ENVIRONMENT IMPACT ASSESSMENT ON THE TOBU-KYURYO-LINE (HSST SYSTEM) IN JAPAN

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Keywords

Tobu-Kyuryo-Line, high speed surface transport, maglev trains, electromagnetic field, health risk assessment.

Abstract

A high speed surface transport (HSST) system using maglev, which is called Tobu-Kyuryo-Line, is introduced, and the outline is described together with the procedure of its environment impact assessment established by Aichi prefecture government. The special emphasis is placed on the environment assessment for electromagnetic fields around the Tobu-Kyuryo-Line. Magnetic field measurements around an experimental line for maglev trains demonstrate that the maglev-induced magnetic fields from the Tobu-Kyuryo-Line should be fully under the international safety guidelines.

1 Status of Tobu-Kyuryo-Line

Tobu-Kyuryo-Line starts from Fujigaoka station of Nagoya Subway called Higashiyama Line and ends at Yakusa station of Aichi Loop Railway. It is about 9 km long medium-quantity transport system. It takes about 15 minutes to run from Fujigaoka to Yakusa station. Due to the hilly landform, the difference between the highest and lowest point is about 130 m, and the maximum slope of the main line is consequently 6% and it continues about 1 km long. Accordingly, a capability of running up smoothly on a steep slope is needed for vehicles. Moreover, this region is being designated as a core district of the Aichi Academic Research and Development Zone, which also needed an image of industrial advanced zone to vehicles.

For this reason, a magnetic levitation system or maglev, called High Speed Surface Transport (HSST) system was selected. The maglev is a type of high speed train that runs on magnets supported by a magnetic field generated around track, and in the HSST system the train is levitated about 8 mm height by the attractive power of magnets and propelled by linear motors. This system will be the world first application for urban transportation system of maglev trains within urban area, although a similar magnetic levitation system called Tranrapid was already developed in Shanghai and runs from downtown to the Pudong International Airport.

On the other hand, when announced the introduction of this system for the Tobu-Kyuryo-Line, many inhabitants living along the line have felt uneasy about the possible health risk of maglev-induced magnetic fields. In order to proceed with the above project, the following procedures: city planning, zoning law and environment impact assessment, had to be completed. Particularly in these procedures it was inevitable to explain the electromagnetic field impact to the inhabitants around the line, while at that time electromagnetic fields were not applicable to the conventional items investigated for the environment impact assessment.

For eliminating their concern on the human health of maglev induced magnetic fields, and also adopting a new transport system like the HSST, electromagnetic field assessment was taken into consideration for the environment impact assessment, which was conducted by Aichi-Kosoku-Kotsu Corporation for an experimental line of maglev trains. This was a trial for the first time in Japan.

2 Outline of Environmental Impact Assessment

The Aichi Prefecture Government established a system for the environmental impact assessment, which was based on the Environmental Impact Assessment Law and the Aichi Prefecture Environment Impact Assessment Ordinance.

2.1 Object of Items

For the environment impact assessment, we investigated the following items:

- Item on maintaining satisfactory air, water and soil conditions, for promoting human health securing desirable living conditions and appropriately conserving the natural environment.
- Item on securing diverse ecosystems; conserving wild animal and plant species; and systematically protecting the varied natural environment (e.g. forests, agricultural land and waterfronts) according to local natural and social conditions.
- Item on maintaining fruitful contact between humans and nature, and creating a conformable environment by using the historical and cultural assets of an area.

2.2 Projects

The object projects were those exceeding a certain scale, which fell under any of the following categories:

Roads, dams or other river works, railroads, airfields, power stations, refuse treatment facilities, human excreta treatment facilities, waste final disposal sites, industrial waste incineration facilities, waste water treatment plants, plant construction/extension, land reclamation in public water bodies, land re-plotting, residential area development, urban infrastructure development, distribution center development, agricultural land development, recreational site development, industrial park development, housing development, soil/rock collection, multipurpose area development.

2.3 Procedures

The procedures below were followed by the organization, which is responsible for the project.

(1) A document describing the items and methods of the environment impact assessment and related information shall be prepared, and made available for public inspection.
(2) The method of surveys forecasts and evaluations shall be determined, after hearing the opinions on the document of residents, the prefecture governor and other parties concerned.
(3) A document describing results of environment impact assessment and related information shall be prepared, and made available for public inspection. A meeting should be held to present the contents of the document to citizens. The governor shall hold a meeting to monitor citizens' opinions on the document.
(4) After hearing the opinions of residents, the governor and other parties concerned, the document shall be reviewed and revised if necessary.
(5) The document shall be revised if necessary, upon receiving the opinions of the Minister of the Environment and licensing authorities.
(6) The final version of the document shall be made available for public inspection. The project may be commenced only after approval of the document.
(7) After the completion of the project, environmental impact shall be investigated according to the plan described in the document.

3 Electromagnetic Field Assessment

Based on the above-described procedure, maglev-induced electromagnetic field assessment was conducted in the following way:

(1) The environmental magnetic fields including both direct-current (DC) and alternating-current (AC) components along the Tobu-Kyuryo-Line under construction were measured at six different measurement locations along the line, using a magnetic field measurement device [2] specially designed for railways which has a wide measurement range from μT to mT.

(2) The maglev-induced DC and AC magnetic fields were measured along an experimental line of the HSST system under various moving conditions of maglev trains. The conditions included:

- the environmental field level
- the field level when the maglev train was turned on the electricity (1500 V)
- the field level when the maglev train started to move
- the field level when the maglev train accelerated to the maximum speed.

(3) The measured magnetic field levels were compared with the well-known safety guidelines issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [1], which are most commonly used for health risk assessment.

(4) Based on the environmental magnetic field levels along the Tobu-Kyuryo-Line under construction and the measured magnetic field levels along the experimental line, the magnetic field levels for the actual Tobu-Kyuryo-Line were predicted to assess the safety of the maglev induced magnetic fields.

4 Results

The ICNIRP published the safety guidelines in 1998 for limiting exposure to time-varying electric, magnetic and electromagnetic fields in the frequency range up to 300 GHz, which were based on scientific data alone [1], and the guidelines provide an adequate level of protection from exposure to time-varying electromagnetic fields. Two classes of guidance are presented in the ICNIRP guidelines. One is the basic restriction that is the current density at DC and low frequencies, and another is the reference level that is provided for practical exposure assessment purpose in order to determine whether the basic restrictions are likely to be exceeded. Table I shows an extract of the reference levels at low frequencies.

Table I Reference Levels for Magnetic Flux Density in ICNIRP Guidelines

Frequency	Magnetic Flux Density
< 1 Hz	40.000 mT
10 Hz	0.500 mT
20 Hz	0.250 mT
30 Hz	0.167 mT
40 Hz	0.125 mT
50 Hz	0.100 mT
60 Hz	0.083 mT

In the present study a three-axes magnetic field probe was employed in the measurements and the DC and AC magnetic flux densities were used to compare with the reference levels shown in Table 1. The DC components were mainly due to the overhead wires and electromagnets, while the AC components were mainly due to the linear motors and inverters of the maglev train.

Among the measurement conditions as given in the previous chapter, the maximum maglev-induced DC magnetic field was observed when the maglev train started to move, and a similar field level also occurred when the maglev train accelerated to the maximum speed. Moreover, the maglev-induced AC magnetic filed was also largest when the maglev train started to move, and its frequency

ranged around 13 – 63 Hz. Compared to the DC level, the AC level of magnetic field was lower in an order of about 1/10 or smaller.

For the DC components, the maximum magnetic flux density was found to be 0.682 mT at a distance of 0.5 m from the maglev train when it started to move. The distance of 0.5 m could be considered as the possible minimum distance from the Tobu-Kyuryo-Line for the inhabitants. According to the ICNIRP guidelines as given in Table I, the maglev-induced DC magnetic fields were fully under this safety guideline and exhibited a safety factor of 58.

For the AC components, the maximum magnetic flux density was 0.063 mT with a frequency of 23 Hz. This level was also found at a distance of 0.5 m from the maglev train when it started to move. Compared to the ICNIRP defined reference level in Table I at 23 Hz, the maglev-induced AC magnetic flux density exhibited a safety factor of about 3 when the train started to move. On the other hand, when the maglev train accelerated to 70 km/h, the induced AC magnetic flux density was 0.042 mT with a frequency of 63 Hz, which exhibited a minimum safety factor of about 2 with respect to the ICNIRP guidelines.

5 Assessment Effect and Conclusion

We had a meeting with the inhabitants living along the line in order to explain the environment impact assessment results together with urban planning. For the magnetic field assessment results for maglev trains, based on the environmental magnetic field measurement along the Tobu-Kyuryo-Line under construction and the maglev-induced magnetic field measurement along the experimental line, we could show the inhabitants that the magnetic fields due to the Tobu-Kyuryo-Line should be fully under the ICNIRP safety guidelines. We also believe that this finding has wiped out their concern on the human health of the maglev induced magnetic fields.

References

[1] International Commission on Non-Ionizing Radiation Protection, *Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)*, Health Physics, vol.74, no.4, pp.494-522, 1998.4.

[2] Eisuke Masada and Takeshi Mizuma, *Electromagnetic Environment in Railway Systems*, Proceedings of 15th International Wroclaw Symposium and Exhibition on Electromagnetic Compatibility, Wroclaw, Poland, pp. 406-409, June 27-30, 2000.