

## The established method of three regulation standards in Japan

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**Abstract** Ministry of the Environment, Japan, introduced odor index regulation using olfactory measurement by the amendment of the Offensive Odor Control Law in 1995. The following 3 types of odor emissions from factories and workshops are regulated. Local governments could establish 3 applicable regulation standards corresponding to those emission types. In this paper, it introduces about the establish method of the regulation standards in Japan. And show the result of the questionnaire about the measurement specimen of the odor index in Japan. We confirmed that the number of the odor index measurement specimen was 18787, which exceeds the one of material concentration specimen. Moreover, the result shows that many of the odor index measurements were done by rather business proprietors than local governments to make efforts to preserve environment.

**Keywords** Odor Index; olfactory measurement; The Offensive Odor Control Law; Triangular Odor Bag Method

### HISTORY OF OFFENSIVE ODOR CONTROL IN JAPAN

With the progress of industrial development and urbanization, complaints about environment pollution such as air pollution, noise and offensive odors increased sharply in the 1960s in Japan. To take measures against offensive odors, the “Offensive Odor Control Law”<sup>1)</sup> (hereafter called “the Law”), that regulates offensive odors emitted from business activities, was enacted in 1972. It could be progressive as few countries have laws applying only to offensive odors.

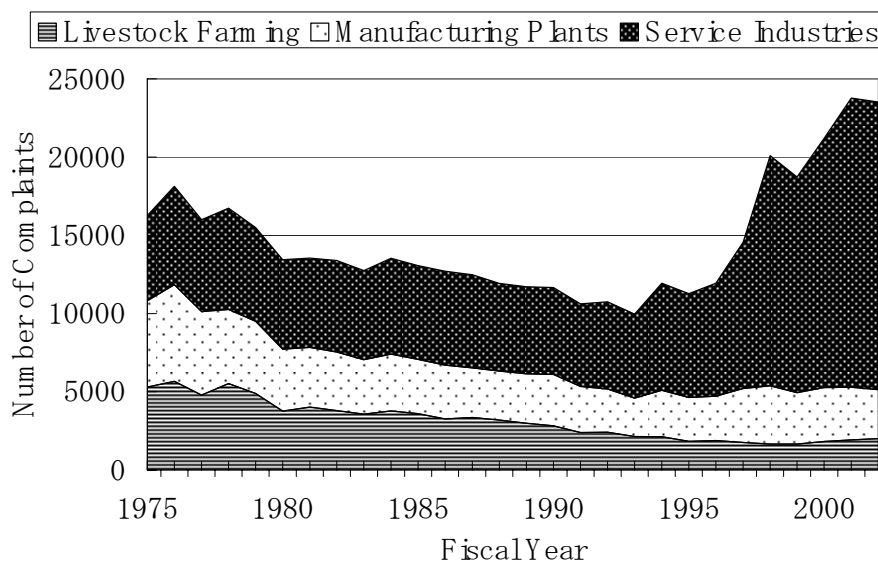
Various efforts toward improvement under the Law resulted in decline of complaints, with the least complaints in 1993 as shown in the figure. However, the number has been increasing dramatically since then. In 2001, there were record numbers of complaints. One of the major causes is the increase in those about service industries such as restaurants and about private households. When the law was enacted, the regulation was focused on the concentration of offensive odor substances. However, as complaints about offensive odors became more diversified, this regulation was no longer sufficient to deal with the increasing number of complaints caused by unregulated substances or complex odors. To improve these situations, the law was revised in 1995 and the odor index regulation was newly introduced<sup>2)</sup>, with “Triangular Odor Bag Method”<sup>3, 4)</sup>, an olfactory measurement method, being officially adopted for measuring the index.

In this method, six or more members of the panel are given a set of three bags; one with a sample in it and two with odor-free and asked to choose the odorous bag. The odor is then gradually diluted and the test is continued until it becomes impossible to identify the bag with odor. The odor index is calculated by the dilution rate at which the panel can no longer tell the correct bag.

$$\text{Odor Index} = 10 \log (\text{Dilution Rate})$$

Olfactory measurement is superior to instrumental odor measurement in its capability to deal with diverse odorants, to evaluate additive and multiplicative effects of odorants, and to meet residents' sense of suffering from offensive odors.

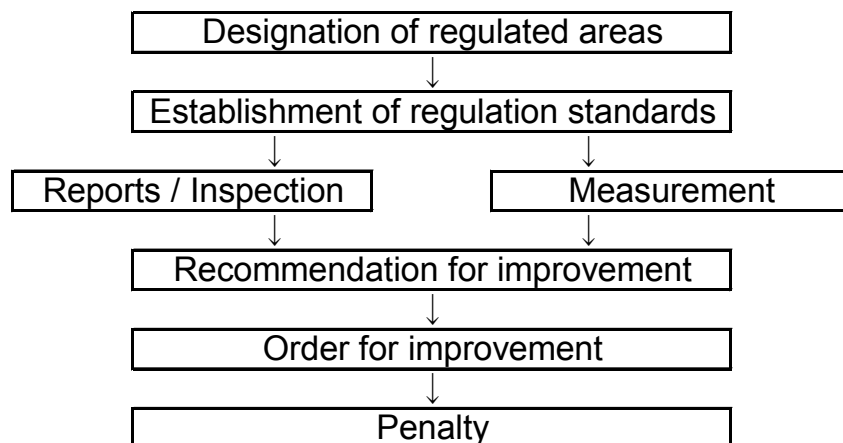
Fig 1. Annual changes of complaints about offensive odors<sup>5)</sup>



### LEGAL FRAMEWORK OF THE OFFENSIVE ODOR CONTROL LAW

Aim of the Law is to preserve the living environment and people's health by reducing offensive odors. To achieve its aim, the Law covers regulatory measures against offensive odors emitted from business activities as described below.

Fig 2. Framework of the Offensive Odor Control Law<sup>6)</sup>



### Designation of Regulated Areas

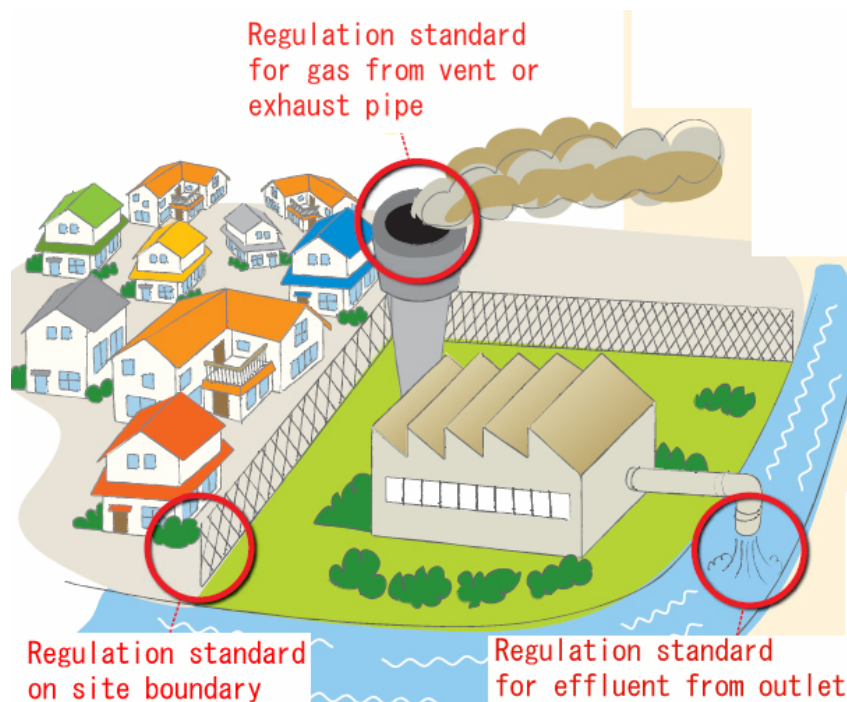
Areas are designated by local governments based on geographical and demographical conditions. Within regulated areas, emissions of offensive odors from business activities are regulated. All kinds of factories and workshops within regulated areas are under regulation of the Law. This applies regardless of type, scale or management organization of business.

### Establishment of Regulation Standards

The following 3 types of odor emissions from factories and workshops are regulated. Local governments could establish 3 applicable regulation standards corresponding to those emission types. They are the standard on site boundary, the standard for gas from exhaust pipe, and the standard for effluent from outlet.

We are going to introduce the establishment methods of three regulation standards this time. The standard of the site boundary is the basis of the calculations of other two standards.

Fig 3. Three types of Odor Emissions from Factories and Workshops



*How to establish regulation standard on site boundary.* First of all, odor intensity in the regulated area should be established. Local governments can choose environmental preservation level value among 2.5, 3.0, and 3.5, according to the conditions of the land use such as residential or industrial purpose.

Table1. Odor intensity scale

Odor intensity scale	Intensity
0	No Odor
1	Very faint
2	Faint
3	Easily noticeable
4	Strong
5	Very strong

Table2. Odor index is established referring to the odor index measurement result list which shows each industry's odor index of the regulated area.

Major types of industry	Odor index corresponding to the Odor intensity		
	2.5	3.0	3.5
Livestock farming (hogger)	12	15	18
Livestock farming (cattle)	11	16	20
Livestock farming (poultry)	11	14	17
Rendering factory	13	15	17
Wastewater processing plant	11	13	16
Garbage burning plant	10	13	15
Painting factory	12	13	15
Coating factory	14	16	19
Asphalt producing factory	12	16	19
Other manufacturing factory, plant, etc.	14	17	20
Food factory	13	15	17
Restaurant	14	17	21
MIN	10	12	14
MAX	15	18	21

*How to establish regulation standard for gas from exhaust pipe.* As for the regulation standard for gas from exhaust pipe, the equation of air diffusion is applied. The gas which contains odor emitted from the exhaust pipe like chimney and so on gradually diffuses and dilutes and eventually lands onto the surface of the ground. This regulation standard is established to meet the odor emission standard at the exhaust pipe, and the odor index at the landing point outside the site boundary should be under the one from vent or exhaust pipe. It is explained following equation.

$$RS2 = RS1 + DI$$

RS2 : Regulation Standard for gas from vent or exhaust pipe

RS1 : Regulation Standard on site boundary

DI : Dilution Index

The emission style applied here covered many kinds of causes such as large-scale plants and low-height chimneys. Therefore we had to consider that the area where buildings close together like big cities, possibly became cause of odor and complaints as a result. In addition to that, odor had to be estimated in a short time. We took these factors, and considered Briggs style (1973) as ascending process, and Huber-Snyder style (1976)<sup>7)</sup> as emitting process and after considering the influence of the buildings, we applied it as the air diffusion model.

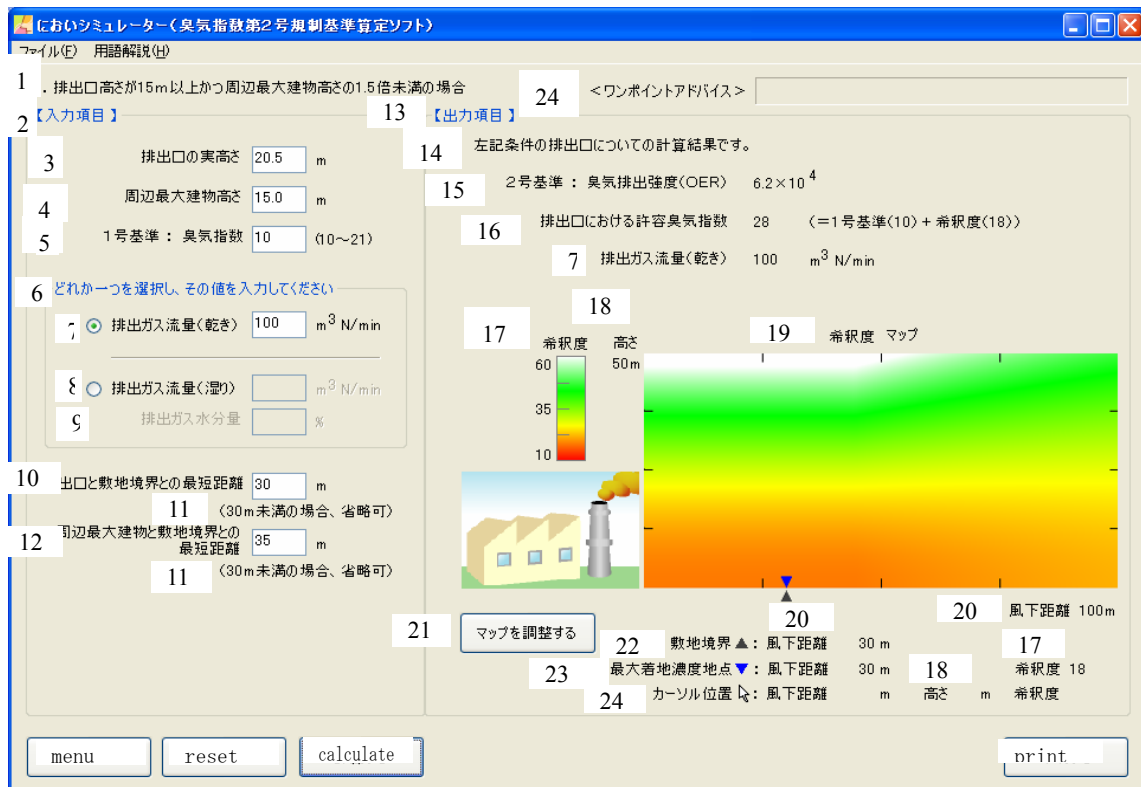
Then we got a lot of requests from the local government officers for the plain calculation method of the exhaust pipe. Therefore we can clearly calculate the regulated standard of the exhaust gas by taking in new standard called the dilution index.

Dilution index means the dilution ratio at the most concentrated point when the gas from exhaust pipe lands on the ground surface diluting.

This measurement enables enterprise staff to calculate the standard of the exhaust gas on the site easily by the addition of dilution index and the standard value shown on the local site boundary.

The Ministry of the Environment in Japan and our association made and calculation software called ‘Odor Simulator’<sup>8)</sup> and plain guidebook<sup>9)</sup> for ‘Regulation Standard for Gas from Exhaust Pipe’, which help us to calculate easily, then we have them for free.

Fig 4. Odor Simulator



Translation in the Figure 4 ‘Odor Simulator’

1. When the height of the exhaust pipe is over 15m and also it is under 1.5 times

- taller than the maximum height of the area's building
2. input items
  3. actual height of the exhaust pipe
  4. maximum height of the area's building
  5. Regulation standard at the landing point : Odor index
  6. Choose one of two and input the value(s)
  7. Flux of exhaust gas (dry)
  8. Flux of exhaust gas (moist)
  9. water in the exhaust gas
  10. the shortest distance between exhaust pipe and site boundary
  11. (when it is less than 30m, omission available)
  12. the shortest distance between area's tallest building and site boundary
  13. output items
  14. calculation result over the exhaust pipe conditioned on the left
  15. Regulation standard at the exhaust pipe : odor emission rate
  16. approved odor index at the exhaust pipe  
(=Regulation standard at the landing point + dilution index )
  17. dilution index
  18. height
  - 19 dilution index map
  20. leeward distance
  21. adjustment of the map
  22. site boundary
  23. landing point of the maximum concentration
  24. cursor position
  25. mini advice

In addition, it makes us possible to develop odor control. One of the countermeasures which are often applied for odor control is to put the exhaust pipe at higher place to dilute landing concentration by diffusion. It enables us to calculate the height of the exhaust pipe from the graph after getting necessary dilution index.

*How to establish regulation standard for effluent from outlet.* We picked 130 business proprietors in Japan among many kinds of business fields and examined effluent from 1997 to 1999. We established the index, which was under the index of the standard on the site boundary, above 1.5 m from water surface to avoid the complaints over effluent downstream. Then we calculated correlation of odor index for gas exhausted from effluent straightly 1.5m above to suppose odor index of effluent and the standard on the site boundary. The odor from the effluent was measured by triangular odor flask

method. After consideration of distinction if there were odor complaints and relations with amount of effluent, possibilities for countermeasure realization, we established dilution as 16 evenly. (40-fold dilution). Therefore the index which is added 16 to the standard on site boundary becomes the standard index effluent from outlet.

### Olfactory Measurement Operator

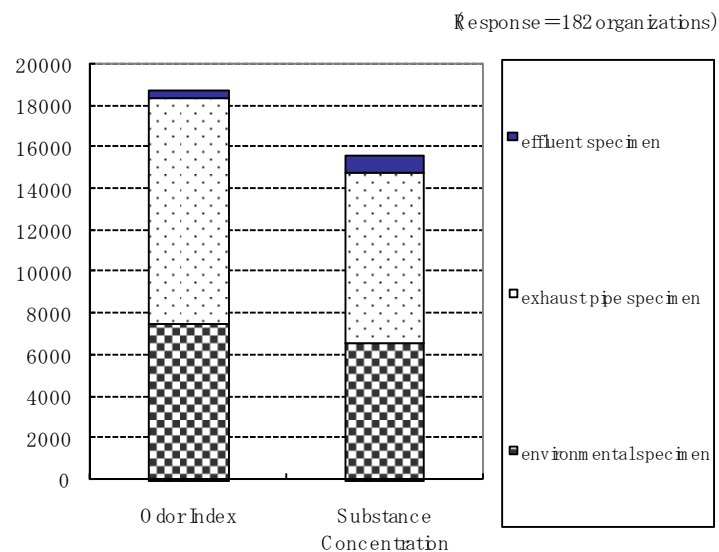
Local government may make recommendations or orders to factories or other business establishments based on the results of measurements, and these orders may lead to penalties. Therefore, these measurements require accuracy. The amended Law also obliged local government to contract with certified operators when they commission olfactory measurement.

An olfactory measurement operator is a person in charge of management and organization of entire series of olfactory measurement from panel selection<sup>10)</sup>, sampling, performance of tests and summarizing the results based on the Triangular Odor Bag Method.

This is a National Certification granted to those who passed both the written examination and an aptitude test using five standard odorants to judge an examinee if he/she has a normal sense of smell. Currently, there are 2929 certified operators nationwide (as of March 2008).

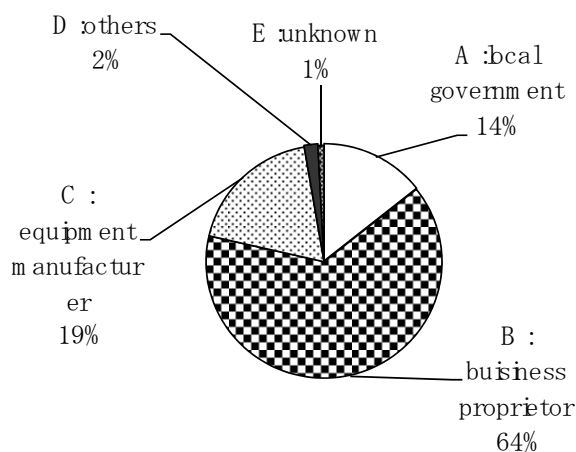
Whether local governments adopt odor substances regulation or odor index regulation depends on their geographical and demographical conditions. As shown the result of the questionnaire about the measurement specimen of the odor index in Japan, we confirmed that the number of the odor index measurement specimen was 18787, which exceeds the one of material concentration specimen.

Fig 5. The measurement specimen of the odor index



Moreover, the result shows that many of the odor index measurements were done by rather business proprietors than local governments to make efforts to preserve environment.

Fig 6. The measurement subject



We often get inquires about quality control and safety of the olfactory measurement since it is measured by human nose. Therefore the Ministry made a manual of quality control on olfactory measurement and published it in 2002<sup>11)</sup>. Also, in carrying out olfactory measurement, it is important to assure safety of samplers, panelists and operators. The Ministry also made a manual of safety assurance of olfactory measurement and published it in 2002<sup>12)</sup>.

Our association works hard for the training of the Olfactory Measurement Operator. We also take care of the system to give recommendation logo for high-quality measurement equipments and the crosscheck which gathers over 100 companies in Japan.

### CONCLUDING REMARKS

Japan has set up the system for odor control, including the Law and its implementing rules, measurement methods, certification for operators, quality control, and safety assurance.

For the further improvement, as the odor index has been unfamiliar to most of the public, the Ministry produced the brochure on the odor index, to promote the public understanding of the regulation and further adoption by municipal governments, which shows odor indices of smell sources familiar to ordinary people, such as smells in drinking coffee, cooking garlic, and sniffing plum flower in the garden.

All odor indices were measured by triangle odor bag method.



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