

THE DANGER OF LEAD IN PAINTS

F. D. TIMMINS

Surface Coating Laboratory, British Railways Board, Research Department, Hartley House,
London Road, Derby DE2 8UP

Abstract—Legal definition of a lead paint and regulations covering its use are not adequate to ensure that effective measures may be taken to minimise the risk of lead poisoning. Consequently, many workmen engaged in the repair, surface preparation and painting maintenance of structural steelwork are subjected to serious toxic hazards in the forms of spray droplets, dry paint film dust or poisonous gas produced when the old paint film is mechanically disturbed or burned. Improved legislation is not a practical answer since its effectiveness would depend entirely on education in hygiene and constant supervision. The ideal solution is a complete ban on the use of lead paints such as red lead, white lead, metallic lead and calcium plumbate. Zinc phosphate which is of low toxicity is the natural successor to these

W. TONG
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Abstract—Legal definition of a lead paint and regulations covering its use are not adequate to ensure that effective measures may be taken to minimise the risk of lead poisoning. Consequently, many workmen engaged in the repair, surface preparation and painting maintenance of structural steelwork are subjected to serious toxic hazards in the forms of spray droplets, dry paint film dust or poisonous gas produced when the old paint film is mechanically disturbed or burned. Improved legislation is not a practical answer since its effectiveness would depend entirely on education in hygiene and constant supervision. The ideal solution is a complete ban on the use of lead paints such as red lead, white lead, metallic lead and calcium plumbate. Zinc phosphate which is of low toxicity is the natural successor to these lead pigments. It is equal in durability and is significantly superior in all the properties which are essential to the formulation of a modern paint.

CAN LEAD PAINTS BE ELIMINATED?

LEAD POISONING arising from the manufacture or application of lead paints is by no means a new problem and it is generally accepted that its occurrence diminishes each year. This is largely due to statistics which reveal that factories making lead paints or pigments observe scrupulously every possible precaution, and to a lesser but still effective extent the same applies to most factories where personnel are involved in applying lead paint.

The use of lead paint is covered by the Lead Paint Regulations 1927 which are widely believed to apply only to the painting of buildings. Consequently all personnel involved in outdoor painting of, for example, steel structures are not considered to be covered by the Regulations, and many people hold the opinion that lead paint may be spray-applied outdoors. Reference to the Factory Act 1961 Section 175 Sub-section 2 shows that interpretation of "Factory" includes "yards" "dry docks" and "works of engineering construction". Section 176 then defines "works of engineering construction" to include the construction, structural alteration or repair (including repainting) or the demolition of any dock, harbour, inland navigation, tunnel, bridge, viaduct, gas holder, etc.

These situations are very different to factory where legal requirements may be scrupulously observed. A man using red lead paint may be found applying it by spray gun, roller or brush with little or no supervision to ensure that he is not liberally contaminated. Even worse, during repair or cleaning operations prior to repainting, personnel using wire brushes, chipping hammers, mechanical tools or oxyacetylene burners may experience extreme danger due to intake of poisonous fumes or dust through the mouth or nose.

It may be considered that the greatest risk of lead poisoning occurs when a dry paint film is disturbed. On the other hand, spray painting of lead paint is not uncommon inside buildings irrespective of legal restrictions and, furthermore, supervision of outdoor maintenance painters is the exception rather than the rule.

There exists an immediate need to provide for the following: to clarify the requirements covered by the Lead Paint Regulations 1927; to educate all personnel involved in the use of lead paint; to ensure adequate hygienic supervision for maintenance, cleaning and painting. Since economics and time, not to mention time-established malpractice, are against these requirements, it is logical to consider the most practical and effective measure, i.e. can lead paint be eliminated in the interest of health and replaced by paints of low toxicity and of comparable performance and durability?

THE DEFINITION OF LEAD PAINT

What is lead paint? Again considerable confusion exists since many paints which include lead pigments are not legally defined as lead paints and consequently escape provisions required to minimise health hazards.

Lead inclusions in paints fall into four categories:

1. lead paints controlled by the Lead Paint Regulations 1927, in which a lead paint is defined as "one yielding to an aqueous solution of hydrochloric acid a quantity of soluble lead compound exceeding, when calculated as lead monoxide, 5 per cent of the dry weight of the portion taken for analysis". Pigments in this category include: red lead, white lead, metallic lead, and calcium plumbate. All are used as the main pigment constituent in preparing priming paints.
2. Chrome yellow paints based essentially on lead chromate or lead molybdate/chromate pigment which fall outside the Lead Paints Regulations 1927. Although these paints may contain approximately 30 per cent of lead they yield less than 5 per cent soluble lead as PbO. They are used extensively in green, yellow and red paints to obtain bright colours. Pigment dyestuffs of low toxicity are available as alternatives.
3. Low-lead paints covered by the British Standard (B.S. 4310-1968) limit the lead content to 1.5 per cent expressed as metallic lead on the dry paint film. The presence of lead is essentially due to the inclusion of an organo-lead compound such as lead naphthenate which is required to assist drying. The majority of proprietary decorative paints are formulated to meet this standard.
4. Paints used for childrens' toys and playthings (B.S. 3443 1968) are limited to a lead content of 0.5 per cent expressed as metallic lead on the dry paint film.

Of the four categories described it is acknowledged that lead paints covered by the Lead Paint Regulations 1927 present a serious health problem. Since their function is essentially to provide protection, their use could be prohibited.

Although the chrome yellow pigmented paints escape the provisions of the Lead Paint Regulations 1927, many medical officers already insist on effective precautions during spray painting, rubbing down, burning off, etc. It may be justifiably claimed that dyestuff pigment alternatives to the lead chromes are considerably more expensive in cost and also substantially inferior in hiding power, resulting in an increase in the number of coats of paint. Since bright yellow livery colours are considered essential for service vehicles as a means of reducing accidents, the prohibition of lead chrome based paints would create resentment due to practical and economic factors. It may be prudent therefore to make provision for this class of paint, which

in any event is used in special circumstances, by introducing legal requirements to cover personal hygiene and operations such as spray painting, rubbing down, burning off, etc. In addition, the labels on the paint containers should clearly indicate these legal requirements.

Finally, in prohibiting certain lead pigments and applying restrictions to the use of others, it should not be readily assumed that other forms of pigments and paints present no health hazards. Any painting operations which expose operators for long periods to intake of solvents, spray droplets, dry film dust, burning gases, etc., should eventually be covered by legislation.

PIGMENT TECHNOLOGY

Red lead and white lead are the oldest established protective pigments. During a period when linseed oil was the only paint medium they provided high build slow drying films. The lead pigment reacted with the vegetable oil to form an insoluble lead soap which hardened the film and afforded improved protection to steel or wood. In view of their reputation it is not surprising to find a distinct reluctance to their complete exclusion but the fact remains that they can play no effective part in modern coating technology.

It should not be overlooked that a pigment is only a part of the priming paint, which in turn is only a minor, although important, part of the complete system. A protective coating depends on many factors to provide maximum performance. For example, surface preparation of the substrate, correct application to provide uniform adequate film thickness, compatibility between coats of paint to ensure adhesion, hardness of film to avoid damage during transit, durability in severely corrosive atmospheres and satisfactory response to maintenance recoating.

In addition, the cost of paints themselves may form a minor part of the total operation costs. In maintenance painting for example, factors such as labour costs, scaffolding, possession etc., may be up to 20 times the cost of the paint. It follows that economics in painting operations must result from reduction in application time and reduction in coats. For this reason airless spray painting provides the major economic criterion. Furthermore, the enlightened customer requires his paints to be formulated to give good can stability, precise viscosity limits and specified volume solids to ensure adequate dry film thickness.

The following table illustrates the various properties required. They indicate conclusively that zinc phosphate is the natural successor to lead pigments. In durability performance it is acknowledged to be in the class of red lead. In all other respects it meets every requirement to formulate a successfully controlled paint. This pigment has been established for approximately 10 years and is rapidly gaining favour in the industry. It was introduced by Dr J. B. Harrison, Goodlass Wall Limited, who are members of The Associated Lead Group. The formula of zinc phosphate is $\text{Zn}_3(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$. It may be included in paints to meet BS 3443 Code of Safety requirements and it is approved by medical authorities for use in painting and operations involving high temperature flames, such as cleaning, cutting and welding.

TABLE 1. PROPERTIES OF PAINT PIGMENTS

Pigment	Toxicity	Storage stability	Viscosity control	Spray application	Colour range	Protection over rusted steel	Flame cutting and welding
Red lead	N	N	N	N	N	A	N
White lead	N	N	N	N	P	A	N
Metallic lead	N	N	N	N	N	P	N
Calcium plumbate	N	N	N	N	N	N	N
Zinc phosphate	A	A	A	A	A	A	A
Zinc chromate	P	A	A	P	P	P	P
Zinc dust	P	P	P	A	N	N	P
Lead chromate	P	A	A	P	P	N	N
Iron oxide	A	A	A	A	N	P	A

A Acceptable. P Partly acceptable. N Not acceptable.