Output Report

from the "Varnishes in Aircraft Construction Working Group" to the "European Chemical Policy Study Group" of the 5th Lower Saxony Governmental Commission on "Environmental Policy in European competition".

Contents:

Preface:

In October 2003, the EU Commission published a proposal for a new European law on chemicals, called REACH (Registration, Evaluation, Authorization and Restriction of Chemicals).

In Summer 2003, the "European Chemical Policy Study Group" of the 5th Lower Saxony Governmental Commission on Environmental Policy in European Competition has been set up in order to accompany the development of the REACH regulation from the Lower Saxony perspective. It consists of members coming from different sectors of society (industry, trade, unions, environmental associations, and authorities) and has published a joint Lower Saxony statement on REACH within the framework of an Internet consultation.

In parallel with this, the concrete effects of REACH on chains of value creation will be investigated in two pilot projects involving companies in Lower Saxony.

To achieve that, the study group has set up two additional working groups, which investigated possible operational effects of the REACH system, using the chains of value creation

- "Varnishes in Aircraft Construction", and
- "From Epichlorhydrin to Epoxy Glue in Automobile Manufacture".

The goal of the investigation was to develop suggestions with regard to

- the REACH regulation draft itself, as well as
- the REACH implementation projects (RIPs) at EU level.

This report is on the chain "Varnishes in Aircraft Construction" (for participants of this study group, see Enclosure 1). The preparation of this report was headed by Mr. Andreas Ahrens, Ökopol GmbH, Hamburg.

0.) Summary:

The "varnish project" was started in fall 2003 and completed in September 2004. Participants were two manufacturers of raw material, one manufacturer of varnish systems, one aircraft manufacturer, one aircraft maintenance and repair company, two service providers for substance evaluation and management of hazardous substances as well as the Federal Institute for Occupational Safety and Health(BAuA).

The major objective of the investigation was to identify critical influencing factors with regard to the REACH implementation. This included

- the identification of "rare raw materials" (few suppliers, small amounts)
- the identification of raw materials directly imported from non-EU regions
- the questioning of the producers regarding the future availability of their products under REACH conditions
- the determination of potential candidates for the approval procedure
- a rough cost assessment for the user and preparation levels
- the determination of specific implementation risks for the companies involved
- the definition of appropriate exposure scenarios

Results of the structural analysis focusing on reactants

The major results to be documented include:

- The aircraft manufacturer employs some 1,000 different paint and varnish products (including operating supplies such as purifiers, etc.), which again consist of up to 50 different components each.
- As part of corrosion protection, chromates of the CMR (carcinogenic, mutagenic and toxic to reproduction) categories 1 and 2 have to be used in the field of varnish. Out of the total of 3,000 formulations used, 145, mainly chromate-containing formulations, have been identified as potential candidates for an approval procedure.
- The varnish producers use 1,100 raw materials. In an internal examination regarding availability carried out by the product developers, 49 raw materials have been identified as critical (30 of them polymers) since they are offered by only one or two producers and their market volume is small so that they might be removed from the market under REACH conditions.
- With 10%, the rate of direct imports of precursors from non-EU countries (with reference to 1,100 raw materials) is relatively low. Corresponding import rates in the foremost chain could not be determined.
- The question for substance-specific problems regarding availability remained open as only 65 (approx. 50%) of the questioned suppliers answered. Out of these, 23 signaled that they would continue supplies under REACH conditions as well. What remains is a substantial uncertainty as the majority of the companies made no or only insufficient statements.

- Due to the legal safety criteria, a non-delivery of some raw material components may already require longstanding re-qualification of changed varnish products in the aircraft sector, e.g. by:
    - Modification in case of a changed concentration of ingredients: average 250,000 € plus a manpower expenditure of 2 person years.
    - Qualification due to changing ingredients: average 750,000 € plus a manpower expenditure of 4 person years.
    - Change of main processes due to changes in material: average 2.5 million € plus a manpower expenditure of 40 person years.
- In a sample calculation for the registration costs of a varnish additive (30 t/a production volume, specific use in aircraft varnishes), the **fictive** assumption was played through that the producer of the additive would completely pass on the registration costs to the aircraft manufacturer via the formulator. The registration costs for the substance were conservatively estimated to be 240,000 EUR. With an annual input of 10 t for the aircraft manufacturer, nonrecurring costs of 80,000 EUR would emerge at the user level. Thus, the follow-on costs for a non-delivery of the varnish additive would be substantially higher for the aircraft manufacturer than a partial or complete payment of the registration costs.

Results of the structural analysis focusing on exposure

- There are about 1,200 different application processes documented for the aircraft manufacturers, for the most part aviation-specific processes for surface finishing.
- For a selected interior varnish (containing the ingredient butyl acetate), the application techniques, the availability of exposure measuring data as well as existing risk management measures were determined. Eleven different, defined exposure scenarios for varnish application in aircraft construction were made out, four of them for labor, and seven for environmental protection.
- It turned out that the information about substances and exposure needed for REACH generally does exist in the chain of value creation, at present, however, it is still spread among the individual actors of the chain.
- The variety of individual applications, application conditions and exposure patterns has to be categorized in order to make the exposure assessment manageable within the framework of the REACH system. This also includes the standardization of the information that is to be communicated within the chains so that the steps, such as the making up of the safety data sheet, may largely be automated. This means that a system consistent in itself is needed for the entire chain, starting with the manufacturer of a substance and ending with the user of the formulation.
- The development of relatively simple standard exposure scenarios for varnish applications seems feasible for the formulator and the user of the varnishes. The interface between the producer of the substance (exposure regarding individual substances and a broad scope of application) and the formulator (exposure regarding formulation and already predictable application conditions), however, remains open in the definition of the scenarios.

Results regarding the potential implementation risks of REACH

- The general risks REACH poses to the aviation industry can be identified and described in terms of quality. On the basis of the current data situation, it is not possible to estimate the extent of potential effects of REACH on the availability of raw materials for the production of varnishes. The reason for that is the regulation approach itself (flexibility with respect to the nature of practical implementation) and a reserved information policy on part of the participants in this chain, who fear for the protection of their interests (know-how, market shares).
- REACH might possibly result in significant competitive disadvantages for European aircraft manufacturers in comparison to the non-European competitors. This also concerns the corresponding supplier industries. There may, for example, occur competitive distortions regarding the availability and the costs of chemicals and raw materials or the time required for re-specification and re-qualification (innovation effects) of reactants. To be able to estimate the extent of the potential competitive disadvantages, it would be necessary to conduct a detailed analysis of the aircraft manufacturer's cost structure.

Therefore, the major implementation risk of the REACH system regarding the production and usage of aircraft varnishes will be that varnish raw materials will have to be substituted because the substance producer does not consider their registration profitable. Should such cases occur and the adjustment period given by REACH be too short, a time and cost-intensive re-qualification of the aircraft varnishes would be necessary, which might lead to a competitive disadvantage and in the end even to a delivery stop of aircraft.

Proposals:

As concerns the further development of REACH, the following recommendations are drawn from the pilot project:

- The study group considers the speedy development of an instrument for a cost-saving and practical REACH implementation (guidance documents) a major contribution to the reduction of the present uncertainty about REACH. This means that the REACH implementation projects (RIP) that are currently started with industry involvement also are an opportunity to put changes of the regulation that might be necessary into concrete terms.
- Annex 1b to the regulation should be put in a more concrete form regarding the requirements for the safety assessment for formulations.
- Applications, application conditions and exposure patterns should be categorized in order to make the exposure assessment manageable within the framework of the REACH system. The wording of the regulation should make it clear that the categorization of exposure patterns and the use of standard exposure scenarios are commensurate with the objectives of REACH.
- Rules should be developed that define under which circumstances specific test requirements may be skipped due to irrelevant exposures.

1. Program of the "Varnishes in Aircraft Construction Working Group"[1]

In fall 2003, the study group had phrased the following issues for its program:

1. Identification of "rare" varnish raw materials[2] and questioning of the producers regarding the presumable further marketing/production stop of substances under REACH conditions.
2. Identification of substances at the user level (all employed products) that are candidates for the REACH approval procedure.
3. Comparison of the registration costs for small-volume varnish raw materials with the current market prices of these substances.
4. Rough estimation of the direct costs for the user and formulator levels.
5. Usage analysis of a varnish product at Airbus Deutschland GmbH
   - Application techniques
   - Availability of exposure models and measured exposure data
   - Relevant exposure scenarios for a varnish product (using the example of the component butyl acetate)

2. Specific Challenges Regarding the Implementation of REACH for "Aircraft Varnishes"[3]

2.1. General Structural Data on the Use of Chemical Products

An aircraft manufacturer like Airbus Deutschland (all plants) uses about 3,000 different aircraft-specific chemical products including about 1,000 different substances classified as hazardous materials (according to safety data sheet). In total, about three quarters of the formulations are used for surface finishing, 50% of which in turn are paint and varnish systems as well as necessary additives[4] (e.g. system purifiers, surface purifiers) in a broader sense.

Airbus Deutschland has documented about 1,200 different application procedures, most of which are aviation-specific.

[1] The data collection and the preparation of the report were financed by Airbus Deutschland GmbH and the company Mankiewicz Gebr. & Co.
[2] Raw materials that are offered by one or two producers and the market volume of which is so small that the specific costs of the REACH registration might cause them to disappear from the market.
[3] Taken from Annex 1 to the study group's first report dated 07 Jul 03; information by Airbus Deutschland dated 25 May 04 is added.
[4] The relatively high number of products can be explained by a large variety of color shades and products for surface and system purification.

Airbus Deutschland purchases its reactants (qualified products) from about 800 different companies[5]. About 50 formulations are provided by non-EU companies (8 USA, 2 Switzerland). This does not include metals, other semi-finished products and system parts.

One of the varnish suppliers is the company Mankiewicz Gebr. & Co. (500 employees), which supplies not only the aviation industry but also, among others, the automotive industry and the general industry. The information system for hazardous substances comprises about 1,100 raw materials (about 80% of them are formulations) with 600 different hazardous substances. The raw materials are obtained from about 200 companies. More than 90% of the raw materials are obtained from the EU market. Great effort is needed to assign the raw materials to specific aircraft construction products.

About 60 different varnish systems are delivered to Airbus Deutschland, which can be broken down to about 200 different products. On the average, a varnish system contains about 30 different raw materials (up to 50 are possible as well).

The number of “rare” (extremely product-specific) formulation components (risk availability and purchase price) can possibly be estimated if there is a detailed information exchange between the producers of the varnish systems and their raw material suppliers.

2.2 Specific Implementation Risks for the Aircraft Industry

Besides the general challenges for the economy which will result from the implementation of the REACH system until about 2017, the following risks for aircraft construction can be phrased:

- Safety has top priority in the aviation industry. Surface protection is a significant and integral aspect of aircraft construction. This means that changed recipes require a time and cost-intensive re-qualification within the framework of aeronautical registration.
- If the technical performance level cannot be met by re-specifying a formulation, this can possibly have an effect on the overall performance level of the aircraft and thus also on registration-related legal aspects of the entire aircraft.
- Apart from the chemical components that are widely used in varnish and paint systems, there are some aviation-specific chemicals, partially with small market volumes. Especially in this sector, REACH might have an impact on the availability of certain substances.
- REACH may result in more or less serious competitive distortions in the overall process chain, depending on whether productions are carried out within or outside of the scope of REACH: availability and costs of chemicals and raw material, time required for re-specification and perhaps re-qualification (innovation effects), production conditions for components, framework conditions for maintenance and servicing of flight hardware, scrappage/disposal.
- Due to the variety of products requiring a registration or re-qualification, there may be capacity shortages at Airbus Deutschland. It must be taken into consideration that a

[5] This number also includes companies from which reactants are obtained only temporarily or in large time intervals.

change of the concentration or the exchange of one out of 40 components in an aircraft varnish already require a re-qualification. The following data provided by Airbus Deutschland give an idea of the average effort needed for this. It becomes clear that the non-delivery of individual varnish raw materials cannot cause only considerable costs but also personnel shortages up to a production stop due to lacking product safety.

- Modification in case of a changed concentration of ingredients: 250,000 € plus a manpower expenditure of 2 person years.
- Qualification due to changing ingredients: 750,000 € plus a manpower expenditure of 4 person years.
- Change of main processes due to changes in material: 2.5 million € plus a manpower expenditure of 40 person years.

Therefore, the major implementation risk of the REACH system regarding aircraft varnishes will be that varnish raw materials will have to be substituted because the substance producer does not consider their registration profitable. Should such cases occur and the adjustment period given by REACH be too short, a time and cost-intensive re-qualification of the aircraft varnishes would be necessary, which might lead to a competitive disadvantage and in the end even to a delivery stop of aircraft.

2. 3 Expected Availability of Substances

The specific registration costs for substances with an annual production below 100 t/a can reach a dimension that cannot be passed on to the price any more. In such cases, the producer or importer would possibly discontinue the marketing of that substance for economic reasons. The formulators or users of varnishes will have to adapt (substitution), and the basis for recipe innovation might become smaller (reduced variety of raw materials).

2.3.1 Survey among Suppliers and Product Developers

Using a varnish system as an example, the UMCO (Umwelt Consult GmbH) tried to find out which ingredients might become subject to availability problems under REACH conditions. For that purpose, a survey among suppliers was conducted.

The suppliers of the selected varnish system for Airbus Deutschland were asked the following questions:

1. Does the product consist exclusively of ingredients that are currently produced within the European Union?

2. Will the product continued to be offered on the European market independently of a new chemical policy (REACH system)?

3. Will the product presumably be registered for the purpose “production of paints and varnishes” according to the REACH system?

As a telephone inquiry, the survey was very reliable, nevertheless, however, most suppliers considered themselves unable to provide concrete details. Moreover, the survey was conducted before the commission’s official REACH draft was published. The result of the survey neither helped to identify a definitely problematic raw material nor to dispel the general fears.

In a second round, also before the publishing of the official REACH draft, it was tried to identify the general risks posed by REACH to the varnish producer Mankiewicz. For that purpose, the product developers were asked which raw materials met the following criteria:

- Is the substance produced outside of the EU?
- Is it a product for only one or very few users (specialty product)?
- Is the substance normally not used for varnishes (special usage)?
- Does the substance have a small market volume and is it of fundamental significance for the varnish producer?

All in all, 49 raw materials that belong to one of these categories were named in this survey. Polymers with customary monomers (30) made up the major part. Upon looking through the data, seven raw materials were classified uncritical by UMCO. For 12 substances, an assessment is still outstanding; REACH-related problems might occur there. Within the framework of the project, it was not asked which of the above criteria caused the developers to mention the raw materials.

In a third step, the varnish producer Mankiewicz conducted a survey among all suppliers. 65 of the questioned suppliers answered, which is less than half of the companies contacted. Out of these, only 23 signaled that they would continue supplies under REACH conditions as well, the majority did not answer this question.

Drawing a conclusion, it can be said that the surveys did not lead to an identification of raw materials with an endangered availability under REACH conditions, but neither did it dispel the existing reservations about the availability of raw materials under REACH conditions.

2.3.2 Determination of the Share of Raw Materials of non-EU Suppliers

The significance of products and pre-suppliers in the non-EU countries was estimated at the formulator and user levels. Under REACH conditions, the directly importing company would possibly be liable to register the substances in such products, if the producer in a

non-EU country does not have his own representative in the EU to take care of the registration. In this case, it is up to the user to register, and above all, the user would be dependent on the producer as concerns the disclosure of the recipe (and thus the know-how). Here, three scenarios are possible:

- The registration of the substances contained in his products for the European market is profitable for the producer a in non-EU country, and he will do that with the help of a professionally competent representative.
- The registration of the substances contained in his products for the European market is not profitable for the producer a in non-EU country, and he will leave it up to the user in Europe. In turn, he will make the recipe available to the user. Such a scenario will be possible if the users have an appropriate negotiating strength against the producers in non-EU countries.
- The registration of the substances contained in his products for the European market is not profitable for the producer a in non-EU country, and the formulation concerned will not be available on the European market after the registration period has expired.

The share of raw materials imported from non-EU countries was about 10% [in relation to all raw materials employed = 1,100] for the varnish producers, and about 2% for the varnish users [in relation to all chemical products used = 3,000].

As concerns the data provided by the aircraft manufacturer, it has to be taken into account that they refer to direct imports. It was not possible to determine to what extent substances that were imported at an earlier commercial level can be found among the products obtained from non-EU suppliers. For indirectly imported products, REACH effects can occur where importers of substances or formulations that are not produced within the EU discontinue the import. Possible reasons:

- The registration of a substance is economically not profitable as the registration costs are too high in comparison with the reliably predictable turnover. This particularly applies to substances that are nonrecurrently or irregularly imported, depending on the market situation.
- The registration is economically not profitable as the registration costs are too high in comparison with the reliably predictable turnover. According to the current regulation proposal, the importer has to draw up a registration dossier for each substance that exceeds the amount of 1 t/a in the imported formulations. The administrative effort for the procurement of the required data (or data user rights) for all components of the imported formulation would be high.

- The registration of the substances in a formulation is not possible as the non-EU producer does not disclose the recipe of his product (and thus his know-how) to the importer, and does not charge an own representative with the registration either.

Basing on the available data, it is not possible to make a quantifying statement on how high the risk of the non-delivery of raw materials and thus necessary production changes will be. One of the reasons for that is the regulation approach itself. The requirements can be met in a flexible manner. Moreover, the regulation draft still contains a series of ambiguities and contradictions, which also have cost implications. Therefore, the amount of the system's direct costs (and thus also the rationalization effects) also depends on the implementation of the regulation on EU guidelines (=Guidance Documents) for industry and authorities. These guidelines will have to be developed in the period from 2004 to 2006. This means that presently even an intensification of the data collection would not provide any more reliable information on the availability of substances. Another factor is that producers who can predict that REACH will lead to specific changes of the portfolio would not communicate this unless it is absolutely necessary. The only thing that can be said is that no particular, varnish-specific availability effects have become visible in the collection, however, a considerable uncertainty will remain as the vast majority of the questioned companies did not make any or merely insufficient statements.

2. 4 Identification of Candidates for Registration (User Level)

REACH requires an obligatory authorization for the future usage of CMRs, persistent and bio-accumulative substances and (possibly) certain sensitizing substances, in which economic-technical reasons have to be given that indicate why the substance cannot be substituted with alternative chemical solutions. At least for corrosion protection in aircraft construction, certain CMRs are currently not replaceable for technical reasons. Both the medium-term development of substitute processes and a possibly necessary limited authorization hold planning and cost risks. At Airbus Deutschland, about 18 active CMR chemicals (categories 1 and 2) are relevant in this context; most of them are chromates. About 145 formulations (out of 3,000 in total) are candidates for an approval procedure due to their content of CMR chemicals. If and when an application for license has to be made depends on the agency's system for establishing priorities according to Article 55.

With regard to the content of PBT (persistent, bio-accumulative and toxic) or vPvB (very persistent and very bio-accumulative) substances in the used formulations, the present classification in accordance with the formulation guideline does not provide any sufficiently reliable hints. Here a step by step query among the producers should be conducted, which asks for recipe components that have environmentally hazardous properties (R53 as well as the combinations R50/53, R51/53 or R52/53), or the environment-related properties of which have not yet been determined by the producer.

2.5 Rough Cost Evaluation at the User and Formulator Levels

In the REACH system, different kinds of direct costs may be relevant for formulators and users. The following cost evaluations are partly taken from RPA 2003 and partly calculated basing on the data given by the Commission in the *Extended Impact Assessment (*2003):

- For the registration of a substance with a production below 100 t/a, the average statistical costs to be expected are about 11,000 EUR (1-10 t) and 84,000 EUR (10-100t) per substance (RPA 2003, adapted to the regulation draft)[6]. The average costs per statistical ton[7] will be about 3,600 EUR or 2,800 EUR/t at a market volume below 100 t/a (cf. Table 2). If a producer or importer had to re-determine all data for an old substance, the registration costs per substance would be about 40,000 EUR (1-10 t/a) and about 290,000 EUR (10-100 t/a)[8]. These maximum costs, like the minimum costs (all data available, merely evaluation and registration costs of about 5,000 to 10,000 EUR per substance), will not be considered any further in the following calculations.

[6] According to Table 2, the average value will be 84,000 EUR, when assumed that about 50% of the substances have to be classified as hazardous.

[7] The registration costs of a substance are distributed to the corresponding marketing volume of the substance. The share of production costs that a marketed ton of a substance has to recover (contribution margin), will decrease the higher the market volume is. Assumed market volumes of 3 t/a and 30 t/a have been taken from RPA 2003.

[8] Calculation by Ökopol on the basis of test costs [with an inhalation test of 28 days; a test to determine the endpoint of reproduction toxicity [OECD 414, rat] calculated with 80,000 EUR on annex VI] and adoption of the administrative costs from RPA.

Direct Costs (average in EUR)**

t/a, Costs per Substance (EUR)	1-10 t/a Band	10-100 Band	100-1000 Band	> 1000 Band
Risk Evaluation (1) Robust Study Summary (1)	(1,500)	1,500	8,700 500*	8,700 1,000*
Exposure Evaluation (1) Contact with User (1)	(1,200)* (2,000)*	2,700* 3,500*	7,200* 12,000*	19,500* 15,000*
Risk Characterization(1) Report (CSR) (1)	(800)* (500)	800* 1,000	3,500* 2,000	3,500* 2,000
Administration (1)	5,000	5,000	10,000	10,000
Test (Consultation Paper) (2) Test (Regulation Draft) (3)	12,100 5,800	73,100 73,100	163,000 163,000	208,000 208,000
Total per t (3, 30, 300 or 3000 t/a) (Consultation Paper)	6,400 7,700+	2,700 2,910+	600 700+	80 90+
Total per t (3 t/a) (Regulation Draft)	3,600			
Current Market Price per Ton (4)	18000		6000	1400

* only for hazardous substances
\+ including hazardous substances
(..) not required in the regulation draft

** Data by RPA (1), JRC (2), acc. to EIA (3), ADL (4)

Table 2: Average direct costs for the registration of a "statistical" substance

- In individual cases, the specific costs per ton for a registered substance may range between 1,600 to 27,000 EUR (1-10 t) and 480 to 16,600 EUR (10-100 t)[9]. The cost level will depend on the following factors:
  - Availability of substance data at the producers or importers
  - Acknowledgement of present test data (also non-GLP [Good Laboratory Practice] standard), of analogous conclusions, of group assessments or of structure-activity relationships (QSAR - Quantitative Structure-Activity Relationships) by the authorities (implementation of the rules according to annex IX by the authorities).
  - Practical rules on the basis of which the registering person can prove that a relevant, subacute or chronical exposure of employees and consumers is not to be

[9] Basis RPA 2003 and JRC 2003 (before cancellation of the CSR obligation and the reduction of the requirements in annex V for the 1-10 t/a band in the latest change to the regulation draft): Depending on the data situation, test costs ranging between 8,600 and 16,400 EUR per substance in the 1-10 t/a band and between 40,500 and 152,000 EUR in the 10-100 t/a band have to be expected. Added to this are the costs for exposure assessment, risk assessment and administration. To calculate the maximum and minimum costs per ton, the minimum and maximum costs per substance need to be divided by the limit of the tonnage band (annual production of 1 ton, 10 tons, or 100 tons).

feared, and that therefore corresponding tests are not necessary (cf. option in Annex VI to the REACH draft)[10].

- Situation of the market volume in the tonnage band.

- For reporting a deviating usage of a hazardous substance and implementing a corresponding safety assessment for the substance, about 9,000 EUR have to be taken into account per case. The same applies to the report of a release-relevant substance in a product. To report an authorized application to the European Central Authority, about 60 EUR have to be taken into account per substance and application (RPA 2003).
- According to an RPA estimate, costs of 8 to 800 EUR per product have to be expected for examining whether hazardous substances in products need to be reported or registered. If a registration is mandatory, the costs of the registration itself will be about 60 EUR per substance.
- The RPA estimates that a producer will have to expect costs of about 50,000 EUR (excluding fees) for the authorization of a registered substance, if an examination of alternatives and a socio-economic analysis have to be conducted. Assuming the authorization is done for a single user, these would also be the maximum costs for the user.

The current estimates of the VCI (German Chemical Industry Association) - VCI 2004 - regarding the registration of phase-in substances are higher: 20,000 EUR per substance in the 1-10 t/a band, 240,000 EUR in the 10 -100 t/a band and 400,000 EUR in the 100 -1000 t/a band. These estimates are based on the assumption that the minimum data records from the VCI's self-commitment will be recognized within the framework of the REACH system. For a statistical substance, this would result in specific registration costs of about 6,700 EUR/t (1-10 t), 8,000 EUR/t (10-100 t), and 1,330 EUR/t (100-1000 t). The higher costs are mainly due to the fact that

- higher laboratory prices are calculated for the tests according to Annex VI (especially screening test for reproduction toxicity),
- the costs of 54,000 EUR for the exposure assessment in the 10-100 t band (WZB - Social Science Research Center Berlin - 2003) are considerably higher than in the RPA studies (6,200 EUR),
- the development of analysis procedures is integrated, and
- many individual estimates are rather conservative (worst case).

Current prices for varnish raw materials can be used to assess the relative cost effects. It would be useful to focus on specific formulation components such as additives, pigments and binding agents as well as on "exotic" substances, if applicable. Comparative values are the statistical average values of the estimated costs in the volume ranges of 10-100 t/a and 1-10 t/a with the cost depreciation spread over 2 years[11]. However, it has to be taken into account that the true specific costs will statistically spread (minimum = 0.240 EUR/kg

[10] In the English original, the requirement is referred to as "relevant exposure".

[11] According to legal provisions for tax and balance sheets, the depreciation of the costs has to be effected in one year (information by Dr.Weinert, Ministry of Economics).

and maximum = 13.5 EUR/kg) and the costs can be shifted over a longer period than 2 years.

	Average market price at 1-100 t/a market volume ADL 2002	Procurement costs of the varnish supplier for aircraft-specific raw materials[12]		Average additional costs 1-100 t/a, passed on over 2 years
Additives, pigments specific binding agents (no commodities)	18.3 EUR/kg	expensive raw materials cheap raw materials	80 EUR/kg 5 EUR/kg	1 - 2 EUR/kg (RPA) Min: 0.24 EUR/kg Max: 13.50 EUR/kg 3 - 4 EUR/kg (VCI)

Table 3: Cost effects due to REACH and market prices for low-volume substances

2.6 Estimate of Aftereffects for Aircraft Construction

A quantitative estimate of the effects resulting from the REACH system for aircraft construction would require the following data to be available:

For which components of varnish products are the specific registration or certification costs so high that they would lead to a significant increase of the varnish price and prevent the producer from passing on the costs by means of the price as the majority of the customers can evade this (by substitution or moving abroad)?

Only if these conditions are met, the need for a re-qualification may arise for the aircraft manufacturer.

If, however, the aircraft manufacturer has to indirectly pay the non-recurrent registration and certification costs through the increased price, he may possibly have a significant competitive disadvantage in comparison with non-European aircraft manufacturers. A detailed cost analysis of the aircraft manufacturer would be required in order to estimate the significance of such an effect.

Therefore all quantifying estimates of consequences that base on current knowledge are very speculative. For that reason, an evaluation of the indirect effects has not been carried out.

However, it has to be highlighted that even the disappearance of very few varnish components may lead to a snowball effect that can tie up multi-million Euro costs and manpower of several person decades. The outlined effects can be illustrated by a **fictive** example:

[12] The examples for expensive and cheap raw materials are taken from a survey that Ökopol currently conducts among varnish producers within the framework of a UBA (German Federal Environmental Agency) project. In individual cases, prices for certain pigments may range between 5 and 80 EUR. A statistically proven range of normal prices for varnish raw materials is not available. According to Ökopol's experience, an average value of 18 EUR/kg for small-volume raw materials (additives and special monomers) seems to be realistic.

- The production output of a particular varnish additive (20 EUR/kg market price) important for aircraft construction is about 30 t/a. On the basis of the VCI estimate (240,000 EUR per substance), the registration within the framework of the REACH system will cost between 2.40 EUR/kg (99.9t) and 24 EUR/kg (10 t/a) in a non-recurrent payment, i.e., 8 EUR/kg in the example. The additive is important for 15 of the 60 varnish systems and the aircraft manufacturer uses an amount of 10 t/a for all varnish products concerned. If the registration costs are completely passed on, the aircraft manufacturer will face non-reccurrent, additional costs of 80,000 EUR. If the production volume of the producer was higher (99.9 t/a), the non-recurrent additional costs would amount to 24,000 EUR. If it was lower (10 t/a) the non-recurrent additional costs for the aircraft manufacturer would be 240,000 EUR.
- In comparison to that, the adjustments would be multiple times higher (e.g. 750,000 EUR per varnish system plus the personnel costs of 4 person years [400,000 EUR] in case a re-qualification is necessary due to recipe changes) if the production of the additive was discontinued.
- This kind of comparative cost-effective analysis would be possible only if the information flow within the supply chain led to an early agreement on the price acceptance of a product that has become extremely expensive. Due to the market conditions, however, it has to be assumed that a raw material supplier will not keep a widely used product on the market that has become too expensive for more than 85% of the customers.

3. Usage and exposure analysis for a varnish product

3.1 Question

Depending on the production volume of the relevant substance, the producers/importers have to conduct a standardized substance safety evaluation for the entire life cycle of the substance and document this in a substance safety report (including recommendations for risk management).

Thus it shall be possible to make out for which applications and under which conditions the substance (or formulation) can be used safely, i.e., no unacceptable risks would emerge for human beings and the environment.

The study group focused on the questions

- of how standardized exposure scenarios (= description of the “safe” application conditions and the risk management measures required for that) can be developed
- which role producers of raw materials, formulators and users will play.

At the level of Airbus Deutschland, on the basis of on-site inspections and written information provided by representatives for environmental protection and occupational safety,

- the application techniques,
- the availability of measuring data regarding exposure, and
- existing risk management measures

of aircraft varnishes in general and of the selected example varnish for internal structural parts (of the company Mankiewicz) in particular have been determined and schematically summarized with respect to the component butyl acetate.

3.2 Results

- From the perspective of the industrial safety for employees, the following elements are considered new to the REACH system:
  - DNEL[13] for all substances > 10 t/a, for which no threshold limit value (TLV) is available.
  - Concrete requirements for application-related measures (especially for small and medium-sized companies) by the corresponding pre-supplier.
  - Standardized document format for the threat analysis following the chain of value creation.
  - Standardized data exchange formats for the European market.
- From the Federal Institute for Occupational Safety and Health's (BAuA) point of view, the REACH system provides an opportunity to introduce a protection level concept (cf. COSHH Essentials) especially for users from small and medium-sized companies. This means that the producer will directly deduce standard sets of measures from the hazardousness of a formulation (and its components). Or the other way round: The producer of the formulation will select those raw materials that support a particular exposure scenario for the user.
- Within the framework of the REACH system, the varnish producer (formulator) is tasked with evaluating the exposure scenarios for the individual, hazardous varnish components and making decisions on whether the customer's scope of application of the produced varnish corresponds to the framework conditions for a safe application. If the varnish contains a larger number of hazardous substances, the formulator has to decide in which way he will communicate the exposure scenarios to his customers. Article 29 allows to consolidate the substance-related individual information to a new

[13] Derived No Effect Level

exposure scenario for the varnish. According to the study group, however, Annex 1b to the regulation does not provide sufficient clarity regarding how to achieve this, if necessary.

- A producer of widely spread varnish components is hardly capable of generating sufficient specific scenarios for the different varnish applications. Due to their knowledge of the general composition of varnishes and of the major varnish applications, it can be useful if the varnish producers (arranged by the association, if applicable) jointly develop the required number of different standard exposure scenarios for the major varnish applications.
- The varnish users and the professional associations can contribute the data coming from the workplace-related exposure analysis. The study group assumes that hardly any new measurements will be necessary. The essential thing is the development and merging of existing data stocks, the harmonization of methods for analogous conclusions (hazardous substances for which no measurements have been made yet) and the selection of guiding components in formulations[14].
- Lufthansa, for example, has a standard worst-case assessment for typical varnishes and their application (e.g. topcoat white) in accordance with the Technical Rule for Hazardous Substances 404. The applicability of other varnishes is only summarily checked, based on the hazardous ingredients. From the perspective of occupational safety at Lufthansa, it should be possible to combine all varnishes/applications to eight groups. However, it has to be noted that Lufthansa has drawn a grey list of substances that are generally excluded from application.
- In a simple model for the application of categories used for the generation of exposure scenarios in a specific field of application (= market segment from the formulator's point of view), the following statements can be phrased as standards:

  The feature of the formulation is defined by:

  - the content of hazardous substances and the type of the possible effects the substance may have (R-phrases in accordance with the Hazardous Substances Ordinance)
  - the mobility of the substances
  - environmental behavior (distribution and decomposition)

  The exposure scenario is defined by the following categories (criteria):

  - used openly or in closed sites

[14] The measuring of exposures at the workplace and the workplace-related threat analysis are common practice in the field of occupational safety for employees. Hazardous substances for which no measurements are available can often be assessed by comparison with substances for which measurements are available. For substance safety assessments regarding formulations, however, the existing instruments have to be developed further.

- application technique (spraying, coating, immersion, ...), place of application (outside or inside); resulting relevant exposure paths;
- short- or long-term exposure
- quantity used
- resulting measures for organizational, technical or personal occupational safety (including ventilation conditions)

A proposal for the categorization with respect to the exposure scenarios for aircraft varnishing at Airbus Deutschland can be found at annex.

The varnish applications considered at Airbus Deutschland can be sufficiently described using four different exposure scenarios for industrial safety and four exposure scenarios for environmental protection. It is safe to assume that these scenarios can be transferred as scenarios, perhaps with some modifications, to other varnish applications as a standard (cf. p. 18).

A special feature at Airbus Deutschland is that the relevant exposure scenarios are designed so conservatively that they allow the handling of carcinogenic chromates even if not all coatings used as part of those scenarios contain chromates.

The compliance with exposure limits for industrial safety is confirmed by measured values. The compliance with exposure limits regarding adjacent solvents is proven by calculations. There are calculating formulas available for the relevant amount of substance used and the dimensioning of the air extraction, based on which the intensity of the exposure can be determined.

Conditions for use in the exposure scenarios for varnish applications at Airbus Deutschland GmbH

Industrial safety

1. Closed procedure, automated; normal working clothes, normal industrial hygiene; eye protection if necessary;
2. Manual spraying or coating, local air extraction, disposable protective clothing, half-mask face piece*, protective gloves, eye protection if necessary*; (* for spraying only)
3. Manual spraying, local air extraction, full protection (independent of ambient air);
4. Manual coating, hangar ventilation, disposable protective clothing, protective gloves, eye protection if necessary

Environmental protection

5. Wet or dry scrubbing of paint aerosols
6. Release solvent-containing air via the roof; limitation in accordance with solvent balance according to Federal Regulation on Immission Control No. 31; additional control of odor emissions if applicable
7. Regenerative afterburning of solvent-containing outlet air

7a. Recovery of solvents through adsorption procedures

8. Collection and disposal of varnish waste sludge and aerosol filters as hazardous waste in need of monitoring; hazardous waste incineration plant;
9. Collection and disposal of the water from the wet scrubbers as hazardous waste in need of monitoring; hazardous waste incineration;
10. Waste discharge after sedimentation of varnish waste sludge (by ....) in local sewage treatment plant

Gloves: The specification of the glove type in the generic exposure scenarios for varnish applications is not useful as the glove type strongly depends on a company's work flow. However, the appropriate glove material for the relevant solvent can be named.

The following differences exist between the exposure scenarios described above and the exposure categories according to the VCI approach (VCI 2004):

- In the VCI model, the producer determines whether a substance can be used for industrial, commercial or private purposes.
- Furthermore, the producer defines which exposure pattern he has confirmed by tests: main absorption paths into the body and the environment as well as long-term/repeated exposure or short-term/occasional exposure.
- In addition, the producer announces which exposure level is acceptable from the (eco-) toxicological point of view (PNEC [predicted no effect concentration] or DNEL).

4. Conclusions

4.1 Availability of Raw Materials and Product Qualification

With 10%, the **import rate** of raw materials or formulations from non-EU countries is relatively low in the varnish chain compared with other production sectors of chemical formulations. Correspondingly, the possible availability effects for raw materials caused by the cancellation of imports for the varnish chain do not seem to represent a particular risk for the formulation producer.

Nevertheless, a relevant risk can arise for the aviation industry: Qualification procedures may become necessary, if the non-European producer discontinues his deliveries and it is difficult to find a European supplier who can replace the raw material. It has to be noted that this is not only a risk of financial nature, but it can also directly influence the aircraft manufacturer's supply ability, and thus would represent considerable competitive disadvantages in comparison with non-European competitors. If the legislative implementation deadlines are too tight, such a scenario can cause a delivery stop of aircraft!

About 5% of the formulations in aircraft construction are potential candidates for **registrations**. This quota is due to 18 active CMR I+II, mostly chromates. The number of resulting cases that require authorization is relatively low and should be enforceable due to the high level of occupational safety in the aircraft industry and the political significance of this industry branch. However, appropriate transitional periods are necessary, and the costs for the documentation of a) appropriate protective measures or b) socio-economic advantages have to be observed (50,000 EUR per substance according to RPA assessment[15]). If there is no registration of chromates, all formulations concerned (about 145 applications) would have to be newly qualified for aviation in several years of work in the research and development department.

Regarding possible PBT and vPvB substances in the formulations, there is an information gap that presently cannot be filled and might cause qualification costs (if substitution is necessary) to indefinable amounts. Here, a speedy clarification with the producers of varnish and raw materials is needed to find out which ingredients might be PBT candidates.

The general risks REACH poses to the aviation industry can be identified and described in terms of quality. The extent of the effects that REACH may possibly have on the availability of raw materials for the production of varnish, however, cannot be estimated on

[15] Prerequisite: Substances are authorized for specific applications (e.g. corrosion protection in varnishes). REACH does not provide for the authorization of individual formulations.

the basis of the current data situation. And even in theory, hardly any quantitative statements can be made:

- In the 1-100 t/a band, the direct registration costs per kg of a substance may vary in a broad range (0.48 EUR – 27 EUR) due to a variety of important factors that are not dependent on the regulation itself but on the way it is implemented.
- Comparing this range of costs with the current, typical market price level (8-25 EUR/kg) shows that the absorption of the costs on the market will probably be unproblematic for certain cases but can cause evasive reactions (discontinuation of substance marketing) including the corresponding consequences. This means that no generalizing statements can be made on the producer's decision if and how he can and wants to absorb the non-recurrent registration costs (pass them on to the customer, reduce the margin, increase the output or discontinue the production). Even a more intense, direct questioning of the producers is unlikely to provide more certainty.

4.2 Exposure Assessment

Applications, application conditions, and exposure patterns have to be categorized to make the exposure assessment conducted within the framework of the REACH system manageable. This also includes the standardization of the information that is to be communicated in the chains so that the work steps, such as the preparation of the safety data sheet, can proceed largely automatically. This means that a system consistent in itself is needed for the entire chain, reaching from the producer of a substance to the user of the formulation.

The development of relatively simple standard exposure scenarios for varnish applications seems to be feasible for the formulator and the user of the varnishes. They refer to the formulation as a whole and not to the individual components. The VCI's category approach does not technically contradict the generation of standard scenarios. The interface between the producer of the substance (exposure regarding individual substances and a broad scope of application) and the formulator (exposure regarding formulation and already predictable application conditions), however, remains open as far as the definition of the scenarios is concerned.

For many substances, data about the intensity of the exposure at typical workplaces do already exist, however, they need to be merged systematically. It is necessary to pursue the further development of standard instruments for the identification of guiding components in formulations and for analogous conclusion with respect to components that have not been measured as yet.

There is also a need for development regarding the environment-related exposure assessment. At EU and OECD level, there are so-called *Emission Scenario Documents*

(ESDs) for numerous branches, including varnishes and paints[16]. Chapter 9 of the ESD describes the environment-related emission scenarios for the usage of varnishes in the aircraft industry. By using models of the environment-related performance of substances, the environmental concentrations can be calculated basing on the emission data. The relevant procedures are described in the TGD[17]. The present instruments, however, were developed for authorities to make assessments of old and new substances. For the safety assessment of substances to be conducted by economic actors under REACH conditions, these instruments have to be refined. This includes: simplification, adaptation to the communication within the chain, definition of the tasks for each of the acting groups in the chain (substance producer, formulator, user). In addition, there is definitely much more need for technical development for specific exposure paths (e.g. air) and life cycle sections (e.g. use of substances in products) than for the use of formulations in industrial manufacturing processes and corresponding emissions via water.

4.3 Options for Actions

From the results of the study, major factors can be deduced that generate possible negative effects in the field of aircraft varnishes:

- The uncertainty among the actors on the market is great, and there has been no strategic communication about the availability of substances between substance producers, formulators and users so far. But the discontinuation of raw materials for aircraft varnishes would be a lot more serious than passing on the registration costs to the product price.
- Importing essential raw materials from “not motivated” formulators[18] outside of the EU can turn into a problem, even if the quantitative import rate is rather low and the aircraft manufacturer would be willing to pay the registration costs.
- The registration costs are fundamentally influenced by the rules for a possible reduction of tests in Annex 6, the permissible scope of the exposure scenarios and using phrases as well as by the rules for the applicability of existing data, for group assessments and analogous conclusions.

This situation allows to draw the conclusion that the speedy development of instruments for cost-saving and practical implementation of the REACH system (EU Guidance Documents) will be a major contribution to the reduction of the current uncertainty. Therefore, the *REACH Implementation Projects* (RIPs) that are currently being started

[16] Risk and Policy Analysts: Emission Scenario Document – Chemicals Used in Coating Industry – Paints, Lacquers and Varnishes (Draft 2003, prepared for the UK Environment Agency).
[17] EU Technical Guidance Document on Risk Assessment 2003
[18] Formulators or substance producers who would discontinue their deliveries if registration became obligatory for the European market.

involving the industry can be considered a chance to put the possibly necessary changes to the regulation in more concrete terms. The following measures result from the present knowledge about aircraft varnishes:

- Complete Annex 1b about the specification of the requirements for a safety assessment of formulations.
- Ensure that the categorization of exposure patterns and the use of standard exposure scenarios correspond to the objective of the REACH regulation.
- Develop rules that determine under which conditions certain test requirements may be skipped due to irrelevant exposure.

In addition, the study group recommends to use case studies in order to determine the concrete profit of the REACH system for environmental protection and industrial safety in a company.

5. Sources

EIA (2003): Commission of the European Communities – Commission Staff Working Paper; Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH); Extended Impact Assessment (Com(2003)644 final); October 2003;

JRC (2003): European Commission - Joint Research Center; Assessment of additional testing needs under REACH; September 2003

RPA (2003): Risk & Policy Analysts Limited; Revised Business Impact Assessment for the Consultation Document Working Paper 4; October 2003

VCI (2004): Chemie Report Spezial; EU-Chemikalienpolitik - Das REACH-System muss praktikabler werden (March 2004).

WZB (2002): Fleischer, Kelm, Palm: Prüfkosten und administrative Kosten. Eine Analyse zur Neuordnung der Chemikalienpolitik in der EU (Final report, December 2002)

Annex 1

Study group members

- Producer of raw materials (BASF)
- Producer of raw materials (SYNTHOPOL)
- Producer of varnish systems (MANKIEWICZ)
- Service provider for substance assessment and management of hazardous substances (UMCO)
- Aircraft construction (AIRBUS Deutschland GmbH)
- Aircraft operation and maintenance (LUFTHANSA)
- Service provider for chemical policy and substance assessment (ÖKOPOL)
- Federal Institute for Occupational Safety and Health (BAuA)

Annex 2

Varnishing (Airbus Deutschland GmbH)

- In aircraft varnishing, a distinction is made between outside and inside varnishing of the component parts. In addition to the varnishing of the component parts in the interior, the plastic parts are also varnished.
- Principally, all metal parts in aircraft construction are covered with a corrosion protection varnish (usually containing chromates – yellow) which simultaneously serves as primer. The topcoat enamel on the outside primarily serves as a protection against temperature and mechanical effects. The interior varnish is designed as a protection against chemical effects (toilet liquids, water, food and drink remnants, hydraulic fluids).
- The inside surfaces make up about 80% of the overall surface to be varnished, the outside makes up 20%. Due to the larger number of layers on the outside, the varnishes used in the interior provide 60% of the weight while the varnishes used on the add up to 40% of the overall weight. In total, 380 kg of solid varnish are needed for one Airbus.
- Component parts are varnished using different procedures and at different locations.
- Mankiewicz varnishes are used for interior varnishing (interior component parts). The varnish selected as an example (and related varnishes) is to be used mainly in the factory in Bremen. In Bremen, two procedures are applied:
    - Fully automated varnishing of component parts in a closed booth with a wet scrubber (particle separation) and drawing off the waste air into the environment.
    - Varnishing carried out by an employee in a closed booth (full protection, waste air is also drawn off outside, particle separation by wet scrubbing). Subsequent to both procedures, the solvent remnants are evaporated in the cab and then the varnish is desiccated to cure in a closed booth. On a small scale, Mankiewicz varnishes are also used for repair varnishing (partially including previous sharpening) in open spray units with wet scrubbing and mechanical ventilation (protective mask and gloves) and for the conversation of residual parts (manual varnishing of riveted spots with a brush - no local extraction, incomplete protective mask and gloves).

- The selected varnish is to be used in the order of 5-6 tons per year and is currently still in the phase of technical optimization. It is a water-based varnish. 100% of the contained solvents (about 15% relating to solids) of water-based varnishes are discharged into the environment.
- N-butyl acetate, selected as an example varnish component within the framework of the present examination, is a solvent used in almost all conventional varnishes at

Airbus Deutschland. Moreover, it is widely used in component part purifiers (consumption: about 160 l of component part purifier per aircraft).

- At least once a year, workplace analyses (including measurements and biomonitoring) are conducted for varnish jobs. N-butyl acetate is one of the routinely monitored substances. However, there are no measurements regarding the preparatory and subsequent works. The percentage of solvent contained in varnish waste sludge (wet scrubbing) is not determined either.
- The AIRBUS Deutschland GmbH objective for industrial safety is that employees are not subject to higher exposures than the average population.

The following varnish applications and steps were identified within the framework of the usage analysis at Airbus Deutschland GmbH[19]:

1. Preparatory works
   - Mixing
   - Filling of the spray machines
2. Varnishing
   - Manual spray varnishing of the fuselage (covered with a canvas, extraction via the floor)
   - Varnishing machines – operated mechanically or by robots (surface spraying machine, component varnishing)
   - Manual spraying in booths or spray units
   - coating works – conservation of residual parts
   -
3. Subsequent works
   - Purifying of the implements (spraying devices, gratings)
   - Disposal of the varnish waste sludge and varnish filters, of the water from the wet scrubbers as well as of the washing liquids used for implement purifying
   - External removal of varnish from the gratings

[19] The plants in Nordenham and Stade were not visited, the procedures applied there were only partially taken into account. Mankiewicz varnishes are used for interior varnishing (interior component parts). The example varnish (and related varnishes) is to be/is used primarily in the plant in Bremen. Therefore, the analysis focused on Bremen.

The industrial safety precautions and many of the environmental protection measures taken by Airbus Deutschland are designed for the existence of chromate-IV combinations. There was no in-depth discussion with Airbus Deutschland on what the corresponding measures for butyl acetate and a varnish without any chromate would look like.

Regarding measures for occupational safety and environmental protection, the procedures (activities) can be assigned to specific exposure scenarios:

Industrial safety

1. Closed procedure, automated; normal working clothes, normal industrial hygiene; eye protection if necessary;
2. Manual spraying or coating, local extraction, disposable protective clothing, half-mask face piece*, protective gloves, eye protection if necessary*; (* for spraying only)
3. Manual spraying, local extraction, full protection (independent of ambient air);
4. Manual coating, hangar ventilation, disposable protective clothing, protective gloves, eye protection if necessary

Environmental protection

5. Wet or dry scrubbing of paint aerosols
6. Release solvent-containing air via the roof; limitation in accordance with solvent balance according to Federal regulation on immission control No. 31; additional control of odor emissions if applicable
7. Regenerative afterburning of solvent-containing outlet air

7a: Recovery of solvents through adsorptive procedures

8. Collection and disposal of varnish waste sludge and aerosol filters as hazardous waste in need of monitoring; hazardous waste incineration plant;
9. Collection and disposal of the water from the wet scrubbers as hazardous waste in need of monitoring; chemical-physical treatment using ……; hazardous waste incineration;
10. Waste discharge after sedimentation of varnish waste sludge (by ....) in local sewage treatment plant

Gloves: The specification of the glove type in the generic exposure scenarios for varnish applications is not useful as the glove type strongly depends on a company's work flow. However, the appropriate glove material can be named for the particular solvent.

Exposure Scenarios *Application of Varnishes in Aircraft Construction (Airbus Deutschland GmbH)*

Application Process	Activity	Employee Scenario			Environmental Scenario[1]	
		Duration/frequency of exposure	Technical measures	Personal protection	Duration/frequency of emission	Technical measures
PREPARATORY WORK						
Mixing of varnishes	manual	regularly up to 8h/d	mechanical ventilation	2c	temporarily	ventilation to the outside
Filling of spray gun	automated	none	closed installation	4		
	manual	regularly < 30 min	mechanical ventilation	2c		
VARNISHING						
Spraying machine	automated	none	closed installation	4	temporarily	wet scrubber or Filter ventilation to the outside[6]
Spraying in booth	manual	regularly up to 8h/d	mechanical ventilation	1		
Outside varnishing	manual	regularly up to 8h/d	mechanical ventilation	1		
Spraying unit	manual	regularly up to 8h/d	mechanical ventilation	1/2a[3]		
Coating, conservation of residual parts	manual	regularly up to 8h/d	local, mobile extraction hangar ventilation [2]	2c/3a[4]		ventilation to the outside
SUBSEQUENT WORK						
PURIFYING						
Purifying of spray guns	automated	none	closed installation	4	temporarily	wet scrubber or filter ventilation to the outside[6]
	manual	regularly < 30 min/d	mechanical ventilation	cf. varnishing[5]		
Purifying of units/installations	manual	occasionally up to 8h/d	mechanical ventilation	2b		
Removal of varnish from gratings	external company					thermal
DISPOSAL						
Varnish waste sludges	external company					hazardous waste, hazardous waste incineration
Filter	external company					hazardous waste, hazardous waste incineration
Waste water	external company					hazardous waste, CPP, hazardous waste incineration

Personal protective equipment	1. Full protection (protective clothing, separately ventilated respiratory mask, special gloves, foot guard) 2.a. Protective clothing (disposable clothing), special gloves, filter mask (SATA filter mask, against aerosols) 2.b. Protective clothing, special gloves, eye protection 2.c. Protective clothing, special gloves 3.a. Working clothes, gloves, filter mask 4. Working clothes, (gloves)

FOOTNOTES:

1 Organizational measures for environmental risk management

- limitation of overall load of solvents (according to regulation on emission control)
- compliance with immission limits (no effect level).

2 Coating of larger parts with local extraction, coating of small parts/single spots with hangar ventilation.

3 Different protective measures for spray units: full protection if chromate-containing varnishes are used.

4 Coating: 2c: coating of larger component parts with extraction?, 3a: Coating of smaller surface in a hangar?

5 Varnishers immediately purify spray pistols (subsequent use of two solvents).

6 A varnishing machine with regenerative afterburning of solvent vapors.