**CLASSES 1-2. Hullform of a Submarine Design**

**Vocabulary work**

**1. Прочитайте слова и выражения, постарайтесь запомнить их значения.**

|  |  |  |
| --- | --- | --- |
|  | a hull form / hull forms | форма корпуса / обводы корпуса |
|  | a drag | торможение, сопротивление, дифферент на корму |
|  | a streamlined shape | обтекаемая форма |
|  | a parabolic bow | нос корабля параболической формы |
|  | an elliptical stern | корма эллиптической формы |
|  | minimum power requirement | минимальные требования к мощности |
|  | negligible flow separation | пренебрежимо малое разделение потока |
|  | insufficient | недостаточный, непригодный, не отвечающий требованиям |
|  | a steep decrease | резкое уменьшение |
|  | aft and forward of the midship region | по направлению к корме и к носу от района миделя |
|  | multiple deck levels | несколько уровней палубы |
|  | a shift | сдвиг, перемещение |
|  | offset | смещённый, несоосный |
|  | spatial use | использование пространства |
|  | the lifetime of the submarine | срок службы подводной лодки |
|  | the maneuverability of the submarine | маневренность подводной лодки |
|  | hydrodynamic forces | гидродинамические силы |
|  | Length to Breadth ratios | отношение длины к ширине |
|  | pressure hull volume | объем прочного корпуса |
|  | displacement of the submarine | водоизмещение подводной лодки |
|  | twin decks, triple decks | двойные палубы, тройные палубы |
|  | dimension / dimensions | измерение / размеры |
|  | diesel electric submarine | дизельная электрическая подводная лодка |
|  | nuclear powered submarine | атомная подводная лодка |
|  | nuclear power plant | атомная электростанция / установка |
|  | battery bank | аккумуляторная батарея |
|  | torpedo operating tanks | торпедо-заместительные цистерны |
|  | vital aspects of submarine design | жизненно важные аспекты проектирования подводных лодок |
|  | submarine stability | остойчивость подводной лодки |
|  | surfaced and submerged conditions | условия надводного и подводного плавания |

**2. Выделите приставки, суффиксы и переведите глаголы.**

|  |  |  |  |
| --- | --- | --- | --- |
| Weaken |  | increase |  |
| incorporate |  | dictate |  |
| prioritize |  | resurface |  |
| operate |  | decrease |  |

**3. Как образованы данные слова? Назовите часть речи, переведите.**

|  |  |  |  |
| --- | --- | --- | --- |
| Insufficient |  | maneuverability |  |
| possibility |  | displacement |  |
| incorporation |  | usability |  |
| aforementioned |  | streamline |  |

**4. У имени существительного *point* насчитывается 61 значение. В числе наиболее употребительных:** точка; румб; след, отметина; место, пункт; уровень, стандарт; степень, ступень; вопрос, дело; главное, суть, смысл; цель, намерение; отличительная, характерная черта; мысль; позиция, точка зрения; момент времени.

**В каких значениях слово point употреблено в данных словосочетаниях?**

starting point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

aforementioned point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

moot point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

rise to a point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

the tipping point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5. Определите значения слов, выделенных в предложениях. Какую роль в предложении они выполняют: (1) выражение причинно-следственных отношений, (2) выражение отношений уступки, (3) выражение отношений сходства, подобия, (4) выражение отношений противопоставления, контраста?**

The evolution of hullform and the reasons behind it is **hence** an interesting aspect of submarine design.

**But** it was observed that **due to** the streamline shape, the usable volume within the hull was insufficient, **as** the radius of the hull saw a steep decrease from just aft and forward of the midship region.

**Though** a shift from the ideal streamlined shape increases the drag and subsequent power requirements, the additional fuel costs over the lifetime of the submarine is offset by the low production costs, **since** cylindrical sections are much cheaper and easier to construct.

This shape **also** enables the incorporation of multiple decks within the same hull volume, **hence** ensures more spatial use.

**Such** large diameters are used mostly in nuclear powered submarines where large vertical space is required for the nuclear power plant.

There are some spaces within the submarine which may be highly volume specific (for example, main ballast tanks), **whereas** some may have only a few specific dimensions (example, battery bank).

**Though** it may seem simple as compared to ships, the understanding of submarine stability is more complex than that of a ship, **as** it would operate in both, surfaced and submerged conditions.

**Grammar Revising**

**6. В чем различие употребления формы used в предложениях? В каких предложениях *used* употреблено как глагол (в какой форме?), а в каких – как причастие (Participle II)? Отметьте форму слова *used* в предложениях, переведите предложения.**

**1)** The first submarines in the 1940s used this shape for minimum power requirement and negligible flow separation around the hull.

2) The hullform used in modern submarines (since late 1970s) is the long cylindrical mid-body with elliptical bow and stern.

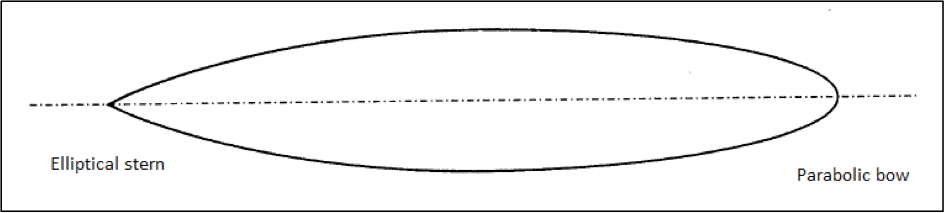
3) The most initial submarines used a hullform which was much different from those used in modern day submarines.

**8. Распределите прилагательные / наречия в сравнительной и превосходной степени сравнения по группам. Для групп, оставшихся незаполненными, приведите свои примеры. Переведите:**

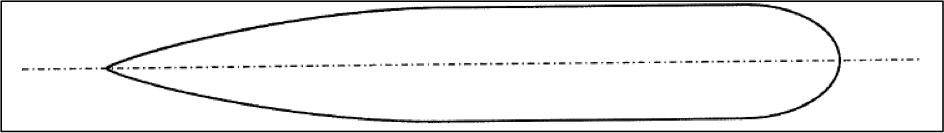
The most initial submarines, the most ideal shape, much cheaper and easier to construct, larger hydrodynamic forces, best maneuverability characteristics, one of the most vital aspects, the understanding of submarine stability is more complex, are used mostly in nuclear powered submarines, ensures more spatial use

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Синтетический способ  (суффиксы) | | Аналитический способ  (вспомогательные слова) | | Супплетивный способ  (другой корень) | |
| сравнительная степень | превосходная степень | сравнительная степень | превосходная степень | сравнительная степень | превосходная степень |
|  |  |  |  |  |  |

**Submarine’s Hull Form**

The most initial submarines used a hullform which was much different from those used in modern day submarines. The evolution of hullform and the reasons behind it is hence an interesting aspect of submarine design. The most ideal shape of a submarine hull for minimum drag is the idea of streamlined shape with a parabolic bow and an elliptical stern, as shown in Figure 1.

The first submarines in the 1940s used this shape for minimum power requirement and negligible flow separation around the hull. But it was observed that due to the streamline shape, the usable volume within the hull was insufficient, as the radius of the hull saw a steep decrease from just aft and forward of the midship region. This not only kept the production costs high, but also weakened the possibility of incorporating multiple deck levels.

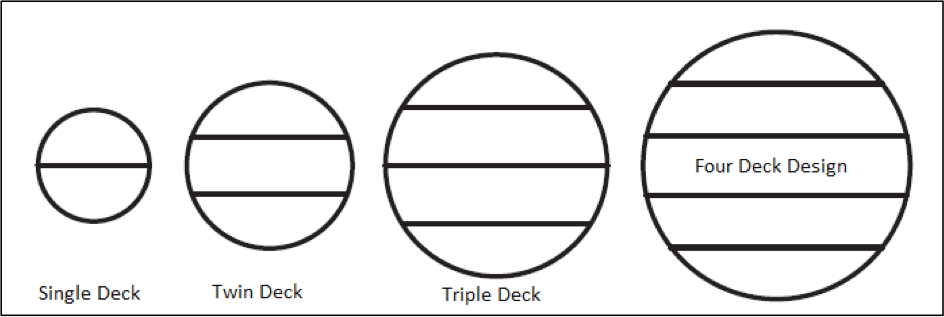


*Figure 2: Modern submarine hullform with cylindrical mid body.*

The hullform used in modern submarines (since late 1970s) is the long cylindrical mid-body with elliptical bow and stern. Though a shift from the ideal streamlined shape increases the drag and subsequent power requirements, the additional fuel costs over the lifetime of the submarine is offset by the low production costs, since cylindrical sections are much cheaper and easier to construct. This shape also enables the incorporation of multiple decks within the same hull volume, hence ensures more spatial use.

It is important to know that the shape and geometry of a submarine hull is an important starting point of the design, since it would not only dictate the aforementioned point, but also affect a range of other factors of the submarine as discussed below.

A cylindrical hullform increases the maneuverability of the submarine due to larger hydrodynamic forces generated by hydroplane action. It has also been observed that the minimum overall drag on the hull and best maneuverability characteristics are obtained for Length to Breadth ratios ranging from 6 to 8.

The diameter of the submarine is decided primarily based on the length. And the length is fixed based on the required pressure hull volume and displacement of the submarine. Multiple decks increase the usability of pressure hull volume, and the number of possible deck levels in a submarine is decided primarily by its diameter.

A submarine with one deck would have two levels within its pressure hull. Submarines with hull diameters ranging from 4 to 7 meters are restricted to one deck. It would allow two accessible levels – below deck level and above deck level,

as shown in the figure below. *Figure 3: Possible deck levels for different hull diameters.*

Twin decks with three accessible levels are possible in submarines with hull diameter ranging from 7 to 8 meters. Large sized diesel electric submarines are usually of this dimension.

Triple decks and four deck designs are used for hull diameters ranging from 9 to 11 meters and 11 to 13 meters. Such large diameters are used mostly in nuclear powered submarines where large vertical space is required for the nuclear power plant.

With the aspects of submarine design discussed in this article, the moot point to be extracted is that having known the parts and functions of the submarine and its systems, the art and skill of a good designer lies in trying to achieve maximum volumetric efficiency for a design. There are some spaces within the submarine which may be highly volume specific (for example, main ballast tanks), whereas some may have only a few specific dimensions (example, battery bank). There would also be cases where there are specific volumetric demands, but not shape specific (for example: torpedo operating tanks and main ballast tanks). Depending on such demands, a good designer would prioritize the stages of design and the parameters that are fixed at each stage.

One of the most vital aspects of submarine design is its stability. Though it may seem simple as compared to ships, the understanding of submarine stability is more complex than that of a ship, as it would operate in both, surfaced and submerged conditions. And the stability parameters of a submarine change drastically at the moment a submarine dives into the water, or resurfaces, which gives rise to a point where the submarine is at the tipping point of floundering.

**Home Work Tasks**

9. Напишите, о каких требованиях к форме корпуса подводной лодки сообщается в тексте; о зависимости количества палуб от диаметра подводной лодки, используя выражения:

|  |  |
| --- | --- |
| The paper is concerned with… It is known that… The fact that … is stressed. It is spoken in detail about… It is reported that … Much attention is given to… It draws our attention to… It is stressed that… The article is of interest to … | В статье рассматриваются...  Известно, что...  Подчеркивается тот факт, что...  Подробно говорится о...  Сообщается, что...  Большое внимание уделяется...  Обращается внимание на...  Подчеркивается, что...  Статья представляет интерес для ... |

**10. Выучите слова и словосочетания.**

1 a drag \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2 flow separation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3 hydrodynamic forces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4 negligible \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5 streamlined shape \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6 parabolic bow \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7 elliptical stern \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8 cylindrical mid-body \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9 cigar-shaped hull \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10 teardrop hull \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11 pressure hull \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12 outer hull (or light hull, or casing) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13 multiple decks \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14 load bearing bulkhead \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15 ring stiffener \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

16 complex stiffening structure \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

17 a circular cross section \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

18 transverse framing construction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

19 power requirement \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

20 maneuverability \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

21 volumetric efficiency \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

22 stability \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

23 operable depth \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

24 seaworthiness (or seakeeping) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

25 to be stealthy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

26 to be intact \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

27 high strength reserve \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

28 buckling stability \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

29 survivability \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

30 to be insufficient \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Справочные материалы.**

**ПРИЧАСТИЕ 2**

Причастие – это неличная форма глагола, имеющая признаки как прилагательного, так и глагола. Существуют простые и сложные формы причастия. Причасти 2 (**Participle II)** простая форма.

**Participle II** это 2-я форма глагола (***designed, made***). В предложении Participle II чаще всего является определением. Переводится причастием пассивного залога с суффиксами и окончаниями, -нный, -емый, -имый, -тый, -шийся, -вшийся.

В функции определения Participle II может стоять перед определяемым словом или после него: The ships *produced by our shop* are of improved quality. – Суда, *выпускаемые нашим цехом*, улучшенного качества.

Обратите внимание на предложения, в которых за подлежащим следуют два слова с окончанием -ed. Первое из них обычно является определением в форме Participle II, второе является сказуемым в Past Indefinite: The cargo ***transported*** **handled** by crane. – ***Перевозимый*** груз **обрабатывался** краном.

Однако первым словом может быть сказуемое в Past Indefinite, a вторым – Participle II в функции определения:

Yesterday the engineer **demonstrated** ***improved*** mechanisms. – Вчера инженер **показал** ***усовершенствованные*** механизмы.

**Self-studying**

**Измените время глаголов в предложениях (напишите не менее 3 новых форм). Назовите эти формы.**

**Образец:** The length of submarine **is fixed** on the base of its pressure hull volume and displacement (Present Simple Passive). Past Simple Passive – **was fixed**, Present Perfect Passive – **has been fixed**, Present Continuous Passive – **is being fixed**.

1.The diameter of the submarine is decided primarily based on the length.

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2. The stages of design and the parameters are fixed at each stage.

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3. Such large diameters are used mostly in nuclear powered submarines.

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4. A good designer will prioritize the stages of design and the parameters.

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5. A shift from the ideal streamlined shape increases the drag and subsequent power requirements.

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