Proposal for the conservation of weathered steel objects at the National Trust Estate of West Penwith, Cornwall and at the West Harbor in Berlin.

With the decreasing significance of heavy industry and mining, increasing numbers of industrial facilities are being classified in some European countries as historical monuments. Some, like the copper and tin mines in West Penwith, Cornwall, have even achieved the status of World Heritage Sites. Industrial buildings from the 19th and 20th centuries were not designed for a long life, unlike the castles and palaces of earlier centuries. Their preservation brings new and interesting challenges. Examples of some possible restoration and conservation practices for weathered steel objects are being carried out on various constructions in Germany and England. Until now, there has been only limited practical work in this area, and therefore only a few written treatises and reports exist on the subject.

In each case, it is important that the object to be preserved be documented carefully in connection with its surroundings before any further work is done. A precise examination of the situation and contributing factors is also an important step on the way to a sensible preservation concept that maintains the authenticity of the object and applies modern conservation techniques.

In the case of weathered steel objects, technical problems, such as the choice of the best-suited anticorrosive, often stand in the foreground. It is sometimes overlooked that the longest-lasting and lowest-maintenance protection for modern steel products is not always the best for an historical object. Some weathered steel objects were uncoated when they were in use. Others have gradually been altered in appearance by environmental influences after being taken out of service, so that their complete overhaul would change the visual impression they created over many years. Here, the best corrosion protection would be the one that changes the original surface as little as possible or not at all. In special cases this means that the omission of any protection can be a sensible choice. A change in environmental conditions can also be a solution. A simple protective roof or a foundation that prevents direct contact with the ground can often be sufficient to slow the deterioration.

A well thought-out care concept applied in the long term can be less expensive than a single intervention targeted to quickly bring the object into so-called “presentable condition“. One point at which continual care differs from the “one-time complete overhaul“ is the length of time over which an investment must be made. The advantage of regular, smaller-scale protective measures is in the associated monitoring. Endangered sites are recognized early, and cost-intensive damages can be avoided by timely intervention. In addition, a long-term care concept offers the advantage of allowing the conservation of the largest possible amount of original material. Often, large surfaces can be found on the object on which the historical corrosion-protection system is still intact and would be sacrificed in the case of a complete overhaul.

In certain cases a complete rust removal and re-coating is the end result of the decision process. Within this choice lies a great deal of leeway. Coating systems at our disposition include those based on analysis of the object, like traditional oil-bound systems, and novel methods like Polyurethane or Epoxy resin-based paints that simply imitate the color of the object.

The choice of coating system depends, again, on many factors. One factor of decisive significance is that the material which is removed and that which is added be thoroughly documented.

A completely different criterion relates to the target audience. This group of people can include residents as well as tourists. It can be determined through surveys and observation what visitors associate with the site. If one disconnects the object from this association through well-intentioned measures, the overall success of the project can be put at risk.

For the objects we discuss in Cornwall and Berlin, a variety of concepts were originated that reflect the range of possibilities.

Case Study 1: Egg Boiler

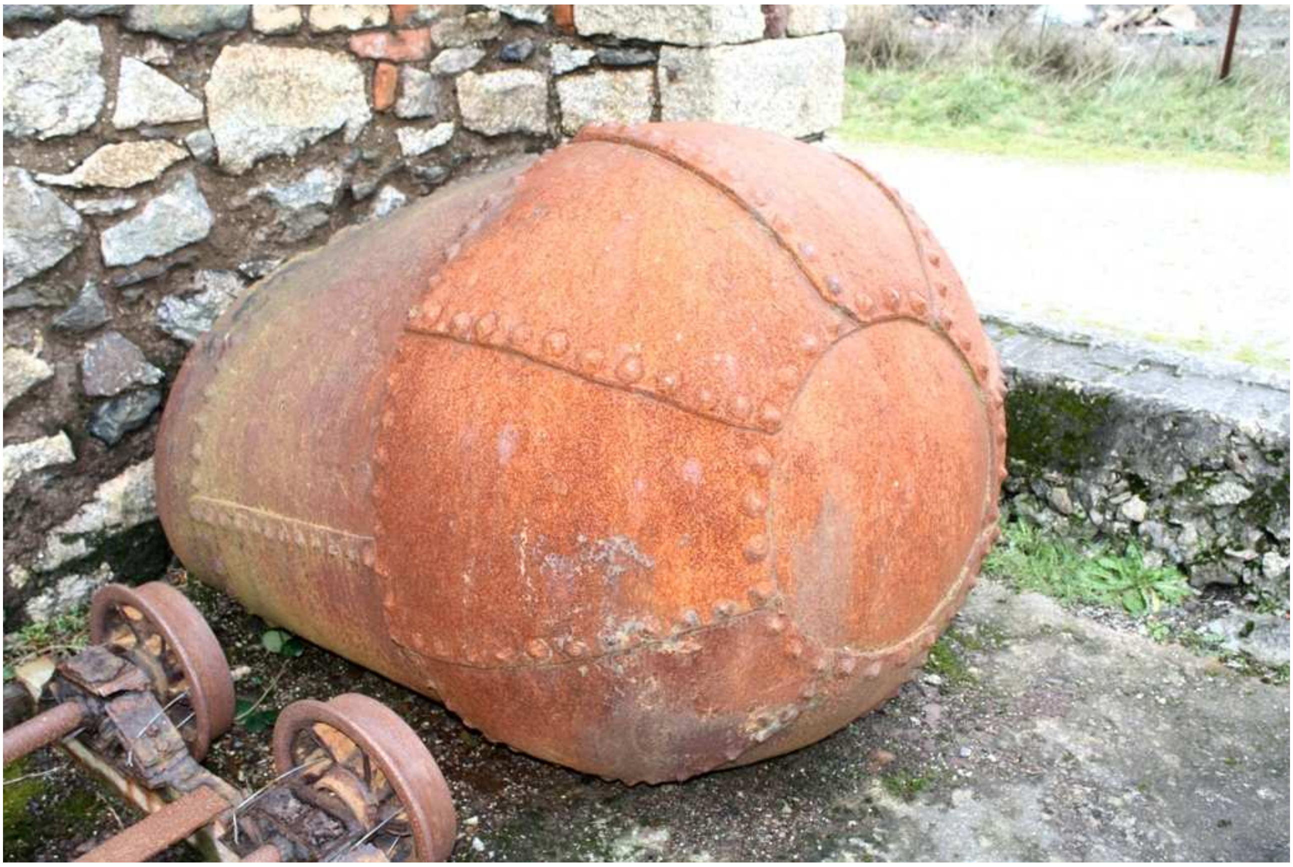

Abbildung 1 Cornish boiler in the East Pool and Agar Mine (Paul Bonington)

The following approach was suggested for a so-called “Egg Boiler“, which may originate from Richard Trevithick’s [1] workshop and is now displayed on the site of the East Pool and Agar Mine. According to anecdotal evidence the boiler was largely used to melt tar for road building. The presence of a thick layer of tar inside the boiler would support this theory. The reason the boiler was cut into pieces is not clear. By shape and construction the remaining part of the boiler still indicates a very early type. The object stands in a wind-protected corner of a ruined building. The steel surface is only slightly corroded, despite long open-air storage. This is high-grade, probably low-sulfur steel, which has come through centuries of industrial and maritime environments in good condition. A pigmented anticorrosive would completely strip away this history. Furthermore, a boiler never could have been coated when it was in use. The application of a temporary, transparent oil- or wax-based protective coat such as Anticorit BW366 [2] and Owatrol [3] could be considered. However, the appearance of the surface would be darkened and it would gain an unnatural brightness [4].

Another realistic proposal, due to the good condition of the steel, is a constructional weather protection and a foundation, which together would be sufficient to drastically reduce the rate of corrosion. As the boiler is no longer presented in its original context but displayed in a museum, a slight change of surroundings would be acceptable. With this approach, the visual appearance of the surface would not be affected, but the significance of the Boiler for the viewer would be enhanced. The financial expenditure for the execution of this concept would be minimal, and the protective effect comparatively large.

From a conservation point of view, transport of the object to a dry, climate-controlled location could also be considered. For the conservation of the steel this would be a very good solution. But there is not enough space to display the boiler in the small museum on site. The only possibility would be to transport the boiler to another museum, probably miles away. The loss of such an important exhibit would not be acceptable for the East Pool and Agar Mine.

Case Study 2: Semi-gantry Crane Nr. 16

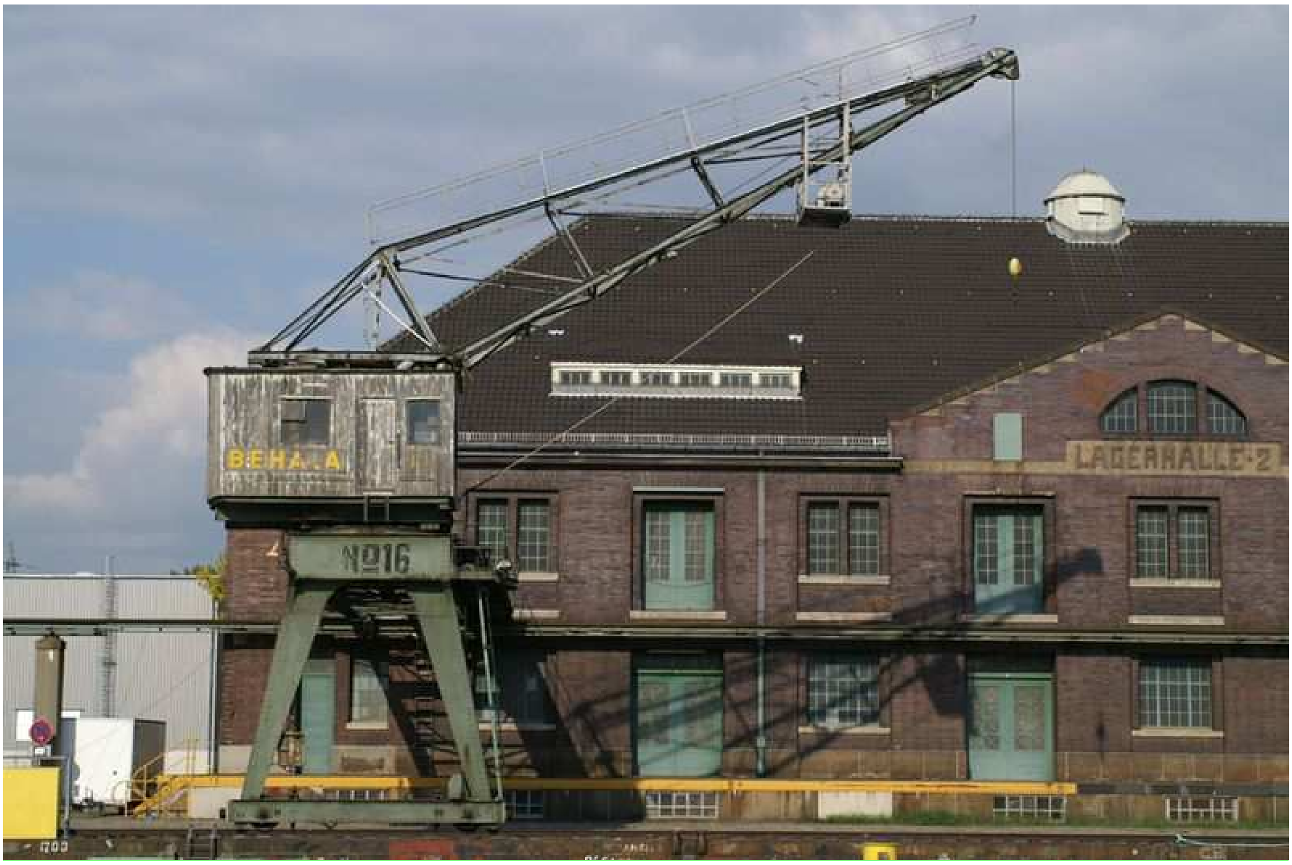

Abbildung 2 Dockside crane No.16 in front of a warehouse at West Hafen Berlin (08.08.Stahn)

Another approach is demonstrated in the restoration concept for semi-gantry crane No. 14 in Berlin’s West Harbor. The concept was developed by students in the Restoration of Technical Cultural Assets program at HTW-Berlin (University of Applied Sciences Berlin) in cooperation with the local historical protection agency and the owner of the site (Berlin Harbor and Warehouse Society, BEHALA).

The crane lost its direct significance in port operation at the end of the 20th century. Bulk handling gave way to container traffic. Today, bulk goods are transported with high-performance conveying equipment. This crane, along with three others, stands as physical evidence of the quotidian and industrial culture of the first half of the 20th century, and as such retains an indirect significance for the entire harbor construction, for its owners (BEHALA), for Berlin's historical landscape and for technical research.

In this concept for preservation and partial restoration we aim to consider the interests of all concerned to the extent possible without moving away from our own goal, an appropriate, state-of-the-art restoration of the object. At the time of completion, all the institutions involved should have gained something from the project. We aspire to a solution in which the age of the crane is made tangible, the work it has performed is valued and its elegant, and, in comparison with modern appearances, calm forms and surfaces fit into the scenery of the elongated, symmetrically ordered harbor.

Since the decommissioning of the equipment was planned well in advance, maintenance was already reduced to the minimum necessary during the crane's last 10 years of service. The last overhaul was 20 years ago. Nonetheless, the historical coatings from up to four phases have been preserved over large areas, and form a stable layer. Some of the labels applied at time of the last protective coating (1989) also remain legible. Here, a partial, situation-oriented surface restoration is suggested. It is preferred to the still commonly practiced complete resurfacing. A decisive advantage is the minimization of expense through the reduction of both labor costs and hazardous wastes produced. Through this approach, long-lasting protection from continuative corrosive assault and the static safety of the system are ensured.

A special challenge in the development of the restoration concept was presented by the intersections and joint areas of the riveted steel skeleton. In the 1980s, a polyurethane- and zinc chromate- based injectable material was developed for similar applications. It was first used to protect ropes and cables from corrosion in bridge building. The polyurethane permeates tiny capillaries and cavities in the structure. Once inside, it reacts and becomes an elastic or elastomeric synthetic material. The grid is thus hardened and sealed, and the progression of the oxidation process is impeded. Open cracks are subsequently sealed with polyurethane/zinc-chromate foam. This method was used in the renovation of the Heinrichenburg ship lift [5]. Shierk's report on the subject [6] was written twelve years later and describes an unchanged corrosion preventive effect for a period of at least ten years. A pigmented corrosion protection system was chosen for the surface areas for its homogenous appearance and longer durability. The color is matched to the remaining protective coating. A special polyurethane system especially developed for such purposes is used. The special feature of this system is the single-component, moisture-hardening polyurethane primer for application over original coatings and steel surfaces with residual rust. [7] This base coat adheres particularly well to slightly rusty surfaces, and removes the residual moisture important for the corrosive process. The corrosive process is thus interrupted. The complete composition of the coating is described in the following table. (For application instructions see below.)

Table 1. Coating system from Dr. A. Conrad's Enamel Inc. (Dr. A. Conrads Lacke GmbH & Co. KG).

Composition	Color	Article Number
EK PUR Base (thin fluid)	Colorless	PE 000090
EK PUR Zinc base	Zinc grey	PE 917709
EK PUR Intermediate basecoat	Yellowish silver	PE 133309
EK PUR Enamel for the first topcoat	Grayish silver	PD 070229
EK PUR Enamel for the second topcoat	RAL or DB shades	PA „ NCS 7020 G10Y “ 88 or PA „ NCS 7020 G10Y “ 63
Solvent for EK PUR System		ZP 215152

For the application of this system, a hand-derusted surface is sufficient. (The cleanliness factor should equal DIN EN ISO 12944 P MA or DIN EN ISO 12944 P St 3.) Loose sections of the old coating must be removed. For a pre-treatment meeting such requirements, abrasive blasting with dry ice pellets was tested with good results. A decisive advantage is the sublimation of the pellets after their successful application. The substance to be protected is only slightly affected.

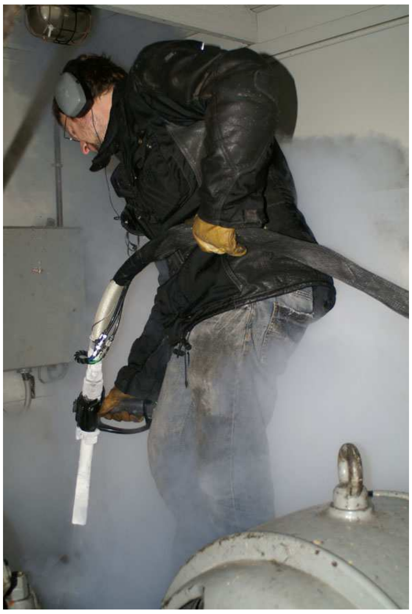

Abbildung 3 Abrasive blasting with dry ice pellets (09.08 Beck)

For the exact mapping of the corrected surfaces, the crane was three-dimensionally laser scanned and drawn with millimeter-exactitude with a CAD program (Fig./Drawing). All the surfaces to be re-coated are noted on the drawing. The above described and a similarly composed enamel system were successfully tested on the steel frame of the Wuppertal Suspension Railway and the furnace of Heinrichshütte in Hattingen, among other objects.

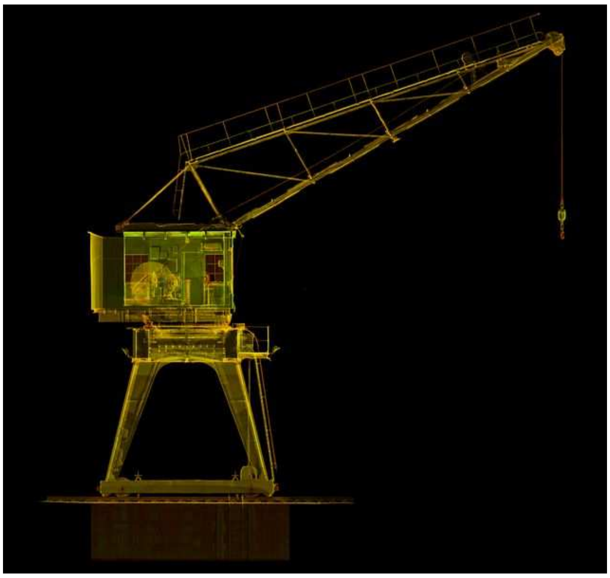

Abbildung 4 Dockside crane No.16 Orthofoto 06.08 Laserscan Berlin

Case Study 3: Water Pump, Kenidjack Valley

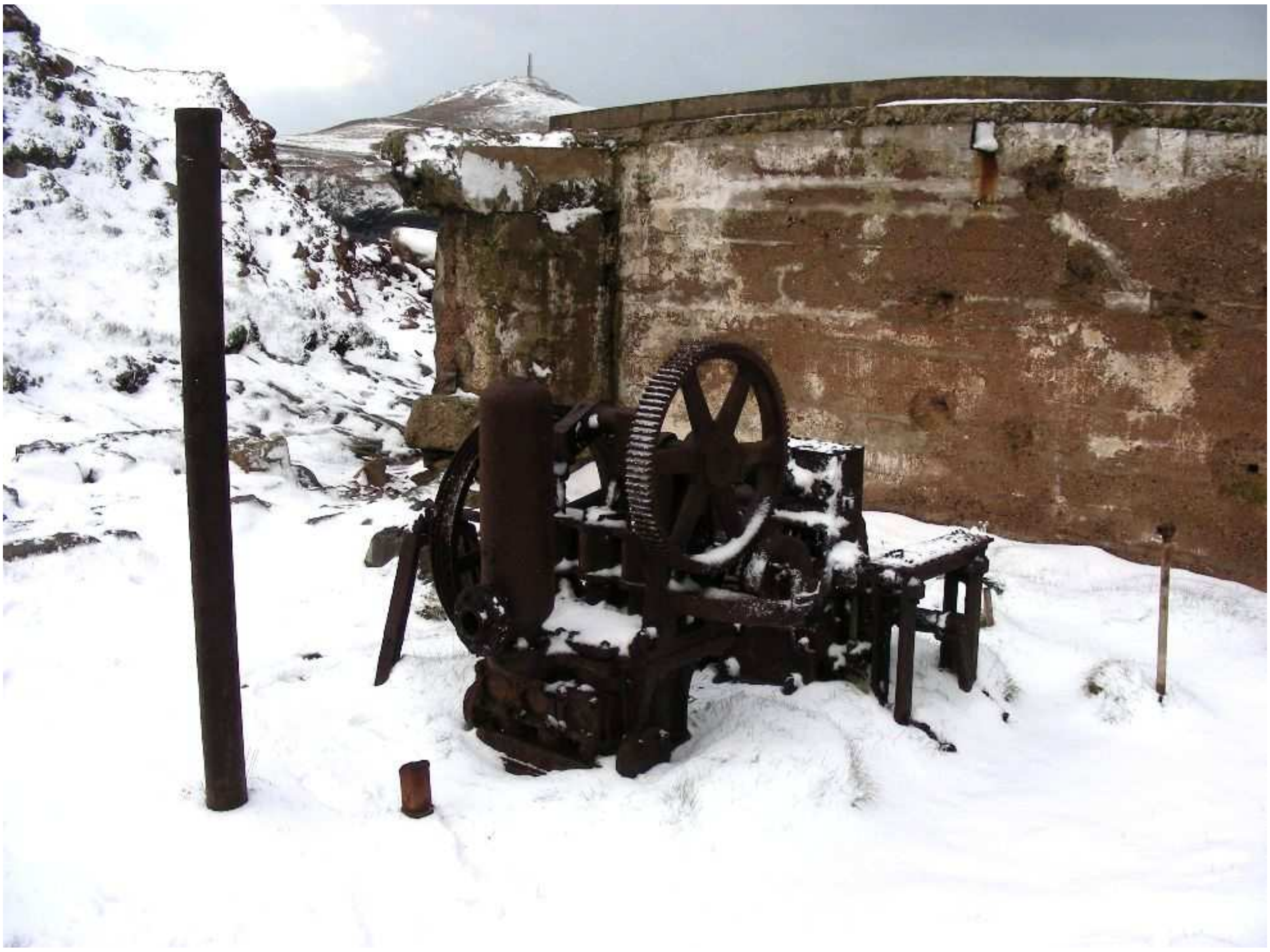

Abbildung 5 Diesel-powered water pump in Kenidjack Valley (Paul Bonnington)

In a valley to the north of Lands End and only a few yards from the sea stand the remains of a diesel-powered water pump. Originally, the pump was used to supply the surrounding area with fresh water from the tunnels of underwater mines.

Because of direct proximity to the sea, salt damage to the steel was considerable. In this case an industrial corrosion protectant was the most economically feasible solution for the object to survive in the long term. Extensive rust removal is a necessary precondition for this strategy as is the thorough removal of salt. Conscientious fulfillment of these tasks is made especially difficult by proximity to the sea, if costs are to be kept low. The use of an active anticorrosive could also be interesting because of its durability. Oil-bonded orange lead pigment is amply proven in a maritime climate and can be applied to lightly rusty and salty surfaces. The application of the very poisonous lead pigment is permitted under certain circumstances, but is environmentally questionable. Alternatively, the above-described polyurethane system can also be applied here. For aesthetic reasons, an understated color should be chosen as a topcoat. Despite the pigmented coating system, the need to preserve the appearance of the site as it has gradually developed remains.

Currently, topcoats are being tested that corrode on the surface without compromising the layers beneath. The appearance of corroded surfaces on an object can thus be preserved.

The decay of the equipment is already quite advanced due to vandalism and proximity to the sea. The technical coherence and meaning of the pump are no longer comprehensible to the inhabitants of the region without explanation. For the uninitiated visitor, the pump is a landmark and an indefinite relict of industrial Cornwall. An approach could be considered that would allow the continuing decay of the pump and would highlight its testimony to the disappearance of mining from the region. Necessary conditions in this case would be the exact documentation of the current state of the object and ongoing monitoring.

In all three case studies presented, a larger one-time investment at the beginning of the intervention, reducing subsequent work to a manageable amount, makes sense. A component of this investment is in every case the documentation and examination of the object. First passive or preventative corrosion protection measures or an active intervention in the decay process may also potentially be carried out. For the preservation of the cultural value of the object, subsequent and continuous monitoring is indispensable.

The possibilities for dealing with weathered objects are numerous. Each object brings different requirements with it. A separate inspection and planning is advisable in many cases. The final costs can also, contrary to frequently expressed misgivings, be reduced through this approach.

Literature Cited:

[1] Trevithick was the first to make high-pressure steam work, in 1799; he also built a full-size steam road locomotive in 1801

[2] FUCHS EUROPE SCHMIERSTOFFE GMBH, Friesenheimer Straße 15, 68169 Mannheim

[3] Vosschemie GmbH, Eisinger Steinweg 50, D-25436 Uetersen Vosschemie GmbH, Eisinger Steinweg 50, D-25436 Uetersen

[4] Brüggerhoff 2002: Stefan Brüggerhoff, Korrosionsschutz für umweltgeschädigte Industriedenkmäler aus Eisen und Stahl, Bochum 2002 http://www.museen-in-bayern.de/landesstelle/pdf/download/EndberichtDBUProjekt.pdf

[5] SCHIERK 1927: Schierk, H.-F.: Korrosionsschutz an Stahlkonstruktionen. In: Das Bauzentrum 44 Heft 7 o.A. 1996 S.122-127

[6] SCHIERK 1927: Schierk, H.-F.: Korrosionsschutz an Stahlkonstruktionen. In: Das Bauzentrum 44 Heft 7 o.A. 1996 S.122-127

[7] CONRADS M. 1997: Conrads M., Die Wuppertaler Schwebebahn – Korrosionsschutzmaßnahmen am Traggerüst, in: Metalla, Forschungsberichte des Deutschen Bergbau- Museums, Nr. 4.2, Bochum 1997, S. 85-89.