SHINKAWA

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Eddy-current track analyzer from Shinkawa

Technical Bulletin

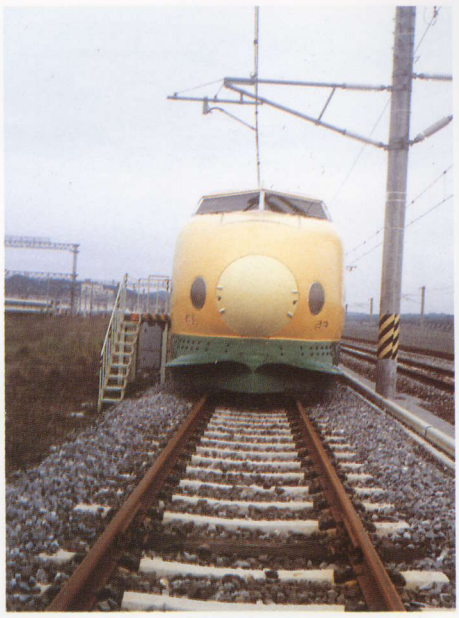
For the health of your railways

Shinkawa eddy-current track analyzer can quickly determine the status of tracks even under bad weather.

Overview

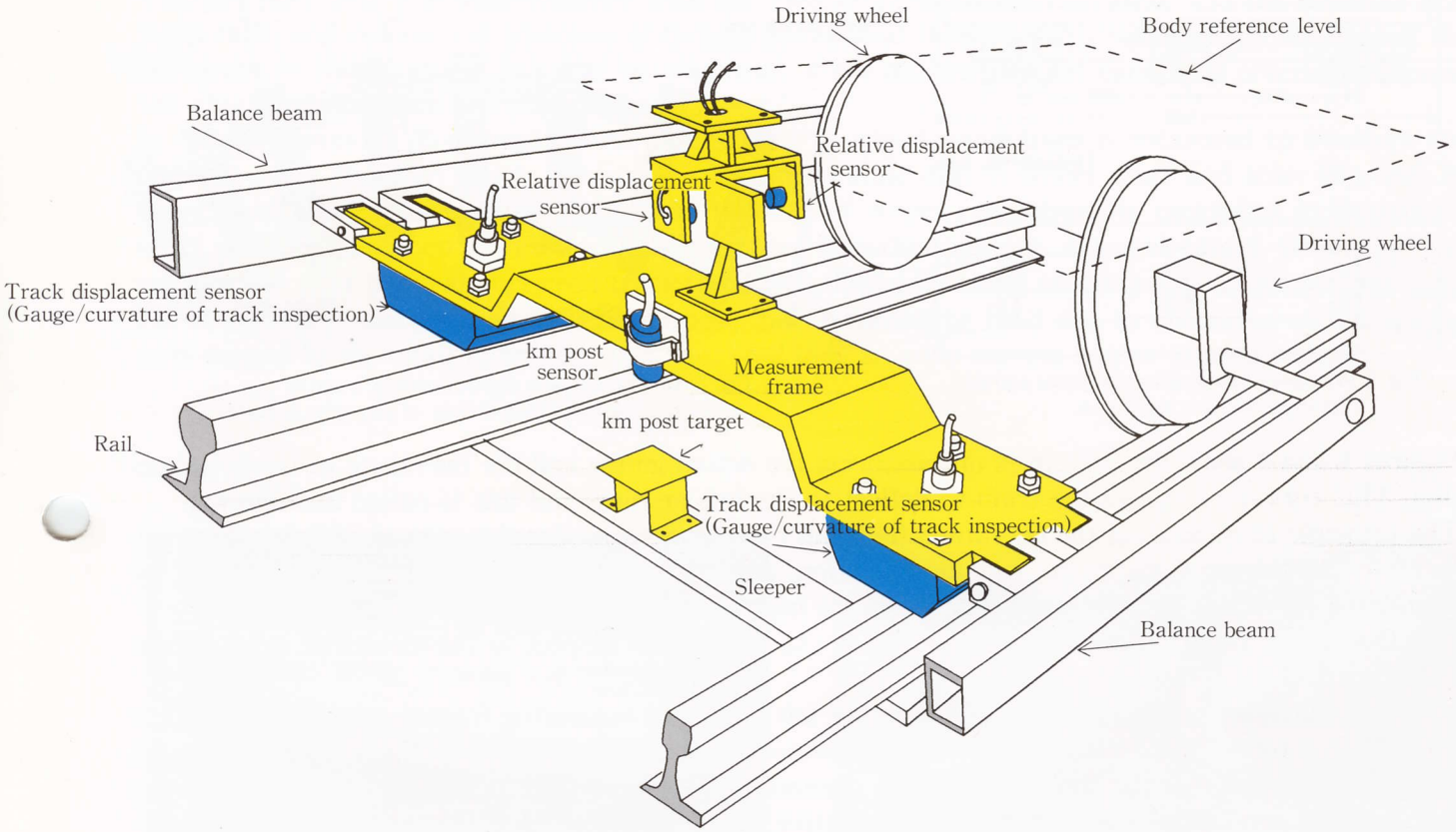
Eddy-current non-contact displacement sensors (RIVERNEW) have been used successfully in all-weather, high-speed track measuring systems on the Shinkansen Line for the past 10 years and have fulfilled their roles as vital sensors which ensure the safety of tracks in Japan.
This bulletin introduces a few examples of the RIVERNEW system used on the Shinkansen Line.
The Shinkansen Line must be maintained safely and provide a comfortable, high speed ride, but it is nevertheless a mass transportation means and must be operated and controlled day and night without a break.
The Shinkansen electric track total test train called Doctor Yellow has an orange body with stripes and blue skirts below the windows and is used to detect the status of the track and electric/signal facilities while running at a speed of 210km/h.
The RIVERNEW system is installed on this test train to check the status of each track and to conduct various measurements at each running point.
Each sensor is installed below the car body and conducts various measurements without contacting the measured object, maintaining perfect performance even when exposed to rain, snow and changes in the ambient temperature.
Data measured under such conditions are simultaneously collected and used to issue instructions on track maintenance and also to calculate the control schedule via a large computer installed on the ground called the SMIS Shinkansen Management Information System.

Shinkansen electric track total test train consisting of 7 cars
(The RIVERNEW system installed on the 5th car)

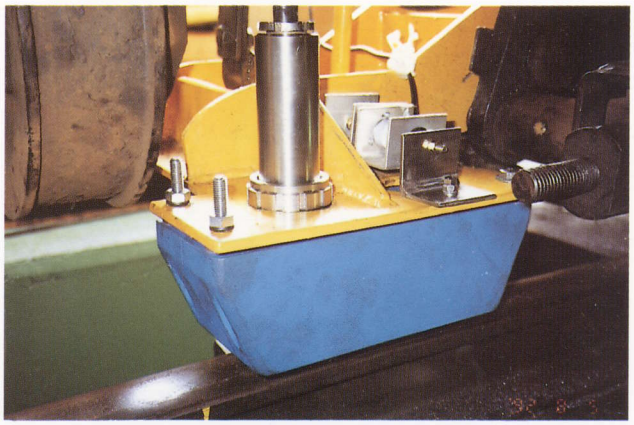


Front view of Shinkansen electric track total test train.

Arrangement of eddy-current track analyzer



The above figure shows the arrangement of the eddy-current high-speed track analyzer. As shown in the figure, the track analyzer consists of track displacement sensors which detect the gauge and the curvature of track inspection, relative displacement sensors which measure the amount of movement between the body and platform car and a km post sensor which detects the points.



Eddy-current Track displacement sensor

Eddy-current km post sensor

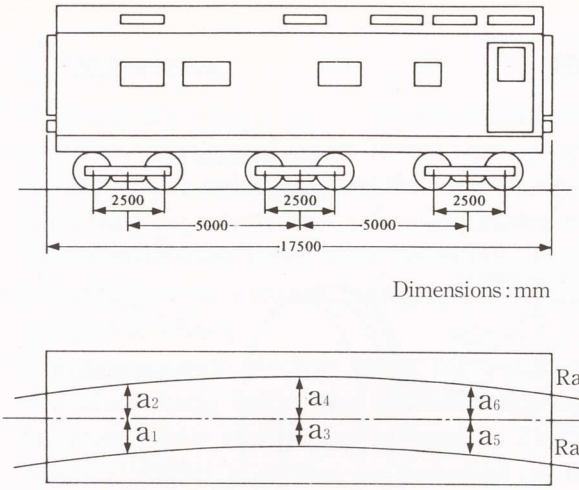


Fig. 1 Principle of measuring the gauge and the curvature of track inspection

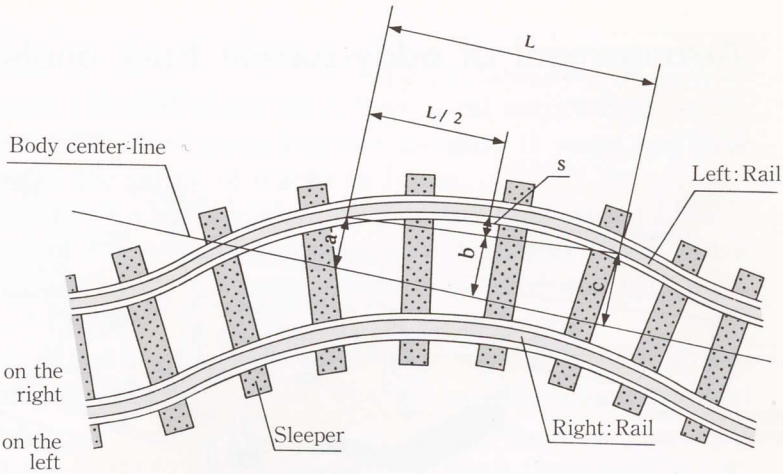
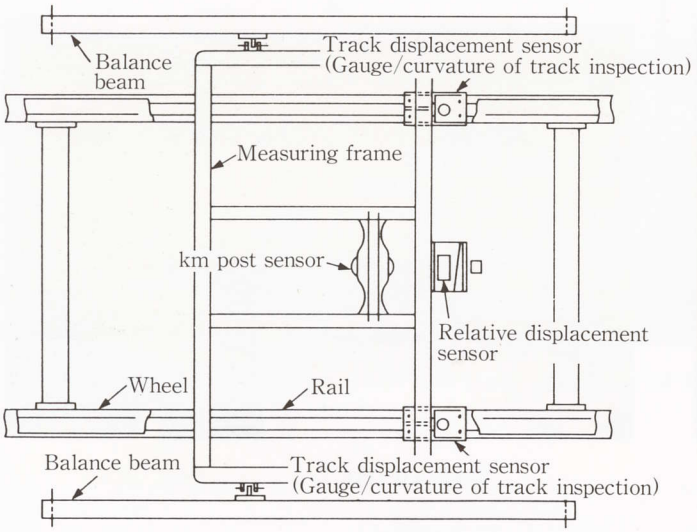
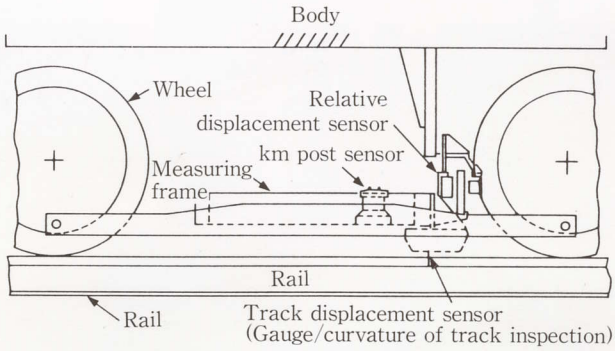
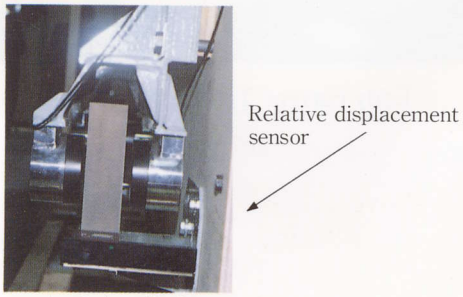


Fig. 2 Amount of track displacement (a, b and c)
(L : Length of chord Height of arc : s=b−(a+c)/2)

Figures 1 and 2 show the principles of measuring the actual gauge and the curvature of track inspection. This curvature causes the train to deflect to the left or right and this is called meandering.
The principle of measuring the curvature (left and right) is to measure the amount of track displacement to the left or right in the running direction, and therefore the curvature can be obtained by measuring the track displacement relative to the body as the reference.
The theoretical equation can be expressed by b−(a+c)/2 with respect to the measured value shown in Figure 2.
Track displacement sensors are installed on the left and right measuring frames on the platform car (3 each, 6 in total) and 3 relative displacement sensor are installed on the body. Each relative displacement sensor measures the amount of track displacement between the body and measuring frames and thus the amount of track displacement relative to the body can be calculated.
The gauge can be obtained by calculating the amount of track displacement to the left or right of the center platform car used for measuring the curvature and the result of the calculation is output as a deviation from the distance set in the sensor.
The figures below show the arrangement of the track displacement analyzer viewed from the top and side.

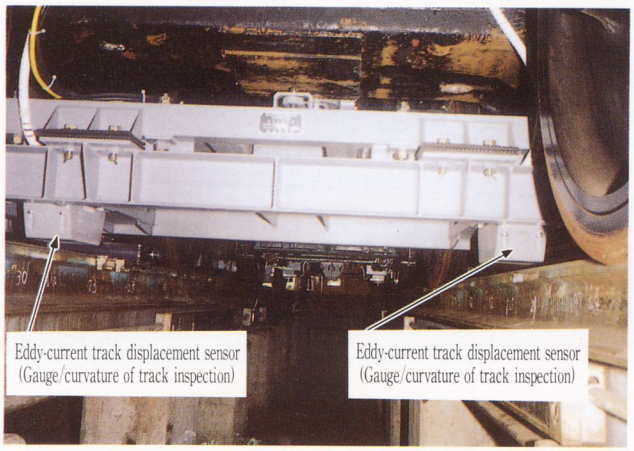


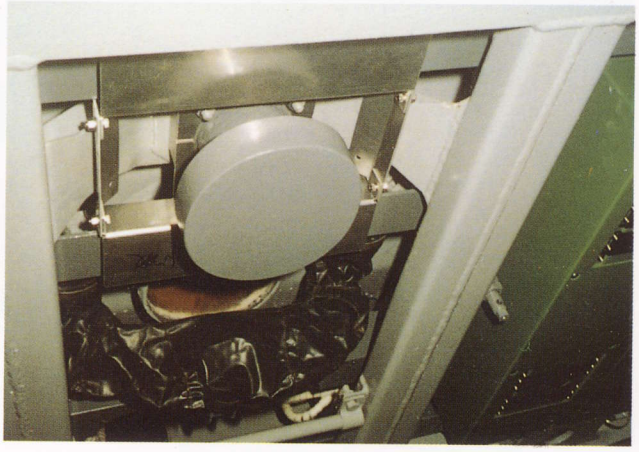




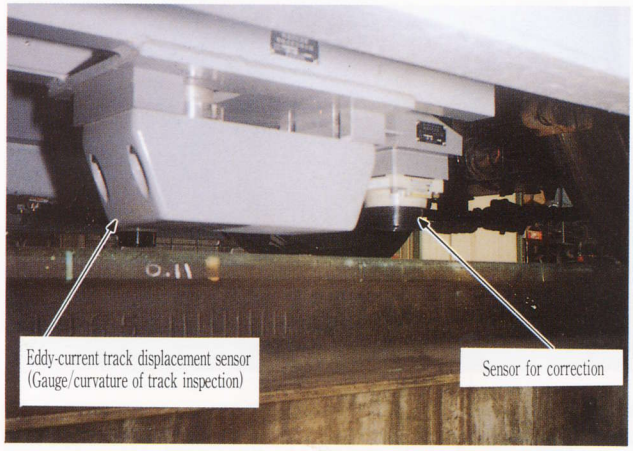
Arrangement of relative displacement sensor

The track displacement and relative displacement sensors are as described on the previous page. This section describes the km post sensor.
The km post sensor is used together with the measurement of the curvature and the distance between rails, and detects the presence of targets installed at 1km intervals between tracks. Even if the curvature or the gauges is found to be abnormal, if the abnormal point cannot be precisely pinpointed, track maintenance becomes difficult.
In order to pinpoint abnormal points, the number of wheel revolutions is measured to measure the distance from the start point, but errors may accumulate due to wheel wear and tear, slip, etc. In order to greatly reduce these errors, the number of wheel revolutions is measured in extremely short sections and then is reset for each section. For this purpose, a metal target (iron plate) is installed at 1km intervals between tracks and is detected by using an eddy-current sensor. An optical sensor may also be used for this purpose, but it cannot be used due to obscuring of the optical axis caused by snowfall in winter, dust, etc., and thus an eddy-current sensor is used instead.





Eddy-current km post sensor



Japan track test car

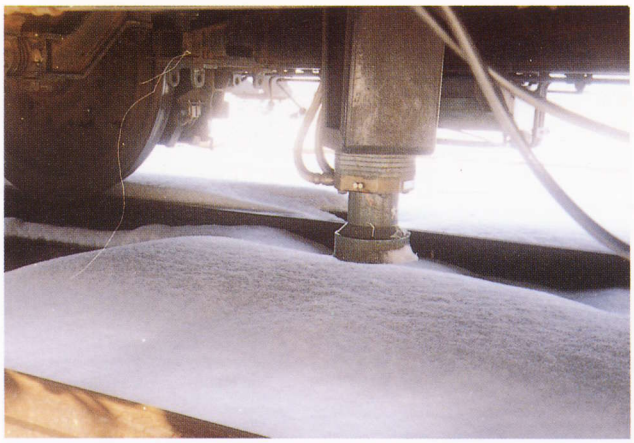
km post target

The above pictures show the km post sensor, track displacement sensors and their related equipment actually installed in the track analyzer.

The eddy-current sensor is used for several reasons. Optical measuring devices, which measure the curvature and the gauges without touching them, have been used to facilitate measurement at high speed. The static accuracy of optical devices is very high and such devices are generally effective for track maintenance and control.
However, when trains run where snowfall is expected in winter such as the Tohoku or Joetsu Lines, protection of the optical system at high speed is limited due to whirling up of snow or ice caused by train motion or contamination caused by rain even without snowfall.
(See the pictures below.)
On the contrary, an eddy-current sensor offers the same performance as the optical sensor, while its economy of maintenance is far superior because of its unrivalled snow-proof characteristics, all weather suitability and high durability.

JR Track Inspector (RFD car)
for JR Tohoku Shinkansen

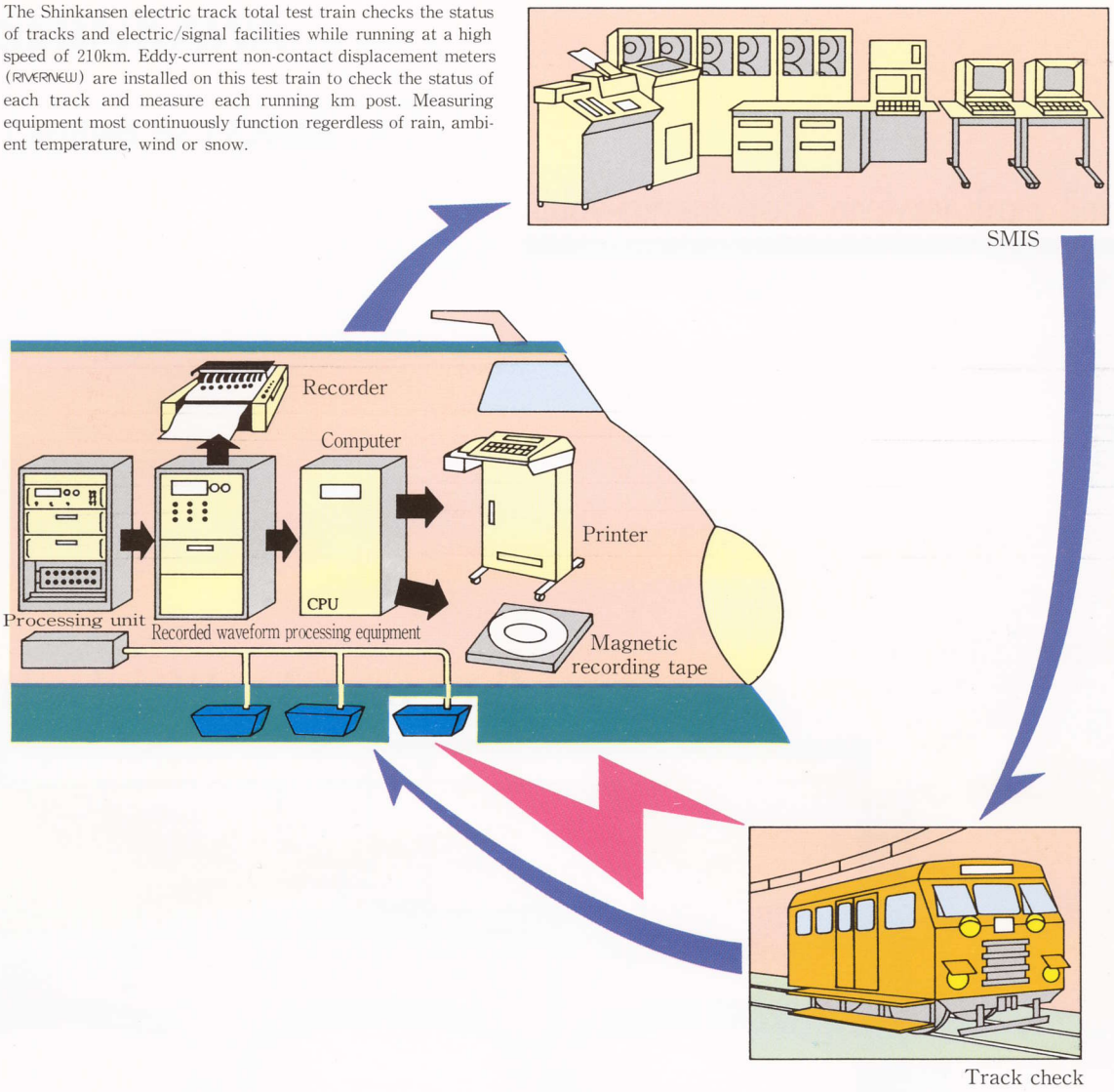
Status of track displacement sensor when frozen



Eddy-current km post sensor

Status when optical type detecting equipment cannot be used because it is covered with snow (left side) and eddy-current sensor which functions normally even if covered with snow.

The Shinkansen electric track total test train checks the status of tracks and electric/signal facilities while running at a high speed of 210km. Eddy-current non-contact displacement meters (RIVERNEW) are installed on this test train to check the status of each track and measure each running km post. Measuring equipment most continuously function regerdless of rain, ambient temperature, wind or snow.



Measured data is simultaneously collected during measurement and processed by a large computer installed on the ground. For this processing, the data which is measured by detecting km posts at 1km intervals is accurately matched with the track position. The test train consists of a variety of electronic equipment and sophisticated mechatronics suitable for advanced track inspection.

Reference:
Data and related data on:
Ex-Japan National Railways Railway Engineering Research Institute
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Writers: (K. Takeuchi, T. Kishimoto, Y. Shirota)

Sales company

SHINKAWA Electric Co., Ltd.

Tokyo Head Office 3rd Fl, Shin-kojimachi Bldg., 3-3 Kojimachi 4-chome,Chiyoda-ku, Tokyo 102 Japan
PHONE(03)3263-4411 FAX(03)3262-2171 TELEX232-4695 SHINKA J

Hiroshima Head Office 10-9 Mikawa-cho, Naka-ku, Hiroshima-shi, Hiroshima 730 Japan
PHONE(082)247-4211 FAX(082)249-6438

Branch Office:
Kanto, Sendai, Mito, Ichihara, Yokohama, Chubu, Kansai, Senboku, Wakayama, Shinki, Takamatsu
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Germany, Belgium, Korea, taiwan, R.O.C., India, Singapore, United States, China, Indonesia, Malaysia, Sweden

Manufacturing company

SHINKAWA Sensor Technology, Inc.

Tokyo Head Office 3rd Fl, Shin-kojimachi Bldg., 3-3 Kojimachi 4-chome, Chiyoda-ku, Tokyo 102 Japan
PHONE(03)3263-4517 FAX(03)3262-2171

Hiroshima Factory 5677 Oaza-yoshikawa, Hachihonmatsu-cho, Higashi-Hiroshima-shi, Hiroshima 739-01 Japan
PHONE(0824)29-1118 FAX(0824)29-0804

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