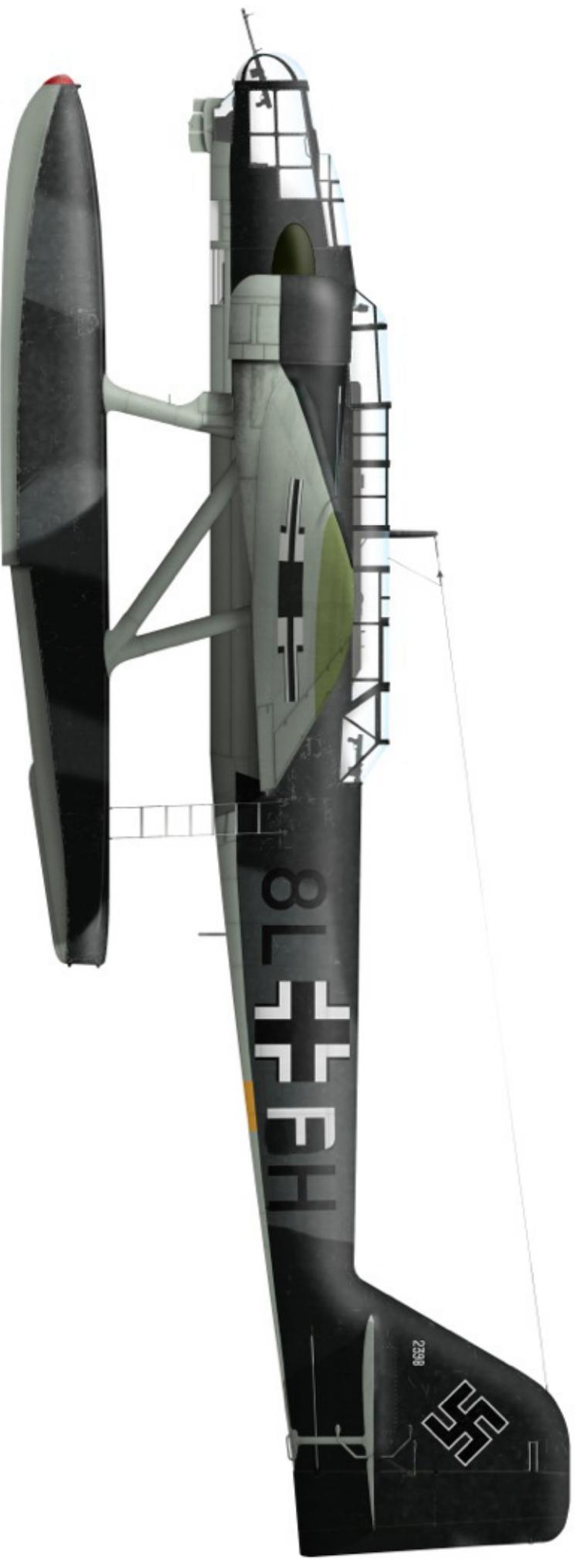


Heinkel He 115

~ Paint and Colour Analysis ~
Flyhistorisk Museum Sola



Heinkel He 115 WrkNr. 2398

Sola - Stavanger, Norway Analysis of Paint Samples (12.07.2014) Erik Pilawskii, Report

Samples of paint finish were retrieved from 2398 and subjected to various forms of chemical and visual analysis. The first examination was to determine the fundamental type of lacquer under investigation. We expected to find mainly butyrate dope on the fabric areas and alkyd enamel elsewhere. Samples were tested for solvency in Cellulose Acetate Thinner, which if true would indicate a dope type finish.

The second examination measured the specific Ph value of the paint. The surface camouflage lacquers on 2398 should mostly be expected to be examples of RLM 71xx.- Series alkyd type enamel, and so should share base chemistry and therefore Ph. The national markings were applied with 716x.- Bekoloid Resin type enamels which feature a very similar Ph value. Paint located on the airframe which did not conform to these Ph values could therefore be eliminated as RLM type finishes.

The third examination tested surface reflectivity using the MPI system at 60 °. The reflectivity value is given in GU units, lower scores indicating matte and higher scores indicating gloss.

Lastly, the pigments in each paint sample were distilled by reduction of the lacquer in white spirit. The resulting fragments were ground into a powder in a mortar and pestle for examination. Many of the retrieved samples were so small that no pigment dust could be saved, and cleaning of the equipment effectively destroyed the test material in most cases. Such small quantities were used deliberately so as to save the remaining samples for possible future analysis, but in the case this method restricted colour testing to *visual examination*, only.

Two paints were used as a control: RLM 65 and the red oxide fabric dope. RLM 65 is well known, and was ubiquitous on 2398. The fabric dope served as a chemical control for the CAT solvency test. No pigments were extracted from this dope.

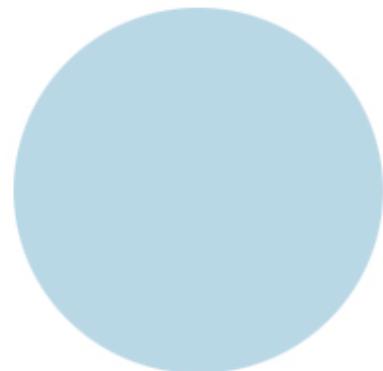
RLM 65 (Control No 1)

Specific Ph: 7.6

Surface Finish (MPI 60°): matte(v) - 7GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



Red Fabric Dope (Control No 2)

Specific Ph: 6.9

Surface Finish (MPI 60°): matte - 3GU

Lacquer Base: Butyrate Dope

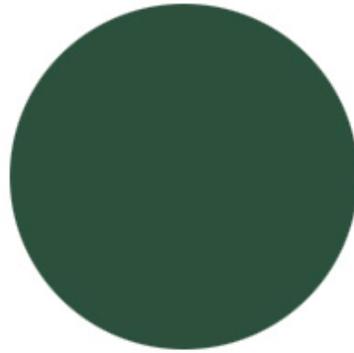
Paint #1 "Marine Green, lighter" (RLM 73)

Specific Ph: 7.6

Surface Finish (MPI 60°): matte(v) - 8GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



This is the lighter green shade of the original camouflage pattern applied to 2398, which according to *Luftwaffe* documentation should have been RLM 65/72/73. I believe that the evidence on 2398 confirms this assertion perfectly, and therefore we may assume that this paint was certainly RLM 73 Grün. The pigment was notable for the healthy amount of blue in the colour, which was slightly more than anticipated.

Paint #2 "Marine Green, darker" (RLM 72)

Specific Ph: 7.6

Surface Finish (MPI 60°): matte(v) - 9GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



This is the darker green shade of the original camouflage pattern applied to 2398, and therefore surely RLM 72 Dunkelgrün. As expected, this paint also showed considerable blue pigmentation, which seems to be suitable for Maritime applications.

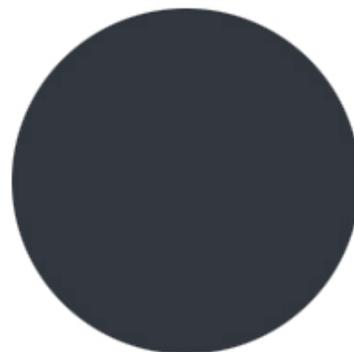
Paint #3 "Applique Dark Grey" (RLM 66)

Specific Ph: 7.6

Surface Finish (MPI 60°): matte(v) - 6GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



A very considerable amount of re-painting was undertaken on 2398, and at some point in its history a new camouflage was applied to replace the original 65/72/73 livery. The lower surface RLM 65 was replaced with RLM 02 Grau, while the upper surface greens were replaced with two dark grey colours. The lighter of these was found across the entire upper surface, and upon inspection this would certainly appear to be RLM 66 Schwarzgrau. Pigment samples from the exterior were compared to a sample taken from the interior nose area (which should be 66 according to documentation), and these were found to be identical.

Paint #4 "Applique Very Dark Grey"

Specific Ph: 7.6

Surface Finish (MPI 60°): semi-gloss - 40GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



The darker of the two applique greys is quite interesting. In the first case, its Ph score (7.6) is consistent with RLM type alkyd enamels, which would be a strange coincidence were it not this kind of lacquer. The surface finish is quite distinct from the usual RLM camouflage paints, being fully semi-gloss. However, this makes a neat fit half-way between 71xx.- RLM enamels and the 716x.- (Bekoloid Resin) enamels used for national markings (with colours 21 through 28) which are basically gloss (MPI=70). This very dark grey paint has a very poor surface adhesion and falls away with minimal contact, a feature of not seen with any other German paints. I was also unable to extract any pigments from this paint, as these simply disintegrated in the spirit solution. However, its apparent (visually identified) colour can be replicated digitally in Photoshop by mixing equal (50:50) parts of RLM 22 and RLM 66. With all these factors in mind, I wonder if this paint was not, in fact, *literally* a mixture of the different RLM paints 22 and 66? Such blending of incompatible base lacquers would surely result in such poor performance as seen here, and the apparent colour would be correct. At least-- for the moment-- I think this possibility cannot be ruled out.

Paint #5 "Interior Green" (RLM 62)

Specific Ph: 7.6

Surface Finish (MPI 60°): matte(v) - 7GU

Lacquer Base: Alkyd Enamel

Distilled Pigments [digital approximation]



This green colour was found on many interior parts of the aircraft. These areas were subsequently over-painted with RLM 02, so we speculate that this green was applied at the factory by Heinkel. Documentary evidence shows that Heinkel applied RLM 62 to various interiors on other aircraft, and anecdotal testimony from Swedish pilots claim that this colour was painted in (and on!) their T2 (He 115S) machines. I am certain that these reports are true, and that this paint is in fact RLM 62. When extracting the pigments from this paint they exhibited the odd tendency to mix partially with water, something not seen with any of the other German paints (it may be that some portion of these pigments were therefore organic, not synthetic). The pigments show that the original colour was darker and more yellow than the paint appears now, and I suspect strongly that this is explained by leeching of the pigment while the parts were submerged in water. In any case, the pigments present a good match with RLM 62, and I am sure that is what we have here.

Other known (and well-documented) RLM paints were recovered from 2398, each with a specific Ph of 7.5 or 7.6, and pigment colours as expected in our better literature on the topic:

RLM 02 Grau (7.6)

RLM 04 Gelb (7.6)

RLM 21 Weiss (7.5)

RLM 22 Schwarz (7.5)

Lastly, one unidentified colour was found on 2398. This bright green paint was located on the wing lower surfaces around the wing tips, and presumably this was used to cover up the RLM 04 theatre markings present on the structure. The properties of this odd colour turned out to be rather different and unusual.

Paint #6 "Mystery Bright Green"

Specific Ph: 8.8

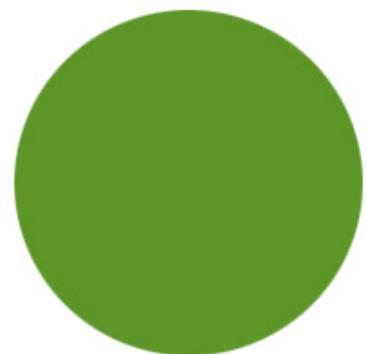
Surface Finish (MPI 60°): gloss - 80GU

Lacquer Base: Acetate or Synthetic (?) Enamel (not very soluble)

Distilled Pigments [digital approximation]

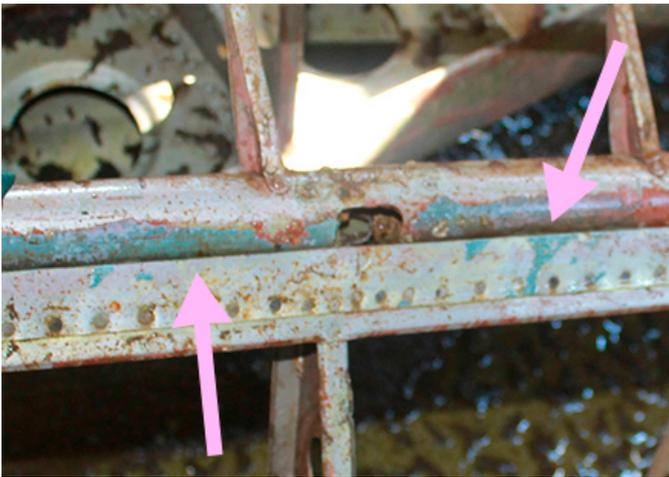
This bright green paint had a very high Ph value, which is inconsistent with the usual aviation type lacquers we see during the 1930-50 period. The enamel itself is virtually indestructible-- I could not grind it in a mortar and had to smash the lacquer grains with a hammer! Moreover, the paint did not solve especially well in white spirit (only a bit), and as a result I did not successfully extract any usable quantities of pigment to analyse. The finish was quite gloss, adding to its hardness. Taking into account these various characteristics, this paint was reminiscent of typical marine use varnish (hull varnish, in particular) and not aviation lacquer. I believe that it is indeed marine boat paint [see Appendix 2].

However, I feel that the colour is sufficiently "fresh" even now to understand the original appearance, which can be seen in this digital chip.

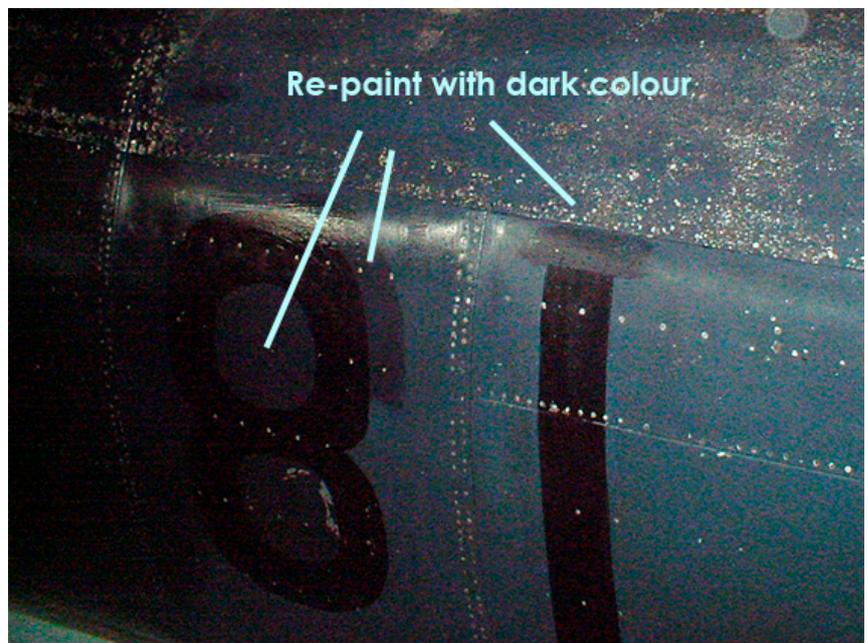


Other Paint Observations

Some unusual “contamination” was found on both the rear fuselage and wing ailerons covering areas of the surface paint. This contamination caused the lacquer to show a changed, or distorted, colouration. When removed by light surface abrasion (1200 grit wet paper) the underlying paint showed normal colouration. This effect was also picked out by over-contrast photography (using a flash) along the fuselage. On the aileron, the contaminated areas of RLM 65 took on a ‘primer-like’ appearance, but subsequent testing revealed that this was typical RLM 65 lacquer. On the fuselage, both the appearance of RLM 22 and 04 were modified in the affected areas. The distortion of the 04 colouration was so pronounced that I spent quite a bit of time searching for RLM 27 pigments; none were found.



The over-exposed photography also revealed that 2398 had been *very considerably* re-painted during its operational lifetime. Evidence for such re-finishing is everywhere, but on the fuselage the various details of this work stand out all the better under flash exposure. This image, for example, shows re-painting around the code letters on the port side using a darker finish over the applique RLM 66, which might be the very dark grey colour identified above.

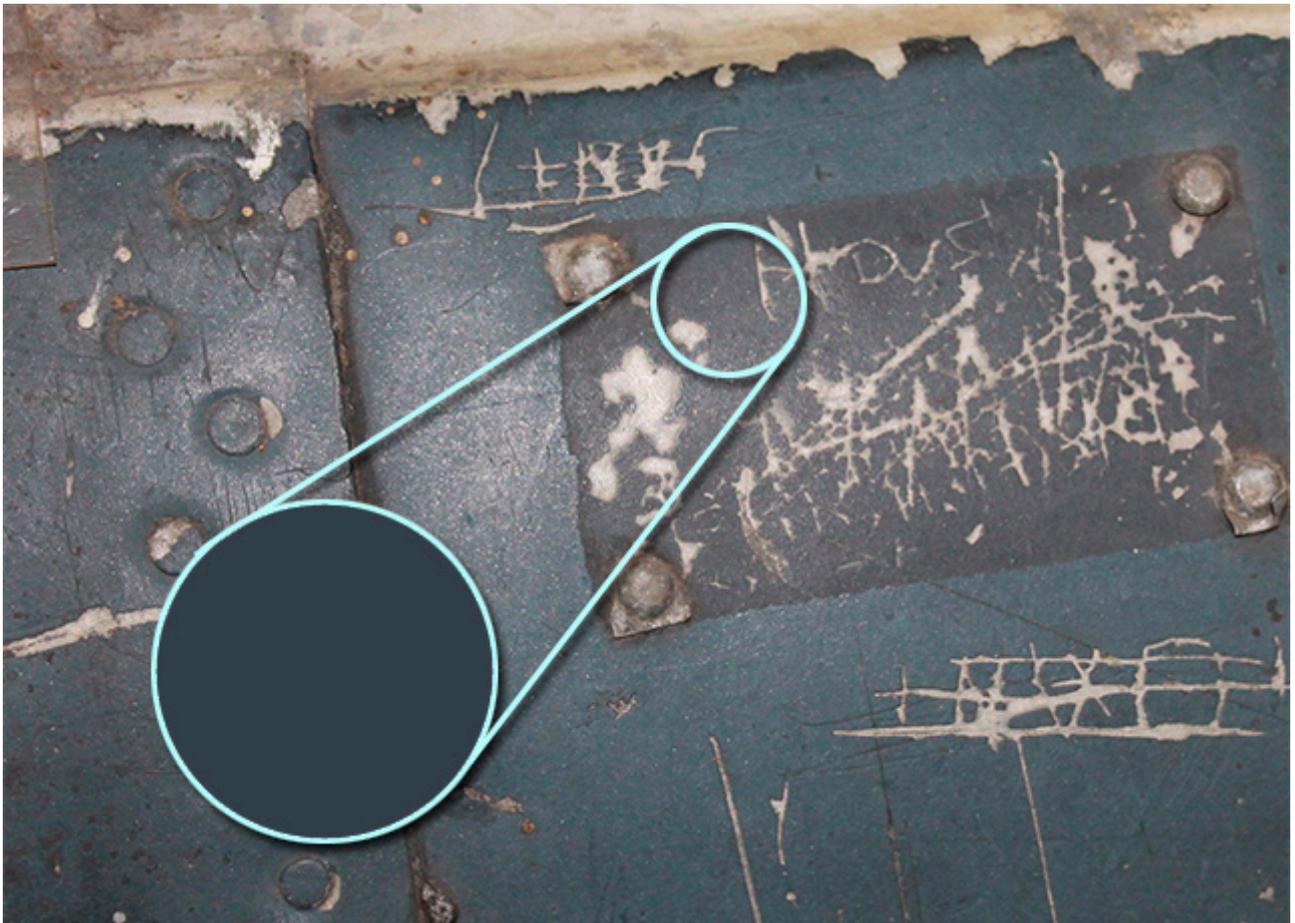


Unknown Blue Colour

One last colour mystery was entertained during the weekend's paint collection activities, this from a float in the museum gallery. The float belonged to a Bv 138 maritime aircraft which apparently went out of service in 1944. An unknown dark blue lacquer had been applied to the float professionally; e.g. not as an applique, but as the only main coating. This colour was seen on the upper surfaces in addition to the usual RLM 65 on the lower surfaces, and so we assume that this combination in fact represented the intended camouflage scheme (over this area).

A sample of the paint was not taken. Pursuant to earlier research conducted by notable *Luftwaffe* historian Michael Ullman, we believed that this paint represented physical evidence of Ullman's recently described RLM 83 Dunkelblau (Maritime). However, upon returning home I discovered that sufficient quantities of this paint were still to be found on my sandpaper so as to enable me to conduct a Ph test. This was done, and the result was conclusive: 7.6. I am convinced that this is the world's first recognised surviving sample of RLM 83. Mr Ullman will be contacted by Kjetil and myself and we will update this investigation as it proceeds.

I believe that the original appearance of this RLM 83 colour is similar to the digital recreation below.



Appendix 1-- MPI Gloss System

Master Painters Institute Gloss Level Standard Index

Gloss Level	Description	Gloss at 60 °
1	matte	< 5
2	matte-velvet	5 - 10
3	semi-matte ('egg-shell')	10 - 25
4	satin	25 - 35
5	semi-gloss	35 - 70
6	traditional gloss	70 - 85
7	high gloss	> 85

Appendix 2-- Marine Paints from Great Britain

Kjetil and I have conducted research on the Norwegian Navy's use of various paints. Some of these were supplied by Alf Bjercke AB, who in turn stocked marine paints from Titanine Ltd (London). Titanine's marine stock was supplied by Ryland (now Llewellyn-Ryland), who still manufacture boat varnishes to this day.

As a result, it seems clear that quantities of British boat varnish were available in Norway, and likely in use for various marine applications. Although presently no copies of Ryland's period (1930-40) colour chip booklets have been found, it is nevertheless fascinating to note that this unknown bright green colour is very similar to a paint in their current (Llewellyn-Ryland) range, #11038 Grass Green. It is also remarkably similar to a colour from the *old* RAL colour system (pre-1954), index #6014, which Ryland has confirmed was used (RAL colour) during the 1930s-40s by their company.

These similarities do not prove-- nor even suggest, in fact-- that this paint was Ryland marine varnish. However, it is no doubt the case that Ryland boat paints were typical of the finishes used at the time, and likely quite similar to the marine varnish which we did find on 2398.