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## **A Moving Work Space - Comfort in the Driver's Cab -**

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In designing train cars, the first priority is given to ensuring comfortableness and safety for passengers. Comfortableness is indispensable also for drivers. A comfortable cab allows the driver to operate equipment and perform other duties correctly to ensure safe train operation; it is a space that causes little physical and psychological fatigue to him or her. In view of this important fact, a design team takes charge of cab design from its earliest stage on, to examine cab space from the angle of human engineering.

### ○ Human Body Dimensions

Human body dimensions represent the basic information for cab design. In most foreign-made vehicles, 95 percentiles\* for men and five percentiles for women are used as references for design, to ensure that drivers can comfortably work in their cab regardless of variations in their height. (For instance, 95 percentiles for men correspond to 1905 mm and 5 percentiles for women to 1540 mm according to the U.S. standard.) As human body dimensions vary according to ethnicity and age, cab designers use data collected in the region for which the design is intended, whenever such data are available.

Human body dimensions, thus determined, cannot be used for design without any modifications; in using them, necessary margins must be provided to various parts. In some cases, the human body proves to be more adaptable than originally expected, making such margins unnecessary. However, there are also some factors, such as seat height, which must be adjusted to optimize the distance between the part in question and other equipment. Sometimes, a life-sized mock-up is manufactured to check a prototype incorporating such considerations. Use of a mock-up, in addition to the check of dimensions on a drawing, contributes greatly to reflecting feedbacks from actual users in a design process. The manufacture of mock-ups is obligated for the design of some cab parts.

### ○ Visibility

The visibility of the forward visual field, as well as that of the equipment console, is important for a driver. Especially, the forward visual field is a critical element in cab design. Regarding the visual field, there are some requirements to be met. First, the driver must be able to recognize signals in front correctly. Secondly, the driver must also be able to check for obstructions and moving objects ahead of him or her, and notice necessary signals and

equipment when the train is at rest. Simulation using 3D data has made it possible for designers to check design features related to the forward visual field more accurately than in the past, when the check was based only on drawings.

During work, the driver's attention is focused mostly on the frontal view. A console may not be designed in such a manner that it obstructs the driver physically or psychologically in watching this view. Also, the driver must be able to recognize and operate each part of equipment quickly and with few eye movements. A widely used method to satisfy these conditions is to classify switches and indicator lamps into clusters, or color-code them according to the degree of importance. Signs are composed not only of characters, but of pictograms that enable the instantaneous recognition of the function of some equipment part. In some vehicles, only pictograms are used for cab signs.

In many cases, a cab has windows on its three sides. Therefore, a designer must consider the use of a sunshade or an appropriate wall color to avoid reflection or glare that may prove a hindrance for the driver.

### ○ Equipment Operability

The masscon is the main tool in a vehicle for power running and braking. It is designed for operation by either the right hand or the left hand, depending on the conventional practice at a railway company, the need to collect rail fare etc. Some vehicles are switched to the power running mode by pushing the masscon forward, and others by pulling it backward. Regardless of the vehicle type, a designer must take due care to ensure that the driver can effect power running and braking in his or her natural posture. Masscons are also classified into the electric type (including the joystick and slide lever types) that requires relatively small body movements, and the gear type linked to a key or front and back levers. There is a significant difference in operability between these types. In designing a masscon, data on the driver posture during operation are used to examine the required operating force and the quality of clicking at particular positions.

In most vehicles, the driver operates the masscon in a sitting posture. Accordingly, the positional relationship between the seat and the masscon represents an important factor for the study of operability. Also, the seat position is related to the above-mentioned requirements on the field of frontal vision. Due considerations must be made to maximize operability while satisfying these various

conditions.

Equipment parts on the console are operated mainly by the hand that is not occupied with masscon operation. Therefore, the driver must be able to operate almost all parts of the console correctly by this one hand. All switches and controllers on the console are critical for train operation. They include controllers for emergency brakes and wipers; switches for front lamps and the broadcasting system; switches for manual door opening/closing; and monitors and indicator lamps that show current equipment operation conditions. On the other hand, there are natural differences among the switches and controllers in the frequency and importance of operation. Accordingly, they are arranged so as to ensure that the driver can operate a necessary part in a required timing in a natural posture, by taking operation condition and the characteristics of human movements into account.

#### ○ Comfortableness of Work Space

In many cases, it is difficult to allot a large space to a conductor's room or a cab. A general practice is to maximize the areas for compartments and other spaces for passengers. Other conditions also contribute to limiting the cab space to a bare minimum, including the need to install many pieces of equipment and, in case of a vehicle designed for coupling, provide a space for gangway. Under these conditions, equipment units must be laid out appropriately by determining the space necessary for the driver's work.

Safety is an essential element of a comfortable cab. Without safety, a space agreeable for the driver cannot be created. Some foreign-made vehicles have such safety features as a safety zone that prevents the cab from suffering an extensive damage in the event of a crash, and a safety pillar that protects the driver against a possible crash.

To design the cab as a work space friendly for the driver, more features should be developed that are aimed at removing physical and psychological obstacles for his or her work. Such features include a seat that does not cause fatigue to the driver even after many hours of work in a sitting posture; an air conditioner that keeps the room temperature at an optimal level; and an appropriate aesthetic design of the cab interior.

We continue to make positive proposals to improve the design of work space for the driver, and develop cab designs that offer ever more comfort.

\* "Percentile" is a technical term used in statistics. It refers to a value assigned to some datum, which belongs to a group of ordered data. A percentile is related to a particular percentage, which represents the proportion of a sub-group consisting of data that are lower in order than the above-mentioned datum.