WORLD COAL ASSOCIATION

Coal Classification

Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code

REPORT 3. COAL CLASSIFICATION GUIDANCE

World Coal Association

The World Coal Association (WCA) is a global industry association formed of major international coal producers and stakeholders. The WCA works to demonstrate and gain acceptance for the fundamental role coal plays in achieving a sustainable and lower carbon energy future.

Membership is open to companies and not-for-profit organisations with a stake in the future of coal from anywhere in the world, with member companies represented at Chief Executive level.

The publication "Coal Classification - Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code" was written by ARCHE, a Belgium-based consultancy specialising in environmental toxicology, under the oversight of the WCA Technical Working Group on Coal Classification and chaired by Dr. Sue Hubbard, Principal Adviser, HSEC Product Regulation & Information Support at Rio Tinto.

ARCHE

ARCHE is a Belgium-based consultancy founded in 2009 by experts with more than 15 years of experience in the field of environmental toxicology, exposure modelling and the preparation of risk assessment dossiers. The company is also recognised as a spin-off of Ghent University.

The experts working at ARCHE have built up in-depth knowledge on the preparation of Chemical Safety Assessments in the framework of the REACH regulation and chemical risk assessments under the predecessor of the REACH regulations (EU regulation 67/1488 on new and existing substances).

One of the key areas of expertise is the preparation of risk assessments for inorganic substances such as metals, alloys, slags etc. ARCHE experts have been involved in the preparation of many guidance documents on these topics - for example Metal Risk Assessment Guidance (MERAG) and a widely used tool for metals classification - MECLAS. The scientific services of ARCHE have also been frequently consulted in the framework of the risk assessment of flame retardants and other organic chemicals.

Any queries related to the publications which are part of this package should be addressed to the WCA Team at classification@worldcoal.org

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Coal Classification – Industry Approach to Hazard Classification under the Revised MARPOL Convention and the IMSBC

Report 3. Coal Classification Guidance

BACKGROUND

This report forms part of a package of reports - "Coal Classification - Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code".

The aim of this publication is to help coal producers comply with the new coal classification requirements introduced by the International Maritime Organisation (IMO) under the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Maritime Solid Bulk Cargoes Code (IMSBC).

The other two reports appearing in this series are:

- Report 1. New Compliance Requirements of the MARPOL Convention and the IMSBC Code
- Report 2: Analysis of Coal Composition, Ecotoxicity and Human Health Hazards

The reports were written by ARCHE, a specialist environmental toxicology consultancy, under the oversight of the World Coal Association Technical Working Group on Coal Classification, chaired by Dr. Sue Hubbard, Principal Adviser, HSEC Product Regulation & Information Support at Rio Tinto.

This publication is available free of charge for all WCA Members.

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1. INTRODUCTION

This guidance document proposes a human health and environmental hazard assessment methodology for coal with regard to the marine transport of coal under the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Maritime Solid Bulk Cargoes Code (IMSBC). For human health classification, due to the complex composition of coal, a mixture approach was not considered feasible. Consequently, test data on coal as a whole serve as basis for the human health classification. Based on the literature review of available studies on adverse effects of coal on mammals, it was concluded that inhalation was the only relevant route of exposure (coal dust inhalation) - which is not a relevant route of exposure for the MARPOL criteria but is relevant for the IMSBC Code criteria. The environmental hazard assessment of coal is solely based on the trace element composition of coal. The assessment does not evaluate potential hazard of toxic organic compounds such as polycyclic aromatic hydrocarbons (PAHs); the hazard assessment that was previously conducted on reported PAH-levels in coal demonstrated that the highest reported concentration levels of PAHs would not trigger any environmental classification. In addition, ecotoxicological data that were generated with coal as test substance did not indicate that the organic fraction of coal would cause adverse acute/chronic effects that are severe enough to trigger an environmental classification.

2. GUIDANCE ON THE HUMAN HEALTH HAZARD ASSESSMENT OF COAL

Due to the complex and variable composition of coal, it is deemed impossible to conduct a human health hazard assessment that is based on the hazards of the individual compounds of coal. Instead, mammalian toxicity data for coal were collected (epidemiological studies, animal studies) and evaluated against the different criteria and end points that are relevant for the different maritime transport regulations (MARPOL, IMSBC Code). This review of existing data clearly demonstrated that inhalation (of coal dust) was the only relevant exposure route that triggered adverse effects in mammals.

2.1. GUIDANCE FOR THE CLASSIFICATION OF COAL ACCORDING TO MARPOL

With respect to the MARPOL criteria for the human health assessment, it is important to point out that only oral and dermal data (or studies where the exposure route is not defined) are taken into consideration for assessing whether a substance/material should be classified as harmful to the marine environment (HME). The inhalation route is not considered relevant for assessing whether a substance/material should be classified as HME.

This approach has important implications for coal since no adverse effects of coal/coal dust via oral or dermal exposure have been identified; all adverse effects were directly related to the *inhalation* of coal dust.

It is therefore concluded that coal is not classified as HME for human health end points.

2.2 GUIDANCE FOR THE CLASSIFICATION OF COAL ACCORDING TO THE INTERNATIONAL MARITIME SOLID BULK CARGOES (IMSBC) CODE

Currently, coal is already classified as a Group B cargo under the IMSBC Code (based on its physico-chemical properties) and therefore already subject to specific transport requirements. An additional classification (based on human health end points) would not alter the Group B classification, but may have consequences on specific, future transport provisions. To date, it remains unclear which additional transport restrictions would arise from a human health classification under the IMSBC Code.

Under MARPOL only human health hazards resulting from oral or dermal exposure are considered, whereas under the IMSBC Code also inhalation exposure is considered relevant for the classification of a substance/material. Evaluation of both human epidemiological data and animal test data has resulted in the following conclusions:

- route of exposure: inhalation is the only exposure route that triggers adverse effects
- germ cell mutagenicity: there is insufficient evidence to classify coal for this end point; coal is not considered to be a germ cell mutagen
- carcinogenicity: there is insufficient evidence to classify coal for this end point; coal is not considered to be a carcinogen
- reproductive toxicity: there is insufficient evidence to classify coal for this end point; coal is not considered to be a reproductive toxicant
- Specific Target Organ Toxicity – Repeated Exposure (STOT-RE): based on the available data that include human epidemiological studies consistently showing that exposure to coal dust induces adverse effects in the lungs (primary effects: pneumoconiosis, fibrosis), it was concluded that coal should be classified as STOT-RE, Cat.1.

It is important to point out that the STOT-RE Cat.1 classification is based on adverse effects that result from long-term high exposures (e.g. during mining). Workers (or the general population) who come into contact with coal during transport will not be exposed to such high levels of coal dust. In

addition, it is noteworthy that in some studies the released respirable crystalline silica[1] from the surrounding mineral rock during mining activities may have contributed to the adverse effects that justify a STOT-RE Cat.1 classification. However, not all adverse lung effects are solely attributed to the respirable crystalline silica. Therefore, as a precautionary principle, a classification of coal as STOT-RE Cat.1 is recommended.

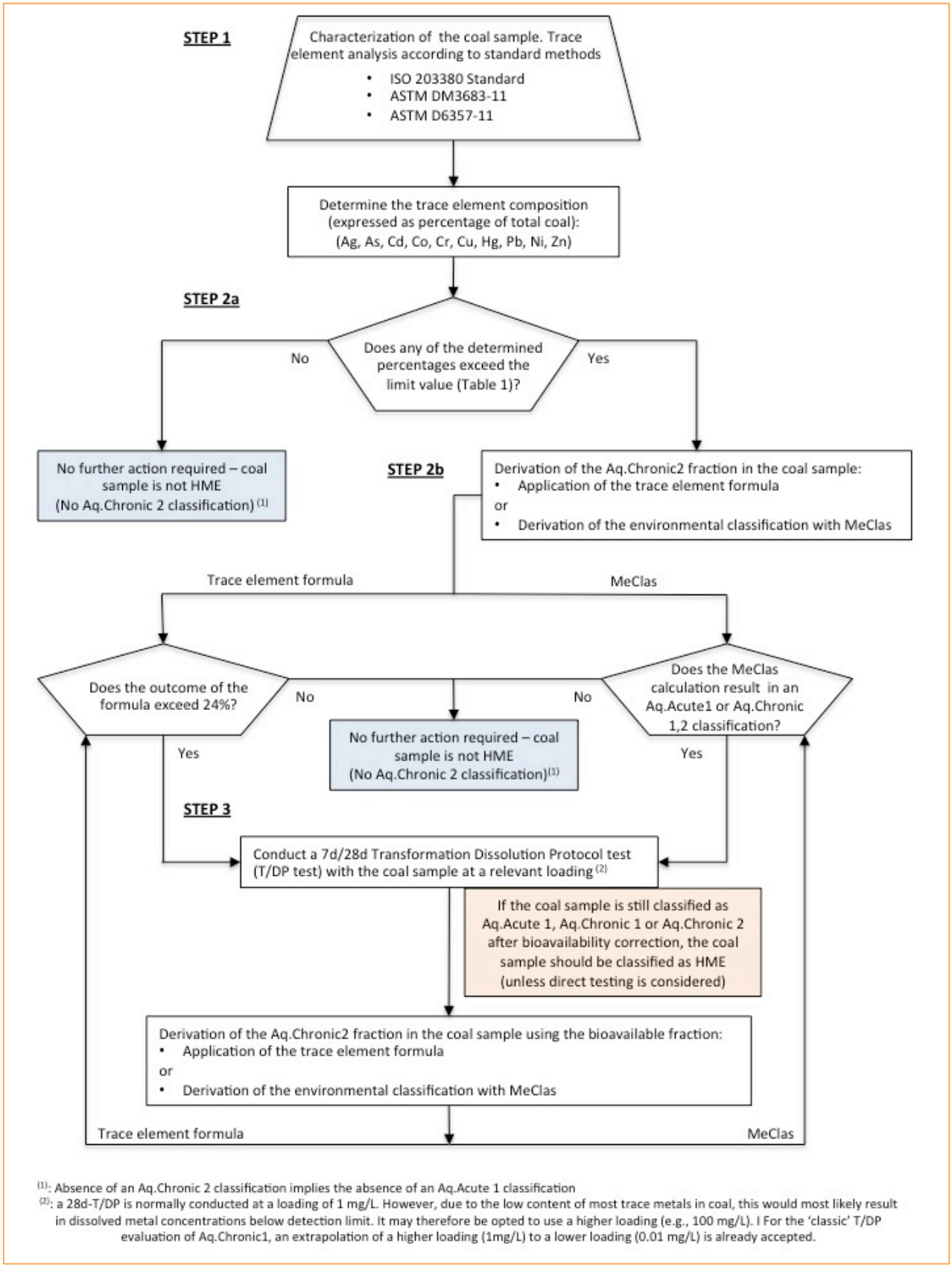
Classification of coal as a STOT-RE Cat.1 (inhalation route) will most likely result in an adaptation of the Group B transport schedules that are currently already in place, ensuring that workers are protected from the potentially adverse effects of coal dust. Within the context of transport-related health and safety, the use of dust masks or respirators may be sufficiently adequate to protect workers who come directly into contact with coal dust (e.g. dust created during loading/unloading, cleaning of cargo space). It remains unclear if or when such revisions will be implemented.

[1] For more information refer to the Industrial Minerals Asssociation website - http://www.ima-europe.eu/eu-policy/product-stewardship/respirable-crystalline-silica

3. GUIDANCE ON THE ENVIRONMENTAL HAZARD ASSESSMENT OF COAL

When deriving the classification of a mixture, there is no legal obligation to take compounds into account that are present at a concentration below 0.1% (or 0.1%/M-factor). Currently, there is no evidence that coal contains specific organic substances at such high concentration levels. Moreover, due to the complexity of the organic fraction in coal, it is not feasible to determine the (very low) concentration levels of every possible organic compound in coal. In addition, the hypothesis that a large mixture of organic compounds at very low concentration levels could still trigger acute/chronic effects is not supported by the few ecotoxicological data that are available for unburnt coal. It is therefore concluded that the organic fraction of coal will not trigger an Aq.Acute 1 or an Aq.Chronic1 / Aq.Chronic2 classification. In theory, the inorganic fraction may trigger a need to classify a coal sample if the concentration of one or more key trace elements exceed a specific threshold. A stepwise approach for the environmental hazard assessment of the inorganic fraction of a coal sample is presented in Figure 1. The different steps of this evaluation are discussed in detail in the following sections.

Figure 1 Stepwise approach for the environmental hazard assessment of coal



(1): Absence of an Aq.Chronic 2 classification implies the absence of an Aq.Acute 1 classification

(2): a 28d-T/DP is normally conducted at a loading of 1 mg/L. However, due to the low content of most trace metals in coal, this would most likely result in dissolved metal concentrations below detection limit. It may therefore be opted to use a higher loading (e.g., 100 mg/L). I For the 'classic' T/DP evaluation of Aq.Chronic1, an extrapolation of a higher loading (1mg/L) to a lower loading (0.01 mg/L) is already accepted.

3.1. STEP 1: TRACE ELEMENT COMPOSITION OF THE COAL SAMPLE

The first step of the environmental hazard assessment of coal entails an elemental analysis that is conducted according to the procedures that are outlined in a number of international accepted guidance documents:

- ISO 203380 Standard (2008, revised 2013): Selection of methods for the determination of trace elements in coal
- ASTM D3683-11: Standard Test Method for Trace Elements in Coal and Coke by Atomic Absorption
- ASTM D6357-11: Test Methods for Determination of Trace Elements in Coal, Coke, and Combustion Residues from Coal Utilization Processes by Inductively Coupled Plasma Atomic Emission, Inductively Coupled Plasma Mass, & Graphite Furnace Atomic Absorption Spectrometry.

Trace elements for which the fraction in coal (as percentage) may be critical for the hazard assessment are those that were identified as predominant contributors to a derived worst-case Aq.Chronic2 classification.[2] The main critical trace elements are cadmium, lead, mercury and zinc. Four minor critical trace elements are chromium, cobalt, copper and nickel. Other elements that should be taken into account (due to their high environmental toxicity) are arsenic and silver.

3.2. STEP 2: HAZARD ASSESSMENT BASED ON CRITICAL TRACE ELEMENT COMPOSITION – MAXIMUM BIOAVAILABILITY

An environmental hazard-based classification of coal as HME under MARPOL is not required when data demonstrate that an Aq. Acute 1, Aq.Chronic1 or Aq.Chronic2 classification is not applicable. Such a classification will depend on the concentration of critical trace elements.

[2] Worst-case classification was derived for a hypothetical coal sample with very high concentration levels of each trace metal.

3.2.1. STEP 2A: EVALUATION AGAINST LIMIT VALUES

A set of limit values that covers all critical elements (Table 1) has been established. The relevant worst-case concentration levels that were previously defined were used as a starting point, thus ensuring that the vast majority of coal samples are covered by this set of limit values.

A coal sample that does not exceed any of these limit values will not be classified as Aq.Chronic 2 (or more severe) for the environment; consequently, a classification as HME under MARPOL is not required. It should be noted that this analysis is based on comparing metal concentration levels against their chronic Ecotoxicity Reference Values (ERVs). Acute ERVs are higher than chronic ERVs, and therefore concentration levels that do not trigger an Aq.Chronic 2 classification will also not trigger an Aq.Acute 1 classification.

Table 1 Critical limit concentrations of trace elements in coal – coal samples that meet these requirements are not classified as Aq.Acute 1, Aq.Chronic 1 or Aq.Chronic 2

Element	mg/kg coal	%	Element	mg/kg coal	%
Arsenic	250	0.025	Lead	1000	0.11
Cadmium	65	0.0065	Mercury	30	0.03
Chromium	100	0.01	Nickel	100	0.01
Cobalt	60	0.006	Silver	0.2	0.00002
Copper	250	0.025	Zinc	2000	0.2

3.2.2. STEP 2A: EVALUATION BASED ON THE GHS-SUMMATION METHOD

If a limit value for one (or more) of the trace elements in Table 1 has been exceeded, then the calculation procedure that is presented in Table 2 should be applied.

Table 2 Calculation of the Aq.Chronic2 contribution (Tier-0 approach) for relevant trace metals in coal

Trace element		Conversion factor to most critical compound[1]		M-factor		Conversion Chronic 1 to Chronic 2[2]		
% Ag	x	1.58	x	100	x	10	=	Ag-contribution
% As	x	1.32	x	1	x	10	=	As-contribution
% Cd	x	1.85	x	100	x	10	=	Cd-contribution
% Co	x	2.63	x	10	x	10	=	Co-contribution
% Cr	x	1.92	x	1	x	10	=	Cr-contribution
% Cu	x	2.51	x	1	x	10	=	Cu-contribution
% Hg	x	1	x	100	x	10	=	Hg-contribution
% Pb	x	1	x	1	x	10	=	Pb-contribution
% Ni	x	2.64	x	1	x	10	=	Ni-contribution
% Zn	x	2.47	x	1	x	10	=	Zn-contribution
Sum of all contributions resulting in no Aq.Chronic2 classification (or more stringent):								<24 %

[1] In Tier-0, the classification is based on the metal compound with the most stringent classification, e.g. Zn is assumed to be present as $ZnSO_4$; therefore, the fraction of Zn has to be converted to a fraction of $ZnSO_4$.

[2] All compounds in this table are classified as Aq.Chronic 1. In order to determine whether a mixture that contains Aq.Chronic1 compounds should be considered as Aq.Chronic2, the fraction of Aq.Chronin1 compounds has to be multiplied by 10.

For example, if a coal sample contains 400 mg Zn/kg coal, then the Zn contribution would be:

0.04% * 2.47 * 1 * 10 = 0.99% (with 2.47 the conversion factor between Zn and $ZnSO_4$).

When the sum of all trace element contributions is less than 24%, there is no need to classify the coal sample as Aq.Chronic1 or Aq.Chronic2. According to GHS rules, the cut-off level for mixtures is actually 25%, but setting a margin of 24% allows a contribution of 0.1% of other trace metals with an Aq.Chronic 1 classification that is not included in Table 2. However, as all Aq.Chronic1 trace metals that are relevant for coal are covered, it is highly unlikely that this scenario would occur.

Alternatively, the trace element percentages could also be entered into the MeClas classification tool (www.meclas.eu), which then automatically calculates the Tier-0 classification.

3.3. STEP 3: CONDUCTING A TRANSFORMATION/DISSOLUTION PROTOCOL (T/DP) TEST WITH A COAL SAMPLE

When the outcome of the Tier-0 evaluation indicates that the worst-case approach would result in an Aq.Chronic2 classification (or worse), then a T/DP test with the coal sample can be conducted. Guidance on how to conduct a T/DP test is provided in OECD Guideline No. 29 (Guidance Document on Transformation/Dissolution of Metals and Metal Compounds in Aqueous Media). Trace metals that should be assessed are those that have the highest Aq.Chronic2 contribution (see Table 2 or MeClas output).

The evaluation of the chronic bioavailability of trace elements is generally done at prescribed loadings. Depending whether a mixture is classified as Aq.Chronic 3, 2 or 1, the loadings are 1 mg/L, 0.1 mg/L and 0.01 mg/L, respectively. Due to practical reasons (limitations of the detection limit (DL) for many metals), extrapolation from a loading of 1 mg/L is applied for assessing lower loading levels.

As the trace metal concentration in coal is generally low (< 0.5% for the majority of coal samples), the dissolved concentrations in the T/DP medium at a loading of 1 mg/L would be situated below standard detection limits, even when 100% dissolution of the trace elements would occur. However, in order to determine a relevant release factor for the most critical trace elements, measured values greater than DL are required. Therefore, the used loading should ensure that 100% dissolution of the critical elements would result in a concentration that is several factors higher than the detection limit for those elements.

The outcome of the T/DP allows the correction of total trace element concentration to bioavailable concentrations, and the latter fraction has to be used in the refinement of the Tier-0 classification. If T/DP correction does not remove the HME classification, a final refinement could be implemented by conducting a number of ecotoxicity tests, using the coal sample as a test substance (direct testing). If no adverse chronic effects are observed at a test concentration of 1 mg coal/L, or – in the absence of chronic data – no adverse acute effects are observed at a test concentration of 10 mg coal/L, a theoretically derived Aq.Chronic2 classification can be waived.

4. CONCLUSIONS

For MARPOL, there is no need to classify coal as an HME based on human health end points. An environmental classification of coal as HME is possible in theory, but only when one or more key trace element concentration levels exceed the critical thresholds that are presented in Table 1. In addition, the GHS classification strategy for mixtures also assumes that the complete trace element fraction would be bioavailable; in reality, the majority of trace elements are embedded in the coal matrix and will not dissolve from coal into the aquatic environment. This limited bioavailability can easily be demonstrated by means of conducting a Transformation/Dissolution Protocol test, and the outcome of this test will most likely allow the removal of any Aq.Chronic1 or 2 classification.

It can thus be concluded that there will be no need to classify coal as an HME according to MARPOL.

For IMSBC, there is a need to classify coal as a STOT-RE Cat.1 due to the observed effects in the lung upon long-term inhalation of high levels of coal dust. This classification, however, will have no immediate implications on the Group B classification of coal that is currently already in place under the IMSBC Code. It is expected that some amendments on the transport schedule for coal will be introduced at some point in time, thereby protecting workers who may come in direct contact with coal and coal dust.

For more information on the work of the World Coal Association, please visit:

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