operation. Please look this over and let me know if there are any areas, which can be changed to get a better picture of the process.

There is also a survey attached which was made directly from the DACUM. You will find the same information listed on that. I will revise the DACUM and survey if you have some recommendations for me to follow. Once again, I appreciate any feedback that you would provide. Thank you.

Sheri Shockey
Company X
<City name>, WI 54XXX
(608)XXX-XXXX

enclosures

June 22, 2001

Dear MF and RO Associates,

Are you curious as to what has been going on with the MFRO operation lately? I have been working on a training needs assessment in this area and have come to the point where I would appreciate your help.

Many times the comment has been said how all teams run the equipment differently, which can have its advantages and disadvantages. My goal is not to come up with the "right" way to operate the MFRO, but to identify any areas where an operator may not have learned how to perform certain tasks. This is how level six operators can be of tremendous help.

I have developed a survey that identifies a majority of the tasks involved in this area. There is also room to add anything that you see as an important task that I have missed. I will hand these out Thursday at the plant meeting. It should only take 5-10 minutes of your time. The surveys are completely anonymous. They ask that you identify your knowledge, skill, and ability level at each task. In the end, I hope the results will show if training is needed on certain tasks in order to attain the same result in operating the MFRO.

Each survey packet contains a cover sheet that is a consent form for participating in this study. When you complete the survey, tear off the cover sheet and put your name on it. I will have a drawing with the names from all of the returned surveys for some Ocean Spray merchandise.

I would like to thank you in advance for participating. Your input is valuable to this study. If you have any questions, please drop me an e-mail or ask me in person. Thank you.

Sheri A. Shockey

Appendix C

APPENDIX C

MFRO Operation

Please rate your personal skill level on each of the competencies listed below. The highest number should be circled if you feel you are extremely competent at the knowledge, skills, and ability to perform the task. The lowest number should be circled if you have never been challenged at the task or have little to no experience performing it. List any skills at the end of the column that you feel are important in this work area that are not presented on this survey.

- 3= extremely knowledgeable (can teach others)
 2= have done before/ would need help to do again
 1= no idea /never learned

Competency

Knowledge, Skill, & Ability level

Operate the Microfiltration Process

1. Prepare process swings	3	2	1
2. Start the Microfiltration process	3	2	1
3. Record process data	3	2	1
4. Monitor process operation	3	2	1
5. Perform batchdown	3	2	1
6. Monitor diafiltration	3	2	1
7. Put unit into pumpdown	3	2	1
8. Shut down the MF	3	2	1
9. Make swings for CIP	3	2	1
10. Verify CIP timers	3	2	1
11. Clean-in-place MF unit	3	2	1
12. Calculate water flux	3	2	1
13. Lay-up MF unit	3	2	1
14. Other: _____	3	2	1

Operate the Reverse Osmosis Process

1. Prepare process swings	3	2	1
2. Start the Reverse Osmosis process	3	2	1
3. Record process data	3	2	1
4. Monitor process operation	3	2	1
5. Shut down the RO process	3	2	1
6. Make swings for CIP	3	2	1
7. Clean-in-place RO unit	3	2	1
8. Calculate water flux	3	2	1

9. Sanitize RO modules	3	2	1
10. Lay-up RO unit	3	2	1
11. Other: _____	3	2	1

Possess Troubleshooting Skills

1. Identify alarms	3	2	1
2. Troubleshoot low system productivity on MF	3	2	1
3. Troubleshoot low feed pressure on MF	3	2	1
4. Troubleshoot high feed pressure on MF	3	2	1
5. Troubleshoot high feed temperature on MF	3	2	1
6. Troubleshoot malfunctioning valve on MF	3	2	1
7. Troubleshoot high permeate turbidity on MF	3	2	1
8. Troubleshoot high permeate solids on MF	3	2	1
9. Troubleshoot low system productivity on RO	3	2	1
10. Troubleshoot low feed pressure on RO	3	2	1
11. Troubleshoot high feed pressure on RO	3	2	1
12. Troubleshoot high feed temperature on RO	3	2	1
13. Troubleshoot high retentate solids on RO	3	2	1
14. Troubleshoot malfunctioning valve on RO	3	2	1
15. Troubleshoot CIP system problems	3	2	1
16. Other: _____	3	2	1

Display Basic Chemical Usage

1. Operate the chemical Quantum unit	3	2	1
2. Utilize the chemical dosing system	3	2	1
3. Wear proper personal protective equipment (PPE)	3	2	1
4. Pause a CIP cycle	3	2	1
5. Hold a CIP cycle	3	2	1
6. Abort a CIP cycle	3	2	1
7. CIP 1000 series tanks	3	2	1
8. CIP 2000 series tanks	3	2	1
9. CIP 4000 series tanks	3	2	1

10. CIP 5000 series tanks	3	2	1
11. Verify CIP quality via swabs	3	2	1
12. Acknowledge CIP expiration times	3	2	1
13. Other: _____	3	2	1

Utilize Basic Skills

1. Update documentation	3	2	1
2. Change MF modules	3	2	1
3. Change RO modules and seals	3	2	1
4. Update MF module maps	3	2	1
5. Update RO module maps	3	2	1
6. Understand glycol system	3	2	1
7. Monitor juice chiller operation	3	2	1
8. Verify Biopectinase pump operation	3	2	1
9. Interpret PS/PC document	3	2	1
10. Identify faulty pumps	3	2	1
11. Change out bad pumps	3	2	1
12. Check seal water tank	3	2	1
13. Change well water filters	3	2	1
14. Perform conductivity test on RO	3	2	1
15. Other: _____	3	2	1
16. Other: _____	3	2	1
17. Other: _____	3	2	1

Appendix D

APPENDIX D

Operate the MF Process:																																	Variance	Mean	Median	Std Deviation																
Prepare process swings	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1671	2.89	3.00	0.4163												
Start the MF process	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1671	2.89	3.00	0.4163									
Record process data	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1939	2.86	3.00	0.4484							
Monitor process info.	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2181	2.82	3.00	0.4756					
Perform batchdown	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681				
Monitor diafiltration	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681			
Put unit into pumpdown	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681		
Shutdown the MF	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681	
Make swings for CIP	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1671	2.89	3.00	0.4163	
Verify CIP timers	3	3	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.5038	2.68	3.00	0.7228
CIP MF unit	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681
Calculate water-flux	2	3	3	3	3	3	3	1	1	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.4592	2.57	3.00	0.6901
Lay-up MF unit	1	3	3	3	3	3	3	1	1	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.6020	2.57	3.00	0.7902
Other: switch feed tanks in process	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3099	0.11	0.00	0.5669

Operate the Reverse Osmosis Process:																																	Variance	Mean	Median	Std Deviation																		
Prepare process swings	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1671	2.89	3.00	0.4163					
Start the RO process	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3112	2.79	3.00	0.5681	
Record process data	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Monitor process operation	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Shutdown the RO process	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Make swings for CIP	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.1671	2.89	3.00	0.4163	
CIP RO unit	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Calculate water-flux	2	3	3	3	3	3	3	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3724	2.64	3.00	0.6215	
Sanitize RO modules	3	3	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.3827	2.79	3.00	0.6299	
Lay-up RO unit	3	3	3	3	3	3	3	1	1	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.5153	2.64	3.00	0.7310	
Other:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.0000

Possess Troubleshooting Skills:

																									Variance	Mean	Median	Std Deviation		
Identify Alarms	3	3	3	3	3	3	3	1	1	2	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3	3	0.3814	2.61	3.00	0.6289
Low system productivity/MF	2	2	3	3	3	3	3	1	1	1	2	3	3	3	3	3	3	3	3	1	2	2	3	3	3	0.5344	2.54	3.00	0.7445	
Low feed pressure/MF	2	2	3	3	3	3	3	1	1	1	2	2	3	3	3	3	3	3	3	1	2	3	3	3	3	0.5344	2.54	3.00	0.7445	
High feed pressure/MF	2	2	3	3	3	3	3	1	1	1	2	2	3	3	3	3	3	3	3	1	1	2	3	3	3	0.6059	2.46	3.00	0.7927	
High feed temp./MF	2	2	3	3	3	3	3	1	2	2	2	3	3	3	3	3	3	3	3	1	2	2	2	3	3	0.3878	2.57	3.00	0.6341	
Malfunctioning valve/MF	1	2	2	2	2	3	3	1	1	2	2	2	2	3	2	3	3	3	3	1	1	2	2	2	3	0.5255	2.21	2.00	0.7382	
High permeate turbidity/MF	2	2	3	3	3	3	3	1	1	2	2	2	3	3	3	3	3	3	3	1	1	1	2	2	2	0.5867	2.36	3.00	0.7800	
High permeate solids/MF	2	3	3	3	3	3	3	1	1	2	2	3	3	3	3	3	3	3	3	1	1	2	2	2	2	0.5344	2.46	3.00	0.7445	
Low system productivity/RO	2	2	3	3	3	3	3	1	1	2	2	3	3	3	3	3	3	3	3	1	2	2	2	3	3	0.4630	2.54	3.00	0.6929	
Low feed pressure/RO	2	3	3	3	3	3	3	1	1	2	2	2	3	3	3	3	3	3	3	1	1	2	3	3	3	0.5344	2.54	3.00	0.7445	
High feed pressure/RO	2	3	3	3	3	3	3	1	1	2	2	3	3	3	3	3	3	3	3	1	1	2	3	3	3	0.5306	2.57	3.00	0.7418	
High feed temp./RO	2	2	2	3	3	3	3	1	1	2	2	2	3	3	3	3	3	3	3	1	1	2	2	2	3	0.5242	2.39	3.00	0.7373	
High retentate solids/RO	2	2	3	3	3	3	3	1	1	1	2	2	2	3	3	3	3	3	3	1	1	1	1	2	2	0.6684	2.21	2.00	0.8325	
Malfunctioning valve/RO	1	2	2	2	2	3	3	1	1	2	2	2	2	3	2	3	3	3	3	1	1	2	2	2	3	0.5255	2.21	2.00	0.7382	
CIP system problems	2	2	3	3	3	3	3	1	1	2	2	3	3	3	2	3	3	3	3	1	2	2	2	2	3	0.4630	2.46	3.00	0.6929	

Display Basic Chemical Usage:

																											Variance	Mean	Median	Std Deviation
Operate Quantum Unit	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	0.1224	2.86	3.00	0.3563	
Operate Dosing system	1	1	1	3	3	3	3	1	2	2	2	3	3	3	1	1	3	3	3	3	1	1	1	1	2	2	0.8099	2.11	2.00	0.9165
Wear PPE	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.0344	2.96	3.00	0.1890	
Pause CIP cycle	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Hold CIP cycle	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Abort CIP cycle	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
CIP 1000 series tanks	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
CIP 2000 series tanks	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
CIP 4000 series tanks	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
CIP 5000 series tanks	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.2895	2.82	3.00	0.5480	
Verify CIP quality (swabs)	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.1671	2.89	3.00	0.4163	
Acknowledge CIP expiration	3	3	3	3	3	3	3	1	1	2	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	0.4018	2.75	3.00	0.6455	
Other: Shutdown CIP's (cycle 22)	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3099	0.11	0.00	0.5669	

Utilize Basic Skills:																													Variance	Mean	Median	Std Deviation
Update documentation	2	3	3	3	3	3	3	1	1	1	3	3	3	3	3	3	3	3	3	3	1	2	2	3	3	3	3	0.5242	2.61	3.00	0.7373	
Change MF modules	2	3	3	3	3	3	3	1	2	2	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	0.2589	2.75	3.00	0.5182		
Change RO modules & seals	2	2	2	3	3	3	3	1	1	1	2	3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	0.4630	2.54	3.00	0.6929		
Update MF module map	2	3	3	3	3	3	3	1	1	1	2	2	3	3	3	3	3	3	3	1	2	2	3	3	3	3	0.5344	2.54	3.00	0.7445		
Update RO module map	2	3	3	3	3	3	3	1	1	1	2	2	3	3	3	3	3	3	3	1	2	2	2	3	3	3	0.5357	2.50	3.00	0.7454		
Understand glycol system	1	2	2	2	3	3	3	1	1	2	2	2	2	3	2	2	3	3	3	3	1	1	2	2	2	2	0.4796	2.14	2.00	0.7052		
Monitor juice chiller	2	2	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	1	2	3	3	3	3	3	0.4324	2.68	3.00	0.6696		
Verify Biopectinase pump	3	3	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	1	2	2	3	3	3	3	0.4184	2.71	3.00	0.6587		
Interpret PS/PC document	2	2	3	3	3	3	3	1	2	2	2	2	2	3	3	3	3	3	3	1	2	2	2	2	3	3	0.3916	2.46	3.00	0.6372		
Identify faulty pumps	1	3	3	3	3	3	3	1	1	2	3	3	3	3	3	3	3	3	3	1	2	2	3	3	3	3	0.5242	2.61	3.00	0.7373		
Change bad pumps	1	1	2	2	2	3	3	1	2	2	2	2	2	3	1	2	3	3	3	3	1	1	2	2	2	3	3	0.5510	2.14	2.00	0.7559	
Check seal water tank	3	3	3	3	3	3	3	1	1	2	3	3	3	3	3	3	3	3	3	1	1	2	3	3	3	3	0.5153	2.64	3.00	0.7310		
Change well water filters	1	2	2	2	3	3	3	1	2	2	2	2	3	3	1	3	3	3	3	3	1	1	2	2	2	2	0.5255	2.21	2.00	0.7382		
Conductivity test on RO	1	2	2	2	3	3	3	1	1	1	2	2	2	2	2	2	3	3	3	3	1	1	1	2	2	2	3	0.5663	2.07	2.00	0.7664	
other: sattop valve understanding	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0344	0.04	0.00	0.1890		
other: utilizing CP forces	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0344	0.04	0.00	0.1890		
other: understanding air pressure	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0344	0.04	0.00	0.1890		