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# The Survey of Case Studies About The Noise Exposures Exposed By Ships' Engine Rooms' Employees in The Scope of The Regulation on The Protection of Risks to Noise Exposures for Employees

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**Abstract:**

In the seas and inland waters covering two-thirds of the world's surface, various types of goods and commodities subject to global trade are carried by sea. The convenience provided for commercial activities conducted worldwide, security, price advantages, etc. sea transportation is preferred for many reasons. The ability of ships, which are the means of transporting goods and suits to be the subject of maritime transport, to fulfill their duties can only be achieved by fulfilling the duties of the seafarers which are an exact part of them. Parallel to the increase in the importance given to human health in recent years, the protection of the health of employees is the main principle in working life. With the effect of legal legislation on this issue [1], safety and health at work practices related to the protection of the health of the individual actively guide the working life as one of the main considerations in all aspects of working life. In this scope; it is determined by the measurements made in the case studies in the framework of the regulations on the protection of the employees from the risks related to the noise exposures [2] exposed in the engine rooms of the ships where the ships which are the basic element of sea trade in the maritime industry are made to supply power for the transfer from one point to another, measures to be taken in terms of protection of health have been tried to be put forward.

**Keywords:** Maritime, Occupational health and safety, Ship, Machinery, Noise Exposure.

## INTRODUCTION

The commodities subject to global trade are transported mostly by maritime transport in seas and inland waters covering two thirds of the world's surface area. Maritime transportation is preferred for many reasons such as the convenience, security, price advantages, etc. provided for commercial activities conducted worldwide. Despite all weather and marine conditions, it is expected that goods and commodities which are carried by the ships should reach their targets without being damaged at the desired time. The fulfillment of this duty by the vessels, which are the main means in the realization of maritime trade, is possible by fulfilling the duties of the seafarers, which are the integral part of these vessels and the essential element in the operation of these vessels. The increase in the importance given to human health in the recent years has been the main principle in the working life of the protection of the health of the employees. With the effect of legal legislation on this issue, occupational health and safety practices related to the protection of the health of the individual actively guide the working life as one of the main considerations in all aspects of working life [3].

Unlike a workplace in the land, workers in the maritime industry are continuing their lives in the workplace where they work. After completing the period of daily work, they are continuing their lives in another part of their workplace until they go back to work. Depending on the seafarers'contract length, type of sea vessel and the burden that the ship carries, this period can continue for weeks or even months without landing on the ground. People working on the ship, due to the differences according to the working environment on a land workplace risk exposure should correctly measured and analyzed in their working environment will have an important contribution to occupational health and security of seafarers.

In this study, maritime trade of the basic elements of the vessels that produce the power required for referral to another from one point, the media spread their noise pollution during operation of the ships engine room running machine measurements have been made. With these measurements, the amount of noise the workers are exposed to in the machine room of the vessels is determined, and the legislative suitability of this noise amount is determined by sampling method and measures to be taken in terms of protecting the health of the employees will be tried to be put forward.

The noise, one of the risks threatening the health of employees in maritime workplaces, arises in the machinery spaces where the most power production systems exist on ships. Navigation has vacated the ship of the needed power generation for the dispatch of a seamless control of machine systems for more, care, and place the ones working in the engine room during the repair of the incoming fault the staff has been working in the machine running during operation. At this time, employees are exposed to noise that can affect their hearing and mental health by working in the place where they are exposed to high levels of noise caused by machines in the environment. In this study, the noise levels of ship

machinery, which are the biggest sources of noise pollution, are measured and the determined values are examined in the framework of the regulation published in accordance with the principles of Occupational Health and Safety Law and will contribute on behalf of occupational health and safety directions by showing the measures to be taken in order to protect the health of employees aimed to put forward a study.

The study of the risk factors of employees in the maritime sector is a study of the health of workers in the maritime sector, since maritime employees are less well-known, unobserved, and less researched than other occupations work will be beneficial.

## MATERIALS and METHODS

This study was carried out on 7 ships in the ports of Mersin and İzmir cities or which on sail to the seas in order to intentionally navigate from these ports. The main element of the work is the exposure of the ships' crew members working in the engine rooms to the noise generated by the diesel engines of different strengths in these spaces. This study was carried out by using the values obtained from the measurements made in the machine rooms, which are closed spaces.

During the measurement, it is intended that the dosimetry be replaced in the machine room, while being mounted on the worker, so that it is measured in the same way as the noise of the shipman working in this area during normal working conditions. Employees are required to follow routines they normally operate within the machinery spaces and to carry out routine activities.

Dosimeters are sound level meters designed to fit on staff and you can measure noise exposure during a full working day or part of a day. Dosimeters are used in situations (for example, someone other than the employee can not be found in the environment) where the measurement is too complicated to be performed with the sound level meter or when the employee is very mobile.

The use of a dosimeter to avoid deceptive consequences due to inaccurate measurements may be more robust than the sound measurement. Some dosimeters record the noise level at certain intervals during measurement. This record helps in identifying the contribution of different sources or jobs to the noise and in the elimination of deceptive consequences. The use of the dosimeter is subject to the provisions of the regulation.

In the noise measurement studies, a DC 112 model personal noise measurement dosimeter of Spain-based Cesva instruments S.L.U was used which meets the requirements of EN 61252, IEC 61252, EN 61260, IEC 61260, EN 60804, EN 60651 and 2003/10 / CE [4].

During the measurements;

- To avoid interference between the noise source and the device,
- To avoid humidity, dust on the device and microphone,
- A device having a full battery level,
- In order not to be tampered by the shipworker which carried the device,
- Do not expose the device and its microphone to any physical impact

has been ensured.

First of all, noise measurements to be made in accordance with the provisions of the Regulation on protecting employees from risks related to noise should be made in accordance with the TS 2607 ISO 1999 standards indicated in the regulation.

During this study, Cesva DC 112, which is the personal noise measuring device we use for measuring noise, is a device according to IEC 60804 criterion which is required in the section where device qualifications of TS 2607 ISO 1999 standard are described.

Various sources related to the measurement period have tried to measure during the time of the vessel man, although there are no compulsory provisions for this, although different durations, usually between 4 and 12 minutes, are specified. When working duration of the workers exceeded 8 hours per day because of unexpected conditions during measurements, the measurements done till to the end of the shift. During this study as a measurement method; the noise exposure of the workers in the machine room where different boats with different power levels are located is measured by the collar microphone positioned as described in TS 2607 ISO 1999 standard and the resulting values are recorded [5].

Following the completion of the measurements, the measurement results of the Cesva DC 112 device were downloaded from the measuring device to the computer with the aid of the Cesva Capture Studio Editor program, which is supplied by the manufacturer and is a special program only for this device.

Subsequently, by analyzing the noise measurement results with the help of the same program, (LEX, 8 hours) dB (A) and (Ppeak) dB (C) breakdowns were taken in order to compare the measurement results with the limit values indicated in the regulation to protect employees against the risks related to noise [6]. These results have been analyzed statistically and it has been tried to show whether the results obtained are in compliance with the provisions of the regulation.

In the engine rooms where the measurements were made, the results obtained by measuring the noise 4 times in order to obtain healthy data were tabulated. After that comparison has done with the highest exposure action values (LEX, 8 hours) = 85 dB (A) and (Ppeak) = 140 Pa [137 dB (C) re. 20 μPa].

## RESULTS

The vessels of the type serving for different purposes with different machine powers shall be exposed to the noise exposure of workers in machinery spaces by means of personal noise measurement dosimetry and the data related to this matter shall be prepared according to the related law which is the basic rule for this subject and the regulations issued on this subject, the data obtained by the standard method ensures that we obtain variable results [5].

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the first ship are shown in Table 1 and their comparement with the highest noise exposure level are shown in Figure 1.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the first ship are shown in Table 2 and their comparement with the highest noise exposure level are shown in Figure 2.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the second ship are shown on Table 3 and their comparement with the highest noise exposure level are shown in Figure 3.

The ($P_{peak}$) dB(C) data which obtained by four

measurements from the second ship are shown on Table 4 and their comparement with the highest noise exposure level are shown in Figure 4.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the third ship are shown on Table 5 and their comparement with the highest noise exposure level are shown in Figure 5.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the third ship are shown on Table 6 and their comparement with the highest noise exposure level are shown in Figure 6.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the fourth ship are shown on Table 7 and their comparement with the highest noise exposure level are shown in Figure 7.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the fourth ship are shown on Table 6 and their comparement with the highest noise exposure level are shown in Figure 8.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the fifth ship are shown on Table 9 and their comparement with the highest noise exposure level are shown on figure 9.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the fifth ship are shown on Table 10 and their comparement with the highest noise exposure level are shown on figure 10.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the fourt sixth ship are shown on Table 11 and their comparement with the highest noise exposure level are shown on Figure 11.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the sixth ship are shown on Table 12 and their comparement with the highest noise exposure level are shown on Figure 12.

The ($L_{EX,\ 8\ hours}$) dB(A) data which obtained by four measurements from the seventh ship are shown on Table 13 and their comparement with the highest noise exposure level are shown on Figure 13.

The ($P_{peak}$) dB(C) data which obtained by four measurements from the seventh ship are shown on tabel 14 and their comparement with the highest noise exposure level are shown in Figure 14.

## DISCUSSION

Although five of the vessels at different powers are establishments that emit noise within the legal boundaries set for employees, last two ones have found noise levels above legal limits. All of these are shown at the tables and figures above.In these noisy working environments, physiological and psychological effects may emerge in the future when the employees are exposed to the noise.

For this reason, noise control must be applied to protect the health of workers in a work environment with noise above legal limits [7]. Measures must be taken to reduce noise sources and the use of noise emitting equipment should be avoided. Precautions must be taken to avoid spreading in a noisy environment resulting from the noise source, another factor of noise control. Noise sources should be prevented from reaching the employees by using the insulation of the material, which will prevent the sound from spreading in the cabin or the case which is frequently seen today [8].

As a final measure on this issue, employees should be encouraged to use personal protective equipment, the importance of using this equipment should be explained to employees, occupational diseases and the protective effect of the use of such materials against occupational diseases should be trained [9]. Taking into account the opinions of employees about the noise and effects in working environments, the obtained data should be used for the positive feedback. It is also important to note the use of personal protective equipment in the entries of these working areas, and the use of protective materials in the controls.

In addition, workers' health should be protected from adverse effects by taking compulsory measures (such as the writing of this in business contracts) to reduce the possibility of encountering legal sanctions due to employees who may have occupational diseases in their employers.

When somebody enters into any ship's machinery room, the oil and fuel odor found in the first place is the first disturbing factor**.** The fumes of the fuel species of diesel, fuel oil and so on. used in ships' machine systems, into the atmosphere and the resulting odor of leakage and leaks from these systems in the working environment is an increasing inconvenience for employees due to the wave and wind effect of the ships in marine weather.

In addition to the odor effect and inadequate ventilation in these areas, the diesel engine appears to be at a noise level and in the comfort of the employees as a negative factor in the working environment. Over long periods of stay at sea, the noise source of an employee's work environment is usually constant and constantly issuing the same violence, which is a factor that continuously affects the comfort of employees. The fact that the workplace is closed removes the possibility of distancing the noise source from the disturbance. In addition, employees are required to perform the necessary checks, observations, maintenance, repairs, etc., to fulfill due to the task descriptions loaded on them during the working period, assignments also require them to work near these noise sources.

Despite the fact that human nature is disturbing itself and distracting it from its comfort, the necessity of being close to these disturbing things in accordance with working conditions leads to this desire of human nature.

The physical and stress effects of these adverse conditions also affect the health conditions of the employees in the negative direction. The way to protect employees' health is; in the source of noise, in the path it follows, or in the ear, which is the recipient of the reach.

Ear protectors should be used to keep earplugs and all ear structures in high noise areas in order to protect the sensitive hearing system from high levels of noise exposure in order to relieve the physiological and psychological effects that are uncomfortable for the health of employees.

The earmuffs that fit the ears that cover the entire ear structure work comfortably in the negative direction and help maintain an effective level of protection [10].

It should be remembered that the use of ear plugs may cause a slight or small opening, speech and chewing action to come out of the way, and check that the plugs are firmly in place by checking them occasionally.

Keeping earplugs clean to reduce the effect of noise exposure is the best measure against unwanted irritation in the ear area or any allergic reaction in the ear. In order to help protect the health of employees, employees in noisy environments should be trained on a regular basis with regard to the use of these materials, the effects of unpleasant hearing, the maintenance and cleaning of ear protection, and such training should be renewed intermittently. For the

protection of the ear health of employees, the regulation on the use of personal protective equipment in the workplace, which sets out the legislation on this matter, should always be taken as a basis.

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**Table 1.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the first ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 20.05.2016 | 15:37:45 | 8 Hours | 19,1 | 85,0 |
| 2 | 24.05.2016 | 16:19:01 | 8 Hours | 9,1 | 85,0 |
| 3 | 24.05.2016 | 16:40:05 | 8 Hours | 81,7 | 85,0 |
| 4 | 24.05.2016 | 17:07:34 | 8 Hours | 40,0 | 85,0 |

**Table 2.** Noise exposure measurement results ($P_{peak}$) dB(C) table for the first ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 20.05.2016 | 15:37:45 | 8 Hours | 68,4 | 137 |
| 2 | 24.05.2016 | 16:19:01 | 8 Hours | 71,7 | 137 |
| 3 | 24.05.2016 | 16:40:05 | 8 Hours | 140,3 | 137 |
| 4 | 24.05.2016 | 17:07:34 | 8 Hours | 102,7 | 137 |

**Table 3.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the second ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 09:28:49 | 8 Hours | 29,3 | 85,0 |
| 2 | 07.06.2016 | 09:49:12 | 8 Hours | 13,9 | 85,0 |
| 3 | 07.06.2016 | 10:17:48 | 8 Hours | 36,6 | 85,0 |
| 4 | 07.06.2016 | 10:38:40 | 8 Hours | 42,1 | 85,0 |

**Table 4.** Noise exposure measurement results ($P_{peak}$) dB(C)table for the second ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 09:28:49 | 8 Hours | 87,9 | 137 |
| 2 | 07.06.2016 | 09:49:12 | 8 Hours | 76,8 | 137 |
| 3 | 07.06.2016 | 10:17:48 | 8 Hours | 93,9 | 137 |
| 4 | 07.06.2016 | 10:38:40 | 8 Hours | 102 | 137 |

**Table 5.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the third ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 10:03:30 | 8 Hours | 35,1 | 85,0 |
| 2 | 07.06.2016 | 10:24.19 | 8 Hours | 37,8 | 85,0 |
| 3 | 07.06.2016 | 10:39.20 | 8 Hours | 41,0 | 85,0 |
| 4 | 07.06.2016 | 10:58:51 | 8 Hours | 44,0 | 85,0 |

**Table 6.** Noise exposure measurement results ($P_{peak}$) dB(C)table for the third ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 10:03:30 | 8 Hours | 95,9 | 137 |
| 2 | 07.06.2016 | 10:24.19 | 8 Hours | 103,5 | 137 |
| 3 | 07.06.2016 | 10:39.20 | 8 Hours | 103,0 | 137 |
| 4 | 07.06.2016 | 10:58:51 | 8 Hours | 109,4 | 137 |

**Table 7.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the fourth ship.

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 10:09:32 | 8 Hours | 31,1 | 85,0 |
| 2 | 07.06.2016 | 10:24:15 | 8 Hours | 42,9 | 85,0 |
| 3 | 07.06.2016 | 10:39:10 | 8 Hours | 22,1 | 85,0 |
| 4 | 07.06.2016 | 10:57:08 | 8 Hours | 39,3 | 85,0 |

**Table 8.** Noise exposure measurement results ($P_{peak}$) dB(C) table for the fourth ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 07.06.2016 | 10:09:32 | 8 Hours | 104,9 | 137 |
| 2 | 07.06.2016 | 10:24:15 | 8 Hours | 106,3 | 137 |
| 3 | 07.06.2016 | 10:39:10 | 8 Hours | 84,9 | 137 |
| 4 | 07.06.2016 | 10:57:08 | 8 Hours | 89,9 | 137 |

**Table 9.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the fifth ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 08.06.2016 | 10:38:14 | 8 Hours | 30,4 | 85,0 |
| 2 | 08.06.2016 | 11:18:05 | 8 Hours | 45,0 | 85,0 |
| 3 | 08.06.2016 | 14:19:28 | 8 Hours | 55,5 | 85,0 |
| 4 | 08.06.2016 | 14:41:17 | 8 Hours | 45,9 | 85,0 |

**Table 10.** Noise exposure measurement results ($P_{peak}$) dB(C) table for the fifth ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 08.06.2016 | 10:38:14 | 8 Hours | 86,6 | 137 |
| 2 | 08.06.2016 | 11:18:05 | 8 Hours | 107,9 | 137 |
| 3 | 08.06.2016 | 14:19:28 | 8 Hours | 109,2 | 137 |
| 4 | 08.06.2016 | 14:41:17 | 8 Hours | 101,3 | 137 |

**Table 11.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the sixth ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 12.07.2016 | 21:54:44 | 8 Hours | 104,4 | 85,0 |
| 2 | 13.07.2016 | 22:53:59 | 8 Hours | 104,2 | 85,0 |
| 3 | 15.07.2016 | 20:29:32 | 8 Hours | 103,7 | 85,0 |
| 4 | 19.07.2016 | 19:08:14 | 8 Hours | 104,2 | 85,0 |

**Table 12.** Noise exposure measurement results ($P_{peak}$) dB(C) table for the sixth ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 12.07.2016 | 21:54:44 | 8 Hours | 133,5 | 137 |
| 2 | 13.07.2016 | 22:53:59 | 8 Hours | 144,7 | 137 |
| 3 | 15.07.2016 | 20:29:32 | 8 Hours | 140,5 | 137 |
| 4 | 19.07.2016 | 19:08:14 | 8 Hours | 144,7 | 137 |

**Tabel 13.** Noise exposure measurement results ($L_{EX, 8\ hours}$) dB(A) table for the seventh ship

| Order | Date | Time | Duration | Exposure ($L_{EX, 8\ hours}$) dB(A) | Max. Exposure Action Level ($L_{EX, 8\ hours}$) dB(A) |
|---|---|---|---|---|---|
| 1 | 21.07.2016 | 08:38:01 | 8 Hours | 95,9 | 85,0 |
| 2 | 24.07.2016 | 15:16:31 | 8 Hours | 90,9 | 85,0 |
| 3 | 24.07.2016 | 23:41:59 | 8 Hours | 91,8 | 85,0 |
| 4 | 27.07.2016 | 09:30:37 | 8 Hours | 92 | 85,0 |

**Tabel 14.** Noise exposure measurement results ($P_{peak}$) dB(C) table for the seventh ship

| Order | Date | Time | Duration | Exposure ($P_{peak}$) dB(C) | Max. Exposure Action Level ($P_{peak}$) dB(C) |
|---|---|---|---|---|---|
| 1 | 21.07.2016 | 08:38:01 | 8 Hours | 126,2 | 137 |
| 2 | 24.07.2016 | 15:16:31 | 8 Hours | 140,9 | 137 |
| 3 | 24.07.2016 | 23:41:59 | 8 Hours | 122,1 | 137 |
| 4 | 27.07.2016 | 09:30:37 | 8 Hours | 130,7 | 137 |

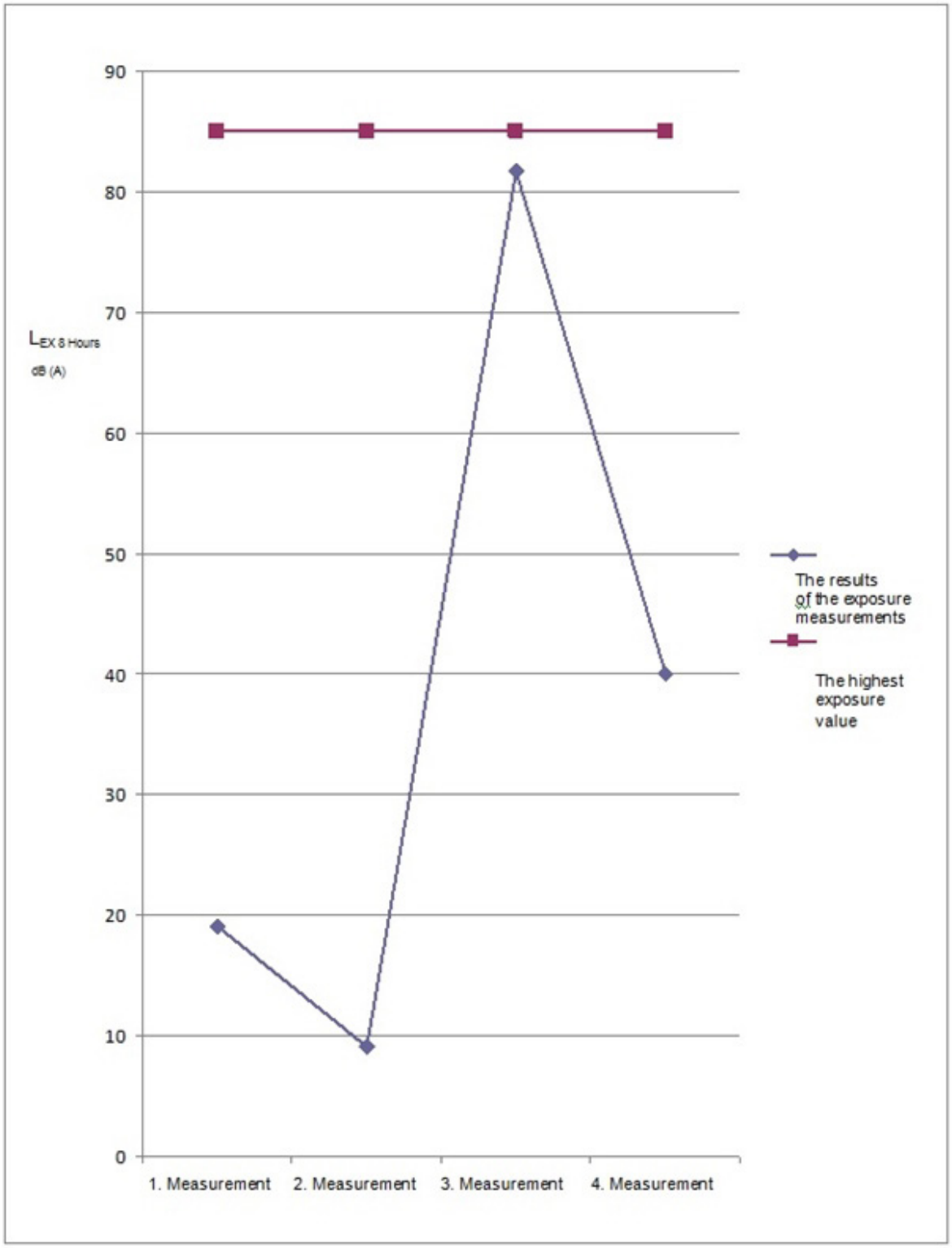


**Figure 1.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the first ship

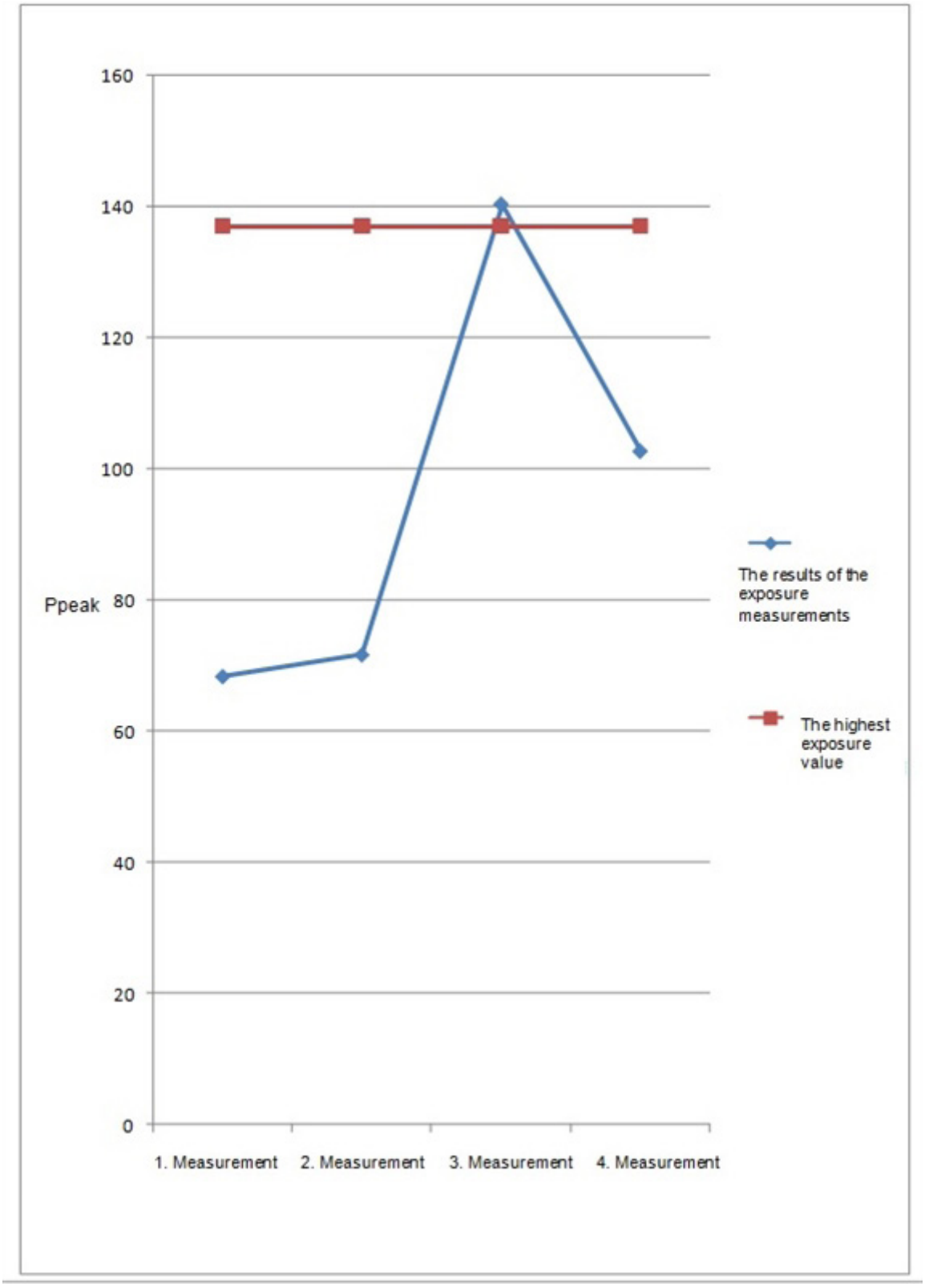


**Figure 2.** Noise exposure measurement results ($P_{peak}$) dB(C)graph for the first ship

**Figure 3.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the second ship

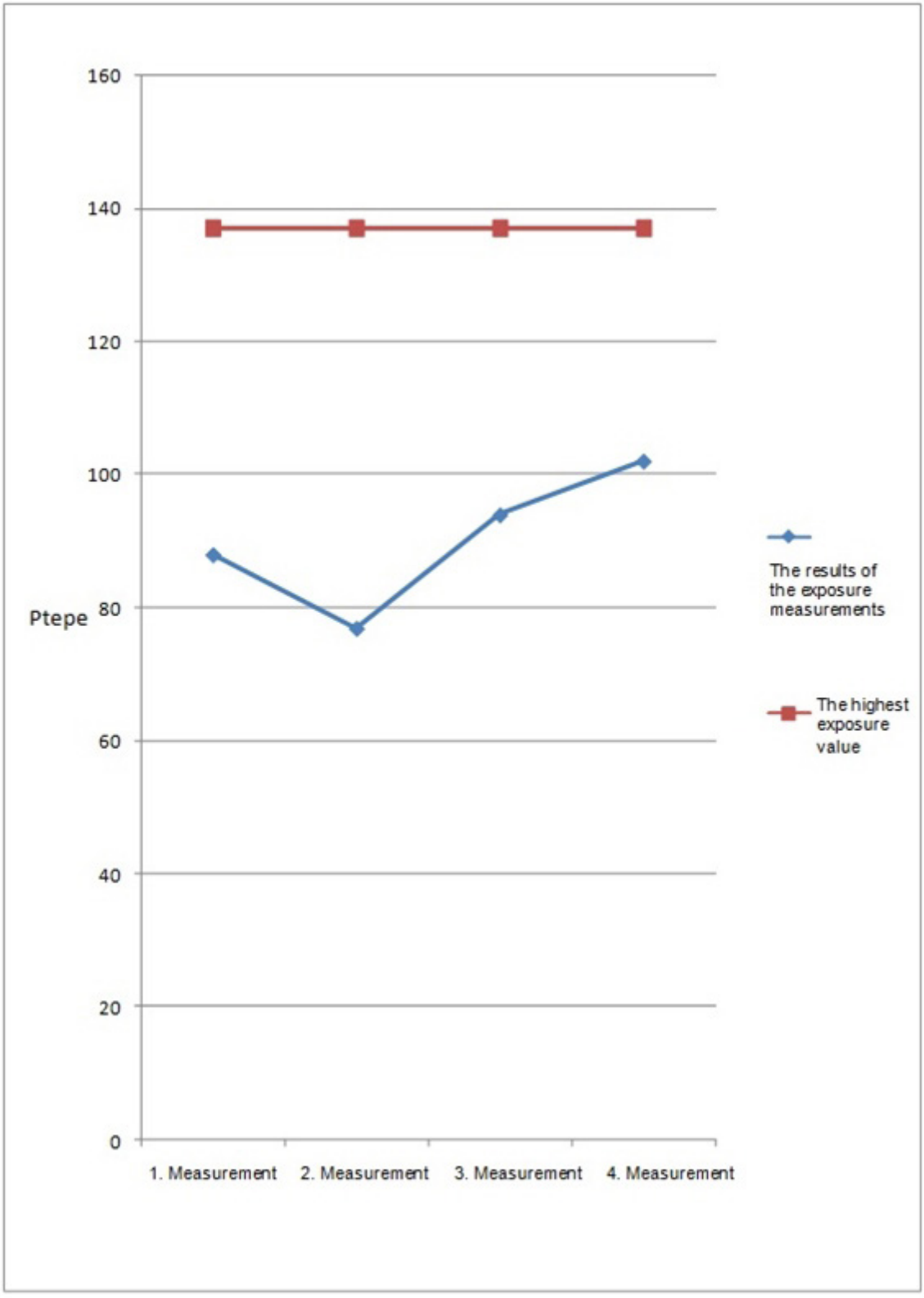


**Figure 4.** Noise exposure measurement results ($P_{peak}$) dB(C)graph for the second ship

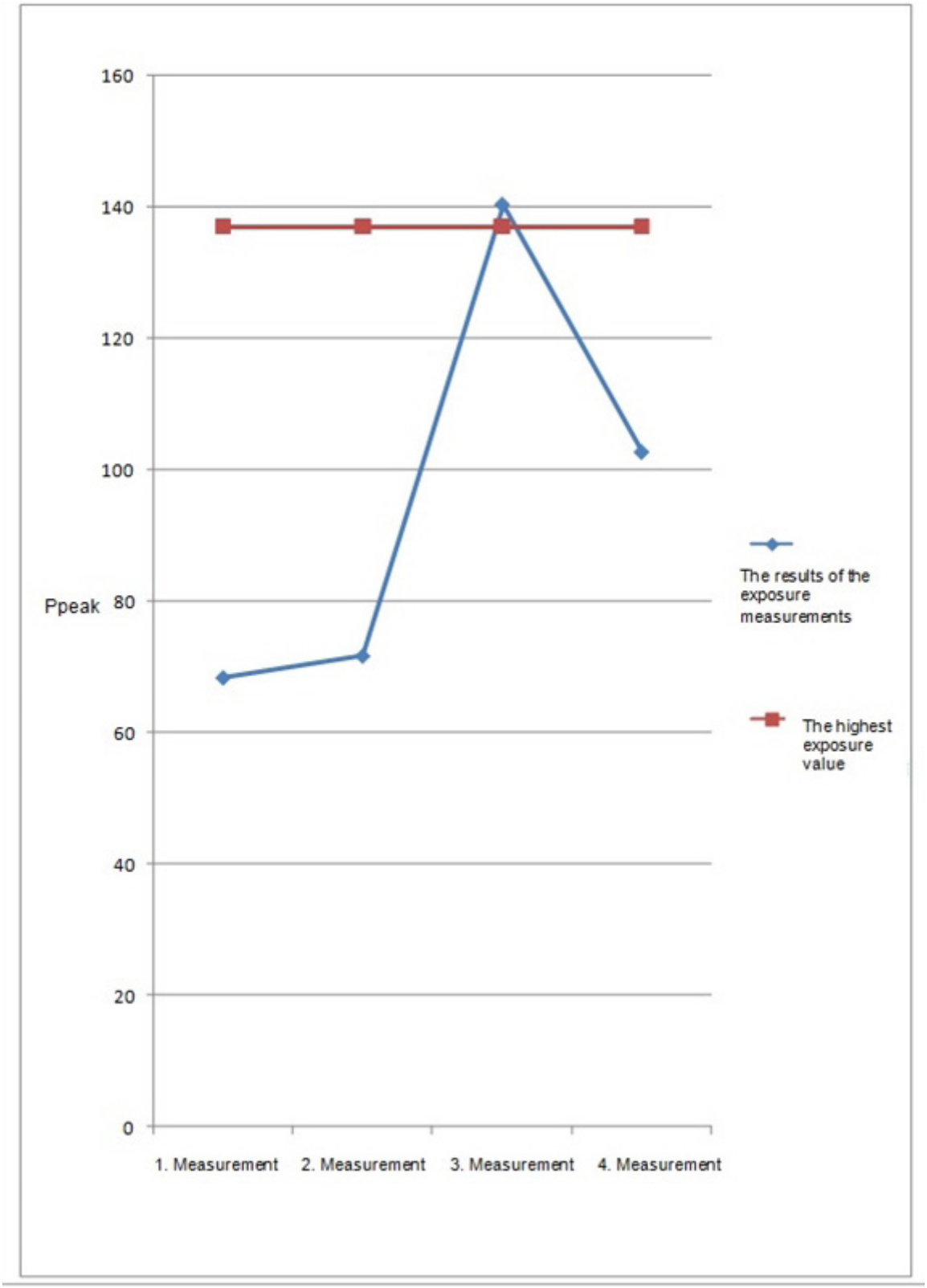


**Figure 5.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the third ship

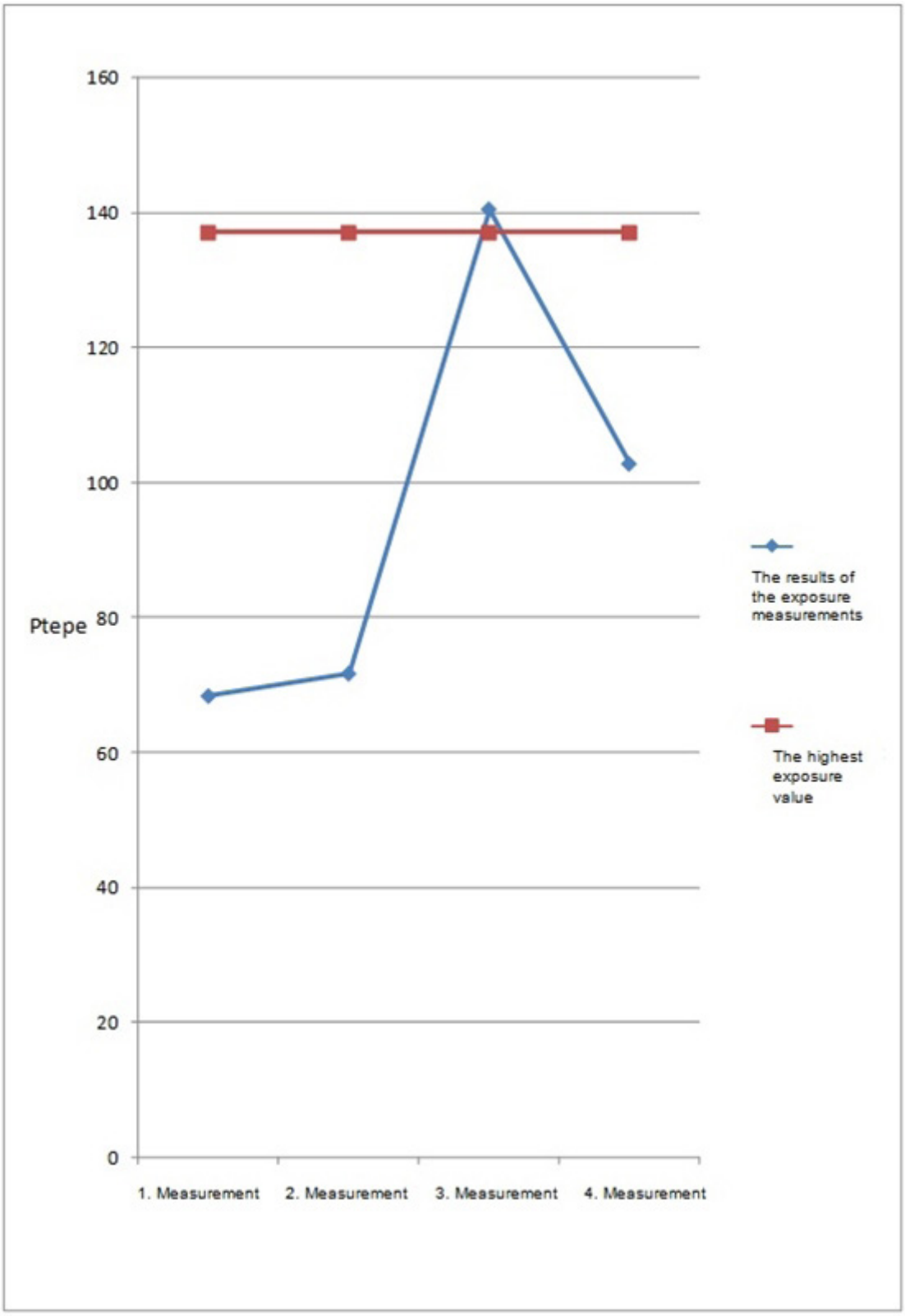


**Figure 6.** Noise exposure measurement results ($P_{peak}$) dB(C)graph for the third ship

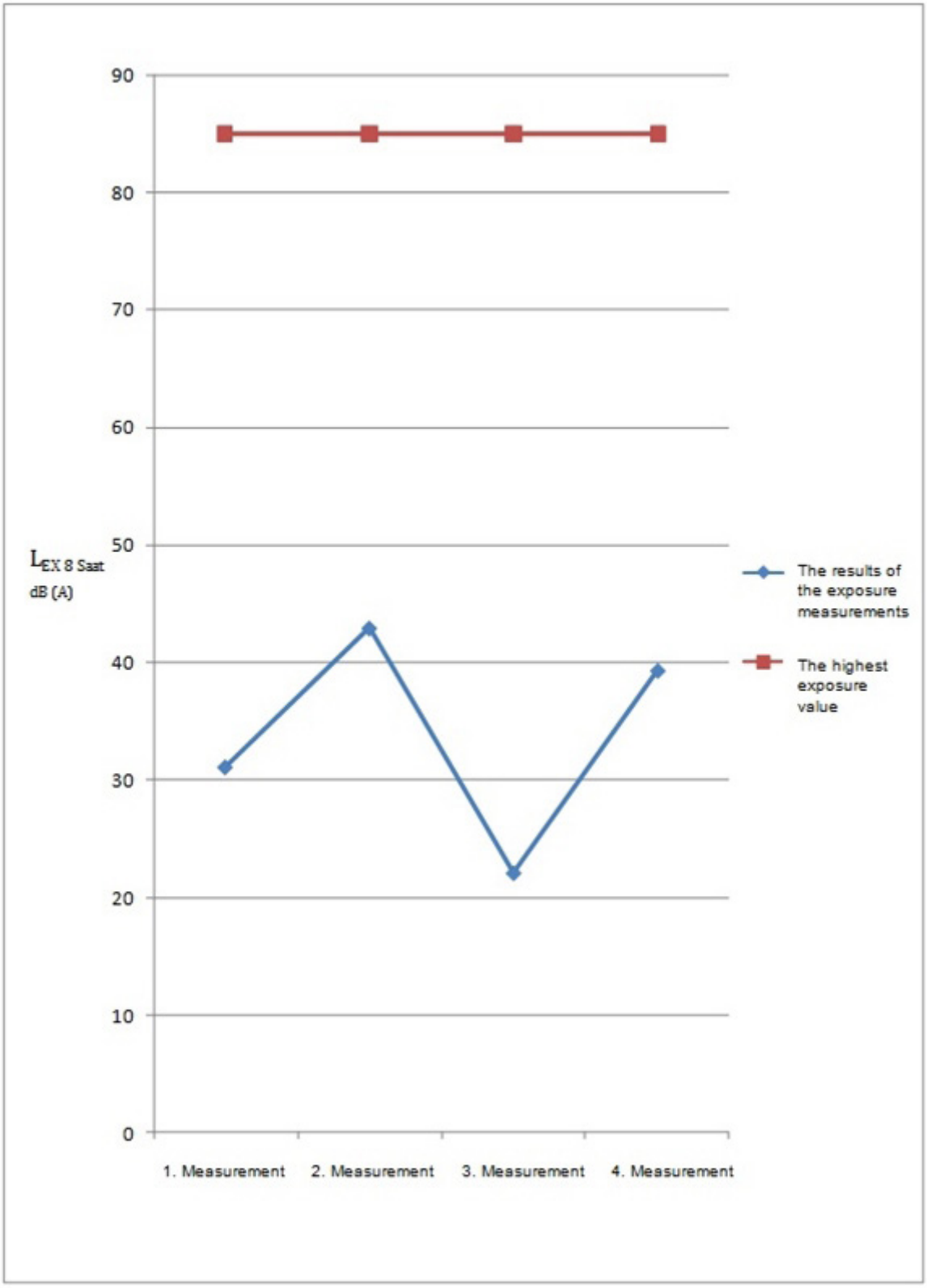


**Figure 7.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the fourth ship

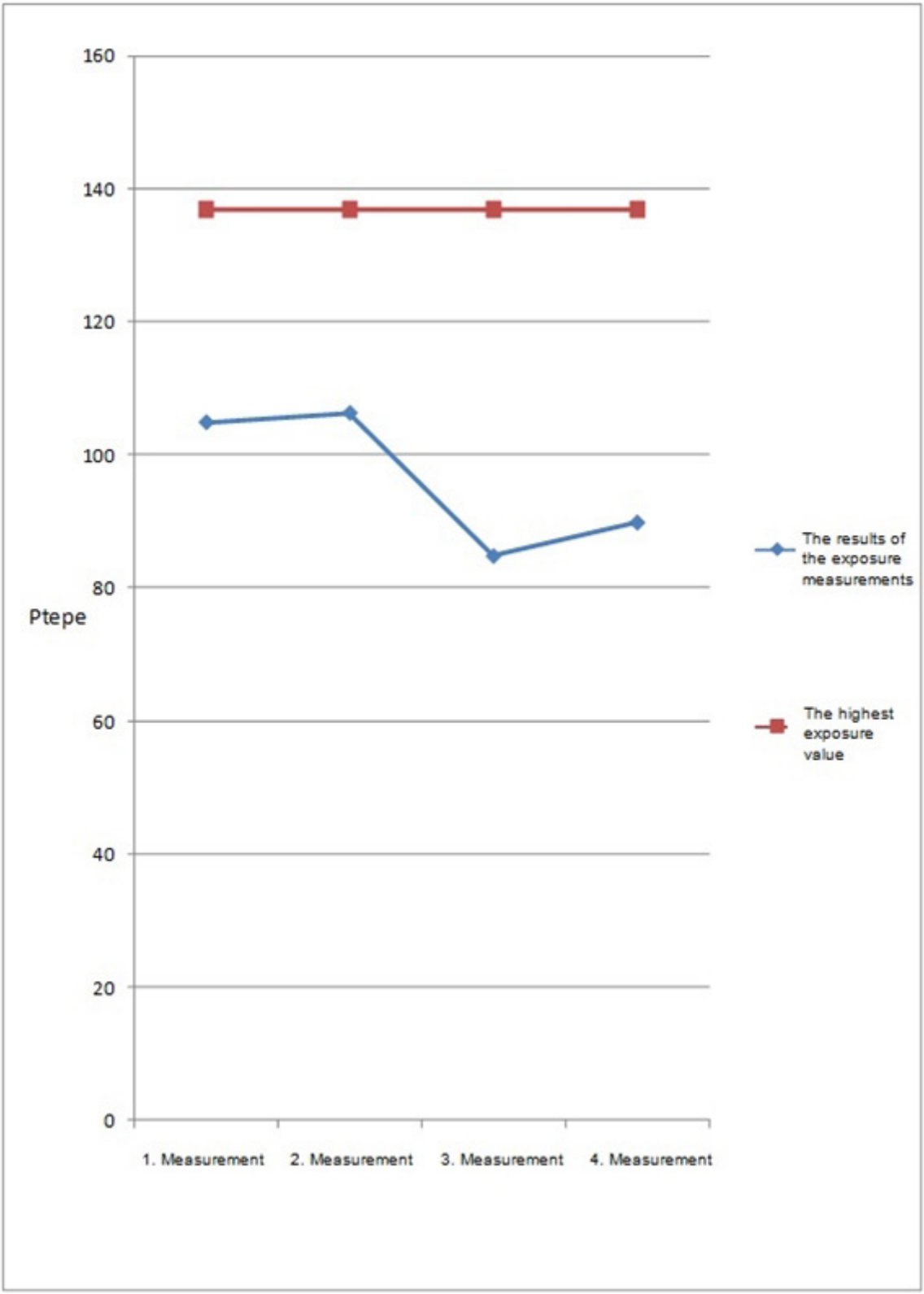


**Figure 8.** Noise exposure measurement results ($P_{peak}$) dB(C) graph for the fourth ship

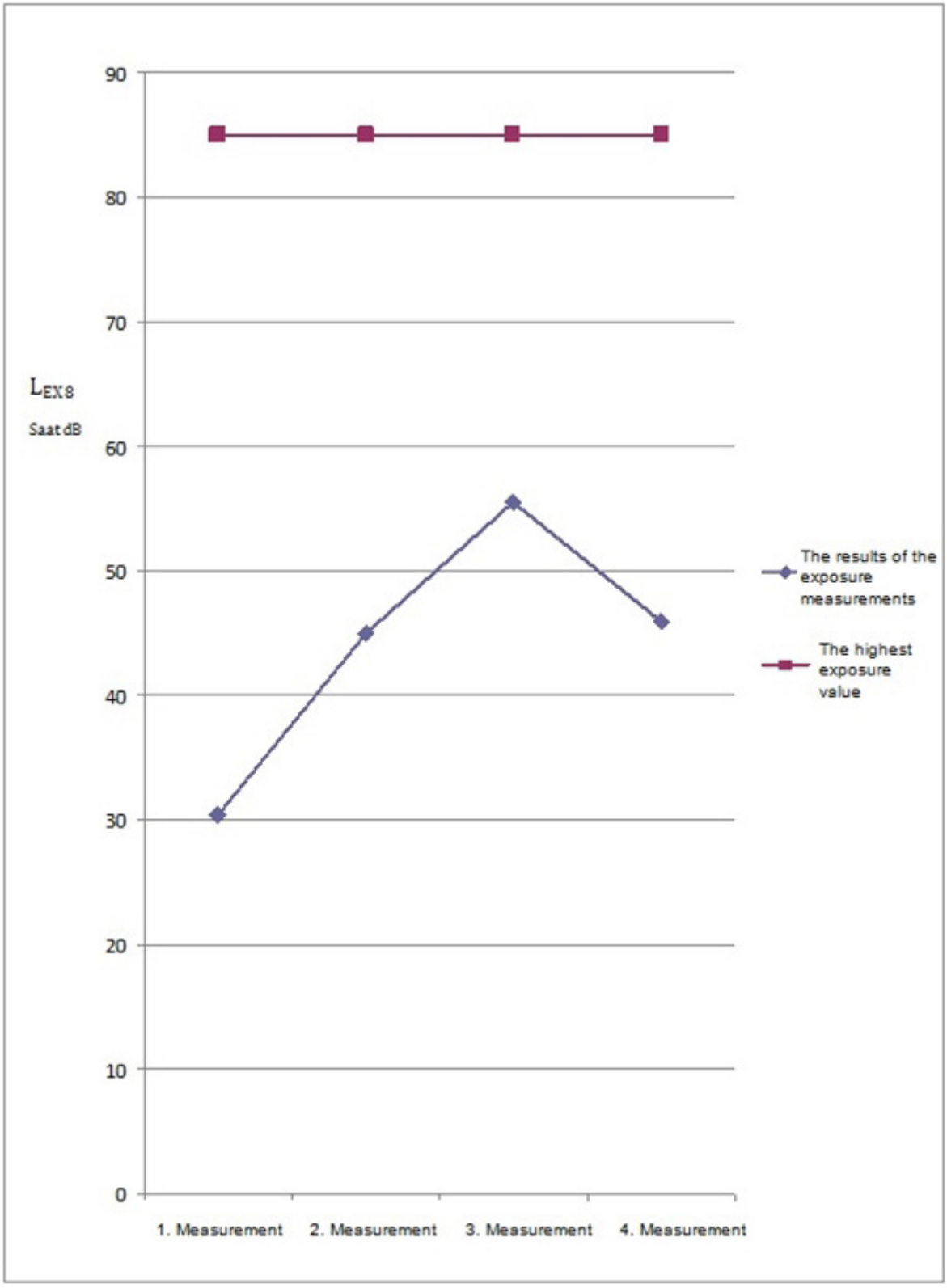


**Figure 9.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the fifth ship

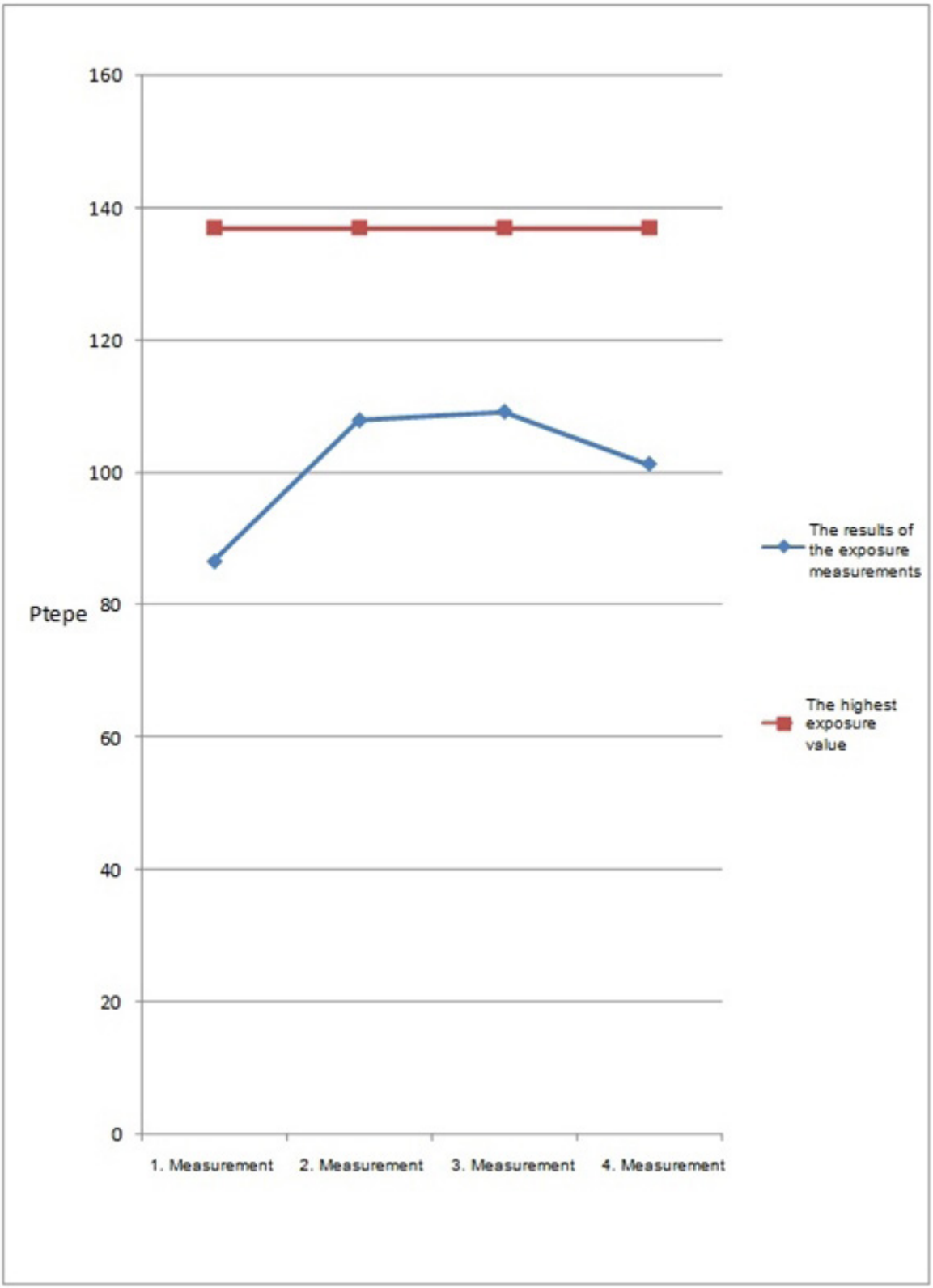


**Figure 10.** Noise exposure measurement results ($P_{peak}$) dB(C) graph for the fifth ship

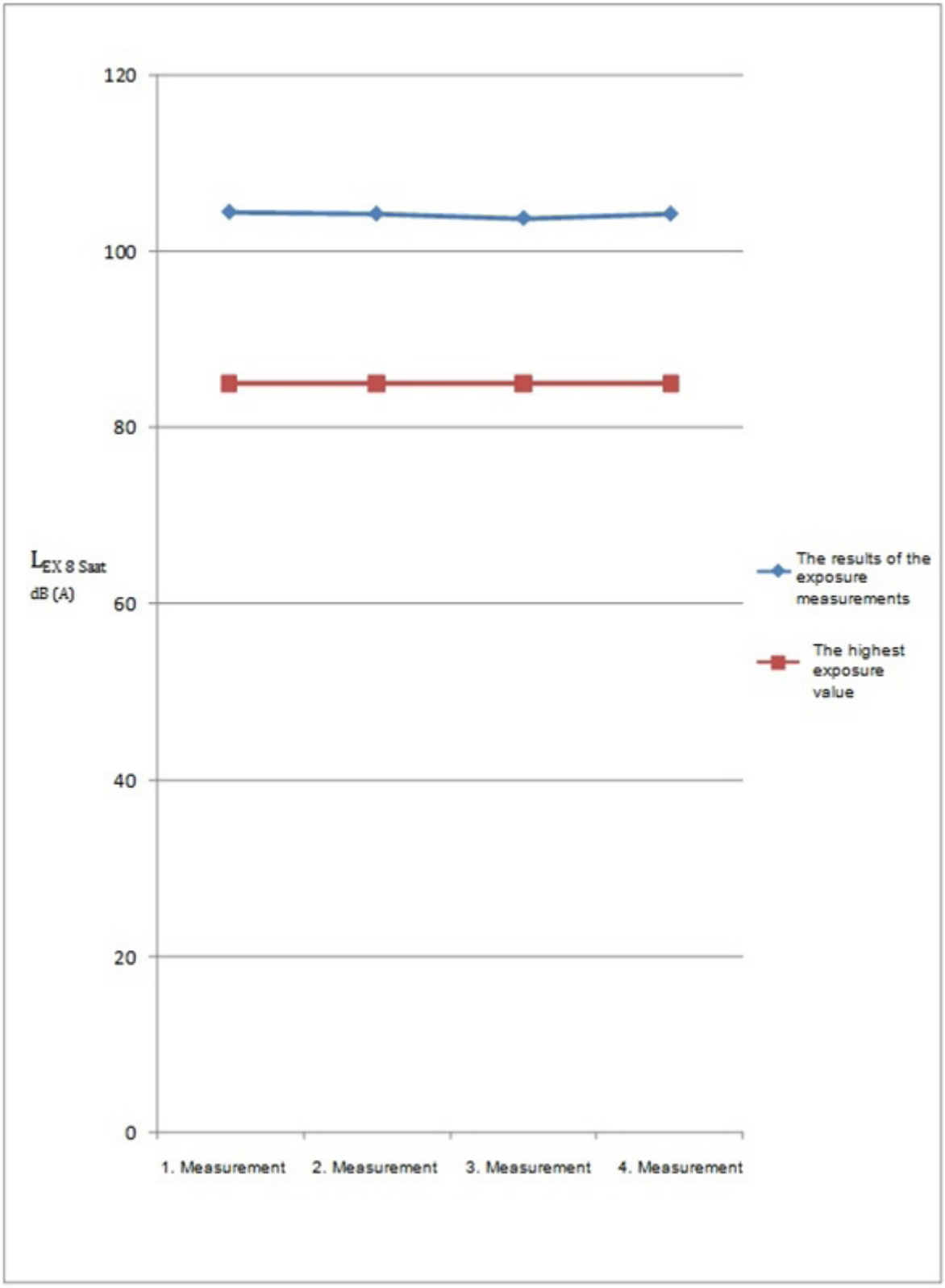


**Figure 11.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the sixth ship

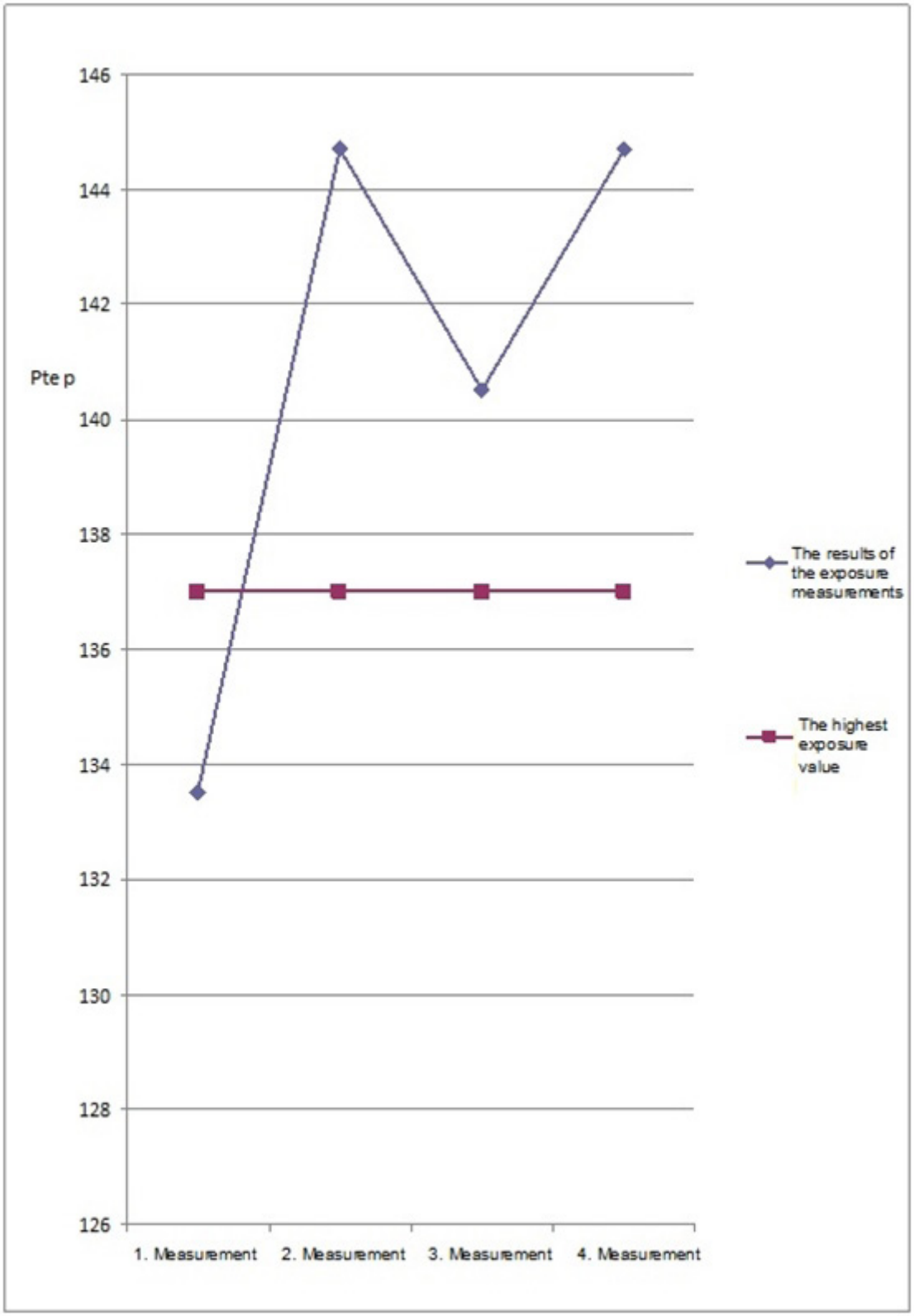


**Figure 12.** Noise exposure measurement results ($P_{peak}$) dB(C) graph for the sixth ship

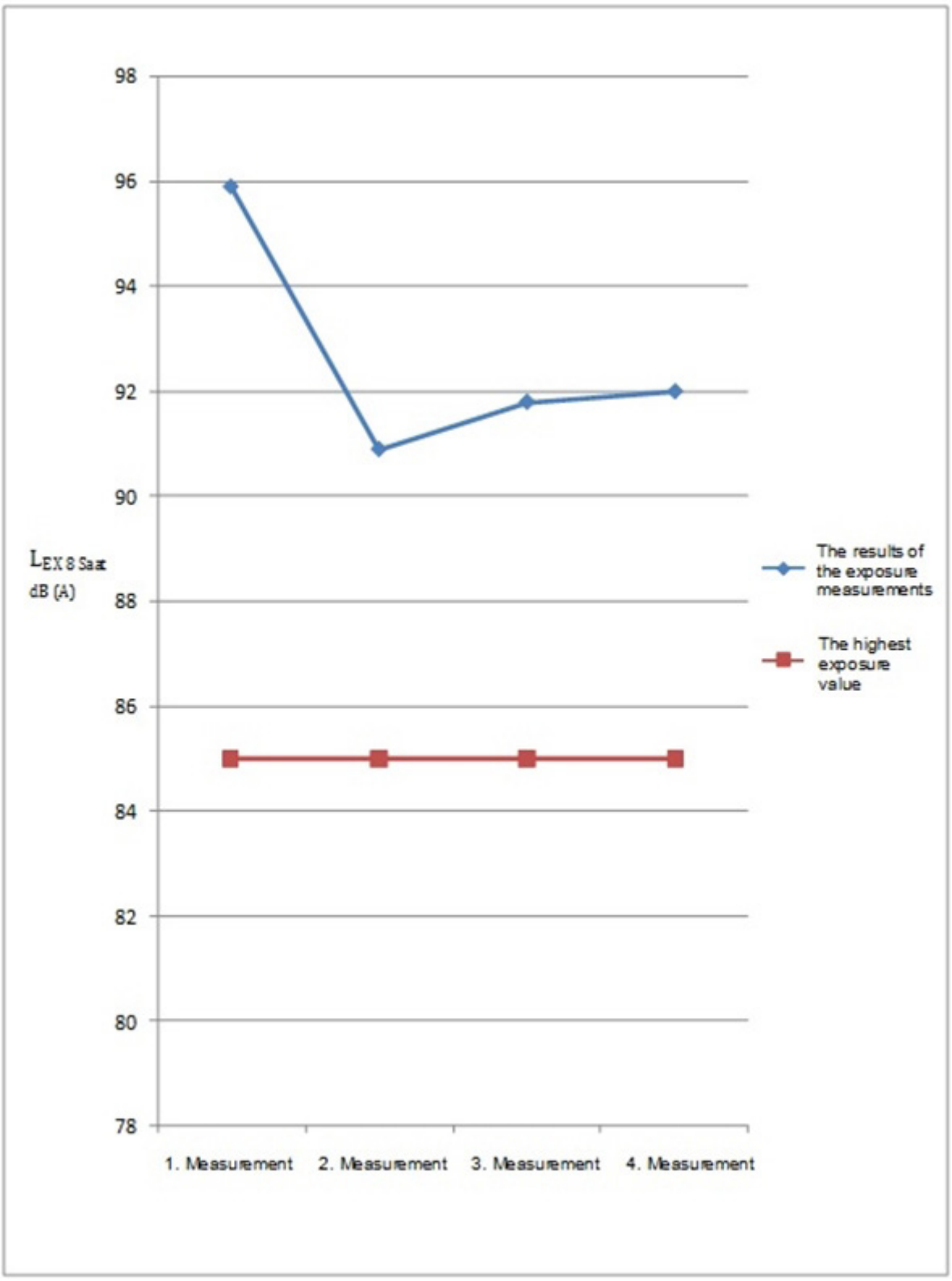


**Figure 13.** Noise exposure measurement results ($L_{EX,\ 8\ hours}$) dB(A) graph for the seventh ship

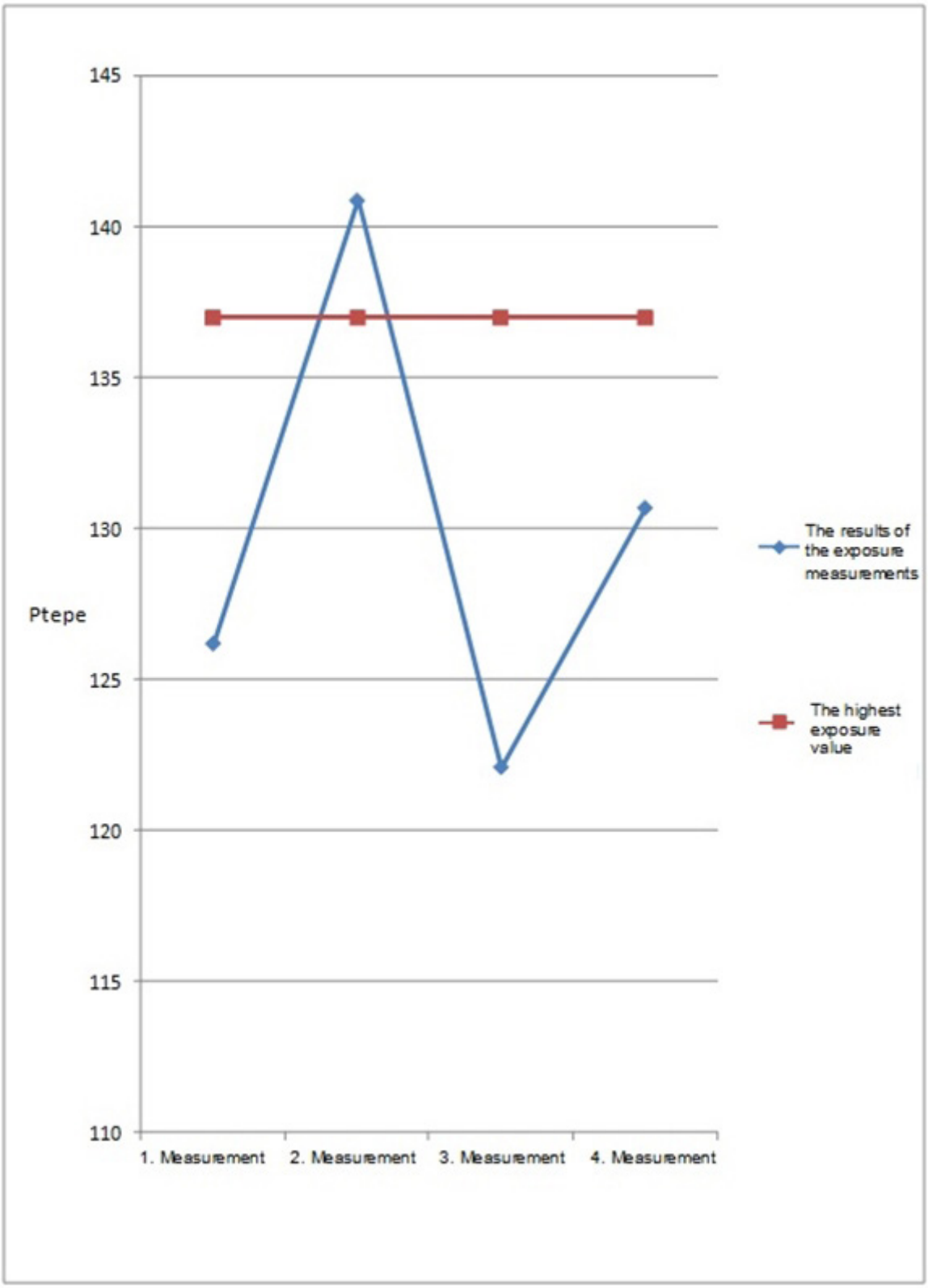


**Figure 14.** Noise exposure measurement results ($P_{peak}$) dB(C) graph for the seventh ship