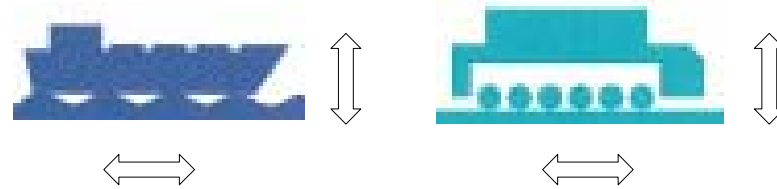


Influence of Mechanical Vibration in Transport on Leak-tightness of Metal Gasket in Transport/Storage Cask for SNF

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Takeda^a, M. Wataru^a, K. Namba^b
^a CRIEPI, ^b Dokon**

Background

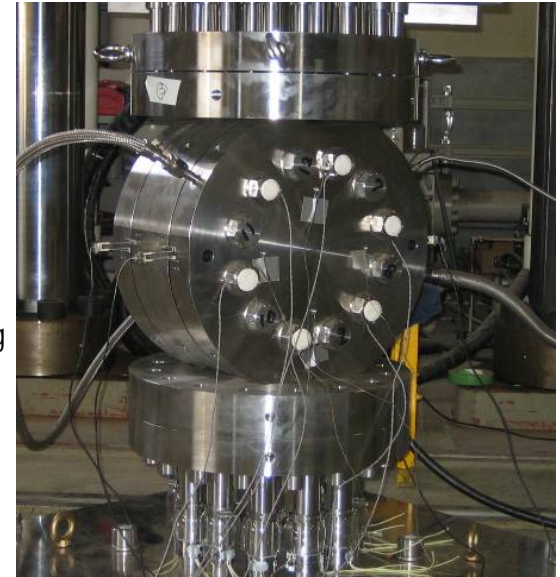
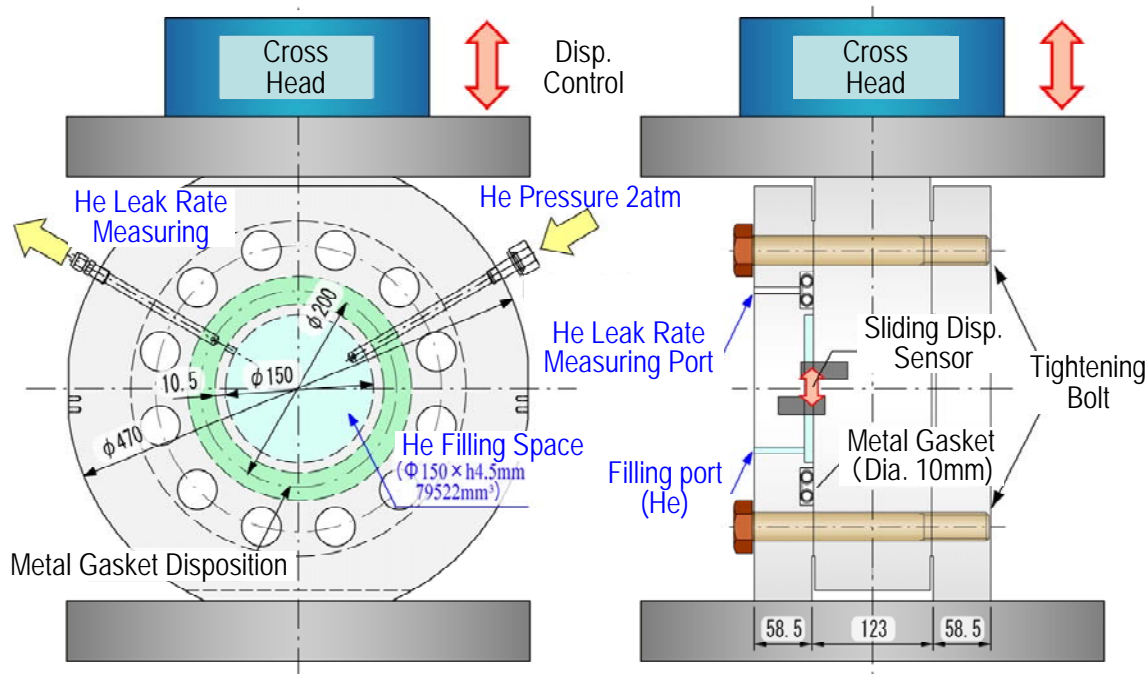


- Transport casks receive mechanical vibration in transport. The containment performance of metal gaskets is influenced by large external load or displacement .
- Quantitative influence of such vibration in transport on the containment performance of the metal gasket has not been known, but is crucial information particularly if the cask is stored as it is after the transport.

Purpose

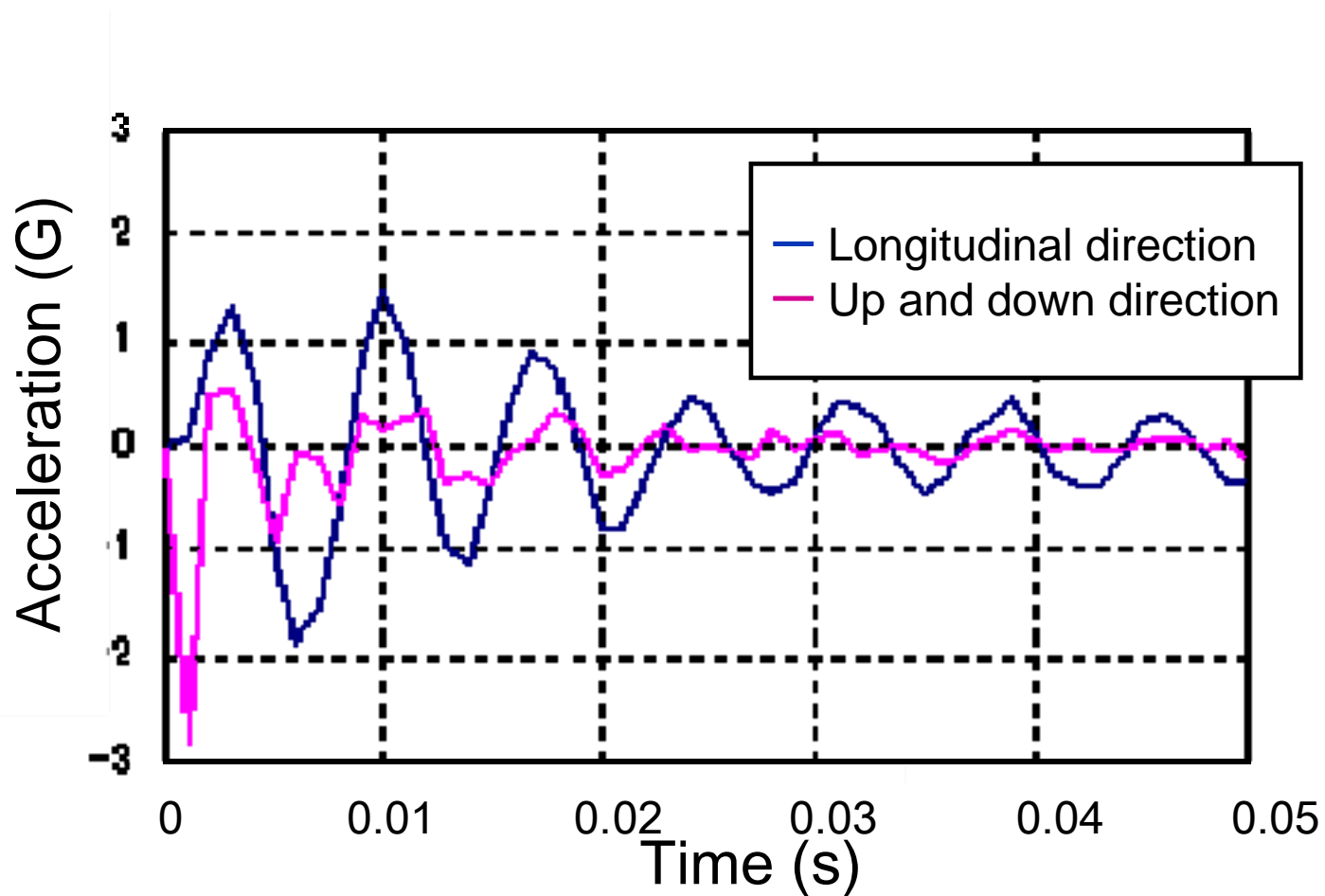
To quantify influence of mechanical vibration in transport of transport/storage cask with metal gasket on the performance in storage.

Experimental Apparatus and Specimen



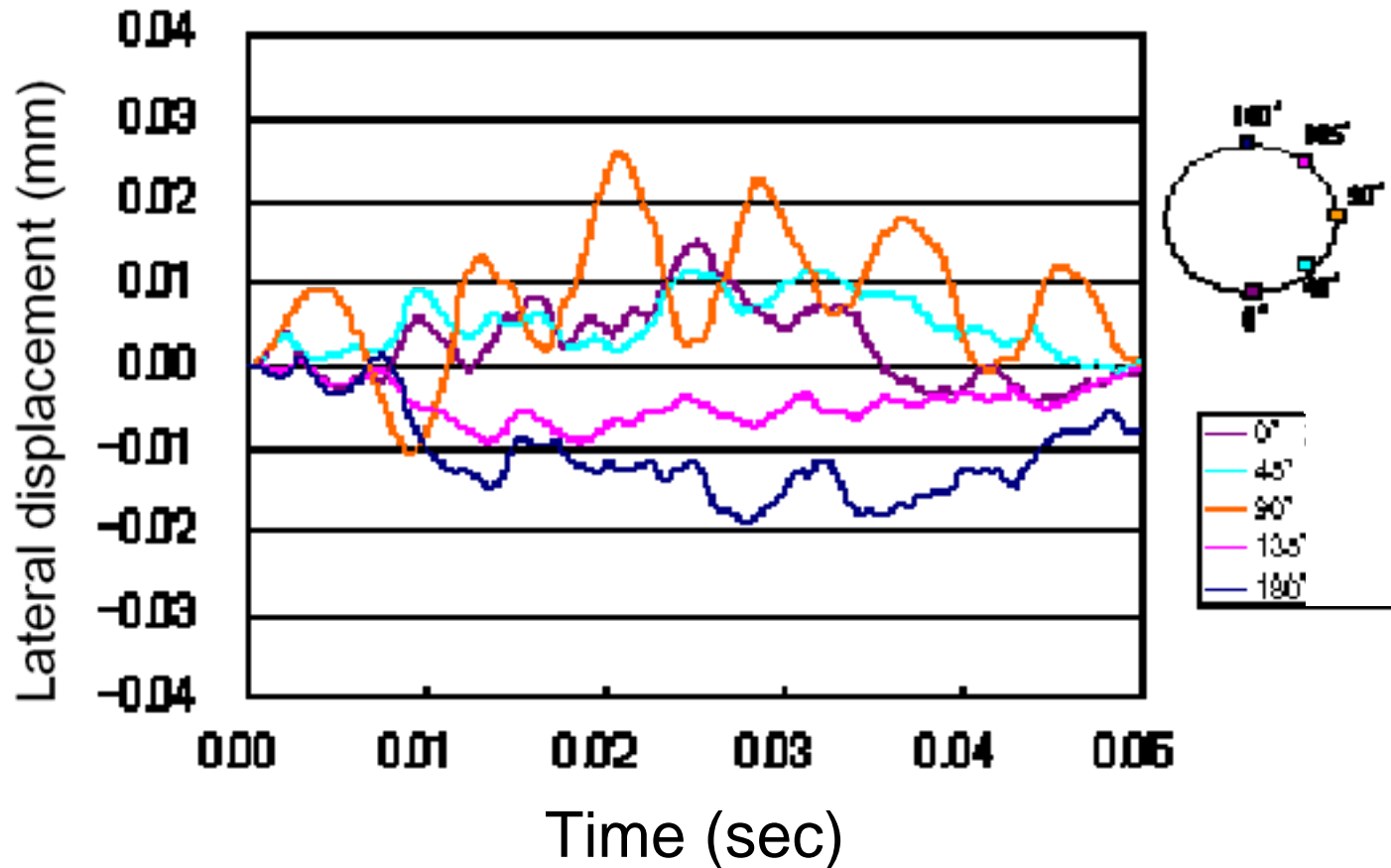
Scale (1/10, 470 ϕ) model of a lid structure of metal cask with a metal gasket with diameter of 10 mm coated with Al. The specimen gasket was thermally aged at 180 °C for 20h simulating thermal history in transport before storage.

Time history of acceleration measured at a trunnion support of a cask transport frame in a sea transport

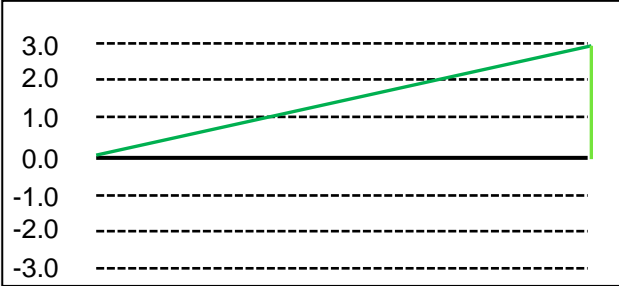
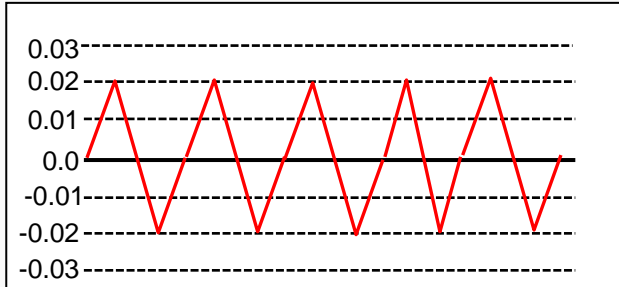
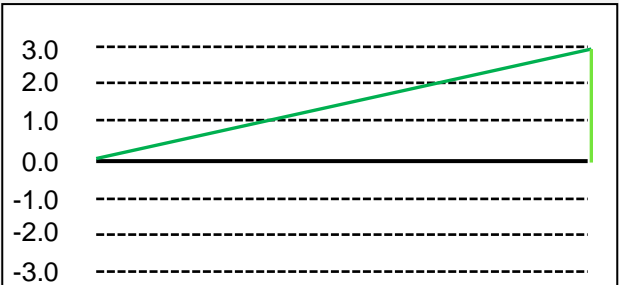


Calculated Time History of Lateral Sliding of Lid in Transport/Storage Metal Cask for Spent Fuel

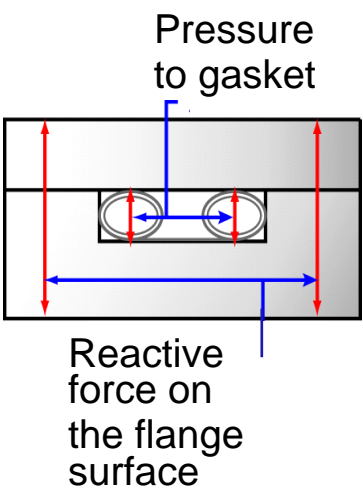
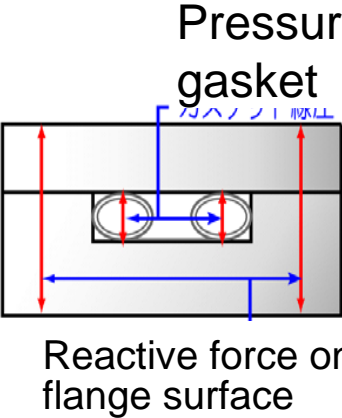
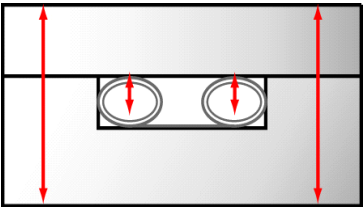
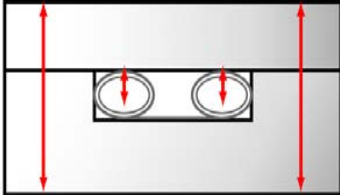
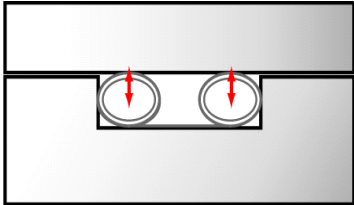
Cyclic displacement of $\pm 0.02\text{mm}$ was assumed for vibration during sea transport.



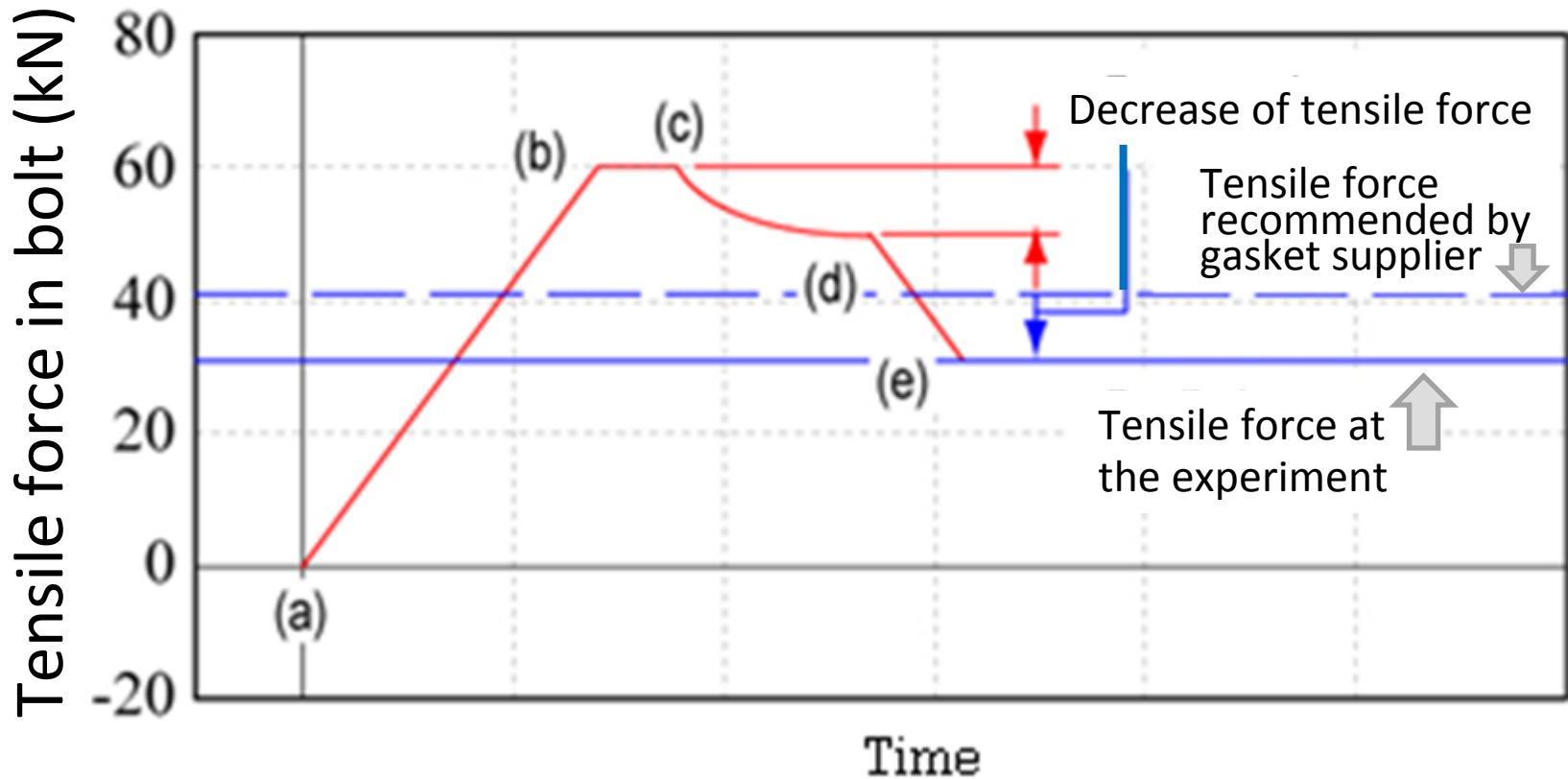
Experimental Conditions

Conditions	Displacement	Speed	Pattern of given displacement
Static and one-directional loading	3mm	0.01m/s	 <p>A line graph with a vertical axis ranging from -3.0 to 3.0 in increments of 1.0. A solid green line starts at the origin (0,0) and increases linearly to a value of 3.0. The line is plotted against a background of horizontal dashed grid lines.</p>
Cyclic loading	± 0.02 mm	0.01m/s	 <p>A line graph with a vertical axis ranging from -0.03 to 0.03 in increments of 0.01. A solid red line forms a periodic triangular wave pattern, oscillating between a maximum value of 0.02 and a minimum value of -0.02. The line is plotted against a background of horizontal dashed grid lines.</p>
Dynamic, one-directional loading	3mm	85mm/s	 <p>A line graph with a vertical axis ranging from -3.0 to 3.0 in increments of 1.0. A solid green line starts at the origin (0,0) and increases linearly to a value of 3.0. The line is plotted against a background of horizontal dashed grid lines.</p>

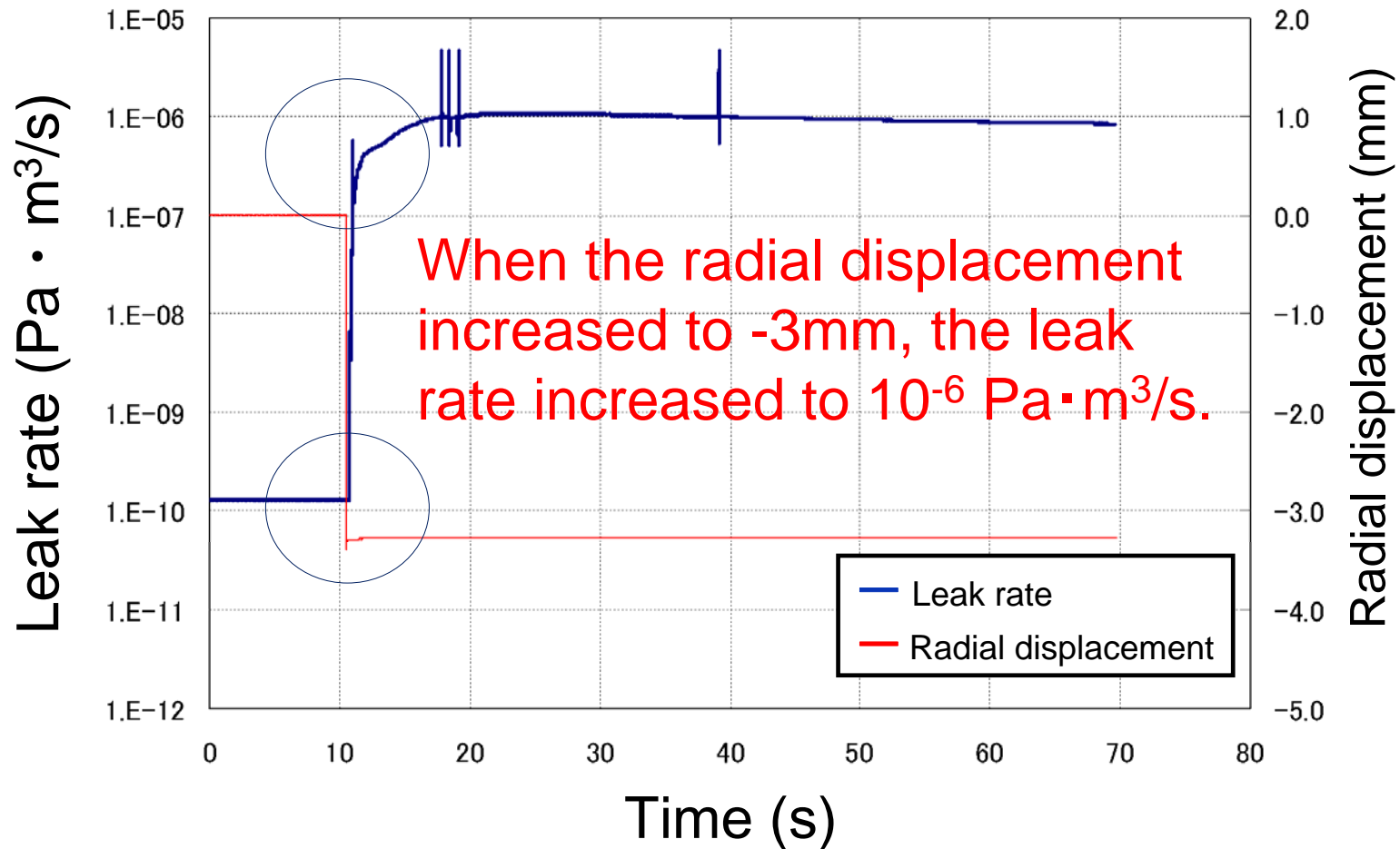
Status of Containment Boundary of Real Cask and Experimental Model

Real Cask Lid Structure	Experimental Model of Cask Lid Structure
<p>Status when SF has been installed and lid has been bolted.</p> 	<p>During Heating</p> 
<p>During cask transportation</p> 	<p>After Heating</p>  <p>Reduced pressure to gasket</p> <p>During Experiment</p>  <p>Flange contact released</p>

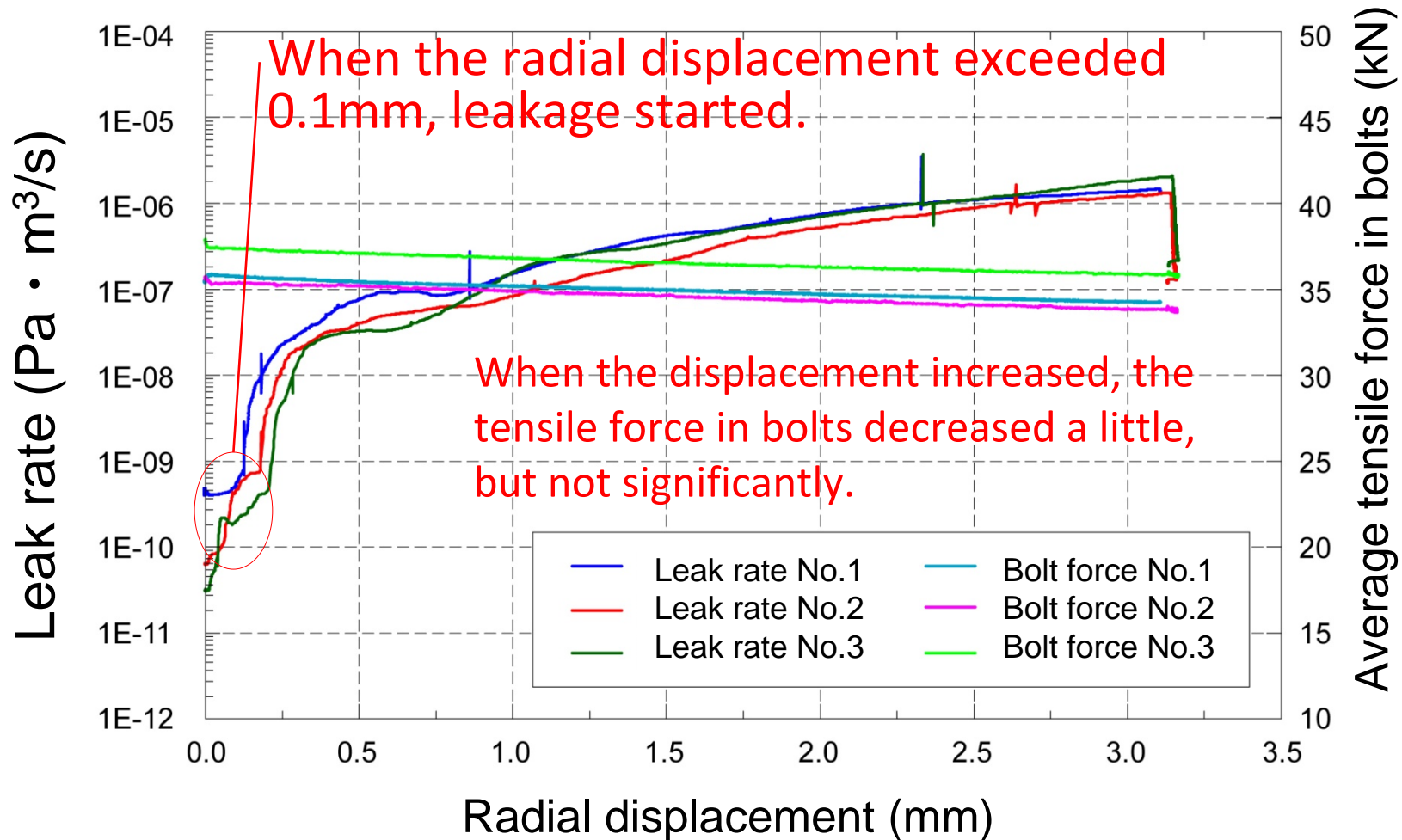
Change of Tensile Force in Bolts with Elapsed Time



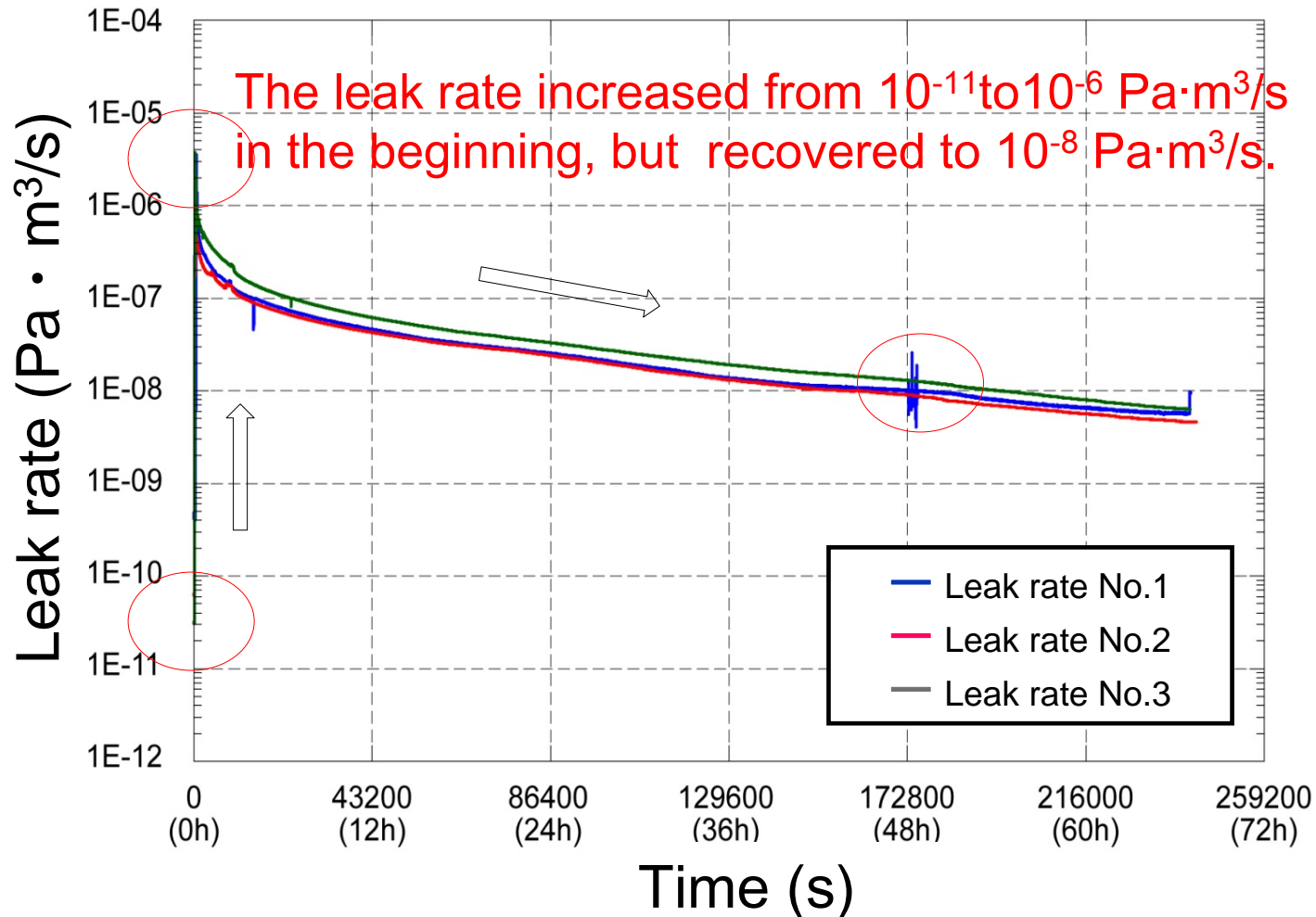
Leak Rate and Radial Displacement as a Function of Time



Leak Rate as a Function of Radial Displacement under Static Loading

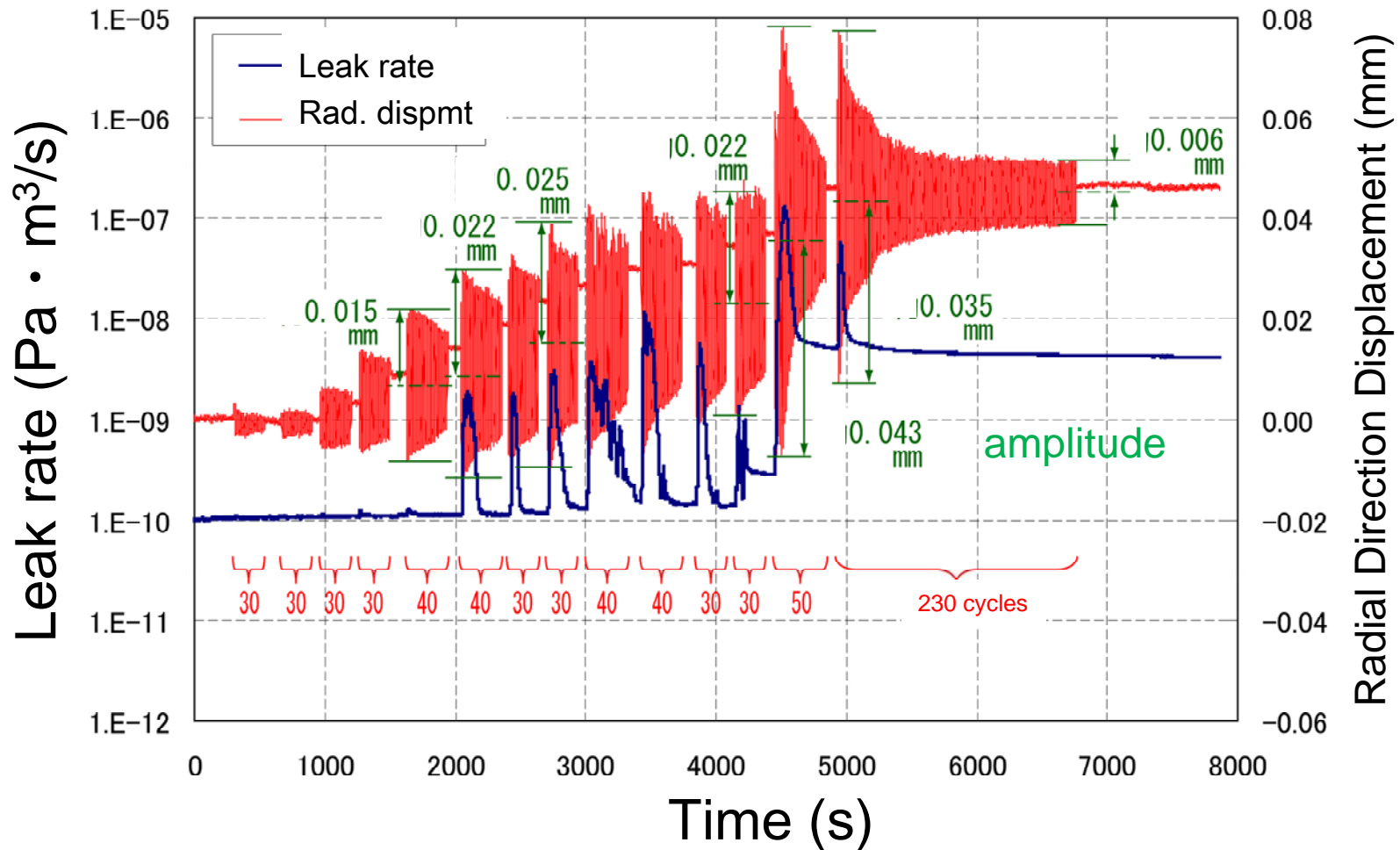


Leak Rate with Time Under Static and One-directional Displacement Loading

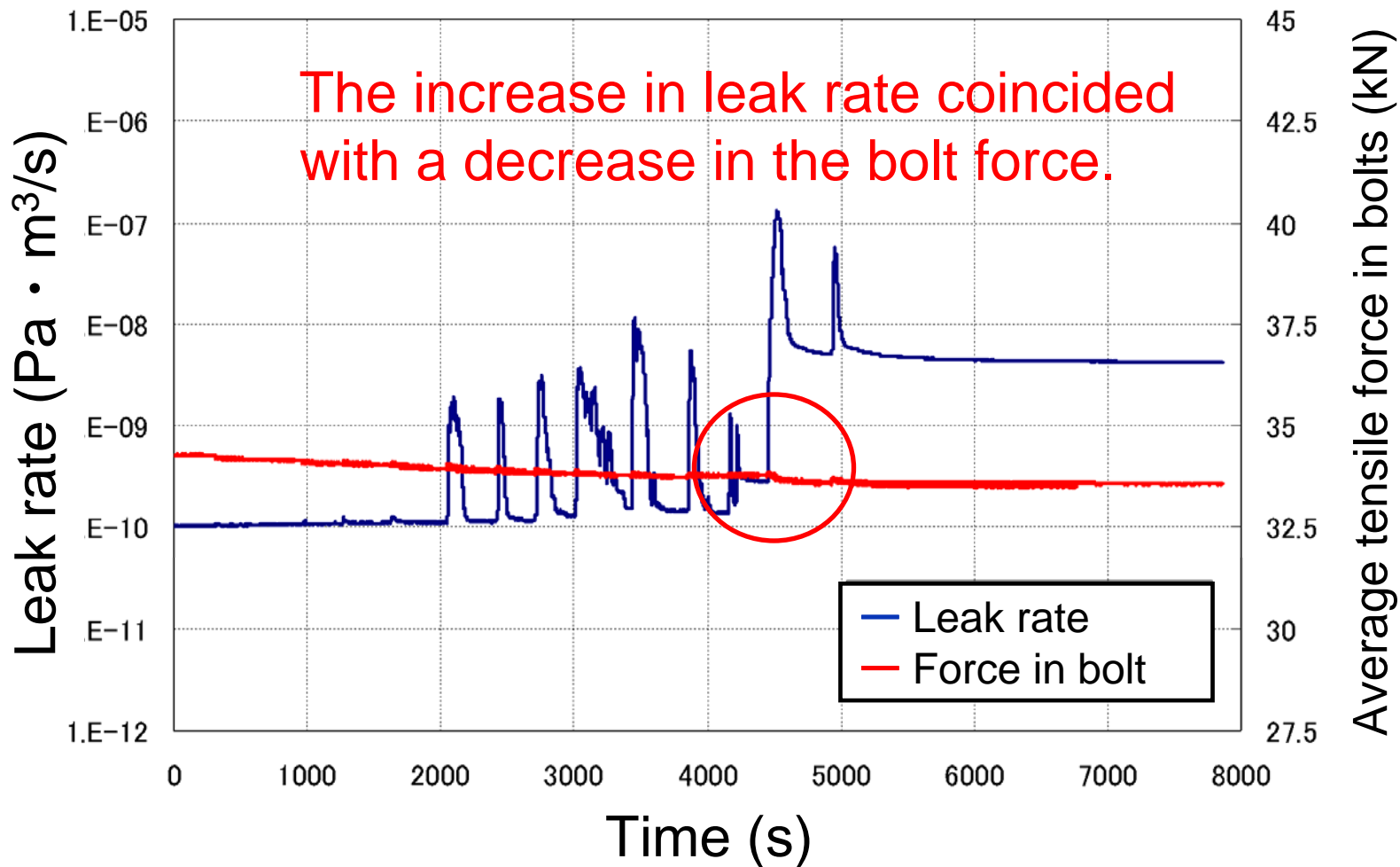


Measurements of Leak Rate and Radial Displacement with Time under Cyclic Loading

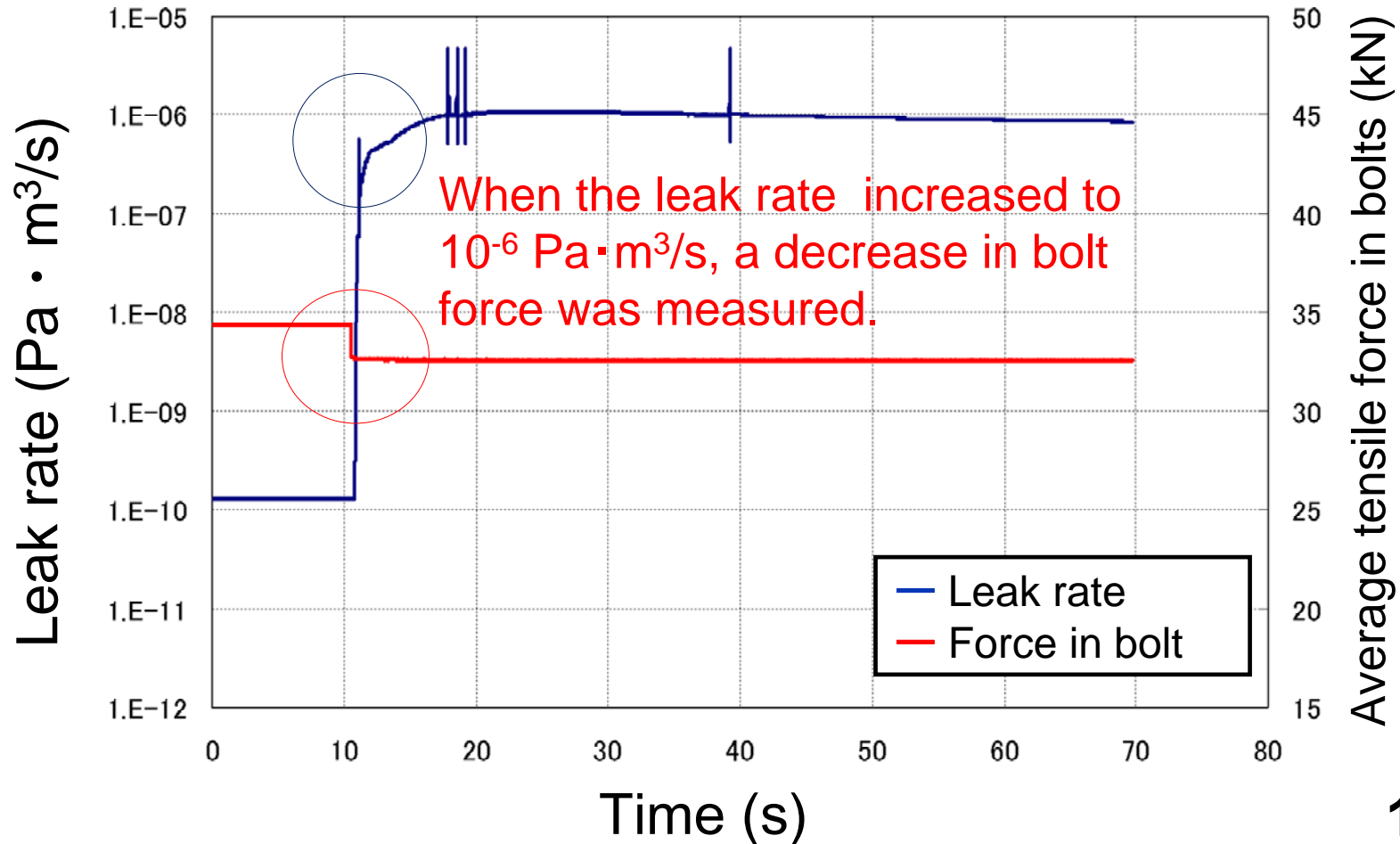
If the amplitude exceeded 0.02mm, the leak rate did not recover.



Measurements of Leak Rate and Average Axial Bolts Force with Time under Cyclic Loading



Leak Rate and Average Bolt Force as a Function of Time



Conclusion

1. Mechanical vibration in transport would influence the containment performance of the metal gasket for storage if the amount of sliding exceeded a threshold value.
2. The threshold values in the model were:
0.1~3 mm of static displacement, or
 ± 0.02 mm of cyclic displacement.