The "Safe Mode" of Water Treatment Plant Operation during the COVID-2019 pandemic by Wuhan Water Group Company Limited, China

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1. Background and early preparation

Wuhan Water Group Company Limited is the biggest water supplier in the Wuhan metropolitan area, Hubei Province, China. The company operates 10 water treatment plants (WTPs) with a total capacity of 3.37 million m^3/d and serves a population of 4.73 million residents in the Wuhan metropolitan area.

Before the Wuhan government announced the lockdown policy for the city on 23 January 2020, Wuhan Water made a series of preparations to keep serving the city continuously and safely during the pandemic. The company held a special meeting on 22 January. All units and all employees were required to prepare for the emergency response as soon as possible.

The company set three objectives: maintaining the water supply, meeting water quality standards, and protecting employees. This was not easy work, since it suffered from insufficient supplies, lack of information about the novel coronavirus, SARS-CoV-2, and the situation was worsening day by day at that time. The managers and engineers set three principles: (1) to rely on themselves; (2) the director of each unit should lead the way; (3) to be prepared earlier, and more adequately. The water company purchased materials for routine operation and personal protection equipment, including face masks, protective clothing, infrared temperature monitors and mobile ultraviolet lamps for room disinfection. Employees with upset health were required to work online from home and report their temperature every day.

2. ‘Safe Mode’ for water treatment plant operation

The lockdown policy of Wuhan city brought great difficulty to water company operation. Meanwhile, strict quarantine was very important for epidemic control. Wuhan water company tried its best to adapt to this situation and develop a new operation mode to maintain service, named the ‘Safe Mode’. The Safe Mode was applied as of 25 January 2020, right after the lockdown of Wuhan on 23 January 2020. It remained in place until the end of April 2020, approximately 20 days after the opening of Wuhan on 8 April.

The Safe Mode includes two principles: (1) applying a strict four-level hierarchical isolation to cut off the transmission route of the SARS-CoV-2 virus: the isolation of each water treatment plant (WTP) and water company office from society; the isolation of on-duty personnel from other people; the isolation of on-duty personnel from their lodgings; and the social distancing of personnel during standby at home. (2) Applying comprehensive measures covering administration, operation, commuting, occupational safety, and physiological and psychological healthcare for employees, etc.

The basic requirements for the Safe Mode are listed below.

(1) *Minimizing the contact of staff in the WTP with the outside*: each WTP was kept strictly isolated from the outside society. Only the basic logistics of reagents, daily diet and personnel protective equipment were allowed to be taken into the WTP, to reduce risk of infection. Only the basic tasks were conducted by staff in the WTP to maintain normal production. This operation mode is similar to the Safe Mode of a personal computer’s Windows operating system.

(2) *Defence in depth*: several parallel working teams were assembled for each WTP or core branch of the water company. If one person in one team got infected, the whole team would be quarantined, and the alternative team could back up quickly to ensure continuous operation. When one working team is on duty, another team stands by in the WTP lodgings. The remaining teams stayed at home as the backup. A general reserve force composed of the experts or senior engineers in the head office can act as a further option.

(3) *Minimising the working team for WTP operation*: selecting experienced workers who can handle multiple tasks to minimise the personnel, which would reduce the risk of personnel being infected and reduce the resource consumption and logistics workload.

(4) *Working period of each team*: both the working period and standby period of each team were set at 14 days each, according to the knowledge of the incubation period of SARS-CoV-2.

3. Management framework of Department of Drinking Water Production of Wuhan Water Company during the epidemic

Wuhan Water Company set up a new management framework to address the situation of the COVID-19 pandemic. The management framework comprises four groups, as set out below.

(1) *WTP operation management group*: this group is responsible for organising and implementing the WTP operation, water quality inspection, and providing technical guidance for workers in each WTP or branch.

(2) *Logistics management group*: this group is responsible for the purchasing, registration and distribution of epidemic-prevention materials with the support of the water company's department of materials and logistics. This group also handles the issues of vehicle allocation and certification, and disinfection in buildings and workshops.

(3) *Equipment maintenance group*: this group is responsible for technical support for equipment and facilities in each WTP or branch, ensuring the smooth transmission of signals and content via the network. This group also handles calls for repair tasks in an emergency, and the dispatching for inspection and maintenance of equipment and facilities.

(4) *Comprehensive support group*: this group comprises the labour union, office of management, office of accounting, and office of environmental health and safety. They are responsible for administrative affairs, news, corporate culture, and so on.

4. Measures to achieve the goals for comprehensive safety

The Wuhan Water Company set up three goals for comprehensive safety during the battle against the COVID-19 pandemic: 'No violation of drinking water quality standards can be allowed for a moment', 'no water shortage can be allowed for a moment', and 'no employee can be infected on duty'. Five aspects of management measures have been conducted to achieve the goals: production safety, water quality management, epidemic prevention and control, logistics support, and human welfare.

4.1 Production safety

To ensure treatment processes, workers in each WTP optimized operation of the sedimentation tank, including increasing the discharge frequency and shortening discharge period according to fluctuations in source water quality, shortening the operation period of filters, emptying the coagulation and sedimentation tank for cleaning, and suspending the reuse of backwashing water to reduce the risk of microbial enrichment.

For risk identification and control, Wuhan Water Company revised the original

emergency response plan and strengthened the measures to fight against the COVID-19 pandemic, adopting the principles of less contact among people to avoid or minimize the risk of infection.

To strengthen instrument inspection and maintenance, the WTP technicians and those at company level worked together to conduct inspections of equipment inside and outside the WTPs. The preventive maintenance of equipment and facilities was also undertaken in a timely way.

To ensure enough production material was reserved, each WTP worked closely with the production material management centre of Wuhan Water Company, checking the existing storage of raw materials, and purchasing and storing sufficient production materials for the coming days.

Wuhan Water set up the emergency repair team to be on call 24 hours per day, which included the technicians in the electrical and mechanical fields, as well as welding, lifting, vehicle and boat driving, and other professional maintenance personnel.

4.2 Water quality surveillance

Inspection of water sources was undertaken by the engineers of Wuhan Water Company, working closely with the local Environmental Protection Agency and local Water Affairs Authority to inspect the water source protection zone and ensure the reagent dosing system was intact and had sufficient reagents.

Wuhan Water strengthened monitoring of source water quality, with the laboratories at the WTP level and company level assessing the water quality daily. They paid close attention to quality changes in the raw water such as pH and chemical oxygen demand, by permanganate titration (COD_{Mn}), and ammonia.

To control the quality of process water and finished water, the turbidity of the sedimentation effluent should be controlled at less than 3 NTU and that of filter effluent should be less than 0.3 NTU. The residual chlorine in the clear well inlet should be maintained in the range of 1.0-1.3 mg/L, the contact time of the clear well should be greater than 30 min, and the CT value for free chlorine disinfection should exceed 30 mg/L.min. The turbidity of the finished water should be controlled within 0.3 NTU, and the residual chlorine of the finished water should be controlled to be within 1.0-1.2mg/L.

Online monitor maintenance was undertaken, with the inspection, calibration and maintenance of water quality online instruments conducted more frequently. The water quality data was inspected carefully, and any odd result was checked by manual testing.

4.3 Pandemic prevention and control

Strict disinfection was implemented, with the workshop, office building, canteen, shower room, toilet, garbage bin, and so on disinfected twice a day. The disinfection work was strictly recorded.

Entry and exit management were strengthened: only personnel on duty are now allowed to enter the WTP. Body temperature testing and disinfection are strictly conducted for all personnel entering the WTP.

Guidance on personal protection and tracking of health status has been undertaken, with guidance for personal protection set up and forwarded to every employee, and temperature measurement and health screening implemented twice per day. A prepared plan to quarantine infected employees on duty was quickly set up.

We also implemented contactless work: an online work mode was initiated by means of corporate WeChat, telephone communication, use of online collaborative documents, and so on to minimize contact between employees. The canteen provided meal boxes for employees, instead of them eating in the hall.

4.4 Strong logistics support

All lodgings for employee were reorganized to satisfy the goal of 'one lodging, one bathroom, one person'. Basic furniture, bedding, daily necessities as well as washing machines were provided in each lodging.

Daily meals were prepared carefully to ensure food safety and quality. Snacks such as milk, bread, fast food, and fruits were also provided for employees.

Commuting was organized carefully after the lockdown measures for Wuhan city were implemented, when no personal traffic was permitted. Wuhan Water Company applied the pass cards for commuting vehicles from the government, picked up employees from home and drove them to the working area.

Wuhan Water Company tried its best to purchase protective materials such as masks, gloves, bleach, 75% alcohol, and infrared thermometers to meet the needs of employees. The company also tried its best to collect personal protective equipment for employees working in high risk areas.

4.5 Welfare

Each employee's family was cared for, including sending electronic birthday cards to employees who had birthday during the pandemic. The administrative team called family members to understand their situation and demands, and helped them solve their difficulties, which relieved the worries of the staff on duty.

Wuhan Water also carried out health screening, caring for the enclosed workers on duty in the factory and organizing daily inspections to fully understand the employees' health conditions.

Wuhan Water provided psychological aids to ease the emotions of employees, helping them to relieve stress and organizing the closed-in employees to do physical exercise properly under the premise of personal protection.

In caring for sick employees, the caring from the company to the sick employees was conveyed via video, WeChat, telephone, and so on.

5. Conclusion

The ‘Safe Mode’ has been proven to be a successful way to maintain the normal water supply under the severe situation of the COVID-19 pandemic. With the collaboration of each employee, the goals of achieving excellent water quality, sufficient water supply capacity, and zero infection of employees on duty was achieved.

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Acknowledgement

This case study is made available through the efforts of the International Water Association’s COVID-19 Task Force as a contribution on ‘lessons learned’ during the COVID-19 pandemic.

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Text last updated: 12 September 2020.

Case study available at:

https://iwa-network.org/news/information-resources-on-water-and-covid-19/

For more information on the IWA COVID-19 Task Force, see:

https://iwa-network.org/groups/covid-19-task-force/