CRITICAL CONTROL POINT ANALYSIS: THE OPERATIONAL BENEFITS

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ABSTRACT

In 2004 Hunter Water embarked on a new method of reviewing and enhancing operational monitoring of plant performance involving undertaking critical control point (CCP) analysis of their treatment plants. It was found the most effective outcome was achieved through holding workshops involving all levels of the operations team. Plant operators are considered essential to the successful outcome due to their in-depth knowledge and understanding of the treatment process. In undertaking CCP analysis a number of operational benefits have been realised, including:

- CCP monitoring targets are discussed and defined
- Unnecessary/redundant monitoring is identified
- Awareness of critical aspects of the plant is increased and becomes the operating focus
- Triggers are defined for increased monitoring when problems arise

This paper will outline the methodology and expand on the benefits derived from undertaking CCP analysis.

KEY WORDS

Critical Control Points (CCP), operations, monitoring, optimisation, training,

1.0 INTRODUCTION

Hazard Analysis and Critical Control Point (HACCP; pronounced 'hás•sip') methodology was first developed to address food safety. This systematic approach allows for the identification of key process parameters and set-points, which when monitored provide a proactive approach to identifying any issues upfront in the process, rather than reacting to problems after they develop in the end product.

This approach, while widely used in the food industry, has also been recommended for water treatment as specified in the Australian Drinking Guidelines 2004 (ADWG)[1], and increasingly with the Australian Guidelines for Water Recycling 2006 (AGWR)[2] also has benefits within wastewater recycling applications.

Hunter Water Australia (HWA) has undertaken the CCP process for a number of Hunter Water facilities as well as for external clients and has determined that the most effective CCP approach is through a more collaborative approach with all levels of the operational team (ie. operators to management) and to provide more graphical outcomes to assist operators on a daily basis with optimising treatment processes.

2.0 DISCUSSION

2.1 What is HACCP?

The HACCP principles are not a new development. The concept was developed in the 1960s by the Pillsbury Company, while working with NASA and the US Army Laboratories to provide safe food for space expeditions.

The practical and proactive system of HACCP evolved from the efforts to understand and control food safety failures. HACCP has been widely used by industry since the late 1970s, and is now internationally recognised as the best system for ensuring food safety. It is endorsed by the Food and Agricultural Organisation (FAO), World Health Organisation (WHO) and, in the US by the National Advisory Committee on Microbiological Criteria for Foods (NACMCF) (Goodrich, et al)[3].

The HACCP methodology has a systematic approach which reviews the hazards and identifies the CCPs throughout any process. There are seven (7) key steps within the HACCP methodology, which are illustrated in Figure 1 below.

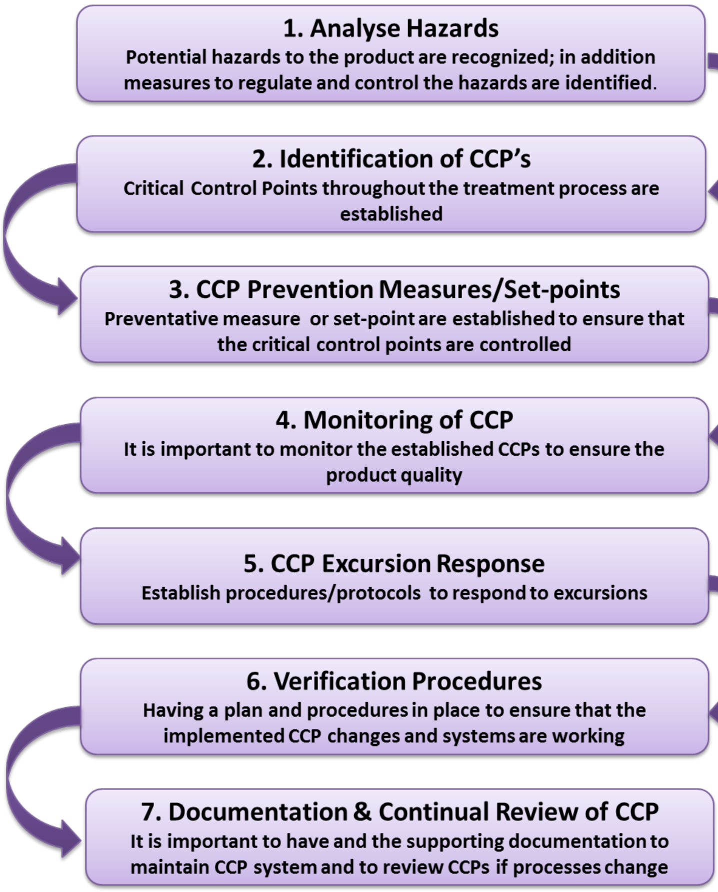

Figure 1: ***HACCP key steps*** *(Produksi PT)* [4]

The major objective of the HACCP process is to establish a monitoring program which effectively manages the risks of each individual system, and also to have effective procedures in place to react to excursions of CCPs to ensure the quality end product is not compromised.

Within the HACCP methodology is the definition for a CCP. A CCP is any point, step or procedure at which biological, physical or chemical factors can be measured or monitored to indicate if a process is in control.

It should be noted that CCPs are often confused with process targets. It is essential that a critical control point be a component within the process that can be directly controlled by operators.

2.2 How Does CCP Apply to Water and Wastewater Treatment?

The 2004 ADWG provided a new focus in water treatment management and specifies a more risk based approach. This less prescriptive method allows the water authority to assess their own water systems and to ensure that there are mitigation measures in place to reduce water quality risks. The ADWG outlines that the CCP methodology is one approach which can successfully assist in reviewing the preventative measures for drinking water quality management (Element 3).

Further the AGWR also specifies within the preventative measures for recycled water management (Element 3) that CCP analysis can be used in managing effluent quality to ensure it is fit for purpose. However, even without recycling quality obligations CCP analysis can also be useful to ensure that wastewater treatment plants are operated successfully to meet EPA licencing obligations, which are generally becoming more stringent.

While the CCP is a recommended approach for both water and wastewater, how does it directly relate to water and wastewater operations?

For water quality there may be a number of aesthetic water quality risks, however microbiological pathogens are generally the key water quality health risks. Dependent on catchment characteristics, these microbiological risks will need different treatment processes and tighter control on set-points. This is similar for wastewater and recycling health requirements. However, wastewater treatment facilities which are not recycling plants also need to understand their key effluent targets and CCPs to meet environmental licenses.

Further to the general definition of a CCP the ADWG also define a CCP as having several operational requirements, including:

- Operational parameters that can be measured and for which critical limits can be set to define the operational effectiveness of the activity (e.g. chlorine residuals for disinfection)
- Operational parameters that can be monitored frequently enough to reveal any failures in a timely manner (online and continuous monitoring is preferable)
- Procedures for corrective action that can be implemented in response to deviation from critical limits.

As previously outlined there can often be confusion in regard to difference between key process targets and CCPs. In both water and wastewater treatment there are both key process targets and controllable components within the treatment process that can have significant impact on end results.

For example, within water treatment the turbidity of water after filtration is a key processes target for removing microbiological pathogens (such as *Cryptosporidium*). However turbidity itself cannot be directly increased or decreased, (much to the disappointment of operators everywhere), but in reality the management of turbidity is a balance of a number of factors including filter run time, chemical dose rates, backwash programs and filter media condition, etc. Therefore while turbidity is a significant and important processes target, turbidity itself is *not* a critical control point. Similarly in wastewater treatment Biological Oxygen Demand (BOD) is critical process target however BOD is *controlled* through the Dissolved Oxygen (DO) levels within the bioreactor along with a number of other contributing factors such as recycle streams, detention time and reactor configuration.

It is important to understand the differences with CCPs and key process/operational targets as this enables operators to recognise what parameters can be directly controlled when there are excursions to water and wastewater quality.

The CCP analysis technique is not only recommended but can be applied to water and waste water applications. As with any process system there are both key process targets and CCPs to manage water and wastewater quality. However, to ensure the success of the CCP approach one must ensure there is a practical approach in implementing the seven (7) guiding principles of HACCP to water and wastewater treatment.

2.3 Making CCP Analysis a Practical Success

As outlined there are seven (7) key components to HACCP:
CCP Analysis Step 1 - Within the CCP component of HACCP the first step is identifying the key water and wastewater objectives, as previously discussed. This includes health requirements as outlined in the ADWG, or environmental license requirements for wastewater treatment.

CCP Step 2 and 3 - The next two (2) steps are the identification of CCPs and setting up set-points and targets for those CCPs.

Identification of CCPs requires a good understanding of the treatment plant operations and therefore it is critical that operators are involved in discussing how the plant is currently operated. However while it is important to have open discussions regarding the plant, this can also lead to much broader items which can often distract and prevent a focused review of CCPs. HWA has found that there are a number of tools that can be effectively used to focus the CCP process. The most important is to create a visual tool to systematically move through the treatment plant to identify the CCPs. CCP diagrams which provide a level of detail somewhere between a process flow chart and a P&ID have been found to be the most effective.

The CCP Diagram needs to represent the process while being simple enough to be functional. It is important that the first diagram is reviewed by operators to ensure that the flow paths have been validated before the CCP workshop,

The CCP workshop is then held which should consist of a good mix of the overall operations team, including engineering supervisors, lead operators and key operators. It also provides a good training opportunity for new operators and those that may need more exposure to different plants.

During the workshop each key water/wastewater parameter as defined in Step 1 is given its own diagram and a systematic approach is then taken by moving through each diagram from plant inflow to outflow. Critical control points, legislative (EPA or ADWG) limits, tighter performance targets and areas which need further investigation are then marked on the diagram.

CCP Step 4 - Using the workshopped diagrams, the CCPs are collated and a new focused monitoring program is created. This proposed program is then compared and scrutinised to the current program in place. If any monitoring currently undertaken is still required for license compliance or operation of the plant, it is added to the proposed monitoring program, as shown in Figure 2.

This new monitoring program and CCP set-points can be included into SCADA alarms or plant log/database systems to alert operators if there are excursions of these targets.

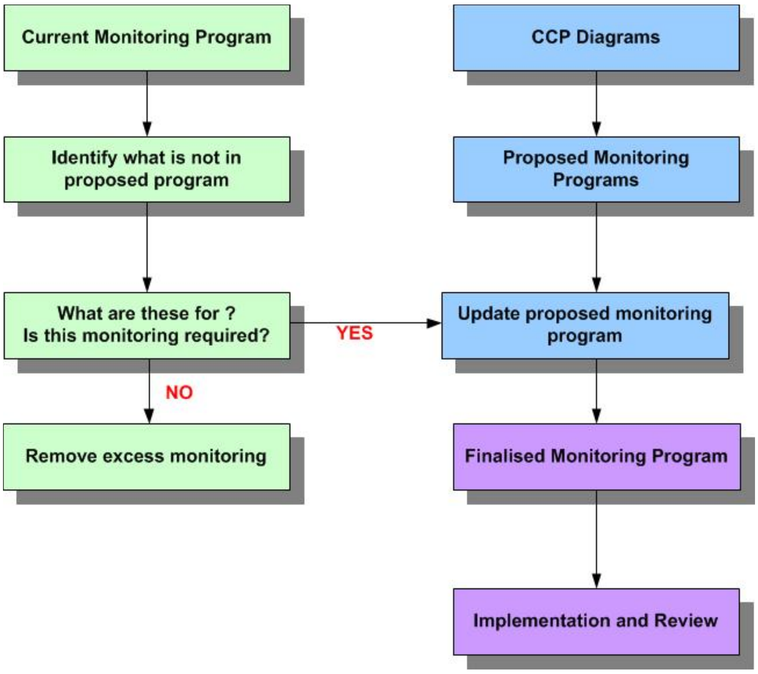

Figure 2: ***CCP Monitoring Program Development Steps***

CCP Step 5 – Through the identification of the CCPs, this process provides a great first step for the water authority to start creating response procedures and troubleshooting tools to assist operators in how to respond to excursions.

CCP Step 6 and 7 – It is important that the new monitoring program is reviewed to ensure no monitoring gaps have occurred or are further identified. If the CCP monitoring program is successful then consideration to extend the time between reviews can be made (eg. annually).

2.3 What are The Benefits of CCP Analysis?

The aim of CCP processes is not to develop more and more complex or expensive plant monitoring and controls, it is to target and focus monitoring on the critical control points of the plant. Advantages to this type of approach include:

- Critical control point monitoring targets are clearly defined for the plant.
- Identifies unnecessary or redundant monitoring.
- Focuses awareness of vital aspects of the plant.
- Defines triggers for increased monitoring when problems arise.
- Clearly defines reason for monitoring i.e. operational, assessable (EPA) and critical control point.

However despite the primary benefits of creating a more targeted monitoring program to better manage water and wastewater quality, HWA has found that there are also a number of secondary operational benefits of undertaking the CCP process.

The workshop approach provides a forum for knowledge sharing. While this often this can lead to debate over plant operations, it also provides an invaluable forum for senior operators to pass on operational knowledge. Even before undertaken the CCP analysis just going through the flow diagrams in a group can often provide a better understanding of the system.

Setting the CCPs and the target set-points in a workshop forum can also provide a sense of consensus that can often be missing in larger operational teams. All key team members have vetted the process and agreed on how the plant is to be operated to ensure that key water and wastewater parameters will be managed.

The creation of the graphical CCP diagrams provides operators with a unique troubleshooting and training tool which can assist them in reviewing plant operations and develops a better awareness of the critical areas of the treatment plant.

The CCP process also allows water authorities to review excursion responses and allows a prioritised approach in creating operating procedures. The creation of well-established excursion procedures can also delegate the responsibility of senior operators to more junior staff when senior staff are not available.

3.0 CONCLUSIONS

Through undertaking CCPs analysis a number of operational benefits have been realised, including:

- CCP monitoring targets are discussed, defined and agreed on in concensus with the operations team.
- Unnecessary/redundant monitoring is identified and removed which can provide a real cost saving.
- There is a more targeted and focused monitoring program on the critical control points of the plant.
- There is a greater shared understanding of the treatment plant.
- CCP diagrams create a visual tool to promote an awareness of critical areas of the plant.
- Excursion procedures can be created which help delegate the responsibility of senior operators when they are not available.

4.0 REFERENCES

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