MATERIAL SAFETY DATA SHEET

Registered

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Rosstandard

Information Analytical Center
"Substance and Material Safety"
Federal State Unitary Enterprise "VNITSMB"

Chief _____ / A. D. Kozlov /
L.S.

Seal: Federal State Unitary Enterprise Primary State Registration Number 1027700169144 * Moscow * All-Russian Scientific Research Center of Standardization * Information and Certification of Raw Materials, Materials, and Substances * Federal Agency for Technical Regulation and Metrology * Information Analytical Center "BV&M" Federal State Unitary Enterprise "VNITSMB"

NAME:

Technical (ND):	**Ferrosilicon**
Chemical (IUPAC):	Ferrosilicon
Trade:	**Ferrosilicon of various grades**
Synonyms:	**Alloy of Iron and Silicon**

Code of All-Russian Classification of Product:
0 8 2 1 0 0

Code of Harmonized Commodity Description and Coding System:
7 2 0 2 2 0 0 0 0 0

Product Registration Information

Not to be registered

Reference Identification and Name of Basic Normative, Technical or Informational Document for Products (GOST, Specifications, Industrial Standards, Proprietary Standard, (M)SDS, etc.)

GOST 1415-93, Amendment No. 1 Ferrosilicon. Specification Requirements and Terms of Delivery

HAZARD IDENTIFICATION:

Signal Word: Danger

Brief (in words): It is moderately hazardous substance for the health impact. Dust has the moderate fibrogenic properties (i.e., causing the lung diseases). Ferrosilicon, having the silicon weight percent of 30%-90% and the particle sizes less than 3.2 mm, releases the explosive gas – hydrogen, mixing with the air and creating the dangerous concentrations inside the closed and non-ventilated premises. Because there are impurities, the very hazardous gases, such as phosphine and arsine (that are poisons), can be released. The gas release intensity increases according to the increase of the alloy particle surfaces in the mass unit and/or the increase of moisture. Dust is able to make explosive mixtures with the air. The product can pollute the environment.

Detailed: in the 16 attached sections of MSDS.

BASIC HAZARDOUS COMPONENT	MPC_{wz}, mg/m^3	Class of Hazard	CAS No.	EC No.
Ferrosilicon	Not determined	No	8049-17-0	No

APPLICANT: "Chelyabinsk Electrometallurgical Integrated Plant joint-stock company", Chelyabinsk
(Organization Name) (City)

Type of Applicant: manufacturer, supplier, seller, exporter, ~~importer~~
(Strike out unnecessary item)

Code of All-Russian Classifier of Enterprises and Organization: 00186507

Hotline: (351) 772-66-09

Head of Applicant Organization: _____ L.S. / A. V. Sheykin /
Signature (Clarification of signature)

Stamp:
Russian Federation Chelyabinsk
Open Joint Stock Company
Chelyabinsk Electrometallurgical Integrated Plant

IUPAC	International Union of Pure and Applied Chemistry
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
ARCP	All-Russian Classification of Products
ARCEO	All-Russian Classifier of Enterprises and Organization
HCDCS	Harmonized Commodity Description and Coding System * This code is not indicated for the Russian Federation internal market.
CAS No.	Number of the Chemical Abstract Services
EC No.	Number of the European Chemical Agency
MPC_{wz}	Maximum Permissible Concentration of Chemical Substance in Working Zone Air, mg/m^3 (maximum one-time/average monthly)
MSDS	Material Safety Data Sheet is used for the Russian Title: "Passport of Chemical Products' Safety" (substance, mixture, material, waste of industrial production)

Material Safety Data Sheet meets:

- Recommendations of the UN ST/SG/AC.10/30 "GHS";
- The EC regulations "Regulation No. 1907/2006 concerning Registration, Evaluation, Authorization and Registration of Chemicals", Attachment II.

Signal Word:	Indicates one of two words "**Danger**" or "**Warning**" (or "**Absent**") according to GOST 31340-2007 "Labeling of Chemicals. General Requirements."

Product Registration Information (*for pesticide, agrochemical, disinfectant, food additive, individual chemical, etc.*) includes: Number and Date of the State Registration; Certificate Number; and the Number of the State Registration (if available)/PHCBSR Number for the Potentially Hazardous Chemical and Biological Substances Register of Russian Federation (PHCBSR).

1. Chemical Product Identification and Information on Manufacturer and/or Supplier

1.1 Chemical Product Identification

1.1.1 Product Name:	Ferrosilicon [1].
1.1.2 Brief Recommendations for Use: (including the restrictions for use)	Metallurgic and foundry industry.

1.2 Information on Manufacturer and/or Supplier

1.2.1 Full Legal Name of Organization:	"Chelyabinsk Electrometallurgical Integrated Plant joint-stock company" (OAO"ChEMK")
1.2.2 Address (Postal and Legal):	454081, Chelyabinsk, Geroev Tankograda Street, 80-P, Bld. 80.
1.2.3 Telephone, including phone for special consultation and convenient time:	(351) 772-66-09
1.2.4 Fax:	(351) 772-96-19
1.2.5 E-mail:	info@chemk. ru

2. Hazard (hazards) Identification

2.1 Level of chemical product hazard as whole: (Information about classification of hazard according to the RF legislation (GOST 12.1.007) and GHS (after approval))	Moderately dangerous substance concerning the influence on the organism, the class of hazard – 3 [1].
2.2 Hygiene regulations for product, as whole, in the working zone air (MPCwz or SRLIwz)	Hygiene regulations for the working zone air are not specified [2].

2.3 Labeling Information (GOST 31340-07)

2.3.1 Hazard Identification:

Signal Word: Danger.
Symbols:

Summary of hazard properties: When it contacts water, it releases flammable gases and vapors which are toxic for inhalation. It can cause the long-term negative consequences for the aquatic flora and fauna [4].
Danger preventive measures:
Keep from moisture. Use gloves and protection for eyes/face. Extinguish with powder fire extinguishing mixes. Keep and use only in the open air or in the well ventilated premises. Avoid inhaling the vapors. After inhaling, apply the fresh air and rest. Immediately appeal for medical aid. Avoid releasing it into the environment [28].

3. Content (Information about Component)

3.1 General Information about Product

3.1.1 Chemical name: (IUPAC)	Ferrosilicon [3].

3.1.2 Chemical formula:
FeSi [3].

3.1.3 General characteristics of composition:
(considering the grade assortment, the impurity indications, and functional additives which influence on the product hazard; production process)

Ferrosilicon is the alloying composition of iron and silicon with the minimum content of silicon 8.0% of mass and maximum 95% of mass, and is obtained by reduction [1].
Ferrosilicon is supplied in pieces of 1-7 grade classes with the mass not more than 25 kg; in pigs with the mass not more than 45 kg; and as the grinded and screened particles [1].

3.2 Ingredients
(name, CAS No., EC No. (if available), weight percent, MPCwz, classes of hazard, references for data sources)

Ingredients [1]	Weight percent, % [1]	MPCwz, mg/m^3 [1]	Class of hazard	CAS No. [5]	EC No. [5]
Ferrosilicon, including:	Up to 100	Not specified	No	8049-17	No
- Silicon	8-95 (depending from grade)	6/2 (silicon dioxide with the content 10-70%)	3		
- Iron	Rest	10/-	4	7439-89-6	231-096-4
Note: Depending from the grade, ferrosilicon contains the controlled impurities: 0.1-1.0% carbon, 0.02% sulphur, 0.03-0.10% phosphorus, 1.0-3.5% aluminum, 0.3-1.0% manganese, and 0.2-0.8% chromium.					

4. First Aid Measures

4.1 Observed symptoms

4.1.1 Inhalation poisoning:

The inhalation of high concentrations causes weakness, cough, sneezing, headache, and rhythm disturbance of breathing [6].

The hazard of inhalation poisoning is related to the released gases' exposures.

In common cases, the phosphine causes pains in the diaphragm region with feeling the low-back pain as well as the cold sense, and then bronchitis [6].

Under middle severity of poisoning, there may be fear, shivering, vomiting, sharp asthmatic fit, retrosternal pain, dry cough, burning pain in occiput, tinnitus, loss of appetite, and thirst.

In heavy cases, there may be torpor, nervous gait, limb twitching, and pupillary dilatation. Lethal termination may be through several days, but under the high concentrations it may occur immediately [6].

There are no symptoms at the moment of contacting the arsine. The poisoning develops over 3-8 hours after the poison inhalation. The first symptom is an indefinite sense of indisposition and an intense weakness; then there may be vertigo, headaches, pain in the pit of stomach, cold sense, sense of breathing difficulty, and sometimes cyanosis, sickness, and vomiting. Then the vomiting becomes continuous; the vomiting matters contain bile and in some time blood; and the jaundice develops. In heavy cases, the lethal termination may occur. In common cases, the effects may only include:

vertigo, weakness, headaches, sickness, pain in the pit of stomach, vomiting, jaundice, cacesthesia.

In very easy cases, there may only be sickness and headaches [6].

4.1.2 Skin exposure: Consequences of mechanical exposure of ferrosilicon particles. The released gases have the irritant action [6].

4.1.3 Eye exposure: Lacrimation, smarting eyes, and rubeosis because of mechanical exposure of ferrosilicon particles. The released gases have the irritant action [2].

4.1.4 Ingestion exposure (per oral way): Unpleasant eructation, sickness, sometimes vomiting, and diarrhea, loss of appetite, and weakness may be caused by the exposure of hydrogen fluoride released from the ferrosilicon into the air or by the intake through inhalation or ingestion of the ferrosilicon dust [6].

4.2 First aid measure for exposed one

4.2.1 For inhalation poisoning: Evacuate from the contaminated air to the fresh air; provide full rest, warm, clear clothes, cardiac drugs, strong and sweet tea or coffee. Urgently appeal for medical aid, inform the medical staff about the poisoning with the toxic gases [3, 6].

4.2.2 For skin exposure: Wash with running water, and visit a physician, if necessary [3, 6].

4.2.3 For eye exposure: Wash with running water, if there is symptom of irritation, appeal for medical aid [3, 6].

4.2.4 For ingestion poisoning: Urgently appeal for medical aid, inform the medical staff that there may be the poisoning with the toxic gases [6].

4.2.5 Contraindications There is no data [2].

4.2.6 First aid kit: The first aid kit shall include the medicines and medications approved by the Public Health Bodies for using in the first aid help at this industry [6].

5. Fire and explosion fighting measures and equipment

5.1 General characteristics of fire and explosion fighting: Ferrosilicon dust is combustion substance, apt to take chemical spontaneous fire [7, 8].

Ferrosilicon with the particle sizes more than 3 mm is incombustible in the normal conditions.

Ferrosilicon with mass percent of silicon 30-90% releases the combustible and toxic gas, phosphine, and support the hydrogen combustion [1, 7, and 8].

The gas release intensity increases with the moisture increase and the alloy particle surface increase in

the mass unit [1, 28].

The hydrogen amount in the released gases is 92% of the volume; the number of phosphine in the released gases is 0.8-1.6% of the volume [1].

5.2 Characteristics of fire and explosion risk:
(List of characteristics according to GOST 12.1.004 and GOST R 51330.0)

Values of the low concentration flammability limit (LCFL) and the spontaneous ignition temperature (tsi) of aerosol for various grades of ferrosilicon are shown in the table 1 [1].

Table 1.

Characteristics	Grade			
	FS90	FS75	FS65	FS45
LCFL, g/m^3	240	150	400	1000
Temperature of spontaneous ignition, °C	980	More than 1000	More than 1000	-

The characteristics of the ferrosilicon dust fire-explosion risk are shown in the table 2 [1].

Table 2.

Grade	Temperature of spontaneous ignition, °C	Maximum explosion pressure, kPa	Explosion pressure rise rate, kPa/s	Minimum ignition energy, kJ
FS90	More than 1000	700	22000	1280
FS75	860	620	26000	280
FS65	More than 1000	40	6000	-
FS45	640	-	-	-

Additional information:
Hydrogen:
Spontaneous ignition temperature 510 °C
Concentration flammability limit 4.12-75% of volume in air; 4.1-96% in oxygen.
Minimum ignition energy 0.017 mJ;
Maximum normal rate of flame spread 2.7 m/s;
Maximum explosion pressure 760 kPa [7].

Phosphine:
Spontaneous ignition temperature 40 °C. It is thermally unstable and is able to spontaneously auto-oxidation in the air at the room temperature with formation of diphosphine; and it explodes in oxygen [7].

Arsine:
Spontaneous ignition temperature 260 °C
Concentration flammability limits 9-90% of volume.
Minimum explosive content of oxygen 6.2% of volume.
Minimum phlegmatizing concentration of nitrogen 70% of volume [7].

5.3 Hazard of combustion products and/or thermodestruction:

It burns generating the toxic gases [3].

5.4 Recommended extinguishing means:

Powder mixes [7, 8]. Dry sand, asbestos fiber cloth, carbon-dioxide extinguisher [28].

5.5 Prohibited extinguishing means:

Do not use water and foam! [7, 8]

5.6 Personal protective gear for extinguishing the fire:
(Personal protective gear of fire-fighters)

Fire-protection suit with escape hood SPI-20 [9].

5.7 Specific character of fire-extinguishing:	The water influence causes the release of the arsine, (hydrogen arsenide) toxic and inflammable gas. Under the influence of acids or their vapors, the toxic fume is released. The reaction of fine-dispersed compositions with oxidants produces an explosion.

6. Activities to prevent and eliminate accidents, emergencies, and their consequences.

6.1 Activities to prevent the hazardous effects on human beings, environment, buildings, constructions, etc, during accidents and emergencies.

6.1.1General required activities:	Isolate the danger zone with radius not less than 200 m. Evacuate unauthorized persons. Enter the danger zone only in the protective gears. Follow the fire safety procedures. No smoking. Eliminate the sources of flame and sparks. First aid measures for injured persons and/or refer them to medical examination. [9].
6.1.2 Personal protective gears: (emergency crew and staff)	For the chemical survey team and the work head – maximum permissible level 3 for 20 minutes. For emergency crews – isolating protection suit KIH-5 and isolating gas mask IP-4M. If there are no such protective gears, use the battledress overgarment L-1 or L-2 and the industrial gas mask with cartridge V. The industrial gas mask PFM-1 with small size, gloves made of butyl rubber, special footwear for protection against the oil and oil product effects. In case of small concentrations in the air (exceeding of MPL as much as 100 times), use the overalls to protect against dust, the individual autonomic protection gear with the forced feed of purified air to the inhalation zone and the cartridge PZU, PZ-2, filtering respirator "FORT-P2", universal respirator "Snezhok-KU-M" [9].

6.2 Procedures for activities to eliminate accidents and emergencies

6.2.1 Activities for leak, overflow, and spill: (including precautions providing the protection of environment)	Report to the local service of Rospotrebnadzor. Do not touch the spilled substance. The spilling is enclosed with dirt wall. It can not be allowed its ingress into bodies of water, basements, and sewerage system. Not damaged product shall be collected considering the precautions, and after coordination with the manufacturer it can be shipped to the destination or for reprocessing. Remainders shall be filled with dry inert material and collected with the upper layer of ground into dry tanks, then marked and shipped for treatment at the sites authorized by the local services of Rospotrebnadzor. Places of cuts shall be filled with fresh layer of ground, the soil shall be ploughed. All the surfaces of rolling stock and the territory shall thoroughly be cleaned, washed with the large amount of water, and treated with diluted solution of acid [9].

6.2.2 Fire-fighting measures:

Do not use water! Avoid the water penetration into tanks and load. Extinguish only with powder mixes. Evacuate personnel considering the movement direction of toxic combustion products [9].

7. Storage and handling rules for chemical products during handling operations

7.1 Safety measures while handling the chemical products

7.1.1 Safety measures and collective protection gears: (including the measure system for fire-explosion fighting)

Combined extract-and-input system or natural ventilation in the work premises; Application of technological processes with minimum dust generation and dust-collecting devices. Observance of preventive fire-fighting regulations; Versions of equipment, utilities, and fittings of artificial lighting shall be explosion-proof; Workplaces shall be equipped with the first fire fighting appliances; Use of individual protection gears [1, 6].

7.1.2 Environment protection measures:

Basic requirements to protect the environment are following:

- Intermittent monitoring of hazardous substance contents in the work zone air;
- Gas- and dust cleaning units when processing the products;
- Analysis of the industrial sewerage systems for the hazardous substance contents and permissible concentrations;
- Cleaning of the working premises air up to the specified standards before releasing it into atmosphere;
- Preventing of the ferrosilicon penetration in the domestic sewerage and rainwater disposal, and in the open water bodies and in soil [1].

7.1.3 Recommendations for transportation safety:

All the grades of ferrosilicon with the particle sizes less than 3.2 mm and more than 3.2 mm, which are packed in steel drums and/or in strong wooden boxes, are transported on the roofed rolling stock.

Ferrosilicon with weight percent of silicon not more than 50% and packed in specialized hard and soft containers is transported on the open rolling stock.

Ferrosilicon pigs with mass not more than 45 kg and lumps with mass not more than 25 kg, as well as crushed one according to the size grades with the particle sizes from 10 to 315 mm are transported in bulk (without package) on the open rolling stock or in the universal containers with the waterproof feeding hole [1, 10].

The measures to eliminate any loss shall be performed for transporting the ferrosilicon having the particle sizes less than 13 mm, or in bulk on the rolling stock with the low unloading gates, which have the through structural clearance more than 5 mm.

When several batches of ferrosilicon are transported in one transport without the package, the individual batches shall be separated by the way to exclude the possibility of their mixing [10].

For transportation, the shipping containers with the gross weight up to 250 kg shall be formed in the transportation packages on the flat pallets by using the restraint means.

For local and international transportation, the ferrosilicon is transported according to the regulations and relevant agreements acting at that type of transport.

When the ferrosilicon that is not specified by GOST 19433 as the dangerous cargo is transported by sea, river, and air transport, the consignor shall submit the manifest about the goods danger.

7.2 Chemical product storage regulations

7.2.1 Conditions and safe storage life:
(including guaranteed storage life, expiration time)

The packed ferrosilicon shall be kept in the closed premises in stacks according to grades, size grades, and year of manufacture.

The ferrosilicon that is transported in bulk and also in specialized containers is stored under shelter or in the closed premises in stacks, bins, or in bowls according to grades and years of manufacture.

The premises may be any construction with the concrete or asphalt-concrete floors and the natural ventilation.

The areas shall have the hard coverage and be even with small slope to the edges (1:100). The perimeter of areas shall have offlets.

Conditions for the ferrosilicon storage shall exclude the ingress of moisture [1, 10].

Storage life:

- Under shelter, the grades FS45 and FS65 – 1 year; the grades FS75 and FS90 – 2 years.
- Closed premises, the grade FS45 – 2 years; the grade FS65 – 3 years; the grades FS75 and FS90 – 10 years [10].

7.2.2 Substances and material incompatible for storage: Oxidizers, acids, and alkalis. The sources of moisture, flame, heating shall be eliminated [3].

7.2.3 Materials recommended for tares and package: Steel drums for the ferrosilicon according to specification TU 14-5-222-90 [28].

	The strong wooden boxes, types II-1, III-1, and III-2 according to GOST 2991, as well as specialized containers. The application of used tares, such as steel drums and wooden boxes, is admitted for packaging the ferrosilicon. The ferrosilicon for export is packed according to the requirements of an external economic contract. Ferrosilicon designated for long-term storage shall be packed in the steel drums painted with black paint. Ferrosilicon with the particle sizes from 10 to 315 mm, in pigs, and in lumps is admitted not to be packed [1, 10].
7.3 Safety measures and storage regulations in private life:	It is not used in the private life conditions.

8. Monitoring means for hazardous effects and individual protection gears

8.1 Working zone criteria, that shall necessarily be monitored (MPCwz or Safe Reference Levels of Impact in Working Zone (SRLIwz)):	MPCwz = 6/2 mg/m^3 – crystalline silicon dioxide, when the dust content is from 10% to 70% [2]. MPCwz = 0.1 mg/m^3 – phosphine [2].
8.2 Safety measures to keep the hazardous substance contents in the permissible concentrations:	Installation and undisturbed operation of combined extract-and-input system with the relevant devices for dust collecting; natural ventilation. Application of technological processes with minimum dust generation. Monitoring of hazardous substance contents in the working zone air according to the requirements of GOST 12.1.005 and GN 2.2.5.1313-03 [1, 3, and 6].

8.3 Individual protection gears for personnel

8.3.1 General recommendations:	Avoid the direct contact with the products; and use the protection overall. The routine cleaning of premises and industrial area by the dry method from dust and spilling. Observe the personal hygiene regulations; do not smoke and do not eat at the workplace. Medical examinations, the first for taking on job and the periodical ones, for the staff involved in operation with ferrosilicon. Persons younger than 18 and pregnant women are not permitted for that job.
8.3.2 Protection of respiratory apparatus: (types of Individual Protection Gears of Respiratory Apparatus)	Workplaces shall have the autonomic individual protection gears with the forced feeding of the purified air in the inhalation zone with the cartridges PZU, PZ-2, the filtering respirators "FORT-P", the universal respirators "Snezhok-KU-M", "Lepestok", or analogical ones [1].
8.3.3 Protection clothes (material and type):	Overalls for protection against dust exposure; gastight goggles; gloves or gauntlets; and special shoes [1, 11].

8.3.4 Individual protection gear in private life	It is not use in the private life conditions [1].

9. Physicochemical properties:

9.1 Physical state: (aggregate state, color, odor)	Solid [1].
9.2 Criteria defining the basic properties of chemical products, first of all the hazardous ones: (Temperature characteristics, pH, solubility, coefficient n-octanol/water, etc.)	
Melting temperature:	1180 – 1350 °C [28].
Density of strewing:	1.2 – 3.2 g/cm^3 [28].
Solubility:	Insoluble in water and fats
Gas release intensity of moistened ferrosilicon powders, fraction 0-3 mm:	Grade GS45 – 0.094 dm^3/kg·h; Grade GS65 – 0.053 dm^3/kg·h; Grade GS75 – 0.142 dm^3/kg·h; (0.030 dm^3/kg·h – for dry polydisperse one); Grade 90 – 0.022 dm^3/kg·h [1].

10. Stability and chemical reactivity

10.1 Chemical stability: (for unstable products, indicate any breakdown products)	Material is stable under the normal conditions, there is no hazardous polymerization. Ferrosilicon with the weight percent 50-60% of silicon undergoes scattering because of lebeauite (unstable phase α – $FeSi_2$ is turned into stable phase β – $FeSi_2$ with the increased volume of alloy), and also because there are impurities of phosphorus, aluminum, and calcium in the alloy [12].
10.2 Chemical reactivity:	It reacts with water, acids, and alkalis [2]. At temperature of 1000 °C it is a strong reducing agent in the pyrometallurgical processes [12].
10.3 Conditions that shall be avoided: (including dangerous behavior under the contact with the incompatible substances and materials)	Ferrosilicon releases the explosive gas, hydrogen, and because of impurities there may be the release of very hazardous gas – phosphine; moistening causes the arsine release, both gases are toxic [2]. Amount of hydrogen in the released gases is 90% of the volume; amount of phosphine in the released gases is 0.8-1.6% of the volume [1]. The gas release intensity increases with the increase of moistening and alloy surface [1, 6, and 28].

11. Toxicity information

11.1 General effect characteristics: (evaluation of hazard (toxicity) extent for the organism effects)	Ferrosilicon is a moderately hazardous substance concerning the effects, mainly fibrogenic, on the organism [1, 6].

The acute poisoning is possible because of hydrogen phosphide (phosphine), toxic gas effecting on the nervous system, destroying the metabolism, and influencing on the blood vessels, respiratory apparatus, liver, and kidneys. The long-term inhalation can cause the lethal outcome [6].

Under moistening the ferrosilicon, hydrogen arsenide (arsine) is produced, that is toxic gas with hemolytic action. It dissolves in plasma and circulates in the human organism and has the harmful effects on internals, mainly on liver and kidneys. It bonds with erythrocytes and causes their hemolysis and the hemoglobin formation [6].

11.2 Routes of entry:
(inhalation, per oral way, skin and conjunctiva)

Inhalation, skin, conjunctiva, and ingestion [3, 6].

11.3 Affected human organs, tissues, and systems:

11.4 Information on the hazardous effects of direct contact with substance on health, as well as consequences of such exposures:
(irritating action for upper air passages, eyes, skin, including percutaneous action; sensibilization)

Ferrosilicon has the irritating action when it intakes the upper air passages and can mechanically influence on skin and conjunctiva. The released gases (phosphine and arsine) have the acute irritating action.

Ferrosilicon does not have the percutaneous action, but the sensibilization is determined [3, 6].

11.5 Information on long-term harmful effects for human organism:
(Effects on reproduction function, carcinogenicity, cumulativeness, etc.)

Cumulativeness is weak.

Effects on reproduction function, mutagenic and carcinogenic effects of ferrosilicon have not been studied [3, 6].

11.6 Criteria of acute toxicity:
(DL_{50}, entry routes (internal, external), animal species; CL_{50}, exposure time (h), animal species)

Ferrosilicon

DL_{50} (mg/kg)	Entry route	Animal species
> 5000 mg/kg	internal	Rat
20000	external	Rabbit [8]

CL_{50} (mg/m^3)	Exposure time	Animal species

CL_{50} is not achieved [3].

11.7 Doses (concentrations) having the minimum toxic effect:

EC 194 mg/m^3, inhalation, 6 hours, 26 weeks, rats (changes of lung mass factor) [3].

12. Information about effects on environment

12.1 General characteristic of effects on environment objects:
(atmospheric air, water bodies, soil)

When concentrations are large, it can contaminate various objects of environment, i.e., give an extraneous odor to the atmospheric air; change the organoleptic properties of water; have fatal effects on living organism of a water body; cause the inhibition of biochemical consumption of oxygen; and delay the plant growth [13].

12.2 Environment impact ways: Violation of storage and transportation regulations, unorganized waste treatment, throwing out on relief or in water bodies.

12.3 Observed features of impact: Extraneous odor to the atmospheric air; increased water turbidity and extraneous taste; bottom and waterside sediments [13].

12.4 Most important characteristics of effects on environment

12.4.1 Hygiene regulations:
(permissible concentrations in atmospheric air, water, including fishery waters, and in soil)

Ingredient	$MPC_{atm.air}$ or Safe Reference Levels of $Impact_{atm.air}$, mg/m^3 (LHI[1], class of hazard) [14]	MPC_{water}[2] or Approximate Permissible $Level_{water}$, mg/l, (LHI, class of hazard) [15]	$MPC_{fishery}$[3] or Safe Reference Levels of $Impact_{fishery}$, mg/l (LHI, class of hazard) [16]	MPC or Approximate Permissible Concentration for soil, mg/kg (LHI) [17]
Ferrosilicon	$SRLI_{atm.air}$ = 0.02 mg/m^3, dust of ferroalloys (iron – 51%, silicon – 47%) /according to iron/	MPC_{water} = 0.3 mg/l, (iron), organoleptic, 3 class of hazard	$MPC_{fishery}$ = 0.1 mg/l, (iron), toxicological, 4 class of hazard; 0.05 mg/l, toxicological, for sea waters	MPC for soil – unknown
Hydrogen phosphide (phosphine)	$MPC_{atm.air}$ = 0.01/0.001 mg/m^3, percutaneous, 2 class of hazard	Unknown	Unknown	Unknown
Hydrogen arsenide (arsine), released by contact with water	$MPC_{atm.air}$ = -/0.002, percutaneous, 2 class of hazard	Unknown	$MPC_{fishery}$ = 0.05 mg/l (arsenic, for all water-soluble forms), toxicological, 3 class of hazard; 0.01 mg/l, toxicological, 3 class of hazard, for sea waters	Unknown

12.4.2 Criteria of ecotoxicity:
(CL, EC for fishes, daphnia Magna, algae, etc.) N/A [3, 13]

12.4.3 Migration and conversion in environment due to biodegradation or other processes (oxidation, hydrolysis, etc.): There is no conversion in environment [3].

13. Recommendations for waste treatment

13.1 Safety measures for handling waste obtained Safety measures for handling waste are

[1]LHI – Limiting Harmful Index (toxicological, sanitary-toxicological, organoleptic, reflex, percutaneous, reflex-percutaneous, fishery (change of commercial quality for aquatic organisms), general sanitary)
[2]Water of water bodies for household and community water consumption.
[3]Water of water bodies having the fishery significance (including the marine ones).

during use, storage, and transportation, etc.	analogical as those used for working with ferrosilicon (see Section 5, 7, and 8 of the MSDS).
13.2. Information about places and ways to decontaminate, utilize, or eliminate the substance (material) waste, including tares (packages):	Wastes, substandard products, not subject to reprocessing, and non-returnable tares shall be destroyed at the landfill for industrial toxic wastes or at the places coordinated with the sanitary inspection and environmental organizations [18].
13.3 Recommendations for treatment of wastes obtained during use in the private life conditions:	There is no use in the private life conditions [1].

14. Transportation information

14.1 UN No.: (according to the UN recommendations for transportation of danger goods (typical rules), last edition)	1408 [19]
14.2 Appropriate shipping name:	Ferrosilicon (grade, grain size category) [1, 19, 28].
14.3 Types of used transport:	All types of transport. Ferrosilicon for local and international transportations is performed according to the regulations and relevant agreements valid at that type of transport [1].
14.4 Danger classification of cargo: (GOST 19433 and the UN recommendations for transportation of danger cargoes)	The class of hazard 4, subclass 4.3, classification symbol 4323, danger sign according to the drawing 4b – basic, and 6a – additional [1, 10, 20]. Based on the data of 1415-93, ferrosilicon with weight percent of silicon from 30% to 90% and particle sizes more than 3.2 mm up to 315 mm is not classified as the danger cargo according to GOST 19433 [1, 10]. When ferrosilicon that is not considered as the danger cargo according to the criteria of GOST 19443 is transported by sea, river, and air transport, the consignor shall submit the declaration about the cargo safety [1, 10].
14.5 Shipping marking: (handling marks; basic, additional, and information notices)	Shipping marking according to GOST 14192. Handling mark: "Keep Dry" [1, 21].
14.6 Packing group: (according to the UN recommendations for transportation of danger goods)	III [19].
14.7 Information about hazard for motor-vehicle transportation (Kemler code):	Kemler code 5DE – information about hazard, which is used for transportation of ferrosilicon classified by GOST 19433 as danger cargo [22]. Information about danger for transportation is not applied, if ferrosilicon has particle sizes from 3.2 mm to 315 mm and the weight percent of silicon from 30% to 90%, because this form of products is not classified as danger cargo according to GOST 1415-93 [1, 10].
14.8 Emergency cards: (For transportation by railway, sea, etc.)	Emergency card No. 408 – for transportation by railway; emergency card F-G and S-N – for transportation by sea; and emergency cards of enterprises without number – for transportation by river or by road [9, 20, 23].

14.9 Danger information for international freight transportation: (AIGTR, ADR, RID, IMDG Code, ICAO/IATA, etc., including the danger information for environment and "sea pollutants")	Danger code 462 – solid toxic substance, reacting with water and producing the flammable gases; Classification code WT2 [24, 26].

15. Information about National and International Legislation

15.1 National Legislation

15.1.1 Russian Federation Laws:	"About environment preservation". "Sanitary-epidemiological welfare of population".
15.1.2 Documents, regulating the requirements for the population and environment preservation: (Certificates, Sanitation and Epidemiological Conclusions, Licenses, etc.)	Not required.

15.2 International Legislation

15.2.1 International Conventions and Agreements: (Is product regulated by Montreal Protocol, Stockholm Convention, etc.?)	It is not covered by the actions of any international conventions and regulations.
15.2.2 Warning marking active in the EC countries: (Danger symbols, risk and safety phrases, etc.)	R: 15/29 – contact with water causes the release of toxic and highly inflammable gases. S: 23.5-38-45 – do not inhale vapors/sputtered particles; if the ventilation is not sufficient, apply the proper protection of respiratory apparatus; if the accident or unwellness occurs, immediately appeal for medical aid (it is desired to have the label of a substance manufacturer) [27].

16. Additional information

16.1 Information about revision (republication) of MSDS: (Indicate: "MSDS is developed for the first time" or other cases, determining the basic reason why the MSDS is reviewed.)	MSDS has been reviewed because the period of validity expired. This MSDS may be used for evaluating the hazard of ferrosilicon, supplied according to Specifications TU 14-5-284-97 "Ferrosilicon for export" and TU 14-139-160-97 "Powder-like ferrosilicon and screening of ferrosilicon", which does not differ on the basis of physical-chemical and toxic properties, for human being and environment [28].

16.2 List of date sources used for compilation of MSDS

1. GOST 1415-93 (ISO 5445-80) Intergovernmental Standard. Ferrosilicon. Specifications and Conditions of Delivery.
2. GN 2.2.5.13.13-03 "Maximum permissible concentrations (MPC) of hazardous substances in working zone air". GN 2.2.5.2308-07 "Approximately safe reference levels of impact of hazardous substances in working zone air". Hygiene regulations. – M.: Russian potentially hazardous chemical and biological substances register of the Russian Ministry of Health, 2003, 2008.

3. Hazardous substances in industry. Volume 3. Inorganic and element-organic compounds. Handbook for chemists, engineers, and physicians. Under the editorship of N. V. Lazarev and I. D. Gadaskina; L.: Chemistry, 1977.
4. GOST 31340-2007. Intergovernmental Standard. Labeling of chemicals. General requirements.
5. ECIS (European Chemical Information Substances) / Data Sheet: Result for EC.
6. Hazardous substances in industry. Volume 2. Inorganic and element-organic compounds. Handbook for chemists, engineers, and physicians. / Under the editorship of N. V. Lazarev; L.: Chemistry, 1971.
7. A. Ya. Korolchenko. Fire and explosion risk of substances and material and means to extinguish them. Handbook in two parts. Part II.; M.: Ass. "Pozhnauka", 2000.
8. Fire risk of substances and material used in chemical industry. Handbook. / Under the editorship of I. V. Ryabov; M.: "Chemisty", 1970.
9. "Safety regulations and procedures of emergency elimination for dangerous cargoes transported by railway". Approved by the RF Ministry of Railways, No. TsM-407, 25.11.1996, and by the RF Emercom, No. 9-733/3-2, 31.10.1996. M.: MPS RF, 1997.
10. Emergency cards for dangerous cargoes transported by railways of CIS, Latvian Republic, Lithuanian Republic, and Estonian Republic. M.: "Transport" 2000. Emergency cards for dangerous cargoes transported by railways of CIS, Latvian Republic, Lithuanian Republic, and Estonian Republic (in the new edition with changes and amendments, 21.11.2008 and 22.05.2009).
11. GOST 26590-85 with amendments Nos. 1, 2, 3. Intergovernmental Standard. Ferroalloys. Packaging, Transportation, and Storage.
12. Collective and individual protection gears. Monitoring of Protection Means. Encyclopedia "Ecometry", the series of handbook publications on ecological and medical measurements. M.: FID "Delovoy ekspress", 2002.
13. Chemical encyclopedia. / Editorial Board: I. L. Knunyants (Chief Editor), etc. M.: Soviet encyclopedia, 1990.
14. Ya. M. Grushko. Hazardous inorganic compounds in industrial sewerage. Handbook. L.: Chemistry, 1979.
15. GN 2.1.6.1338-03 "Maximum permissible concentrations (MPC) of polluting substances in atmospheric air of populated areas". GN 2.1.6.2309-07 "Approximate safe reference levels of impact of polluting substances in atmospheric air of populated areas". Hygiene Regulations of Russian Federation, 2003, 2008.
16. GN 2.1.5.1315-03 "Maximum permissible concentration (MPC) of chemical substances in water of water bodies of household and community water consumption". GN 2.1.5.2307-07 "Approximate permissible levels of chemical substances in water of water bodies of household and community water consumption". Hygiene Regulations. M.: Russian Potentially Hazardous Chemical and Biological Substances Register of the RF Ministry of Health. 2003, 2008.
17. Water quality standards for water bodies having the fishery significance, including Standards for maximum permissible concentrations of hazardous substances in water of water bodies having fishery significance. Approved by the Order of Federal Agency for Fishery No. 20, 18.01.2010.
18. Maximum permissible concentrations (MPC) of chemical substances in soil. Enactment of Chief State Medical Officer of the Russian Federation, 23.01.2006. No.1. GN 2.1.7.2041-06. Approved on January 19, 2006, M.: Federal Center of Hygiene and Epidemiology of Rospotrebnadzor, 2006.
19. Sanitarian and epidemiological regulations and standards. SanPiN 2.1.7.1322-03. Hygiene requirements for disposal and sterilization of the industrial and consumption wastes.
20. Recommendations for transport of dangerous goods. Typical rules. 16-th reviewed publication. The UN. New-York and Geneva, 2009.
21. GOST 19433-88. Dangerous goods. Classification and Marking. M.: Standard Publisher, 1988.
22. GOST 14192-96. Marking of Cargoes. M.: Standard Publisher, 1988.
23. Regulations for transportation of dangerous cargoes by road. M.: the Russian Federation Ministry of Transport. 1996.
24. International Maritime Dangerous Goods Code. IMDG Code., volumes 1, 2. S-Pt.: CJSC "TsNIIMF", 2007.
25. European Agreement concerning the International Carriage of Dangerous Goods by Road. ADR. The UN, New-York and Geneva, 2006.

26. Regulations for transportation of dangerous goods by railways, MPS RF. M.: Transport, 1997.
27. Regulations for transportation of dangerous goods. Attachment 2 to "Agreement on International Goods Transport by Rail", MPS RF.
28. A. K. Chernyshev, etc. Criteria for hazard of substances and materials. T1/A. / Under the editorship of V. K. Gusev. M.: Fund named after I. D. Sytin, 1999.
29. Information notice about entering the changes and amendments to title page and text of MSDS. OJSC "ChEMZ", 23.06.2011.
30. GOST 30333-2007. Intergovernmental Standard. Chemical production safety passport. General requirements.