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Inland Transport Committee

Working Party on the Transport of Dangerous Goods

Joint Meeting of Experts on the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) (ADN Safety Committee)

Twenty-first session
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Item 6 of the provisional agenda
Catalogue of questions

Guidelines of the Administration Committee for the use of the catalogue of questions for the ADN expert examination (Chapter 8.2 of ADN)

Transmitted by the Central Commission for the Navigation of the Rhine (CCNR)[1, 2]

1. General

To improve safety during the transport of dangerous goods, an expert capable of proving specialized knowledge of the transport of dangerous goods must be on board the vessel.

On the basis of Chapter 8.2 of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN), the Administrative Committee referred to in article 17 of ADN established the following guidelines under which examinations must be carried out in all the Contracting Parties to ADN.

The examinations referred to in subsection 8.2.2.7 of the Regulations annexed to ADN shall be conducted by a competent authority or an examination centre authorized by such an authority. The examination shall be carried out by:

[1] Distributed in German by the Central Commission for the Navigation of the Rhine in document CCNR/ZKR/ADN/WP.15/AC.2/2011/22.

[2] In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/2010/8, programme activity 02.7 (b)).

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- For basic courses, a chairperson at a minimum;
- For specialization courses, a chairperson and an assessor with the required proficiency at a minimum.

Candidates who pass the examination shall be issued an ADN specialized knowledge certificate as stipulated by subsection 8.2.2.8, in conjunction with subsection 8.2.1.3, 8.2.1.5 or 8.2.1.7.

The examinations for refresher and advanced training referred to in 8.2.2.7.3.1 of ADN are carried out by a training organizer.

After success in the examination, the training organizer issues the candidate with a written statement for presentation to the competent authority.

Candidates who fail the examination shall be informed of the reasons why they failed. Candidates who fail specialization course examinations (on gas or chemicals) shall be informed of the reasons in writing.

The competent authorities are invited to inform the Safety Committee of questions that are obviously confusing or doubts as to the accuracy of the answers provided.

2. Numbering of examination questions in the catalogue

The numbering of the questions in the catalogue is independent of language version, continuous and straightforward.

To facilitate electronic data processing procedures, the question numbers are organized as a series of eight digits.

The first digit indicates whether the question relates to basic training or advanced training (in gases or chemicals).

The second indicates whether the question is part of the “General” or the “Transport by dry cargo vessels” or “Transport by tank vessels” parts of the examination.

The third indicates whether the question relates to “basic general knowledge”, “knowledge of physics and chemistry”, “practice” or “emergency measures”.

The fourth, fifth and sixth digits form a figure indicating the examination objective. The examination objectives follow the numbering of the current objectives (for example, 01.1 or 10.0) so that they are more easily recognizable.

The seventh and eighth digits indicate the question number and are separated from the figure referring to the objective by a hyphen.

Place of the digit in the question number	*Possible codes*	*Meaning*
1	1	Basic training
	2	Advanced training in gases
	3	Advanced training in chemicals
2	1	General
	2	Dry cargo vessels
	3	Tank vessels
3	0	Basic general knowledge

Place of the digit in the question number	*Possible codes*	*Meaning*
	1	Knowledge of physics and chemistry
	2	Practice
	3	Emergency measures
4 to 6	0 to 9	(Examination objective under 8.2.2.3.1)
7 and 8	0 to 9	(Continuous numbering – maximum 99 questions possible)

A “0” is sometimes used to fill empty spaces.

Examples:

110 06.0-01 Basic training – general – basic general knowledge – examination objective 6 – question No. 1.

231 01.1-11 Advanced training in gases – transport by tank vessels – knowledge of physics and chemistry – examination objective 1.1 – question No. 11.

332 12.0-16 Advanced training in chemicals – transport by tank vessels – practice – examination objective 12 – question No. 16.

3 → Advanced training in chemicals

3 → Tank vessels

2 → Practice

12.0 → Examination objective 12

16 → Question No. 16

In addition, references to ADN are indicated for various questions, depending on the subject.

3. Examinations

3.1 Basic training

Examinations for basic training shall be held in accordance with 8.2.2.7.1.

The following three types of examinations may be held for basic training:

- Examination on general ADN questions and on ADN dry cargo vessels;
- Examination on general ADN questions and ADN tank vessels; or
- Examination on general ADN questions, ADN dry cargo vessels and ADN tank vessels.

The attached model (see 3.1.1) shall be used when preparing the examination questions.

In accordance with 8.2.2.7.1.5, the examination shall be written. Candidates shall be asked 30 multiple-choice questions and no substantive questions. The examination shall last 60 minutes. The examination shall be considered as passed if at least 25 of the 30 questions have been answered correctly. During the examination, candidates may consult the texts of regulations on dangerous goods and CEVNI or the police regulations based on these regulations.

The catalogue of questions for basic training is available in English, French and Russian on the ECE website (http://www.unece.org/trans/danger/publi/adn/catalog_of_questions.html). The German version is available on the CCNR website (www.ccr-zkr.org).

3.1.1 Models for the examinations

The following models, in accordance with 8.2.2.7.1.4, indicate the number of questions in the catalogue of questions for each examination objective and the number of questions to be selected for the various examination objectives when drawing up the examination.

For example, for the part of the examination on dry cargo vessels, five questions in all must be chosen for the examination objective "Construction and equipment": two under the "General" heading and three under "Transport by dry cargo vessels". In total, this part of the examination shall comprise 30 questions.

(a) Dry cargo vessels

Examination objective		*Number of questions in the catalogue*		*General*	*Specific to dry cargo vessels*	*Total*
		General	*Specific to dry cargo vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	1	-	1
2	Construction and equipment	21	32	2	3	5
3	Treatment of holds and adjacent spaces	--	19	-	2	2
4	Measurement techniques	21	--	2	-	2
5	Knowledge of products	78	--	2	-	2
6	Loading, unloading and transport	19	70	2	5	7
7	Documents	31	22	2	2	5
8	Hazards and measures of prevention	72	27	2	3	6
9	Stability			2		2
	Total			**15**	**15**	**30**

(b) Tank vessels

Examination objective		*Number of questions in the catalogue*		*General*	*Specific to tank vessels*	*Total*
		General	*Specific to tank vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	1	-	1
2	Construction and equipment	21	50	2	2	4
3	Treatment of holds and adjacent spaces	--	33	-	3	3
4	Measurement techniques	21	13	2	1	3

Examination objective		*Number of questions in the catalogue*		*General*	*Specific to tank vessels*	*Total*
		General	*Specific to tank vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
5	Knowledge of products	78	--	2	-	2
6	Loading, unloading and transport	19	56	2	4	6
7	Documents	31	24	2	2	5
8	Hazards and measures of prevention	72	37	2	3	6
9	Stability			2		2
	Total			**15**	**15**	**30**

(c) Combined dry cargo/tank vessels

Examination objective		*Number of questions in the catalogue*			*General*	*Specific to tank vessels*	*Specific to dry cargo vessels*	*Total*
		General	*Specific to tank vessels*	*Specific to dry cargo vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	--	1	-	-	1
2	Construction and equipment	21	50	32	2	1	1	4
3	Treatment of holds and adjacent spaces	--	33	19	-	2	1	3
4	Measurement techniques	21	13	--	2	1	-	3
5	Knowledge of products	78	--	--	2	-	-	2
6	Loading, unloading and transport	19	56	70	2	1	3	6
7	Documents	31	24	22	2	1	1	5
8	Hazards and measures of prevention	72	37	27	2	2	1	6
9	Stability				2			2
	Total				**15**	**8**	**7**	**30**

3.1.2. Matrices for the examinations after refresher and advanced training

The following matrices in accordance with 8.2.2.7.3.2 and 8.2.2.7.3.3 of ADN indicate the number of questions in the catalogue of questions for each exam objective. They indicate the number of questions to be selected for the different examination objectives when the examination is being set.

(a) Dry cargo vessels

Examination objective		*Number of questions in the catalogue*		*General*	*Specific to dry cargo vessels*	*Total*
		General	*Specific to dry cargo vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	1	-	1
2	Construction and equipment	21	32	1	2	3
3	Treatment of holds and adjacent spaces	--	19	-	1	1
4	Measurement techniques	21	--	1	-	1
5	Knowledge of products	78	--	1	-	1
6	Loading, unloading and transport	19	70	1	4	5
7	Documents	31	22	1	1	2
8	Hazards and measures of prevention	72	27	2	2	4
9	Stability			2*		2*
	Total			**10**	**10**	**20**

* For the period from 1 January 2013 to 31 December 2014, these questions are only relevant if the training has also dealt with "stability". If this is not the case, the other examination objectives should be increased by the corresponding number.

(b) Tank vessels

Examination objective		*Number of questions in the catalogue*		*General*	*Specific to tank vessels*	*Total*
		General	*Specific to tank vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	1	-	1
2	Construction and equipment	21	50	1	1	2
3	Treatment of holds and adjacent spaces	--	33	-	2	2
4	Measurement techniques	21	13	1	1	2
5	Knowledge of products	78	--	1	-	1
6	Loading, unloading and transport	19	56	1	3	4
7	Documents	31	24	1	1	2
8	Hazards and measures of prevention	72	37	2	2	4
9	Stability			2*		2*
	Total			**10**	**10**	**20**

* For the period from 1 January 2013 to 31 December 2014, these questions are only relevant if the training has also dealt with "stability". If this is not the case, the other examination objectives should be increased by the corresponding number.

(c) Combined dry cargo/tank vessels

Examination objective		*Number of questions in the catalogue*			*General*	*Specific to tank vessels*	*Specific to dry cargo vessels*	*Total*
		General	*Specific to tank vessels*	*Specific to dry cargo vessels*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*	*Number of questions to be selected*
1	General	14	--	--	1	-	-	1
2	Construction and equipment	21	50	32	1	-	-	1
3	Treatment of holds and adjacent spaces	--	33	19	-	1	1	2
4	Measurement techniques	21	13	--	1	-	-	1
5	Knowledge of products	78	--	--	1	-	-	1
6	Loading, unloading and transport	19	56	70	1	1	1	3
7	Documents	31	24	22	1	1	1	3
8	Hazards and measures of prevention	72	37	27	2	1	1	4
9	Stability				2*			2*
	Total				**10**	**5**	**5**	**20**

* For the period from 1 January 2013 to 31 December 2014, these questions are only relevant if the training has also dealt with "stability". If this is not the case, other examination objectives should be increased by the corresponding number.

3.2 Advanced training in gases

Candidates who are successful in the ADN basic training examination may apply for enrolment in a specialization course on gases, to be followed by an examination.

The gas specialization examination shall be held in accordance with the provisions of ADN section 8.2.2.7.2.5.

The model below (3.2.1) shall be used when preparing the examination questions.

The examination shall be written and shall comprise two parts. The competent authority or examining body may choose the order of the parts.

One of the parts of the examination shall comprise 30 multiple-choice questions selected from the catalogue of questions on gases. The questionnaire shall be drawn up in accordance with the model in 3.2.1, below. This part of the examination takes 60 minutes. Each correct answer is worth one point. The maximum number of points that may be obtained is 30.

The other part of the examination (3.2.2) shall consist in a substantive exercise, with 15 questions specific to a substance, to be selected by the competent authority or examining body designated by that authority from the catalogue of substantive questions on gas.

The multiple-choice questions on gases are available in English, French and Russian on the ECE website (http://www.unece.org/trans/danger/publi/adn/catalog_of_questions.html). The German version is available on the CCNR website (www.ccr-zkr.org).

3.2.1 Model for the examination

The following models, in accordance with 8.2.2.7.1.4, indicate the number of questions in the catalogue of questions for each examination objective and the number of questions to be selected for the various examination objectives when preparing the examination.

For example, for examination objective 2, “Gases: partial pressures and mixtures”, of part (a), the “Knowledge of physics and chemistry” part of the examination, one question must be selected from subsections 2.1, Definitions and simple calculations, and 2.2, Pressure increase and gas release from cargo tanks. This part of the examination shall be made up of nine questions in total.

(a) Knowledge of physics and chemistry

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	Law of ideal gases		
1.1	Boyle-Mariotte, Gay-Lussac	10	1
1.2	Fundamental law	10	
2	Partial pressures and mixtures		
2.1	Definitions and simple calculations	10	1
2.2	Pressure increase and gas release from cargo tanks	10	
3	Avogadro’s number and calculation of masses of ideal gases		
3.1	Molecular mass, mass and pressure	10	1
3.2	Application of the mass formula	10	
4	Density and volume of liquids		
4.1	Density and volume in terms of temperature increase	10	1
4.2	Maximum degree of filling	10	
5	Critical pressure and temperature	5	
6	Polymerization		1
6.1	Theoretical questions	5	
6.2	Practical questions, conditions of carriage	10	1
7	Evaporation and condensation		
7.1	Definitions, etc.	10	1
7.2	Vapour pressure at saturation	10	
8	Mixtures		
8.1	Vapour pressure and composition	10	1
8.2	Hazard characteristics	10	
9	Chemical bonds and formulae	10	1
	Total		**9**

(b) Practice

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	Flushing		
1.1	Flushing in the event of a change of cargo	5	
1.2	Addition of air to the cargo	5	1
1.3	Methods of flushing and degassing before entering cargo tanks	10	2
2	Sampling	10	1
3	Danger of explosion	10	2
4	Health risks	10	1
5	Measuring gas concentration		
5.1	Measuring devices	10	2
5.2	Use of measuring devices	10	2
6	Monitoring of closed spaces and entry to these spaces	10	1
7	Certificates for degassing and permitted work	10	1
8	Degree of filling and overfilling	10	1
9	Safety installations	10	2
10	Pumps and compressors	10	1
	Total		**17**

(c) Emergency measures

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	Physical injury		
1.1	Liquefied gasses on skin	5	
1.2	Breathing in gas	5	2*
1.3	Emergency assistance, general	5	
2	Irregularities relating to the cargo		
2.1	Leak in a connection	3	
2.2	Fire in the engine room	3	
2.3	Hazards in the vicinity of the vessel	4	2*
2.4	Overfilling	2	
2.5	Polymerization	3	
	Total		**4**

* The questions must be taken from two different subsections.

3.2.2 List of substantive questions on gases

The following documents shall be made available to the candidate (see annex I):

- A description of situation 01 or 02 (see annex I, 1);
- The selected questions (15 partial questions) (see annex I, 2);

- A certificate of approval (see annex I, 4);
- A sheet containing information on the characteristics of the substance relevant to the use of a breathing apparatus (see annex I, 3); and
- The information sheet on the GASEX motor tanker equipment;
- The safety data sheet with the maximum permissible concentration at the workplace or equivalent documents for the substance in question.

The texts of regulations and technical literature referred to in 8.2.2.7 are also authorized for use during the examination.

The questions regarding the threshold limit value at the workplace may not be used if no such maximum exists for the substance.

The candidate shall have 90 minutes to complete this part of the examination. The maximum number of points that may be obtained is 30. The distribution of the points shall be set by the competent authority or examining body prior to the examination depending on the degree of difficulty of the questions.

The examination shall be marked in accordance with 8.2.2.7.2.5.

The substantive questions and model answers to the examination for the specialization course on gases shall be made available by the respective national authorities only to the authorities responsible for the examinations and to approved examining bodies.

The model answers shall serve as a guide.

3.3 Advanced training in chemicals

Candidates who are successful in the ADN basic training examination may apply for enrolment in a specialization course on chemicals, to be followed by an examination.

The chemicals specialization examination shall be held in accordance with the provisions of ADN section 8.2.2.7.2.5.

The model below (3.3.1) shall be used when preparing the examination questions.

The examination shall be written and shall comprise two parts. The competent authority or examining body may choose the order of the parts.

One of the parts of the examination shall comprise 30 multiple-choice questions selected from the catalogue of questions on chemicals. The questionnaire shall be drawn up in accordance with the model in 3.3.1, below. This part of the examination takes 60 minutes. Each correct answer is worth one point. The maximum number of points that may be obtained is 30.

The other part of the examination (3.3.2) shall consist in a substantive exercise, with 15 questions specific to a substance, to be selected by the competent authority or examining body designated by that authority from the catalogue of substantive questions on chemicals.

The multiple-choice questions on chemicals are available in English, French and Russian on the ECE website at http://www.unece.org/trans/danger/publi/adn/catalog_of_questions.html. The German version is available on the CCNR website (www.ccr-zkr.org).

3.3.1 Model for the examination

The following models, in accordance with 8.2.2.7.1.4, indicate the number of questions in the catalogue of questions for each examination objective and the number of questions to be selected for the various examination objectives when preparing the examination.

For example, in part (a), the "Knowledge of physics and chemistry" part of the examination, one question must be selected from those relating to examination objective 3, "Physical state". This part of the examination shall be made up of 12 questions in total.

(a) Knowledge of physics and chemistry

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	General	8	1
2	Temperature, pressure, volume	23	1
3	Physical state	11	1
4	Fire, combustion	6	1
5	Mass density (density)	16	1
6	Mixtures, chemical bonds	8	1
7	Molecules, atoms	15	1
8	Polymerization	17	1
9	Acids, bases	16	1
10	Oxidation	7	1
11	Knowledge of chemicals	20	1
12	Chemical reactions	16	1
	Total		**12**

(b) Practice

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	Measurements	14	2
2	Sampling techniques	12	1
3	Cleaning of cargo tanks, degassing, washing of tanks	24	3
4	Handling slops, residual cargo and residual substance tanks	10	2
5	Certificates for degassing and permitted work	12	2
6	Loading, unloading	34	3
7	Heating	12	2
	Total		**15**

(c) Emergency measures

Examination objective		*Number of questions in the catalogue*	*Number of questions on the examination*
1	Physical injury	7	0 or 1
2	Material damage	6	0 or 1
3	Environmental damage	5	0 or 1
4	Damage-control plans	6	0 or 1
	Total		**3**

3.3.2 List of substantive questions on chemicals

The following documents shall be made available to the candidate:

- Description of the situation (see annex II, 1);
- The selected questions (15 partial questions) (see annex II, 2);
- A sheet containing information on the characteristics of the substance relevant to the use of a breathing apparatus (see annex I, 3); and
- A certificate of approval (see annex II, 4); and
- The safety data sheet with the maximum permissible concentration at the workplace or equivalent documents for the substance in question.

The texts of regulations and technical literature referred to in 8.2.2.7 are also authorized for use during the examination.

The questions regarding the threshold limit value at the workplace may not be used if no such maximum exists for the substance selected.

The candidate shall have 90 minutes to complete this part of the examination. The maximum number of points that may be obtained is 30. The distribution of the points shall be set by the competent authority or examining body prior to the examination depending on the degree of difficulty of the questions.

The examination shall be marked in accordance with 8.2.2.7.2.5.

The substantive questions and model answers to the examination for the specialization course on chemicals shall be made available by the respective national authorities only to the authorities responsible for the examinations and to approved examining bodies.

The model answers shall serve as a guide.

Annex I

Data sheets for substantive questions for the specialization course on gases

1. Situation description

This section of the examination is based on the following situation descriptions:

Situation 01:

Loading and unloading

Your motor tanker carries certificate of approval No. 001. The tank vessel has just left the shipyard; the cargo tanks have already been opened and the piping is now under pressure; the blocking valves are closed.

At terminal 1 the vessel is to be loaded with a maximum of [substance from 3] UN XXXX (NAME, class, classification code, packing group), and it is later to be unloaded at terminal 2.

Loading port = terminal 1

The substance to be loaded is stored in spherical tanks.

The terminal can deliver a nitrogen flow of up to 1,000 m^3/h at a maximum pressure of 5 bar (gauge) and has a flare stack with a capacity of 1,000 m^3/h.

During loading the vapours/gas must not be returned to the on-shore spherical tank.

The terminal's loading flow is 250 m^3/h.

The temperature of the substance and the ambient temperature are both 10° C.

Unloading port = terminal 2

The vessel is unloaded with the on-board pumps. The greatest possible quantity must be unloaded.

The substance is unloaded into a spherical storage tank. A gas return line is available.

The ambient temperature is 10° C.

Situation 02:

Loading and unloading

Your motor tanker carries certificate of approval No. 001. The tank vessel contains UN No. 1011 n-BUTANE; the pressure in the cargo tank is 0.2 bar (gauge).

At terminal 1 the vessel is to be loaded with a maximum of [substance from 3] UN XXXX (NAME, class, classification code, packing group), and it is later to be unloaded at terminal 2.

Loading port = terminal 1

The substance to be loaded is stored in spherical tanks.

The terminal can deliver a nitrogen flow of up to 1,000 m^3/h at a maximum pressure of 5 bar (gauge) and has a flare stack with a capacity of 1,000 m^3/h.

During loading the vapours/gas must not be returned to the on-shore spherical tank.

The terminal's loading flow is 250 m^3/h.

The temperature of the substance and the ambient temperature are both 10° C.

Unloading port = terminal 2

The vessel is unloaded with the on-board pumps. The greatest possible quantity must be unloaded.

The substance is unloaded into a spherical storage tank. A gas return line is available.

The ambient temperature is 10° C.

2. Questions

The questions must be selected in accordance with the following scheme. A logical order should be followed.

A. Preparation for loading

General questions:

Choose two questions from A-1, A-2 (a or b) and A-3.

[Note: for situation 01, question A-2a, for situation 02, question A-2b.]

Substance-related questions:

Choose one question from A-4/1 to A-4/6.

B. Flushing of cargo tanks

Choose three questions from B-1 to B-10.

C. Loading

General question:

Choose question C-1.

Choose three questions from C-2 to C-10.

[Note: C-3 and C-4 cannot both be chosen for the same examination session, nor can C-7 and C-8. Thus, C-3 or C-4 may be chosen, and C-7 or C-8 may be chosen. This means that C-3 or C-4 and C-7 or C-8 may be chosen. Question C-8 is not suitable for the following substances:

1-3-BUTADIENE, STABILIZED and VINYL CHLORIDE, STABILIZED.]

D. Load calculation

Choose three calculations D-1 to D-3.

E. Unloading

Choose two questions E-1 and E-2.

3. Substances and their characteristics

A substance and its accompanying information sheet should be chosen from among those in the following list.

Substance properties PROPANE

Name: **PROPANE**	UN No. **1978**
Formula: **C_3H_8**	
Boiling point: **- 42° C**	Molar mass: ***M* = 44 (44.096)**
Ratio between the vapour density and that of air = 1 (15° C): **1.53**	
Flammable gas/air mixture, vol.%: **1.7 – 10.8**	
Auto-ignition temperature: **470° C**	Critical temperature: **96.8° C**
Maximum permissible concentration at the workplace: **1,000 ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	3.45	541.9	7.54
-5	4.06	535.4	8.81
0	4.74	528.7	10.23
5	5.50	521.8	11.82
10	6.36	514.7	13.63
15	7.31	507.5	15.65
20	8.36	500.0	17.90
25	9.51	492.3	20.39
30	10.78	484.3	23.18
35	12.17	476.1	
40	13.69	467.4	
45	15.35	458.4	
50	17.14	448.9	

Substance properties PROPYLENE

Name: **PROPYLENE**	UN No. **1077**
Formula: **C_3H_6**	
Boiling point: **- 48° C**	Molar mass: ***M* = 42 (42.080)**
Ratio between the vapour density and that of air = 1 (15° C): **1.46**	
Flammable gas/air mixture, vol.%: **2.0 – 11.6**	
Auto-ignition temperature: **485° C**	Critical temperature: **91.9° C**
Maximum permissible concentration at the workplace: **--- ppm**	

Vapour-liquid equilibrium

T [°C]	***p max [bar]***	**ρL [kg/m^3]**	**ρG [kg/m^3]**
-10	4.28	559.9	9.05
-5	5.01	552.9	10.54
0	5.83	545.7	12.22
5	6.75	538.3	14.11
10	7.78	530.7	16.25
15	8.91	522.8	18.62
20	10.16	514.7	21.28
25	11.53	506.4	24.23
30	13.04	497.7	27.53
35	14.69	488.6	
40	16.49	479.1	
45	18.44	469.2	
50	20.56	458.6	

Substance properties BUTANE

Name: **BUTANE**	UN No. **1011**
Formula: **C_4H_{10}**	
Boiling point: **1.0° C**	Molar mass: ***M* = 58 (58.123)**
Ratio between the vapour density and that of air = 1 (15° C): **2.01**	
Flammable gas/air mixture, vol.%: **1.4 – 9.4**	
Auto-ignition temperature: **365° C**	Critical temperature: **152° C**
Maximum permissible concentration at the workplace: **1,000 ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	0.70	611.9	1.90
-5	0.85	606.5	2.27
0	1.03	601.1	2.72
5	1.24	595.6	3.23
10	1.48	590.1	3.81
15	1.76	584.4	4.49
20	2.07	578.7	5.23
25	2.43	572.9	6.09
30	2.83	566.9	7.04
35	3.27	560.9	
40	3.77	554.7	
45	4.32	548.5	
50	4.93	542.0	

Substance properties ISOBUTANE

Name: **ISOBUTANE**	UN No.: **1969**
Formula: **C_4H_{10}**	
Boiling point: **-12° C**	Molar mass: ***M* = 58 (58.123)**
Ratio between the vapour density and that of air = 1 (15° C): **2.01**	
Flammable gas/air mixture, vol.%: **1.5 – 9.4**	
Auto-ignition temperature: **460° C**	Critical temperature: **~152° C**
Maximum permissible concentration at the workplace: **1,000 ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	1.08	592.0	2.96
-5	1.31	586.3	3.55
0	1.56	580.6	4.18
5	1.86	574.8	4.94
10	2.20	568.9	5.79
15	2.58	562.9	6.73
20	3.00	556.8	7.77
25	3.48	550.5	8.96
30	4.01	544.2	10.28
35	4.60	537.6	
40	5.25	531.0	
45	5.96	524.1	
50	6.74	517.1	

Substance properties BUTYLENE-1

Name: **BUTYLENE-1**	UN No.: **1012**
Formula: **C_4H_8**	
Boiling point: **-6° C**	Molar mass: ***M* = 56 (56.107)**
Ratio between the vapour density and that of air = 1 (15° C): **1.94**	
Flammable gas/air mixture, vol.%: **1.5 – 10.6**	
Auto-ignition temperature: **360° C**	Critical temperature: **146.4° C**
Maximum permissible concentration at the workplace: **--- ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	0.87	626.9	2.29
-5	1.06	621.2	2.75
0	1.28	615.5	3.28
5	1.54	609.7	3.90
10	1.83	603.9	4.59
15	2.16	597.9	5.36
20	2.54	591.8	6.26
25	2.96	585.7	7.24
30	3.44	579.4	8.37
35	3.97	573.0	
40	4.56	566.4	
45	5.21	559.8	
50	5.93	552.9	

Substance properties ISOBUTYLENE

Name: **ISOBUTYLENE**	UN No.: **1055**
Formula: **C_4H_8**	
Boiling point: **-7° C**	Molar mass: ***M* = 56 (56.107)**
Ratio between the vapour density and that of air = 1 (15° C): **1.94**	
Flammable gas/air mixture, vol.%: **1.6 – 10.0**	
Auto-ignition temperature: **465° C**	Critical temperature: **144.7° C**
Maximum permissible concentration at the workplace: **--- ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	0.89	628.5	2.34
-5	1.09	622.8	2.83
0	1.31	617.0	3.36
5	1.57	611.2	3.98
10	1.87	605.2	4.69
15	2.20	599.2	5.47
20	2.59	593.0	6.39
25	3.02	586.8	7.40
30	3.50	580.4	8.52
35	4.04	573.9	
40	4.65	567.3	
45	5.31	560.5	
50	6.05	553.6	

Substance properties 1,3-BUTADIENE, STABILIZED

Name: **1,3-BUTADIENE, STABILIZED**	UN No.: **1010**
Formula: **C_4H_6**	
Boiling point: **-5° C**	Molar mass: ***M* = 54 (54.092)**
Ratio between the vapour density and that of air = 1 (15° C): **1.88**	
Flammable gas/air mixture, vol.%: **1.4 – 16.3**	
Auto-ignition temperature: **415° C**	Critical temperature: **152° C**
Maximum permissible concentration at the workplace: **--- ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	0.81	656.7	2.05
-5	0.99	651.0	2.47
0	1.19	645.2	2.93
5	1.44	639.3	3.50
10	1.71	633.4	4.11
15	2.03	627.3	4.83
20	2.39	621.2	5.64
25	2.80	614.9	6.56
30	3.25	608.6	7.56
35	3.76	602.1	
40	4.33	595.5	
45	4.97	588.7	
50	5.67	581.9	

Substance properties AMMONIA, ANHYDROUS

Name: **AMMONIA, ANHYDROUS**	UN No.: **1005**
Formula: **NH_3**	
Boiling point: **-33° C**	Molar mass: ***M* = 17 (17.032)**
Ratio between the vapour density and that of air = 1 (15° C): **0.59**	
Flammable gas/air mixture, vol.%: **-15.4 – 33.6**	
Auto-ignition temperature: **630° C****	Critical temperature: **132.4° C**
Maximum permissible concentration at the workplace: **20 ppm**	

** At 450° C ammonia, anhydrous begins to decompose, producing highly flammable hydrogen (gas).

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-35	0.93	684.6	
-30	1.19	678.2	
-25	1.51	671.8	
-20	1.89	665.2	
-15	2.35	658.6	
-10	2.89	651.9	
-5	3.52	645.0	
0	4.26	638.1	3.4
5	5.12	631.1	4.1
10	6.10	623.9	4.9
15	7.23	616.6	5.7
20	8.50	609.2	6.7
25	9.95	601.6	7.8
30	11.57	593.9	9.0
35	13.39	585.9	
40	15.42	577.9	
45	17.68	569.6	
50	20.17	561.1	

Substance properties VINYL CHLORIDE, STABILIZED

Name: **VINYL CHLORIDE, STABILIZED**	UN No.: **1086**
Formula: **C_2H_3Cl**	
Boiling point: **-14° C**	Molar mass: ***M* = 62.50**
Ratio between the vapour density and that of air = 1 (15° C): **2.16**	
Flammable gas/air mixture, vol.%: **-3.8 – 31.0**	
Auto-ignition temperature: **415° C**	Critical temperature: **158.4° C**
Maximum permissible concentration at the workplace: **3 ppm***	

* Vinyl chloride, stabilized, is carcinogenic.

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	1.16	962.3	3.5
-5	1.40	954.8	4
0	1.69	947.3	5
5	2.02	939.7	6
10	2.40	931.9	7
15	2.83	924.1	8
20	3.33	916.1	9
25	3.89	907.9	11
30	4.52	899.6	13

4. Certificate of approval; technical equipment

A certificate of approval should be selected, including information on the technical equipment.

ADN certificate of approval No. 001

1. Name of vessel: GASEX
2. Official number: 04090000
3. Type of vessel: motor tanker
4. Type of tank vessel: G
5. Cargo tank designs: 1. Pressure cargo tanks[1)2)]
   ~~2. Closed cargo tanks~~[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank: 1. Independent cargo tanks[1)2)]
   ~~2. Integral cargo tanks~~[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of the ~~high-velocity vent valves/~~safety valves:[1)2)] 1,580 kPa
8. Additional equipment:
   - Sampling device
     Possibility of a connection Yes/~~no~~[1)2)]
   - Sampling opening ~~Yes~~/no[1)2)]
   - Water-spray system Yes/~~no~~[1)2)]
     Internal pressure alarm 40 kPa ~~Yes~~/no[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore ~~Yes~~/no[1)2)]
     Cargo heating installation on board ~~Yes~~/no[1)2)]
   - Cargo refrigeration system ~~Yes~~/no[1)2)]
   - Inerting facilities Yes/~~no~~[1)2)]
   - Pump-room below deck ~~Yes~~/no[1)2)]
   - Pressure relief device in rear housing ~~Yes~~/no[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)[1)2)]
     Piping and installation heated ~~Yes~~/no[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T4
   - Explosion group: IIB
10. Loading rate: Permitted mass density (density):
11. Permitted relative mass density (density): 1.00
12. Additional observations:[1)] The possibility of a sampling connection is appropriate for an ETS

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

Technical equipment of the GASEX motor tanker

A. Cargo tanks

Number:	6
Volume per cargo tank:	250 m³
Minimum authorized temperature:	-10° C

B. Pumps: 1 submerged pump per cargo tank

C. Compressors: 2 compressors

D. Piping systems: Separate for liquids and gases (vapours)

E. Possibility of longitudinal flushing: Yes

Annex II

Examples of substantive questions for the specialization course on chemicals

1. Situation description

This section of the examination is based on the following situation description:

Your motor tanker (NAME OF VESSEL) carries certificate of approval No. (xx).

You receive an order to transport 1,500 tonnes of UN No. XXXX (NAME, class, classification code, packing group).

Your tank vessel is empty. The previous cargo was UN No. XXXX (NAME, class, classification code, packing group).

The outside temperature during loading is +9° C.

2. Questions

The questions must be selected along the following lines. A logical order should be followed.

A. Loading (including preparation)

General questions:

Choose three questions from A-1 to A-11.

Substance-related question:

Choose one question from among E-1 to E-20.

B. Transport

General questions:

Choose three questions from B-1 to B-10.

Substance-related question:

Choose one question from among E-1 to E-20.

C. Unloading (including preparation)

General questions:

Choose three questions from C-1 to C-10.

D. Flushing

General questions:

Choose three questions from D-1 to D-13.

Substance-related question:

Choose one question from among E-1 to E-20.

3. Substance and its characteristics

A substance should be selected from the following list and included in situation description 1 along with its properties.

The substances listed in the table may be included in the certificates of approval referred to in section 4.

UN No.	*Name and description*	*Class*	*Classification code*	*Packing group*	*Number of certificate of approval*
			Flammable		
1089	ACETALDEHYDE	**3**	**F1**	**I**	**03**
1125	n-BUTYLAMINE	**3**	**FC**	**II**	**01, 03**
1155	DIETHYL ETHER	**3**	**F1**	**I**	**03**
1275	PROPIONALDEHYDE	**3**	**F1**	**II**	**01, [03]**
1991	CHLOROPRENE, STABILIZED	**3**	**FT1**	**I**	**01, 03**
			Toxic		
1163	DIMETHYLHYDRAZINE, UNSYMMETRICAL	**6.1**	**TFC**	**I**	**01, 03**
2023	EPICHLOROHYDRIN	**6.1**	**TF1**	**II**	**01, 03**
2205	ADIPONITRILE	**6.1**	**T1**	**III**	**01, 03**
2487	PHENYL ISOCYANATE	**6.1**	**TF1**	**I**	**01, 02, 03, 04**
2831	1,1,1-TRICHLOROETHANE	**6.1**	**T1**	**III**	**01, 03**
			Liable to crystallization		
1605	ETHYLENE DIBROMIDE	**6.1**	**T1**	**I**	**01**
1662	NITROBENZENE	**6.1**	**T1**	**II**	**01, 02, [03] 04**
2021	2-CHLOROPHENOL	**6.1**	**T1**	**III**	**01, 02, 04**
2218	ACRYLIC ACID, STABILIZED	**8**	**CF1**	**II**	**01**
2238	CHLOROTOLUNES (p-CHLOROTOLUNE)	**3**	**F1**	**III**	**01, 02**
			Liable to polymerization		
1092	ACROLEIN, STABILIZED	**6.1**	**TF1**	**I**	**01, 03**
1218	ISOPRENE, STABILIZED	**3**	**F1**	**I**	**01, 03**
1280	PROPYLENE OXIDE	**3**	**F1**	**I**	**03**
1919	METHYL ACRYLATE, STABILIZED	**3**	**F1**	**II**	**01, 03**
2348	n-BUTYL ACRYLATE, STABILIZED	**3**	**F1**	**III**	**01, 03**

4. Certificate of approval

A certificate of approval number (01, 02, 03 or 04) is to be selected in accordance with the situation description.

ADN certificate of approval No. 01

1. Name of vessel: ALBAN
2. Official number: 04010000
3. Type of vessel: Motor tanker
4. Type of tank vessel: C
5. Cargo tank designs:
   1. ~~Pressure cargo tanks~~[1)2)]
   2. Closed cargo tanks[1)~~2)~~]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank:
   1. ~~Independent cargo tanks~~[1)2)]
   2. Integral cargo tanks[1)2)]
   ~~3. Cargo tanks distinct from the hull~~[1)2)]
7. Opening pressure of high-velocity vent valves/~~safety valves~~:[1)2)] 50 kPa
8. Additional equipment:
   - Sampling device
     Possibility of a connection Yes/~~no~~[1)2)]
     Sampling opening Yes/~~no~~[1)2)]
   - Water spray system Yes/~~no~~[1)2)]
     Internal pressure alarm 40 kPa Yes/~~no~~[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore Yes/~~no~~[1)2)]
     Cargo heating installation on board Yes/~~no~~[1)2)]
   - Cargo refrigeration system ~~Yes~~/no[1)2)]
   - Inerting facilities ~~Yes~~/no[1)2)]
   - Pump-room below deck ~~Yes~~/no[1)]
   - Pressure relief device in rear housing Yes/~~no~~[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated Yes/~~no~~[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T4
   - Explosion group: IIB
10. Loading rate: 800 m^3/h
11. Permitted relative mass density (density): 1.50
12. Additional observations:[1)] The available sampling connection is appropriate for DOPAK, DPM-1000

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

ADN certificate of approval No. 02

1. Name of vessel: BALDA
2. Official number: 04020000
3. Type of vessel: Motor tanker
4. Type of tank vessel: C
5. Cargo tank designs: ~~1. Pressure cargo tanks~~[1)2)]
   2. Integral cargo tanks[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank: ~~1. Independent cargo tanks~~[1)2)]
   2. Integral cargo tanks[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of the high-velocity vent valves~~/safety valves~~:[1)2)] 30 kPa
8. Additional equipment:
   - Sampling device
     Possibility of a connection Yes/~~no~~[1)2)]
     Sampling opening Yes/~~no~~[1)2)]
   - Water spray system ~~Yes~~/no[1)2)]
     Internal pressure alarm 40 kPa ~~Yes~~/no[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore Yes/~~no~~[1)2)]
     Cargo heating installation on board ~~Yes~~/no[1)2)]
   - Cargo refrigeration system ~~Yes~~/no[1)2)]
   - Inerting facilities ~~Yes~~/no[1)2)]
   - Pump-room below deck ~~Yes~~/no[1)]
   - Pressure relief device in rear housing ~~Yes~~/no[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated Yes/~~no~~[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T3
   - Explosion group: IIB
10. Loading rate: 800 m^3/h
11. Permitted relative mass density (density): 1.00
12. Additional observations:[1)] The available sampling connection is appropriate for HERMetic Sampler, partly closed

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

ADN certificate of approval No. 03

1. Name of vessel: CALDEZ
2. Official number: 04030000
3. Type of vessel: motor tanker
4. Type of tank vessel: C
5. Cargo tank designs: 1. Pressure cargo tanks[1)2)]
   ~~2. Closed cargo tanks~~[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank: 1. Independent cargo tanks[1)2)]
   ~~2. Integral cargo tanks~~[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of the ~~high-velocity vent valves/~~safety valves:[1)2)] 400 kPa
8. Additional equipment:
   - Sampling device
     Possibility of connection: Yes/~~no~~[1)2)]
     Sampling opening: ~~Yes~~/no[1)2)]
   - Water spray system: ~~Yes~~/no[1)2)]
     Internal pressure alarm 40 kPa: ~~Yes~~/no[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore: Yes/~~no~~[1)2)]
     Cargo heating installation on board: ~~Yes~~/no[1)2)]
   - Cargo refrigeration system: ~~Yes~~/no[1)2)]
   - Inerting facilities: ~~Yes~~/no[1)2)]
   - Pump-room below deck: ~~Yes~~/no[1)]
   - Pressure relief device in rear housing: ~~Yes~~/no[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated: ~~Yes~~/no[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T4
   - Explosion group: IIB
10. Loading rate: 800 m^3/h
11. Permitted relative mass density (density): 1.00
12. Additional observations:[1)] The available sampling connection is appropriate for DOPAK, DPM-1000

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

ADN certificate of approval No. 04

1. Name of vessel: DALDORF
2. Official number: 04040000
3. Type of vessel: Motor tanker
4. Type of tank vessel: C
5. Cargo tank designs
   ~~1. Pressure cargo tanks~~[1)2)]
   2. Closed cargo tanks[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank
   ~~1. Independent cargo tanks~~[1)2)]
   2. Integral cargo tanks[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of the high-velocity vent valves~~/safety valves~~:[1)2)] 25 kPa
8. Additional equipment:
   - Sampling device
     Possibility of connection: Yes/~~no~~[1)2)]
     Sampling opening: Yes/~~no~~[1)2)]
   - Water spray system: ~~Yes~~/no[1)2)]
     Internal pressure alarm 40 kPa: ~~Yes~~/no[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore: Yes/~~no~~[1)2)]
     Cargo heating installation on board: ~~Yes~~/no[1)2)]
   - Cargo refrigeration system: ~~Yes~~/no[1)2)]
   - Inerting facilities: ~~Yes~~/no[1)2)]
   - Pump-room below deck: ~~Yes~~/no[1)]
   - Pressure relief device in rear housing: ~~Yes~~/no[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated: Yes/~~no~~[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T2
   - Explosion group: IIA
10. Loading rate: 800 m^3/h
11. Permitted relative mass density (density): 1.10
12. Additional observations:[1)] The available sampling device is appropriate for HERMetic Sampler, closed

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

Annex III

Examples for the substantive examination questions of the specialization courses on gas and chemicals

Example of a substantive question – Gas

Situation description:

Your GASEX motor tanker carries certificate of approval No. 001. The tank vessel contains UN No. 1011 BUTANE; the pressure in the cargo tank is 0.2 bar (gauge).

At terminal 1 the vessel is to be loaded to the maximum with UN No. 1086 VINYL CHLORIDE, STABILIZED, class 2, classification code 2F, and it is later to be unloaded at terminal 2.

Loading port = terminal 1

The substance to be loaded is stored in spherical tanks.

The terminal can deliver a nitrogen flow of up to 1,000 m^3/h at a maximum pressure of 5 bar (gauge) and has a flare stack with a capacity of 1,000 m^3/h.

During loading the vapours/gas must not be returned to the on-shore spherical tank.

The terminal's loading flow is 250 m^3/h.

The temperature of the substance and the ambient temperature are both 10° C.

Unloading port = terminal 2

The vessel is unloaded with the on-board pumps. The greatest possible quantity must be unloaded.

The substance is unloaded into a spherical storage tank. A gas return line is available.

The ambient temperature is 10° C.

During the examination, the texts of the regulations and technical literature referred to in 8.2.2.7 may be consulted.

The following documents are at your disposal:

- Certificate of approval No. 001;
- Equipment description for the GASEX motor tanker;
- Information sheets on the properties of both substances;
- Safety data sheets on both substances.

ADN certificate of approval No. 001

1. Name of vessel: GASEX
2. Official number: 04090000
3. Type of vessel: motor tanker
4. Type of tank vessel: G
5. Cargo tank design: 1. Pressure cargo tanks[1)2)]
   ~~2. Closed cargo tanks~~[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank 1. Independent cargo tanks[1)2)]
   ~~2. Integral cargo tanks~~[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of the ~~high-velocity vent valves/~~safety valves:[1)2)] 1,580 kPa
8. Additional equipment:
   - Sampling device
     Possibility of connection Yes/~~no~~[1)2)]
     Sampling opening ~~Yes~~/no[1)2)]
   - Water-spray system Yes/~~no~~[1)2)]
     Internal pressure alarm 40 kPa ~~Yes~~/no[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore ~~Yes~~/no[1)2)]
     Cargo heating installation on board ~~Yes~~/no[1)2)]
   - Cargo refrigeration system ~~Yes~~/no[1)2)]
   - Inerting facilities Yes/~~no~~[1)2)]
   - Pump-room below deck ~~Yes~~/no[1)]
   - Pressure relief device in rear housing ~~Yes~~/no[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated ~~Yes~~/no[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3.2[1)2)]
9. Electrical equipment:
   - Temperature class: T4
   - Explosion group: IIB
10. Loading rate: Permitted mass density
11. Permitted relative mass density (density): 1.00
12. Additional observations:[1)] The available sampling connection is appropriate for an ETS

[1] Delete as appropriate.
[2] If the cargo tanks of the vessel are not all of the same type, see page 3.

Technical equipment of the GASEX motor tanker

A.	**Cargo tanks**	
	Number:	6
	Volume per cargo tank:	250 m³
	Minimum authorized temperature:	-10° C
B.	**Pumps:**	1 submerged pump per cargo tank
C.	**Compressors:**	2 compressors
D.	**Piping systems:**	Separate for liquids and gases (vapours)
E.	**Possibility of longitudinal flushing:**	Yes

Substance properties BUTANE

Name: **BUTANE**	UN No.: **1011**
Formula: **C_4H_{10}**	
Boiling Point: **1.0° C**	Molar mass: ***M* = 58 (58.123)**
Ratio between the vapour density and that of air = 1 (15° C): **2.01**	
Flammable gas/air mixture, vol.%: **1.4 − 9.4**	
Auto-ignition temperature: **365° C**	Critical temperature: **152° C**
Maximum permissible concentration at the workplace: **1,000 ppm**	

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	0.70	611.9	1.90
-5	0.85	606.5	2.27
0	1.03	601.1	2.72
5	1.24	595.6	3.23
10	1.48	590.1	3.81
15	1.76	584.4	4.49
20	2.07	578.7	5.23
25	2.43	572.9	6.09
30	2.83	566.9	7.04
35	3.27	560.9	
40	3.77	554.7	
45	4.32	548.5	
50	4.93	542.0	

Substance properties VINYL CHLORIDE, STABILIZED

Name: **VINYL CHLORIDE, STABILIZED**	UN No.: **1086**
Formula: **C_2H_3Cl**	
Boiling point: **-13° C**	Molar mass: ***M* = 62.50**
Ratio between the vapour density and that of air = 1 (15° C): **2.16**	
Flammable gas/air mixture, vol.%: **-3.8 − 31.0**	
Auto-ignition temperature: **415° C**	Critical temperature: **158.4° C**
Maximum permissible concentration at the workplace: **3 ppm***	

* Vinyl chloride, stabilized, is carcinogenic.

Vapour-liquid equilibrium

***T* [°C]**	**p_{max} [bar]**	**ρ_L [kg/m^3]**	**ρ_G [kg/m^3]**
-10	1.16	962.3	3.5
-5	1.40	954.8	4
0	1.69	947.3	5
5	2.02	939.7	6
10	2.40	931.9	7
15	2.83	924.1	8
20	3.33	916.1	9
25	3.89	907.9	11
30	4.52	899.6	13

Preparation of loading operations	A - 1
Give a short list of at least five general safety requirements applicable before a loading operation begins.	
Points:	

Preparation of loading operations	A - 2b
What concentration of BUTANE can remain in the cargo tanks before loading begins?	
Points:	

Preparation of loading operations	A - 4/1
For the substance being loaded, is an entry required in the transport of document, and if so, which?	
Points:	

Flushing of cargo tanks	B - 2
What flushing method do you choose, and why?	
Points:	

Flushing of cargo tanks	B - 6
What pressure should be reached in the cargo tanks after flushing, and why?	
Points:	

Flushing of cargo tanks	B - 10
If your vessel is coming from the shipyard, how do you test the piping system and the cargo tanks for gas-tightness?	
Points:	

Loading	C - 1
Explain precisely how you load the first amounts of goods into your tank or tanks at the beginning of the loading procedure and why you proceed in this manner; (As a gas (vapour)? A liquid? One cargo tank at a time, or several at the same time? With the piping used for flushing, or with the bottom piping?)	
Points:	

Loading	C - 4
During loading, do you return gas or nitrogen? If so, where? If not, why not?	
Points:	

Loading	C - 5
What personal protective equipment must be worn by persons connecting and disconnecting the loading and unloading piping and the gas return piping? Please provide the source in ADN.	
Points:	

Loading	C - 7
What pressure do you expect to find in the cargo tanks after loading is completed?	
Points:	

Load calculation	D - 1
Calculate the total mass of the liquid loaded, in kg. (Write the entire method of calculation and not just the answer.)	
Points:	

Load calculation	D - 2
Calculate the total mass of the gas, in kg. (Write the entire method of calculation and not just the answer.)	
Points:	

Load calculation	D - 3
Calculate the total mass loaded. (Write the entire method of calculation and not just the answer.)	
Points:	

Unloading	E - 1
Describe how you would efficiently unload (leaving minimal residual quantities) so as to discharge as much of the substance as possible. Mention the use of pumps or compressors, or pumps and compressors; the use of vapour balancing; the order of unloading cargo tanks; the means of unloading liquids, etc.	
Points:	

Unloading	E - 2
What final pressure do you expect after unloading as completely as possible?	
Points:	

Example of a substantive question – Chemicals

Situation description:

Your motor tanker ALBAN carries certificate of approval No. 01.

Your assignment is to transport 1,500 tons of UN No. 1662 NITROBENZENE, class 6.1, classification code T1, packing group II.

Your motor tanker is empty. The previous cargo was UN 2205 ADIPONITRILE, class 6.1, classification code T1, packing group II.

The outside temperature during loading is +9° C.

During the examination, the texts of the regulations and technical literature referred to in 8.2.2.7 may be consulted.

The following documents are at your disposal:

- ADN certificate of approval No. 01;
- Safety data sheets on both substances.

ADN certificate of approval No. 01

1. Name of vessel: ALBAN
2. Official number: 04010000
3. Type of vessel: Motor tanker
4. Type of tank vessel: C
5. Cargo tank designs:
   ~~1. Pressure cargo tanks~~[1)2)]
   2. Closed cargo tanks[1)2)]
   ~~3. Open cargo tanks with flame arresters~~[1)2)]
   ~~4. Open cargo tanks~~[1)2)]
6. Types of cargo tank:
   ~~1. Independent cargo tanks~~[1)2)]
   2. Integral cargo tanks[1)2)]
   ~~3. Cargo tank wall distinct from the hull~~[1)2)]
7. Opening pressure of high-velocity vent valves~~/safety valves~~:[1)2)] 50 kPa
8. Additional equipment:
   - Sampling device
     Connection for a sampling device Yes/~~no~~[1)2)]
     Sampling opening Yes/~~no~~[1)2)]
   - Water spray system Yes/~~no~~[1)2)]
     internal pressure alarm 40 kPa Yes/~~no~~[1)2)]
   - Cargo heating system:
     Possibility of cargo heating from shore Yes/~~no~~[1)2)]
     Cargo heating installation on board Yes/~~no~~[1)2)]
   - Cargo refrigeration system ~~Yes~~/no[1)2)]
   - Inerting facilities ~~Yes~~/no[1)2)]
   - Cargo pump-room below deck ~~Yes~~/no[1)]
   - Pressure relief device in rear housing Yes/~~no~~[1)]
   - Gas supply/return line according to 9.3.2.22.5 (c)
     Piping and installation heated Yes/~~no~~[1)2)]
   - Conforms to the rules of construction resulting from the remark(s) ... in column (20) of Table C of Chapter 3[1)2)]
9. Electrical equipment:
   - Temperature class: T4
   - Explosion group: IIB
10. Loading rate: 800 m^3/h
11. Permitted relative mass density (density): 1.50
12. Additional observations:[1)] The available sampling connection is appropriate for DOPAK, DPM-1000

[1)] Delete as appropriate.
[2)] If the cargo tanks of the vessel are not all of the same type, see page 3.

Loading (including preparation)	A - 3
The cargo tanks of your tank vessel were emptied but probably not cleaned of the previous product (see introduction). What must you do from the point of view of safety before taking on new cargo? Please provide the source in ADN.	
Points:	

Loading (including preparation)	A - 6
During loading, the vapour pipe is connected to the shore facility. What determines the maximum loading rate and what is the maximum permissible loading rate? Please explain your answer and provide the source in ADN.	
Points:	

Loading (including preparation)	A - 10
At what percentage must a level alarm and overflow prevention device be triggered? Please provide the source in ADN.	
Points:	

Substance-related question	E - 1
At the current outside temperature, can you load this substance in your vessel? Please explain your answer and provide the source in ADN.	
Points:	

Transport	B - 2
Name eight documents that must, as a minimum, be kept on board during transport under ADN.	
Points:	

Transport	B - 3
You wish to berth near a residential area during the voyage. What is the minimum distance that you must observe if there is no available berthing area designated by the competent authority? Please provide the source in ADN.	
Points:	

Transport	B - 6
During the carriage of certain goods, persons under 14 years of age are not authorized on board. Is this requirement applicable to UN No. 1662 NITROBENZENE? Please provide the source in ADN.	
Points:	

Substance-related question	E - 9
During the transport of this substance you note on the pressure gauge that the pressure is rising in a cargo tank. Explain your response and provide the source in ADN.	
Points:	

Unloading (including preparation)	C - 1
During unloading, your hear crackling noises from the discharge pump on the deck. (a) What could be causing this? (b) What must you do?	
Points:	

Unloading (including preparation)	C - 5
What must you attend to above all during the unloading of the cargo tanks? Please explain your answer.	
Points:	

Unloading (including preparation)	C - 9
The vessel carries only a blue cone/light. Is it necessary to supervise the unloading procedure on board? What should you be mindful of? Please provide the source in ADN.	
Points:	

Flushing	D - 1
Under ADN, under what conditions may one enter a cargo tank without protective equipment? Please provide the source in ADN.	
Points:	

Flushing	D - 4
You degas while the vessel is under way. Near the wheelhouse you measure a concentration 25% below the lower explosive limit of the substance. Should you do anything and, if so, what? Please provide the source in ADN.	
Points:	

Flushing	D - 11
The gas concentration must be measured once an hour in the first two hours after the beginning of the degassing operation. Who should take these measurements? Please provide the source in ADN.	
Points:	

Substance-related question	E - 12
What is the major hazard posed by this substance and what are the subsidiary hazards? Explain the types of hazard and provide the source in ADN.	
Points:	