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Reagent Storage and Handling (Spill Prevention)

ПОЯСНИТЕЛЬНАЯ ЗАПИСКА

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SUMMARY

The reagent storage project was completed by JSC ZAO OMGC during construction of the Julietta mine and milling complex. The license to design mining and other facilities was issued by Gosgorteknadzor G 890704 R No. FLT(1) dated May 15, 2000 and valid for a period of three years until May 15, 2003.

In accordance with the mine development plan, the following chemical reagents will be consumed by the mill:

Substance	Storage Total (Tonnes)
1. Sodium cyanide	336.0
2. Amyl xanthate	7.3
3. Frother MIBC	3.5
4. Flotation reagent 3477	2.9
5. Anionic flocculent	42.0
6. Lime	60
7. Sodium metabisulfite	219.0
8. Copper sulfate	7.3
9. Lead nitrate	11.7
10. Antiscalant	1.0
11. Zinc powder	36.5
12. Diatomite	17.5
13. Quartz sand	7.3
14. Borax	27.4
15. Caustic soda	5.5
16. Potassium nitrate	9.1
17. Calcium fluoride	4.4
18. Magnesite	6.2
19. Vanol	0.2
Total	440

Reagents will be delivered to site in metal, 40-foot containers by vehicle. The reagents will be stored in these containers in the reagent storage area near the mill. The amount of reagents stored there will be a 1-year supply. All reagent handling and use will be conducted by specially trained mill personnel.

Table of Contents

SUMMARY	2
1. INTRODUCTION.....	4
1.1. ENVIRONMENTAL BASELINE INFORMATION.....	4
1.2. PROJECT DESCRIPTION	5
2. BASIS OF REAGENT CONSUMPTION	7
2.1 REAGENT CHARACTERIZATIONS	9
3. CHARACTERIZATION AND CLASSIFICATION OF SUBSTANCES	12
4. REAGENT STORAGE.....	16
4.1. GENERAL ARRANGEMENT	16
4.2. STORAGE CONSTRUCTION	16
4.2.1. Fenced area.....	16
4.2.2. Open Storage Area.....	17
4.3. FIRE SAFETY	18
4.3.1 LIGHTNING ROD	18
4.4. VENTILATION.....	20
4.5. STORAGE SECURITY	20
4.6. POWER SUPPLY AND COMMUNICATION	20
5. SAFETY MEASURES.....	21
5.1. REAGENT TRANSPORTATION	21
5.2. CONTAINER MARKING.....	21
5.3. DOCUMENTATION	22
5.4. DISTRIBUTION.....	22
5.5. STORAGE	22
5.6. HIGHLY ACTIVE POISONOUS SUBSTANCES	22
5.7. STORAGE ACCESS	23
6. EMERGENCY RESPONSE PROCEDURES.....	24
6.1. REAGENT SPILLS	24
6.2. FIRE	25
6.3. POISONING.....	25
7. ENVIRONMENTAL MONITORING	26
7.1. ENVIRONMENTAL PROTECTION	26
7.1.1. Air Protection	26
7.1.2. Water Protection.....	26
7.1.3. Soil Protection	27
7.1.4. Waste Disposal	27
7.2. ENVIRONMENTAL MONITORING	28
7.2.1. Source Monitoring	28
7.2.2. Environmental Monitoring	28
8. REFERENCE LIST.....	29

ATTACHMENTS

Material Safety Data Sheet

1. INTRODUCTION

The Julietta Mine Site is located 180 kilometers southwest of the village of Omsukchan in the Omsukchan Region (raion) of the Magadan Oblast, Russian Federation. The closest population centers are the village of Kupka (Omsukchan Region) and Talaya (Xasynsky Region) and are 170 and 190 kilometers from the site via temporary roads.

The site is connected to Omsukchan via a 324 kilometer road, that includes 184 kilometers from Gerba to Omsukchan. Omsukchan is connected to the Oblast center, Magadan, via a 575 kilometer road and an airport. There is also a helicopter pad at Julietta capable of receiving all makes of helicopters.

Reagents will be delivered to the site via the Magadan-Omsukchan road to kilometer marker 76 (a total of 391 kilometers) and then via the site gravel road (another 140 kilometers). The total distance is 531 kilometers.

1.1. ENVIRONMENTAL BASELINE INFORMATION

The construction area is located in the lower reaches of the Ozernyi River – a left tributary of the Left Jugajaka River which confluent with the Kilgan River (a tributary of the Bolshoy Kupka – Buyunda- Kolyma). The terrain in the construction area is moderately mountainous, prone to erosion, and has steep slopes that have an absolute elevation of 1150-1400 meters and relative elevations of 350-400 meters. The slopes are generally steep at 18-35 degrees. The site is situated in the middle of a permafrost area. The thickness of the seasonal freeze-thaw zone does not exceed 2 meters. The gravel composition consists of boulders and coarse gravel cemented with a sand and gravel mixture with some sandy loam and clays. The thickness of this zone is up to 12 meters. The host rock is primarily quartz andesite and its tufts. The site is located within Seismic Zone 8 of the MSK-64 scale.

The climate of the region (in accordance with SNIIP 2.01.01-82) is of the 1st Region, 1A Subregion) of the northern construction zone. The annual amount of precipitation is 300-450 mm. The predominant wind direction for the different seasons is north and north-west (45-50% of the time). Calms occur 36% of the time during the year. The number of days with an average temperature above zero is 130 (with a negative temperature is 235 days). The average date that average temperatures cross zero occurs in the last 10 days of May and the last 10 days of September.

Winter lasts on an average of 7 months (from the 1st 10 days of October thru April) and is characterized by extremely low temperatures. In the valleys, the absolute temperatures can reach -60 °C. Inversion conditions are observed in the mountains. The

average annual wind speed is 3-4 meters per second. The average number of days with snowstorms is 81 days. Snow cover appears in the 1st 10 days of October and remains until the 2nd half of March or the beginning of April. The maximum snow depth is 47-80 cm. The relative humidity in January is 76-79%.

Spring is short (April-May) and is characterized by fog, unpredictable weather, and frequent freezes. The average date of last freeze is the 19th of June. The maximum daily temperature in April is -7.8 °C with the nighttime temperature dipping to -20.7 °C. In May the maximum daily temperature is 4 °C with a nighttime temperature of -6.4 °C. The date that the average 24-hour temperature crosses 0 °C occurs in the last 10 days of May. The date that the average 24-hour temperature crosses 5 °C occurs during the 1st 10 days of June.

Summer is not long (June-August) and is relatively warm with an average temperature in July of 12 °C. The absolute maximum temperature recorded is 32 °C. Precipitation during summer is unpredictable with infrequent downpours and thunderstorms. The maximum 24-hour storm events occur in August and can deliver between 47-74 mm of precipitation. The relative humidity in July averages 66-68%.

Fall is short (end of August- beginning of October) and is characterized by dry, warm weather during the day and freezing at night. Wet snow begins to fall in the 2nd half of September.

1.2. PROJECT DESCRIPTION

Construction of the Julietta mine began in 1997 in accordance with the Feasibility Study approved by the government Expertiza Committee. This feasibility was completed by the Omsukchan Mining Company (OMGC) that includes:

- Bema Gold, Canada; 79%;
- ZAO Nedra, Russia 11%; and,
- OAO Dukat Mining Company, Russia, 10%.

The primary metals of interest in the ore are gold and silver. Other metals (lead, zinc, and copper) as well as other rare elements (cobalt, nickel, indium) are not present in any commercial amounts. The government reserves for the project based on categories C1+C2 are 18,598 tonnes of gold and 228.7 tonnes of silver using a cut-off grade of 28.7 and 353.3 grams per tonne, respectively.

The mine is an underground mine with cake backfill. The life of the mine is estimated to be 6-8 years beginning in November 2001. Approximately 800,000 tonnes of ore will

be processed over this period. The throughput of the mill will be 400 tonnes per day or 146,000 tonnes per year.

The mill flowsheet includes gravitational concentrate followed by flotation and cyanidation of the gravity-flotation concentrate. The Dore will be recovered using the Merrill Crowe process. The Dore will be shipped to the Kolyma Refinery via the all-season Omsukchan-Magadan road.

Process water that contains cyanide will be decontaminated using the INCO metabisulfite process followed by treatment of the water with hypochlorite to remove additional cyanide and thiocyanate. The cyanide tailings will be discharged into a separate, lined facility. The process water from the flotation circuit will be discharged to the flotation tailings pond and recycled to the mill.

Due to the distance that the mine is from population centers, a mancamp and supporting infrastructure was constructed. The mancamp can accommodate up to 160 persons. Wastewater from the mancamp will be treated using a rotary biological contactor (RBC). Power is supplied from a local diesel powerhouse. Fuel is stored in 2-700 m³ fuel storage tanks near the mill.

Workers from Omsukchan and other places within the Magadan Oblast are transferred to the site via the existing Magadan-Omsukchan-Julietta road. It is anticipated that the total work force will be 260 persons working on 2-fifteen day shifts. The mill and the mine operate 24 hours per day.

2. BASIS OF REAGENT CONSUMPTION

The following chemicals will be used during milling of Julietta ore and decontamination of process mixtures (Table 1).

Table 1
Types and amounts of reagents to be stored at reagent storage

Reagent	Amount (kg/tonne ore)	Use (tonne/yr)	Storage (tonne)
Sodium Cyanide	2.301	336.0	144.0
Amyl Xanthate	0.050	7.3	7.3
Frother (MIBC)	0.024	3.5	3.5
Flotation reagent 3477	0.020	2.9	2.9
Anionic Flocculent	0.288	42	20
Lime	0.411	60	50.0
Sodium Metabisulfite	1.500	219.0	80
Copper Sulphate	0.050	7.3	10.3
Lead Nitrate	0.080	11.7	11.7
Antiscalant	0.007	1.0	2.7
Zinc Powder	0.250	36.5	41.1
Diatomaceous Earth	0.120	17.5	2.5
Quartz sand	0.050	7.3	7.3
Borax	0.188	27.4	45.4
Sodium Carbonate	0.038	5.5	13.5
Potassium Nitrate	0.062	9.1	9.1
Calcium Fluoride	0.030	4.4	22.7
Magnesite	0.043	6.2	4.5
Vanol	0.001	0.2	0.2
		804.8	478.7

The amount of reagents was determined by assuring a 1 year supply of reagents and includes factory packaging of materials. In accordance with design, the mill is able to process 146,000 tonnes of ore in a 12 month period.

The packaging type is in accordance with Russian standards and are transported to the site in a safe manner. The reagents are stored on site in accordance with the following plan (Table 2).

Table 2

Description of the reagents and packaging that is stored at reagent storage

Reagent	Container	Total (tonne)	Type of Package	Amount	No. of Containers
Sodium cyanide, solid granular	C1, C2	144	1000 kg packets	144	4
Amyl Xanthate, Liquid	C18, C19	7.3	160 kg drums	46	1
MIBC, Liquid	C21	3.5	160 kg drums	22	1
Flotation reagent 3477, liquid	C10	2.9	220 kg drum	12	1
Anionic flocculent, liquid	C6	20.0	23 kg drum	87	1
Lime, solid	C17,C25	50.0	45 kg bag	1111	2
Sodium metabisulfite, solid	C8, C14, C24, C28	80.0	23 kg bag	3478	4
Copper sulphate, solid	C15	10.3	45 kg bag	229	1
Lead Nitrate, solid	C4	11.7	25 kg bag	468	1
Antiscalant, liquid	C5	2.7	220 kg drum	12	1
Zinc Powder, solid	C20,C22	41.1	23 kg pail	1787	2
Diatomite, solid	C5	2.5	23 kg bag	109	1
Quartz Sand, solid	C27	7.3	45.4 kg bag	161	1
Borax, solid	C12, C13	45.4	23 kg bag	1973	2
Caustic Soda, solid	C9	13.5	23 kg bag	587	1
Potassium Nitrate, solid	C26	9.1	50 kg bag	182	1
Calcium Fluoride, solid	C11, C16	22.7	23 kg bag	987	2
Magnesite, Solid	C7	4.5	45.4 kg bag	99	1
Vanol, liquid	C23	0.2	18 kg pail	11	1
Total		478.2		11505	29

The number of containers shown assumes 20 tonne containers.

There are a total of 19 reagents. Of these, 6 are liquids (xanthate, MIBC, 3477, flocculent, antiscalant, and foam suppressant) and the remaining reagents are solids. The maximum amount of reagents that can be stored at site is 478.2 tonnes. The total

number of packages is 11505 (see Table 2). The maximum number of 40 foot containers for reagent storage is 30 units.

2.1 REAGENT CHARACTERIZATIONS

Sodium Cyanide (NaCN)

It is used to leach metals from the gravity-flotation concentrate.

- Granular cyanide is packed in plastic, water resistant bags and then placed in wooden crates. The total weight per package is 1000 kg.

The consumption of cyanide is 2.301 kilogram per tonne of ore or 920.4 kilograms per 24-hour period. The maximum allowable amount of cyanide to be stored at site is 144 tonnes or 144 packages. The remaining cyanide can be ordered as needed.

Amyl Xanthate (C_nH_nOS₂K)

Is used as a collector during the flotation process. It arrives in liquid form (a concentrated solution) in 200 liter metal barrels/drums. Xanthate is used at 0.05 kg/tonne of ore or 20 kilograms per 24-hour period. The maximum amount stored at site is 46 barrels or 7.3 tonnes.

Flotation Reagents MIBC

The flotation reagent MIBC (T-80) is used in the flotation circuit as a foaming agent and to reduce surface tension. The amount of flotation reagent used is 0.024 kilogram per tonne or 9.6 kg/day. The maximum allowable storage is 22 barrels or 3.5 tonnes.

Flotation Reagent (Aeroflot 3477)

The reagent 3477 (Aeroflot 3477) is used in the flotation circuit as a collector for excessive hydrophobic materials. The amount used is 0.02 kilogram per tonne. Reagents are in liquid form and are in metal, 200-liter drums. The maximum amount storage at site are 12 barrels (2.9tonnes).

Anionic Flocculent (Percol 727)

The polyacrylamide flocculent is used in the thickener for improved settling of the solids and water clarification. It is provided in liquid form in 23 kg metal drums. The flocculent use is approximately 0.288 kilogram per tonne or 115.2 kg/day. The maximum allowable storage is 87 barrels or 20 tonnes.

Lime (CaO)

Used to regulate the pH in the process. Lime is added to the crushing circuit and the cyanide destruct circuit. It is provided in solid phase in polyethylene bags that weigh 45 kilograms. The lime use is 0.411 kilograms per tonne of ore or 164.4 kilograms per 24-hour period. The maximum storage is 1111 bags or 50 tonnes. The remaining 10 tonnes will be ordered as needed.

Sodium Metabisulfite ($\text{Na}_2\text{S}_2\text{O}_5$)

Sodium Metabisulfite is used to oxidize cyanide in the cyanide destruct circuit. It is provided in 23 kilogram, polyethylene bags. It is used at a rate of 1.5 kilograms per tonne or 600 kilograms per 24-hour period. The maximum storage amount is 3478 packets or 80 tonnes. The remaining 139 tonnes will be ordered as needed.

Copper Sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)

Blue vitriol is used as a catalyzer in the cyanide destruct process and for settling of iron-cyanide complexes. It is provided in 45-kilogram polyethylene bags. It is used as needed but the approximate dosage is 0.05 kilograms per tonne or 20 kilograms per 24-hour period. The maximum storage amount is 229 bags or 10.3 tonnes.

Lead Nitrate

Lead nitrate is used to activate the zinc powder during the Merrill Crowe process. It is used at a rate of 0.08 kilogram per tonne. It is provided in solid form in 25 kilogram bags. The maximum storage is 468 boxes or 11.7 tonne.

Antiscalant

Antiscalant is added to the chemical mixtures to prevent accumulation of sediments in the tanks and the pipes. It is provided in liquid form in metal 222-liter barrels and is added directly from the barrels to the mixtures. It is used at a rate of 0.007 kilogram per tonne of ore. The maximum storage is 12 barrels or 2.7 tonnes.

Zinc Powder

Zinc powder is used in the Merrill Crowe process. It is provided in 23-kilogram pails. It is used at a rate of 0.25 kilogram per tonne or 100 kilograms per 24-hour period. The maximum storage amount is 1787 pails or 41.1 tonnes.

Diatomite, Quartz Sand

Diatomaceous earth with quartz sand is used in the Merrill Crowe process. It is provided in either cloth or paper, 23 or 45.4, kilogram bags. It is used at a rate of: Diatomite – 0.12 kilogram per tonne (48 kilograms per 24-hour period) Sand – 0.05 kilograms per tonne (20 kilograms per 24-hour period). The maximum storage is 109 and 161 bags or 2.5 and 7.3 tonnes.

Borax, Caustic Soda, and Potassium Nitrate

These reagents are components of the flux and are used in the process of refining the gold-silver concentrate. They are provided in plastic or paper bags of 23 and 50 kilograms. They are used at a rate of: Borax – 0.188 kilogram per tonne, Soda – 0.038 kilogram per tonne, Potassium nitrate – 0.062 kilogram per tonne. The maximum storage is 1973, 587, and 182 bags or 45.4, 13.5, and 9.1 tonnes.

Calcium Fluoride (CaF₂)

Calcium Fluoride is used as an additive in the refining process. The consumption rate is 0.03 kilogram per tonne. It is provided in 23 kilogram plastic bags. The maximum storage is 987 bags or 22.4 tonnes.

Magnesite (MgO)

This material is used for the formation of cupels, which are used during analyses of ore and concentrates. The consumption rate is 0.043 kilograms per tonne. It is provided in 45.4 kilogram plastic bags. The maximum amount of storage is 99 bags or 4.5 tonnes.

Vanol

Vanol used in the flotation process as a foam depressant. It is provided in 18 kilogram pails. The rate of consumption is 0.001 kg/tonne of ore or 0.4 kg/day. The maximum allowable storage is 11 pails or 0.2 tonnes.

3. CHARACTERIZATION AND CLASSIFICATION OF SUBSTANCES

A summary of the physical, chemical and toxicological characteristics of the reagents are provided in Table 3. The basis for the classification system is health and welfare of both individuals and society. The levels of potential dangerous impacts on an organism by a hazardous substance are divided into 4 classes in accordance with GOST 12.1.007-76.

- Class 1 – Extremely Dangerous
- Class 2 – Highly Dangerous
- Class 3 – Moderately Dangerous
- Class 4 – Slightly Dangerous

The determination of the Danger Class is based on a range of indicators and toxicological parameters that include:

- Air Maximum Allowable Concentration for Working Zone;
- LD₅₀ for Ingestion;
- LD₅₀ for Skin Exposure; and,
- LB₅₀ and others.

In accordance with these indicators, the list of reagents used is divided up into the following:

- Extremely Dangerous (2 substances) – cyanide and lead nitrate;
- Highly Dangerous (3 substances) – xanthate, copper sulfate, and zinc powder;
- Moderately Dangerous (12 substances) – frother, flotation reagent 3477, flocculent, lime, metabisulfite, diatomaceous earth, potassium nitrate, borax, caustic soda, calcium fluoride, vanol and manganese dioxide; and,
- Slightly Dangerous (2 substances) – antiscalant and magnesite

The classification of the substances and materials are primarily aimed at transportation and storage of materials on the basis of their potential to kill, injure, poison, irradiate or make a person ill. This also includes potential for explosion, fire, and necessary equipment for transportation and storage. The primary classification for hazardous cargo is provided in RD 31.15.01-89 and includes:

- Class 1 – Explosive material;
- Class 2 – Compressed or pressurized gases;
- Class 3 – Highly flammable liquids;
- Class 4 – Highly flammable solids;

- Class 5 – Oxidizing substance;
- Class 6 – Poisonous or infectious substances;
- Class 7 – Radioactive substances;
- Class 8 – Caustic or corrosive substances;
- Class 9 – Other dangerous substances.

Among the reagents stored at the Julietta reagent storage, the substances had the following class of hazard:

- Class 3 (Highly flammable liquids) – MIBC;
- Class 4 (Highly flammable solids) – Xanthate, zinc powder, vanol;
- Class 5 (Oxidizing substance) – metabisulfite, lead nitrate, and potassium nitrate;
- Class 6 (Poisonous) – sodium cyanide;
- Class 8 (caustic agent) – flotation reagent 3477, lime;
- Class 9 (Other dangerous substances) – flocculent, copper sulfate, calcium fluoride, diatomite, borax, caustic soda, antiscalant, and magnesite.

Along with the above classification, there exists a third classification system for hazardous materials that is utilized during production and for use, development, storage, transportation, and destruction of hazardous substances in accordance with the following classification system (Federal Law “On Industrial Safety for Hazardous Production Facilities):

- Ignitable gases;
- Combustible substances;
- Toxic substances;
- Highly toxic substances;
- Oxidizing substances;
- Explosive substances; and,
- Environmentally hazardous substances.

When comparing the previous two classification systems it can be established that indicators from the two systems provide comparable results. Frequently, a toxic substance with a Class 2 toxicity will have a Class 1 explosive potential. Classification of the reagents using the last classification system provides the following results:

- Highly toxic substances – sodium cyanide;
- Toxic substances – lead nitrate;
- Oxidizing substances – metabisulfite, lead nitrate, potassium nitrate;
- Combustible liquids – MIBC; and,
- Environmentally hazardous substances – all reagents listed.

Independent of the previously listed classification systems, there is an officially approved normative status that exists as a category known as Highly Active Poisonous Substances (HAPS) that defines the conditions for storage and are controlled by the following documents:

- Temporary rules for storage of Highly Active Poisonous Substances at Metallurgical Facilities, Moscow, Mintsvetmet, 1975; and,
- SP 2.2.1.022-98 “Sanitary Rules for Storage and Use of Highly Active Poisonous Substances at Metallurgical Facilities, Sanitary and Epidemiological Supervisors, Magadan Oblast, 1998 (thru 2000).

In accordance with these documents, HAPS are divided into 5 groups based on typical indicators. HAPS that do not fit into any one category are classified by the Head Governmental Doctor and the Sanitary and Epidemiological Committee of the Russian Federation/Magadan Oblast or his deputies. From the list of reagents that will be stored by OMGC, only sodium cyanide is on the list as a Group 2 poisonous substance (granular or solid HAPS).

During design and development of the reagent storage area at Julietta, all the characteristics and hazardous categorizations were determined and taken into consideration. As a result of this analysis, the following table was compiled to show the indicators (Table 4).

Table 4
Classification of Hazard Level for Chemical Reagents

Substance	Classification of Hazard			
	GOST 12.1.007-76	RD 31.15.01-89	Federal Law	Temp. Law
Sodium cyanide	Extremely	Poisonous	Highly toxic	HAPS
Amyl xanthate	Highly	Flammable liquid	Environmentally hazardous	
MIBC	Moderately	Flammable liquid	Flammable liquid	
Flot. 3477	Moderately	Caustic	Environmentally hazardous	
Flocculent 727	Moderately		Environmentally hazardous	
Lime	Moderately	Caustic	Environmentally hazardous	
Metabisulfite	Moderately	Oxidizing	Oxidizing	
Copper sulfate	Highly		Environmentally hazardous	
Lead nitrate	Extremely	Oxidizing	Oxidizing	
Antiscalant	Slightly		Environmentally hazardous	
Zinc powder	Highly	Flammable solid	Environmentally hazardous	
Diatomite	Moderately		Environmentally hazardous	
Borax	Moderately		Environmentally hazardous	
Caustic soda	Moderately		Environmentally hazardous	
Potassium nitrate	Moderately	oxidizing	Environmentally hazardous	
Calcium fluoride	Moderately	Caustic	Environmentally hazardous	
Magnesite	Slightly		Environmentally hazardous	
Vanol	Moderately	Caustic	Environmentally hazardous	

4. REAGENT STORAGE

The reagents are shipped to site in manufacturer's packaging - plastic sealed bags or metal drums. The packages are stocked in 40' sea containers - each reagent in a separate container except for compatible cargos of small amounts. Upon arrival on site, the containers are placed at the storage area. The containers have storage for 12 months of reagents.

4.1. GENERAL ARRANGEMENT

On-site reagents storage area is an open container pad 100x12 meters in size, located on the right side terrace of the Magnitny creek, 50 meters from the main mill building and 500 meters to the south from the camp. The foundation of the mill laydown area is bed rock; the container pad, located on the eastern part of the mill site, is filled with deluvial rock. The pad is accessed via an internal roadway from the camp to the mill. There is also a fenced area in the storage facility for highly poisonous substances.

4.2. STORAGE CONSTRUCTION

The reagent storage area consists of two areas that have a total of 1700 square meters. These areas include:

- a fenced area 20x15 meters
- an open area 70x20 meters

4.2.1. Fenced area

The fenced area of the on-site reagents storage is designed strictly for the storage of cyanides and other highly active poisonous substances (HAPS). The area is designed to keep up to four 20-tonne containers, two columns stacked two high. The maximum amount of cyanides that is allowed to be stored is 144 tonnes (36 packages per container).

The reagents are stored at ambient temperature. All reagents are stored inside the container in such a way to prevent tipping. A 2 meter high barbwire fence surrounds the containers and is 2 meters away from the nearest containers.

The containers of the first level are placed end-to-end, doors to the outside. The containers of the second level are placed doors to the inside. The containers are handled by the 40 tonne KATO 450 crane.

Reagents are transported to the mill by front-end loader. The packages (boxes) are safely fixed to the forks and moved to the mill (the distance is 50 meters). Each reagent is transported separately.

The loader enters the fenced area through the locked gate. There is a ramp in front of the container doors. When the containers of the lower level are emptied, they are replaced with the containers of the upper level. The manufacturer's package is left intact until the reagents are moved to the dedicated reagents mixing areas in the mill. Empty containers are stored at the laydown area below the container pad.

The fenced reagents storage and diversion ditch are lined with an impervious membrane. Storm water is diverted into a water tight sump. The fenced area is provided with lighting, armed security rounds and 24 hour operating security camera that transmits the view to the central control desk in the mill. The storage is clearly visible from the mill (Attachment, Figure 2).

4.2.2. Open Storage Area

The open storage area is located to the north from the fenced storage. It is designed for the storage of other reagents. The containers are placed in one row, wall to wall, doors facing the mill.

There are 18 types of reagents, the maximum allowable quantity for the open site storage is 334.7 tons, which can be housed in 23 containers. The total package quantity is 11361 units. Normally different types of reagents are stored separately, in their shipping containers. Combined storage is allowed based on compatibility (similar classifications).

Containers with highly flammable substances (MIBC frother, xanthate) and flammable substances (zinc dust in 3 containers) are stored at the far end of the open storage area.

Containers with quartz sand and lime, which are allowed to be used for fire suppression, are placed close to the fenced storage area. Beside the lime container there is a separate opened container with fire fighting equipment, personal protection equipment, and decontamination equipment (alkaline chlorides: hypochlorites - 0,2 tons, lime -0,5 tons). The rooms for the personnel, employed in handling the reagents are located in the mill building. The distribution of the containers with other reagents depends on their chemical characteristics and hazard rating. Handling and transportation of these reagents is done by the front end loader as well.

4.3. FIRE SAFETY

The reagents storage area does not have any vegetation; there is no dry grass, wood or other highly flammable substances. The 40 foot containers are composed of metal up to 3 mm thick and considered a Class 1 substance in accordance with NPB 105-95. Within this area there are separate containers that contain flammable substances that occupy an area of 500 m² (36.7 m²). Containers C18, C19, and C20 do not have automated fire protection (in accordance with PB 06-227-98). They are not equipped with fire alarms because all the containers are under constant visual observation via cameras and have inspections twice per shift.

In the container next to the fenced area is where the fire fighting equipment will be located and includes:

- dry type fire extinguishers - 4 ea;
- a box of sand 0,5 m³ - 1 ea;
- first aid kit - 4 ea;
- safety equipment (rubber gloves, safety glasses) - 4 sets;
- gas mask - 4 ea;
- shovels - 2 ea;
- brooms - 2 ea;
- plastic container - 1 ea;
- axes, hooks - 2 ea;

The reagents storage area is located in the proximity to fire water tanks and in less than 50 meters to the truck shop, where the fire engine will be parked. Using water for fire suppression is allowed only according to the Material Safety Data Sheet (MSDS).

4.3.1 LIGHTNING ROD

There is a lightning rod located on the storage area due to the presence of flammable material located in containers C18, C19, C20, C21, and C22. This is in accordance with the special rules and instructions approved in the Russian Federation (PPB-01-93, PB 06-227-98, NPB 105-95 and others).

The lightning rod is a single rod 14.3 meters established in the center of the reagent storage area. The zone of its protection is a cone from the top of the rod at 12.16 meters. This creates a protection zone of 13.06 meters. The horizontal profile of the cone on the reagent storage area $h_x = 2.7$ meters and has a radius of 11.92 meters.

For calculating the height of the lightning rod, the following parameters were used:

- Shortest distance of the lightning rod to the protective equipment – 3.0 meters;
- The maximum distance required for protecting the containers with the lightning rod = 26.0 meters;
- The diameter of the protected area in the plane on top of the containers = 26.0 meters;
- This radius of protection = 13.0 meters
- The height of the containers = 2.7 meters.

The maximum height possible was used to ensure that the entire area was protected against a lightning strike.

In accordance with RD 34.21.122-87, the following calculations were completed:

1. Cone of protection: $0.85 \times 14.3 = 12.16$ meters;
2. Zone of protection at the height of containers: $(1.1 - 0.002 \times 14.3) \times 14.3 = 13.08$ m;
3. Radius of the zone of protection: $(1.1 - 0.00214) \times (14.3 - 14.3/0.85) = 11.92$ m.

Based on the calculations, it is easy to see that all of the containers containing flammable materials will be protected by a lightning rod of 14.3 meters.

The lightning rod is grounded at the base. Therefore, it can be calculated that the resistance at the ground shall not exceed 40 Ohms. To prevent this, the ground should be attached to a 5 pronged ground made of solid steel with a diameter of 20 mm. The prongs will be interconnected with steel 40 mm rods. The length of the steel shall be 3000 mm and have a distance between the prongs of 5 meters.

The resistance to the flow due to the derived frequencies (R_i) at the several resistance points in the ground is up to 1000 Ohm/m and $R_i = 41$ Ohms. The impulse resistance R^* is defined by the formula:

$$R_1 = a \times R^*$$

Where $a = 0.3$ – impulse coefficient that depends on the lightning parameters, and the lightning arrestor design.

The maximum grounding resistance is

$$R_1 = 0.3 \times 41 = 12.3 \text{ Ohm}$$

The actual resistance will be tested during dry weather to ensure that the lightning rod is adequate to protect the reagent storage area during the lightning periods.

4.4. VENTILATION

The reagent storage area is subject to natural ventilation. The working area around the containers is near the container doors. The normal operational procedures include naturally venting the containers with the doors open for 10-15 minutes prior to working within them. This satisfies the requirements for air in the working zone in accordance with GOST 12.1.005-88.

4.5. STORAGE SECURITY

The storage security is assured by security lighting, barbwire fence around the highly poisonous substances storage area, security camera and regular armed security rounds (guards equipped with the radios). The access to the fenced area will be granted only to authorized personnel and in accordance with the cyanide and other hazardous reagents usage logs. Security will inspect the locks daily to ensure that they are locked.

4.6. POWER SUPPLY AND COMMUNICATION

The project does not allow for installation of power equipment or communication equipment on the territory of the reagents storage area. The lighting is installed on the posts, which are the part of the fence. The lighting is fed by overhead line 220 kVt.

5. SAFETY MEASURES

Listed below are the procedures for industrial, sanitary, fire and environmental safety for shipping, handling and storage of the hazardous substances.

5.1. REAGENT TRANSPORTATION

For shipping of the reagents only licensed and experienced companies should be contracted. These companies will use their own transport, licensed for haulage of hazardous substances. The reagents are shipped to site year round via the dirt road, using the approved route, and in compliance with “Instruction on Safe Shipping of Hazardous Loads by Vehicular Transport” and “Regulations on Vehicular Shipments of Hazardous Loads”. Incompatible reagents are shipped separately, the cargos are tracked the entire way. Cyanides are always shipped separately. All the drivers will be instructed and trained for transporting hazardous loads.

Additionally, during the transportation of cyanide the following measures are taken to ensure that adequate environmental, health, and safety measures are taken by the transportation company.

1. The vehicles travel in convoy and are led by a police escort. The vehicles have constant phone contact (via satellite phones) with the site, the half-way road camp, the Magadan office and all emergency services.
2. The convoy is equipped with an antidote kit to treat cyanide poisoning. There will also be a kit located in Magadan and at site.
3. The vehicles are equipped with spill response equipment.
4. There are persons riding in the vehicle that are trained to use the antidote and spill response kits.

5.2. CONTAINER MARKING

All containers and transport of containers will have the appropriate markings. The container labels must be marked in accordance with the Russian regulatory requirements. Every reagent that is placed in the container must have the following information:

- Hazard class;
- Name;
- Number;
- Producer or supplier; and,

- Labels with the toxicity shown.

5.3. DOCUMENTATION

Documentation for all reagents that are enroute to the site or that are stored at the site at reagent storage must include the following information:

- Reagent name (and must be correspondingly marked on the container);
- A description of the substance (to include amount and packaging);
- The Hazardous code and its toxicity; and,
- MSDS

5.4. DISTRIBUTION

All the containers, stored on site are 20' or 40' steel containers, which meet international standards for protection from ambient influences and are resistant to the reagents that are stored in them. The containers at reagent storage will be numbered and marked. There will be a storage inventory that lists chemicals stored in accordance with the container markings.

5.5. STORAGE

The container pad is located 500 meters away from the living camp. The area is accessed by the site road. Only the reagents, listed above are stored at the reagent storage area. Highly Active Poisonous Substances (sodium cyanide) are stored separately in sealed containers inside the fenced area. The fenced area capacity is 90 tons (sodium cyanide). All the reagents are stored in manufacturer's package, which is corrosion resistant and sealed. It is prohibited to unpack the reagents on the territory of the fenced area. There are no electrical or heating devices in the containers. Containers with flammable substances are not stacked. A lightning arrester is mounted beside the container with highly flammable liquids.

The cyanide boxes are transported from the storage area to the mill only in accordance with Russian safety guidelines. It is strictly prohibited to move the cyanides alone. Every spillage is eliminated and decontaminated immediately. After handling the cyanides the personnel must shower thoroughly. All personnel, employed at handling cyanides is given a training course on labor and industrial safety.

5.6. HIGHLY ACTIVE POISONOUS SUBSTANCES

Highly Active Poisonous Substances (sodium cyanide) are transported from the storage area to the mill only in accordance with Russian safety guidelines. This includes transport in the steel containers (75 kg) and inside the wooden packaging. There are special clothing for handling cyanide located in the reagent storage area in an unlocked container as well as chemicals used for clean-up. It is strictly prohibited to move unpackaged cyanide. All spills are cleaned-up and decontaminated immediately. After handling cyanide, the personnel must shower thoroughly. All personnel, employed at handling cyanides, are given a training course on labor and industrial safety.

5.7. STORAGE ACCESS

Only authorized personnel will have access to the cyanide storage area. Access is granted in accordance with the reagents consumption log and marked in reagents issue log. The list of authorized personnel and access procedures for the reagents from the open storage is defined by the corresponding usage log. A record of reagents issue reflects the time, amount and person receiving the reagents.

6. EMERGENCY RESPONSE PROCEDURES

The following situations are classed as emergencies:

- Spill / leakage of chemical reagents;
- Fire; and,
- Poisoning;

In case of any listed above situations actions according to the Emergency Response Plan are taken. The mine/mill manager is responsible for the development of the Emergency Response Plan, familiarizing the personnel with the safety procedures, and control over the measures taken in case of an emergency.

6.1. REAGENT SPILLS

In case of emergency the priorities are:

- Personnel safety;
- Environmental safety;
- Materials safety; and,
- Production.

The first measure is to define which reagent was spilled and take the corresponding safety measures, which are listed on the MSDS (see the attachment) for this reagent. The next steps if someone has been poisoned include:

- Get first aid or provide medical help depending on the situation;
- Determine the fire potential;
- Inform your direct supervisor of the circumstances of the spill.

When the spill is located:

- Eliminate the source of the spill;
- Use appropriate materials for collecting and decontaminating the spilled substance;
- Take measures to prevent the spill from entering waterways.

Inform the management or responsible person to carry on with the emergency response procedures using the fastest means of communication available. While collecting and decontaminating the spilled substance follow the procedures, listed on the MSDS that

should be available for each substance. Use sorbents, pumps, decontaminating materials and other equipment available for clean-up.

6.2. FIRE

Fire will be suppressed with dry type fire extinguishers. Under no circumstances should a water fire extinguisher be used to suppress a fire at cyanide storage. All the fire extinguishers should be approved by licensed fire departments. In the event of a fire at the cyanide storage area, there will be a siren.

6.3. POISONING

A first aid kit is stored in the container with the emergency response equipment. It contains cyanide antidote, medicines and medical instruments used to treat poisoning by cyanide. Also, there are emergency showers and eyewash stations in the mill. All personnel, working with reagents, will be trained to give the first aid by licensed doctor.

7. ENVIRONMENTAL MONITORING

Reagents Storage is classified as a hazardous industrial facility and is a potential pollution source. The design of the storage allows for the necessary pollution preventive measures, which provide for environmental safety standards at a mining facility.

7.1. ENVIRONMENTAL PROTECTION

The key advantage of the projected facility is the storage of the reagents in the shipping containers and manufacturer's package without intermediate handling. Based on this environment pollution is only a *potential* hazard, unless there is an emergency, resulting in damage to a manufacturer's sealed package. In case of reagents entering the environment there is a possibility of contamination of the storage site ground and air as well as a change of the ground water composition.

7.1.1. Air Protection

The air can be polluted by the dust of the spilled powder or solid reagents. The majority of solid reagents are rated as 3 or 4 Hazard Class (e.g., low to mildly dangerous substances), with worker zone Maximum Allowable Concentrations of 1 mg/m^3 and more.

As per the Sanitary Regulations SanPiN 2.2.1/2.1.1.984-00 the Sanitary Protection Zone for the reagents storage area is 300 meters, as it is a facility of the 3rd class (enclosed storages, handling areas, contained chemicals storages).

Considering that the distance to the mancamp (500 meters to the north of the reagent storage), exceeds the sanitary zone boundary and that the prevailing wind direction is north (45% of the time), it can be stated that there is no potential influence of the facility on the quality of the air in the populated area.

7.1.2. Water Protection

In order to prevent impacts due to surface run-off, measures have been completed to prevent run-off from the mill area that includes reagent storage. These measures include diversion ditches on the western perimeter of the mill area and the natural slope towards Magnitny Creek. The diversion ditches at the mill area report to a settlement pond that is located on the terrace 10 meters below the mill area.

Additionally, a protective liner has been placed in the cyanide storage area (16x10 meters). The liner is composed of 3 layers. Two layers of hyroisolation and one layer of geotextile liner. The liner was placed on a 10 cm layer of gravel. The edge of the liner contains a lined diversion ditch that runs to a sump area. When the sump is filled, it is pumped and shipped to the tailings area. The sump was sized based on 213 mm per year of precipitation and a run-off coefficient of 1.0. The sump can hold approximately 15 m³ per year.

7.1.3. Soil Protection

To reduce the risk of soil contamination at the reagent storage area during a spill, the area has been lined and diversion ditches installed. Clean-up equipment is available in the event of an accident to prevent reagents for entering the soil. Clean-ups will be completed in accordance with the MSDSs. The necessary clean-up equipment is stored in the containers near the reagent storage. All material that has been cleaned up will be used in the mill or placed in the tailings impoundment. All clean-ups will include the use of self-protective equipment as necessary to include respirators, glasses, and gloves. There is no soil cover at the reagent storage area.

7.1.4. Waste Disposal

Reagent packaging will be classified as wastes after removal or reagents in the mill. The majority of wastes will be metal containers or wooden barrels from the cyanide packaging. Additionally, there will be plastic wrapping and metal containers from liquid reagents. The metal packaging is considered scrap metal and should be collected by organizations that are involved in recycling. Wooden packaging, after decontamination at the mill with water, should be burned at the landfill. Plastic bags or other containers should be placed in the tailings impoundment. It is anticipated that the approximate volume of packaging waste that will be generated is 20 tonnes per year.

Assuming the project operates under normal circumstances, and that there are no upset conditions, it can be stated that there are no real environmental impacts from the reagent storage facility.

During operations, the project will continue to search for additional ways to prevent any environmental impacts relating to reagent storage. All these measures will be in compliance with international environmental standards for environmental protection.

7.2. ENVIRONMENTAL MONITORING

Environmental monitoring of the storage area will take place within the overall site monitoring plan prepared by OMGC. This monitoring plan was developed in accordance with existing norms and regulatory requirements and has been approved by the regulatory agencies that monitor environmental protection.

Environmental monitoring will be conducted with the goal of monitoring potential sources of pollution and potential environmental impacts. The purpose of this monitoring is to implement measures to prevent and reduce negative impacts due to operations.

7.2.1. Source Monitoring

Source monitoring includes periodic sampling and analyses of the water in the sump area of the reagent storage and settlement pond of the mill. These samples should be analyzed for the basic parameters as well as sodium cyanide and xanthates. To date, sampling has not shown the presence of any reagent within the sump areas.

7.2.2. Environmental Monitoring

The environmental monitoring program includes regular observations for the following environmental parameters:

- Meteorological conditions;
- Hydrological conditions;
- Ambient air measurements at the mancamp; and,
- Chemical analyses of ground and surface water.

Water quality monitoring points include the upper reaches of Magnitny (background) and the confluence of Magnitny in Ozernyi Creek. Groundwater monitoring will occur at the monitoring well in the confluence of Ozernyi and Magnitny Creeks.

A list of monitored parameters and frequency will be determined by the environmental regulatory agencies during development of natural resource use applications during operations to include: Water Use Permit, Air Pollution Discharge Permit, and Waste Discharge Permit.

The results of monitoring will be used to comply with the environmental requirements, development of measures to create a stable environment, and to calculate pollution payments.

8. REFERENCE LIST

Transportation, storage, and other activities associated with reagent storage are in accordance to the current laws of the Russian Federation and rules and instructions for production and use of chemicals. The following documents were used as the basis for this document:

1. Russian Federal Law “On Industrial Safety at Hazardous Facilities” №116-ФЗ. Approved 7/21/97, 6/20/97, and with changes on 8/7/2000.
2. Federal safety rules for ancillary facilities at mining operations, PB 06227-98, Moscow, 2000.
3. Rules for developing mining operations using open pit mining, Moscow NPO OBT, 1992.
4. Safety rules for developing ore bodies, Moscow, NPO OBT, 1996.
5. General Safety Rules for Facilities and Organizations Associated with Metallurgical Processing. Metallurgical. 1998.
6. Guidelines for Fire Safety in the Russian Federation. ППБ-01-83, Moscow, МНФРА-М, 1994.
7. NPB 105-95 Calculating the fire category for locations and buildings, Fire Inspectorate of Russia, 10/31/95.
8. Sanitary Rules for Designing, Equipment, and Compositions of Warehouses for Storage of Highly Active Poisonous Substances. 1965.
9. СанПиН 2.2.1/2.1.1.984-00 "Sanitary Protection Zones and Sanitary Classification of Operations, Equipment and Facilities"
10. СП 3183-84 "Rules for Accumulating, Transporting, Decontaminating, and Storage of Toxic Industrial Wastes"
11. ГОСТ 12.1.007-76. ССБТ. Hazardous Substances. Classification and General Safety Requirements.
12. РД 31.15.01-89. Rules for Sea Transportation of Hazardous Cargo.
13. Rules for Operation of Equipment at Mills. МЛМ USSR. 1978.
14. СНиП 2.11.01-85 Construction Rules and Norms, Storage Facilities.
15. ОНТП 6-85. All Union Norms for Design of Storage Facilities.
16. General Sanitary and Hygienic Requirements for Worker Air Quality. ГОСТ 12.1.005-88.
17. Instructions on the Order of Realization, Acquisition, Storage, Tracking, and Transportation of Highly Active Poisonous Substances. 1968.
18. Instructions on the Composition and Process for Development of Health and Safety Measures in Facilities Associated with Precious Metals. BCH-08-83.
19. Temporary Rules for Storage of Highly Active Poisonous Substances in the Precious Metals Industry. 1976.
20. Hazardous Transportation, Classification and Markings. ГОСТ 19433-88.

21. Rules for transport of hazardous materials, Department of Transportation, Russian Federation, Moscow, 1996.
22. Hazardous Substances in Industry, Volumes 1 and 2. Reference Material. Moscow. 1965.
23. A Short Chemical Reference Manual. Rabinovich V.A., Z. Ya. Xavin, 1991.