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DEVELOPMENT OF WATER QUALITY STANDARDS FOR INDUSTRIAL USE

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SHANGHAI, PEOPLE'S REPUBLIC OF CHINA.

TECHNICAL REPORT 2/4/89 - 1/5/89
PERIOD IN SHANGHAI 7/4/89 - 26/4/89.

Prepared for the Government of the People's Republic of China
by the United Nations Industrial Development Organisation
acting as the executive agency for the United Nations Development Programme.

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION, VIENNA.

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I INTRODUCTION.

The one-month project included a briefing session in Vienna (3/4/89) and briefing and de-briefing sessions in Beijing (6/4/89, 27/4/89). The project work was carried out in Shanghai between 7/4/89 and 26/4/89, at the Shanghai Industrial Water Treatment Centre (SIWTC) offices and laboratories, and at selected industrial sites. This report was compiled on 28 - 30/4/89 and 1/5/89.

SIWTC requested that I perform two main functions, both in accordance with the Job Description.

First, to assess the capabilities of the water analysis laboratory in relation to the requirements expected of it. This was done and is reported on below (Chapter II).

Second, to establish water quality standards for the food and beverage industry in Shanghai. SIWTC consider (correctly) that these standards must take priority over others of less concern to public health, e.g. textiles and dyeing. Background data to support the standards was obtained by visiting :

Yimin Brewing Company (Heineken associate)
Shanghai Soft Drinks Factory
Yiming Food Products (canned meat, canned and bottled vegetable plants)
Chang Tao Water Treatment Plant.

Water quality standards were prepared. After full discussion with representatives of the industry and relevant SIWTC personnel, the standards were accepted and agreed(Chapter IV and Appendix 3).

Additional discussions were held concerning water treatment technology for cooling and boiler water, and the National boiler water standards were reviewed. I visited Wu Ching Fertilizer Plant to discuss cooling tower treatment. These subjects will not be reviewed in this report, as they were secondary to the main objectives.

During discussion of the water quality standards, the Chinese drinking water standards were reviewed at length and compared with European standards. A half-day presentation of the proposed standards and the treatment procedures needed to achieve them was made on 24/4/89.

II SIWTC WATER ANALYSIS LABORATORY

A considerable amount of time was spent in assessing the equipment and staff, and in advising on procedures. The laboratory has been set up for less than one year and currently has a staff of eight.

The instrumentation supplied by UNIDO has been checked, but is at the present time practically unutilized. Usage will be slowly increased during the rest of 1989. They are anxious to obtain the G.C./E.C.D. instrument requested in July 1988, for quantitative analysis of pesticides and PCBs.

<u>Conclusions and recommendations</u>

a) The overall competence of the laboratory staff, and of the equipment, are quite adequate for the analytical requirements which they are expected to fulfill. Additional staff training overseas has been carried out and more is planned: this will be beneficial.

b) Where the levels of accuracy and precision required for any specific water constituent permit, locally produced instruments are to be preferred over imported ones. Spare parts and servicing are greatly facilitated in this way.

c) There is a need to establish clearly written analytical procedures for each substance to be analysed. As far as possible, they wish to have a chemical and instrumental procedure. The selected analytical method can be from the International Standards Organisation (ISO); the U.S. Environmental Protection Agency (EPA); or the American Society for Testing Materials (ASTM), depending upon which is most appropriate in terms of local availability of reagents.

d) Laboratory staff, though technically well trained and qualified, lack experience in water analysis, because the laboratory is new. Accordingly, testing is slow. The only way to improve this situation is to collect and analyse a large number of water and waste water samples from the widest possible range of industrial applications. This will have the dual advantage of providing experience and confidence, and of building up a data-base of water quality across Shanghai industry, including the effects of seasonal variations on the city supply and downstream treatment processes.

e) The most important part of the standards (Appendix 3) is that concerning bacterial quality. Over the next one to three years, SIWTC should establish their own micro-biological testing laboratory.

III SHANGHAI CITY WATER SUPPLY

The water supply to the food and beverage industry is derived from the Shanghai City Water Company, which provides more than 90% of the requirements. A small volume of underground well water is used, which is treated in the plant. It was, therefore, necessary to examine the operation of the city water treatment plants.

Raw water is derived from the middle and upper reaches of the Huangpo river, where the water is somewhat less polluted than in the city region. About 4,400,000m^3 are supplied daily from 13 plants, of which Chang Tao supplies 1,300,000m^3.

Treatment in all the plants is the same: pre-chlorination, flocculation with alum,sedimentation, filtration and post-chlorination. The resulting treated water is characterized by high mineral salts, hardness, chloride and sulphate: and low turbidity, bacteria and coliforms.

Treatment and analytical control compare favourably with European practice.

IV WATER QUALITY STANDARDS FOR THE SHANGHAI FOOD AND BEVERAGE INDUSTRY

The major task of the mission, as required by SIWTC, and requested of them by the industry, was to establish suitable standards. The SIWTC group with whom these standards were discussed and eventually agreed were : Li Yi Hong (leader), Zhao Lon Sen, and Wu Jian Hua.

Drawing up the standards proved to be difficult. Literature searches carried out by SIWTC and myself had failed to locate any existing standards, though there are some sketchy guidelines. This is because, in Western Europe anyway, quality control tests are applied to the finished product, and it is entirely up to the individual manufacturers how they treat their water supplies: if the final product quality passes bacterial quality tests, it is assumed that the water used is satisfactory. If product palatability is unsatisfactory, then the company concerned will not survive.

Accordingly, we visited plants producing beer, soft (carbonated) drinks, meat and vegetable packing (cans and bottles) to examine their current quality control procedures, water treatment facilities and views. The plants visited were market leaders, with standards above the average.

A distinction must be drawn between the various uses of water which can have a major effect on public health and product quality :-

water constituting more than 90% of the product, as in beer and soft drinks.
water constituting up to 30% of the product, as in vegetable canning and bottling.
water will only be in the product in very small amounts, e.g. by leaking seals and lids in the cooking and sterilizing of filled containers.

To cover all aspects, we considered that three kinds of standard are required.

A Primary Standard is proposed to cover water quality for all of these uses. This will be enforceable.

Mandatory Standards are proposed for those constituents of water which can affect public health. There are somewhat different standards for each category of water usage. These will also be enforceable.

Advisory Standards are proposed for those constituents of water which can affect product quality in terms of palatability. These are different for each category of water usage. In the case of water used in cooking and sterilizing, there are two standards: one for water which is used once only: the other for water which is recycled. These will not be enforceable.

The standards are detailed in Appendix 3 with explanatory notes. Representatives of the industry indicated that they are practically achievable with existing treatment and analytical equipment.

An additional comment is required here concerning aluminium and nitrate in the primary and mandatory standards. Currently the Chinese drinking water standards do not mention aluminium. Because of its suggested connection with Alzheimer's disease, it is desirable to institute a limit of 0.2 mg/l (the present European limit) and this will be discussed with the appropriate authorities. For nitrate, which has suspected connections with stomach cancer, the Chinese drinking water standard is 20 mg/l N (88.6 mg/l NO_3), as compared with the European standard of 50 mg/l NO_3. These factors are reflected in the mandatory standards.

There is some pressure in the EC to reduce both of these standards.

<u>Implementation and Management</u>

When the final report is received from UNIDO, it will be translated by the project group, and checked by the National Bureau of Technology. A Chinese expert will comment and, if he feels it to be necessary, amend the proposed standards before they are published and distributed to the food and beverage industry. SIWTC are aware that the draft standards left with them are not to be implemented until these steps have been taken.

It is anticipated that the primary and mandatory standards will be enforced one year later, and the advisory standards one year after that.

The actual work of supervising the industries' compliance with the standards will be done by the Shanghai Bureau of Technology with tne back-up services of SIWTC. It is possible that SIWTC will eventually take over the whole responsibility for supervision and checking, which I believe would be a preferable course of action.

V FUTURE DEVELOPMENTS

In addition to the existing boiler water standards, and the food and beverage industry standards discussed in this report, the only other requirements for which there is a clear need are those for ultra-pure water in semiconductor manufacture and some uses in pharmaceuticals. The last two are well documented.

This writer is far from convinced that industry in general will be helped by arbitrarily imposed standards, e.g. in the oil refining, steel, automotive, textile and petrochemical sectors. My experience of industry is that they can get along very well without them. It is worth noting that more than 90% of industrial water is used for cooling, and despite many attempts, no-one has yet produced an acceptable set of standards for cooling use.

The water and analysis department (I cannot speak for other groups in SIWTC) should develop its experience and expertise in developing a broad knowledge of industrial water and waste water quality and treatment processes. In this way, they will be best able to help in the tasks which should have clear priority. These are to participate in the hoped-for reduction in water pollution; to improve overall management of water resources; and to assist individual industrial plants to improve their treatment control processes and deal with water related problems.

VI ACKNOWLEDGEMENTS

I am greatly indebted to Mr. Luo Hua-Ren, Mr. Gu Jia-Long, their colleagues and staff, for their co-operation, kindness and hospitality during my stay in Shanghai. I am especially grateful to Li Yi Hong, Zhao Lon Sen, Wu Jian Hua and Chen Ping for devoting so much of their time to helping me in this project.

APPENDIX 1: DOCUMENTS LEFT WITH SIWTC

ASTM: Manual on Water.

Industrial Water Society: Water Use and Re-use in the Food and Drink Industry. Symposium Papers.

P. T. Jordan: Membrane Processes for Ultra-Pure Water.

D. A. Stewart: Improved Analysis and Monitoring of High Purity Water.

U.K. Department of the Environment:

a) Safeguarding the Quality of Public Water Supplies.

b) Regulations on Quality of Water Supplies (Consultation Papers)

Conference Manual (1984): Water for Manufacturing Food and Drink.

B. Wise: Cooling Water Treatment in the Food Canning Industry (1987).

APPENDIX 2: POTABLE WATER STANDARDS IN THE PEOPLE'S REPUBLIC OF CHINA

Issued 1985-08-16. Implemented 1986-10-01.

Colour	Less than 15 units
Turbidity	" " 3 NTU
(in special circumstances	Less than 5)
Visible Material	0
Total Hardness mg/l $CaCO_3$	Less than 450
Iron mg/l Fe	" " 0.3
Manganese mg/l Mn.	" " 0.1
Copper mg/l Cu.	" " 1.0
Zinc mg/l Zn	" " 1.0
Volatile Phenol mg/l	" " 0.002
Anionic Detergent mg/l	" " 0.3
Sulphate mg/l SO_4	" " 250
Chloride mg/l Cl.	" " 250
Total Dissolved Solids mg/l	" "1,000
Cyanide mg/l CN.	" " 0.05
Arsenic mg/l As.	" " 0.05
Selenium mg/l Se.	" " 0.01
Mercury mg/l Hg.	" " 0.001
Cadmium mg/l Cd.	" " 0.01
Chromium mg/l Cr^{6+}	" " 0.05
Lead mg/l Pb.	" " 0.05
Silver mg/l Ag.	" " 0.05
Nitrate & Nitrite mg/l N.	" " 20
Chloroform µg/l	" " 60
Carbon Tetrachloride µg/l	" " 3
Benzpyrene µg/l	" " 0.01
DDT µg/l	" " 1
Phenylhexachloride µg/l	" " 5
Total Bacteria col/ml.	" " 100
Total Coliforms/litre	" " 3
Chlorine mg/l free	more than 0.3

APPENDIX 3: WATER QUALITY STANDARDS FOR THE FOOD AND BEVERAGE INDUSTRY IN SHANGHAI.

Primary Standard

All water supplies used in the production of food and beverages must comply with the drinking water standards of the People's Republic of China, issued 1985-08-16, implemented 1986-10-01, and with any subsequent revisions of them. An additional standard is recommended for aluminium, which should not exceed 0.2 mg/l.

Notes

1. If water is not supplied from a Shanghai city water treatment plant, it may require some pre-treatment to meet the standards.

2. Some medical authorities believe that there is a link between aluminium and Alzheimer's Disease. The present European standard is that aluminium should not be more than 0.2 mg/l.

Quality Standards for Water Used in Beverages

Mandatory Standards

	Optimum	Maximum
Total viable bacteria CFU/ML	Less than 20	100
Total coliforms per litre	0	3
Aluminium mg/l Al.	-	0.2
Nitrate mg/l NO_3	Less than 50	90

Advisory Standards

	Optimum	Maximum
pH value	Range 6.0 - 8.0	
Turbidity, NTU	Less than 0.2	1
Colour	" " 5	15
Dissolved solids mg/l	" " 100	250
Free chlorine mg/l Cl_2	" " 0.05	0.1
Iron mg/l Fe	" " 0.05	0.1
Manganese mg/l Mn	" " 0.02	0.05
Total hardness mg/l. $CaCO_3$	" " 50	100
Total alkalinity mg/l $CaCO_3$	" " 50	100

Notes

1 These standards apply to water which has been treated in the plant. In the case of beer, standards are before addition of brewing salts.

2. Some medical authorities believe that there is a link between nitrate and stomach cancer. The present European limit is 50 mg/l.

Quality Standards for Water used in Food Containers.

Mandatory Standards

	Optimum	Maximum
Total viable bacteria cfu/ml	Less than 100	1,000
Total coliforms per litre	" " 30	100
Alumnium mg/l Al	-	0.2
Nitrate mg/l NO_3	Less than 50	90

Advisory Standards

	Optimum	Maximum
pH value	Range 6.5 - 8.5	
Turbidity NTU	Less than 1	3
Colour	" " 5	15
Free Chlorine mg/l Cl_2	" " 0.01	0.03
Iron mg/l Fe	" " 0.1	0.3
Manganese mg/l Mn	" " 0.02	0.1
Volatile Phenol mg/l	" " 0.001	0.002

Notes

These standards apply to water which has been treated in the plant, before sterilization. After sterilization the bacterial and coliform standards shall be the same as those for drinking water.

Quality Standards for Water used in Cooking and Sterilizing.

A. Water used Once Only.

Mandatory Standards

	Optimum	Maximum
Total viable bacteria cfu/ml	Less than 20	100
Total coliforms per litre	0	3
Free chlorine mg/l Cl_2	At least 0.2	

Advisory Standards	Optimum	Maximum
Iron mg/l Fe	Less than 0.3	1
Calcium mg/l as $CaCO_3$	" " 200	500

Notes

If high hardness water causes deposition of calcium carbonate on containers, sodium hexametaphosphate should be added to the water at about 2 mg/l.

B. Recycled Water.

Mandatory Standards

	Optimum	Maximum
Total viable bacteria cfu/ml	Less than 20	100
Total coliforms per litre	0	3
Free chlorine mg/l Cl_2	Range 0.5 - 1.5	

Advisory Standards

	Optimum	Maximum
Iron mg/l Fe	Less than 1	3
Calcium mg/l as $CaCO_3$	Range 25 - 100	
pH value	Range 6.5- 8.5	

Notes

1. It will be necessary to add sodium hypochlorite (or other chlorine compound) to the recylced water to maintain the standard for free chlorine.
2. The amount of condensed steam will control the calcium level in the recycled water, and this cannot be predicted. It may be necessary to add some softened water to maintain the standard for calcium. If 100 mg/l is exceeded, there can be undesirable calcium salt deposits on containers. If calcium is below 25 mg/l, corrosion of steel will be too high.
3. In recycle water systems the product of corrosion of steel (iron oxide, Fe_2O_3), will remain in the system for many hours, and can cause

staining of containers. Corrosion inhibiting chemicals should be added to reduce corrosion of steel to an acceptable level. Suitable chemical treatment systems are :

zinc	2 - 3 mg/l
polyphosphate	8 - 12 mg/l
OR	
total phosphate ortho & poly	20 - 30 mg/l
orthophosphate	10 - 20 mg/l

The advice and services of a reputable chemical treatment supplier should be obtained.