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02	2007-10-16	MLPRJO	Text about choice of type of painting moved from page 4 to 3
03	2008-05-28	MLPRJO	References to AFS 2005:18 "Thermosetting Plastics" added
04	2010-09-03	MLPRJO	Revised after the content of BSK 07 (instead of BSK 99)
05	2012-02-21	MLPRJO	Added new LKAB colours
06	2013-02-08	MLPRJO	Added requirements for contact with LKAB Chemical Board
07	2013-05-24	MLPRJO	LKAB's brand profile has changed colours: the NCS code for dark blue, dark grey and white is altered
08	2013-08-07	MLPRJO	LKAB's brand profile has changed the NCS code for dark grey and corrected for dark blue
09	2014-03-25	MLPRJO	LKAB's Industrial colour "orange" NCS 1060-Y80R changed to S1080-Y60R
10	2015-06-17	KLKEHU	Corrosivity Category C5-I New painting changed from C5 A5.02 to A51.02
11	2017-06-19	KLJRLE	Examples of corrosivity categories Im1-3 and information about cathodic protection has been added
12	2018-08-17	MLJNPV	Revision chemical supply

Translation

This document is a translation from Swedish of LKAB Technical Instruction LKT 1520.520.005. In the event of disagreement concerning the interpretation and content of this text, the Swedish version shall have priority.

Latest revision

The latest revision of this instruction can be obtained from e-mail address: tekadm.krn@lkab.com or tekadm.mbg@lkab.com or alternatively at www.lkab.com.

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References

SS-ISO 10006:2003	Quality management systems – Guidelines for quality and management in projects
EN ISO 12944-5	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
EN ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
BSK 07	BSK 07 – Swedish Regulations for Steel Structures. (The National Board of Housing Building and Planning) Boverket’s Hand book of steel structures
AFS 2005:18	Thermosetting Plastics (Swedish Work Environment Authority’s provision)

Definitions

Corrosivity Category	With regard to the corrosive aggressivity of the environments, a structural element may normally be assigned to a Corrosivity Category.
NCS Notation	Natural Color System shortened to NCS. The NCS system describes colours based on how the human eye sees colours where each colour gets a unique NCS Notation. The code describes the tone shade, the shade of saturation, its brightness level and the mixing ratio between the basic colours.

Background and purpose

LKAB strives to follow international standards as much as possible and in our Technical instructions, called LKTs, the company’s specific requirements and interpretations of standards are precisely defined. The instructions also express the company’s experience as well as giving information on LKAB’s choice of alternative solutions within standards.

LKAB can also state requirements that are higher than those found in standards. By following this instruction, LKAB’s requirements are fulfilled.

The purpose of these instructions is that, based on environmental conditions; recommend a limited selection of paint systems for application in LKAB for new painting and maintenance painting of steel.

The instruction also specifies colours used within LKAB.

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LKAB's requirements, application and interpretation

LKAB's requirements for corrosion protection of steel are in accordance with BSK 07 section 8:7 "Corrosion protection". The section is mainly based on ISO 12944-1 – 7. The latest version of BSK 07 has priority before extract from BSK 07 in this instruction.

Suitable systems for corrosion protection painting is chosen based on the environments Corrosivity Category C1–C5-M or Im1–Im3, according to BSK 07 section 1:23 (that is in accordance with EN ISO 12944-2).

LKAB prefers a limited selection of paint systems for application within LKAB according to Table 1.

Chemical Board within LKAB must always be contacted with an application before a new chemical product may be used within LKAB. This applies if the product has not already been approved for use.

Instructions supplier - Chemical products

All activities using chemical products must, according to current legislation, have competence and good knowledge of these, e.g. which chemical products are authorized to be used, how they are handled, stored, possible hazards and have a proper and systematic self-check that ensures compliance with these and other legal requirements.

The supplier shall describe responsibilities, how to prevent and address chemical hazards, handling, storage, deposition, fire protection, remediation, waste disposal, transportation, personal protective equipment, medical examinations.

In addition to complying with the requirements of the law, the supplier must match all chemical products to "Forbidden substances in chemical products at LKAB" list to ensure that no forbidden substances will be used. The supplier shall ensure that the chemical list contains the requested information and is always kept up to date. For each chemical product there must be a current safety data sheet and a risk assessment.

A supplier who, in his or her assignment, hires another supplier is responsible for fulfilling his / her requirements.

Chemical list: To facilitate the suppliers, LKAB provides this template on chemical list and template for application to the LKAB Chemical Board.

This LKAB Template for Chemicals List can be used with advantage. The user's own template must contain all the headings contained in the LKAB template.

1. Fill in the chemical list using the information in the product safety data sheet (SDS)
2. Match all chemical products with the "Forbidden substances in chemical products at LKAB" , which is available on LKAB's external website under "Supplier". See the instructions below.
3. Submit the file to LKAB's Contact Person

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Corrosivity Category and paint systems

Corrosivity Category	Environment	Example	Paint system acc. to BSK		Comparable LKS**	
			New painting	Maintenance painting	New painting	Maint. painting
C1	Hot surfaces up to 600 °C intermittently, in neutral atmosphere	Heating plants	LKAB Table 3:1	–	521.04	
C2	Steel in dry areas	Work shops	C2 A2.03	C3 A3.03 *	521.01	521.11
C3	Steel exposed to moisture and water stress	Under-ground installations	C3 A3.03 C3 A3.12	C3 A3.03 *	521.02	521.12
C4	Steel exposed to excessive moisture and water stress	Pumping stations	C4 A4.09	C3 A3.08	521.03	521.13
C5-I	Steel exposed to very high humidity and water stress	Industry	A5I.02	–		521.23
C5-M	Steel exposed to very high humidity and water stress	Marine environment	A5M.02	–		
Im2	Steel submerged in sea water/ (process water***)	Port facilities/ process water complex	A6.04 A6.06			

*) If blast cleaning cannot be performed, scraping and brushing shall be carried out to not lower than St 2.

**) LKS = Older LKAB Technical Instruction that is replaced with this instruction.

**) Can, with benefits, be combined with cathodic protection for longer durability in places that is hard to access or places exposed to very high humidity. The suitability should be investigated case by case. For further information see the section "Cathodic protection with sacrificial anodes" further down.

Table 1: Corrosivity Category and paint systems

At new painting, all the paints for the same paint system must be from the same manufacturer, unless otherwise agreed. For maintenance painting deviation may be allowed.

It is essential that only anti-corrosion system that has type approval from accredited testing laboratory and is documented by each paint supplier is used.

In choosing the type of paint from the environmental and health viewpoint, the least environmentally damaging or hazardous product is to be selected as technically possible. Consider the Work Environment Authority's provision AFS 2005:18 "Thermosetting Plastics" when, for instance, two-pack coatings are included. In the Material Safety Data Sheets (MSDS) for the selected type of paint the requirements on, for example, protective equipment are defined.

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Paint systems

Extract from BSK 07 Appendix 4 tables

BSK Table	B4:1a	B4.1b	B4.1b	B4.1b	B4.1c	8.72d	B4:1f	B4:1f	
Corrosivity Category	C2	C3	C3	C3	C4	C5-I	Im1-Im3	Im1-Im3	
Designation	A2.03	A3.03	A3.08	A3.12	A4.09	A5I.02	A6.04	A6.06	
Durability	High	High	Medium	Medium	High	High	High	High	
Preparation in acc. with ISO 8501-1	Sa 2½	Sa 2½	Sa 2½ *	Sa 2½	Sa 2½	Sa 2½	Sa 2½	Sa 2½	
Primer	Type of paint ¹	AK	AK	EP	EP(Zn), PUR(Zn)	EP	EP, PUR	EP	EP ²
	Coat thickness (µm)	80	80	80	60	80	80	80	800
	Number of layers	1-2	1-2	1-2	1	1	1	1	1
Finishing coat/ second coat	Type of paint ¹	AK	AK	EP, PUR	AY	EP, PUR	EP, PUR	EP ²	-
	Coat thickness (µm)	80	120	80	120	200	240	420	-
	Number of layers	1-2	2-3	1-2	1-2	1-2	2-3	2	-
Total thickness of system (µm)	160	200	160	180	280	320	500	800	
Total number of layers	2-4	3-5	2-4	2-3	2-3	3-4	3	1	

1) Primer and finishing coat in accordance with code in table 4

2) Coat thickness is best achieved with a colour without solvent.

*) LKAB may allow for deviations in maintenance painting

Table 2: Extract from BSK 07 Appendix 4 from tables for paint systems

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LKAB specific requirements

LKAB specific paint systems

Table 3		3:1	3:2
BSK Table		–	–
Corrosivity Category		C1	C1
Designation **		LKAB LKS.521.04	LKAB LKS.521.04
Durability		High	High
Preparation in acc. with ISO 8501-1		Sa 2½	Sa 2½
Primer	Type of paint	Heat resistant aluminium pigmented silicone resin	Zinc rich ethyl zinc silicate
	Coat thickness (µm)	50	50
	Number of layers	2	1
Finishing coat/ second coat	Type of paint	Heat resistant aluminium pigmented silicone resin	Heat resistant aluminium pigmented silicone resin
	Coat thickness (µm)	25	25
	Number of layers	1	1
Total thickness of system (µm)		75	75
Total number of layers		3	2
Comment		Normal corrosion protection	Higher demands on corrosion protection

***) LKS = Older LKAB Technical Instruction that is replaced with this instruction.

Table 3: LKAB specific paint systems

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Type of paint

Paint	Designation	Type of paint
Primer	AK	Alkyd with a passivizing pigment
	AY	Acrylic with a passivizing pigment
	EN (Zn)	One-pack epoxy, zinc rich (=at least 90% zinc, calculated on bases of dry substance of paint in percent of weight)
	EP	Two-pack epoxy (As an alternative, a solvent free type of paint)
	EP(Zn)	Two-pack epoxy, zinc rich
	OX	Two-pack oxirane ester with a passivizing pigment ⁴
	PUR	Two-pack urethane with a passivizing pigment ⁴
	PUR(Zn)	Two-pack urethane, zinc rich
Finishing coat/ second coat	AK	Alkyd
	AY	Acrylic
	EP	Two-pack epoxy, including those modified with resin (can chalk outdoors)
	PUR	Two-pack urethane
	OX	Two-pack oxirane ester

4) On a hot dip zinc coated surface the paint does not need to contain passivizing pigment.

Table 4: Types of paint in paint systems

BSK 07 can be ordered from “The National Board of Housing Building and Planning” (Boverket) or downloaded from their website; www.boverket.se.

All elements of structure must be protected against corrosion. Splice plates and occurring welds in plate shall have a corrosion protection at least equivalent to that of other parts of the structure.

Embedded fasteners

Embedded fasteners are to be corrosion protection painted before embedment to a depth of, at least, 50 mm below the planned surface of the concrete.

Weld zone

If possible, the surfaces intended as weld zones shall not be painted. Painted surfaces must be sanded or scraped clean of paint before welding. Preparation and painting of the weld after welding shall be equal to the original paint system. This also applies to heat damaged paint close to the weld and to the object's back side.

Inaccessible surface

Inaccessible surfaces shall, prior to assembly, undergo a full treatment.

Mechanical damage

Damage to the paint layer during for instance transportation and installation must be repaired. Preparation and painting of damaged surface must correspond to the originally specified system.

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Requirements for finished paint system

- Identity, colour and gloss shall conform to specification
- The paint must be opaque and have a uniform appearance on both edges of open areas.
- Each coating shall be continuous without visible runnings, drops, dry spray, bubbles, pores, craters and other defects, and applied to a smooth uniform surface
- The paint system nominal total dry coat thickness shall conform to the specification. Determination of coat thickness on metallic surface is made in accordance with SS-ISO 19840:2005 Appendix B.
- Paint coat thicker than twice the nominal thickness is normally not acceptable.

Colours at LKAB

The following colours are most common at LKAB and shall apply when any of the final colours below are requested, if not otherwise agreed. Colour choice must be confirmed by LKAB before painting begins.

Industrial colours	
NCS Notation	Final Colour
NCS S1080Y	Yellow
NCS S4502B	Grey
NCS S5020-B 10 G	Blue
NCS S2070-R	Red
NCS S1080-Y60R	Orange

Colours for LKAB's brand profile	
NCS Notation	Final Colour
NCS S2065-R90B	LKAB Blue
NCS S4550-R90B	LKAB Dark blue
NCS S1510-R90B	LKAB Light blue
NCS S4550-R90B	LKAB Metallic blue
NCS S7005-R80B	LKAB Dark grey
NCS S1085-Y90R	LKAB Accent red
NCS S0580-G30Y	LKAB Accent green
NCS S9000-N	LKAB Black
NCS S0500-N	LKAB White
	LKAB Silver
	LKAB Metallic dark grey

Table 5: Colours at LKAB

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Cathodic protection by using sacrificial anodes

Cathodic protection may be used in metallic constructions mainly situated in water, mould or concrete. The protection could be made by sacrificial anodes or with an applied current. Cathodic protection may be applied on both newly installed and old, already existing constructions affected by corrosion, to inhibit the corrosion.

The protection current is galvanically generated during protection with sacrificial anodes. The anode material is less precious than the material of the object that should be protected, the cathode, and there exist an galvanic voltage that fuels the protection current between the anode and the metal. So this process requires no external power source.

The most common anode materials are zinc, magnesium and aluminium, see table 6.

Frequently recommended materials for anodes	
To protect	Recommended anode material
Steel and cast iron	Magnesium
Steel and cast iron used in sea water	Aluminum
Steel and cast iron used in process water at LKAB	Aluminum alloyed with at least 5% zinc
Steel used in concrete	Zinc

Table6: Common anode materials

As a result of the current and a small amount of self-corrosion the sacrificial anodes gets used over time. When dimensioning protection for constructions used in the ground the anode life should have a durability of about 10 to 20 years. For constructions used in water, where one easily can replace used anodes with new ones, one can dimension cathodic protection with a shorter durability than for the anodes used in the ground.

Cathodic protection with sacrificial anodes are used in for example:

- Agitators and thickeners
- Internal protection in tanks and cisterns.
- Offshore platforms and port facilities.
- Steel structures in the ground

When using cathodic protection it is important to be sure that all parts of the objects that should be protected is provided with an appropriate current. The surfaces next to the anode does always get higher current than the ones located further away. One can considerably improve the current distribution by coating the object that should be protected by painting or any other suitable coating methods.

The sacrificial anodes can be mounted by welding or screwing directly on the construction that should be protected. The anodes may also be placed a short distance from the construction but in case of that a connecting cable has to be mounted from the anode to the construction. During

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protection with sacrificial anodes it is particularly important to have a connection with high conductance between anode and construction. All parts within the construction that should be protected cathodically should be in a high conductivity connection to each other.

Proposals for Improvement

LKAB carries out continual improvements in accordance with the LKAB quality policy (SS ISO 10006, sections 8.2 and 5.2.7) and this also applies to instructions and codes of practice. Comments and suggested improvements are welcome at the following e-mail address: *instructions@lkab.com*

The LKAB internal address in Lotus Notes: *SE SM Anvisningar LKT*