The first review (15th April 1972) covered abstracts Nos. 1-26. The first supplement (22nd May 1972) gave revised information about four abstracts (3-A, 12-A, 15-A and 23-A) and covered abstracts Nos. 27-49.

This second supplement again gives revised information (as further thought) about 18 earlier abstracts (indicated by the suffix "A") and covers abstracts Nos. 50-70. It will also be made available to delegates attending the CVMA Colloquium in York (September 25th to 30th) and an Appendix has therefore been included in which the abstracts are indexed according to the Appendix to Dr. Brill's plea (Abstract No. 3) at Versailles in September 1971.

In the first supplement I was able to announce that the Pilgrim Trust had made a substantial grant to enable experimental work to be carried out; the Department of Trade and Industry has now made an additional grant.

1-A. BIMSON and WERNER (1964)

These authors demonstrated clearly that 17th century hollow glass articles can be damaged by only moderate heating (90°C) reached over a period of 8 hours) but there is increasing evidence that thin medieval stained glass may not necessarily be damaged by heating in this way. For example, Dr. Frenzel has told me that many pieces of medieval stained glass have been heated to 500° to 600°C during the "superfusion process" but they did not crack; nevertheless he would be reluctant to heat any glass which shows "microcracks". Thus it seems to me that this question should be re-opened and it will be useful if delegates to the CVMA Colloquium could bring quantitative data with them for discussion. For example, x pieces of medieval stained glass have been heated to y°C and z of them were damaged.

2-A. BRILL, R. H. (1970)

In the original abstract I commented that glasses with poor durability should have recognisable compositions, but my experience over the past four months has shown that I had over-simplified the question. For example, I have now seen a potash-containing glass which can be attacked by acid (see item 33-A below) and it seems that phosphate-containing glasses also may have low durability. Moreover, even though a statistical analysis of data from Dr. Brill has clearly demonstrated compositional differences between English and Continental glasses it has so far failed to relate the observed durability to the compositions of the glasses. Professor Douglas and I will be attempting to rationalise the present rather confused situation and I hope that there will soon be something positive to report.

4-A. BRILL and MOLL (1961)

It should be noted that there is another paper with exactly the same title ("The electron-beam probe microanalysis of ancient glass") which was published two years later, as pages 293-302 of "Advances in Glass Technology, Part 2" Plenum Press, New York 1963. The two papers are similar in content but the 1961 paper is longer and has more illustrations.

6-A. CVMA (1970)

In Section 1 of the original abstract it is implied that exterior glazing protects ancient windows against sonic bangs; the discussion at Durham on 15th April 1972 suggested that overflights by the Concorde do not damage ancient stained glass windows.

8-A. DOMASLOWSKI et al (1962)

At the end of this abstract (p.3 col.1 of the first bibliography) it was stated that comments would be sought from polymer technologists about the installation of polymethylmethacrylate, and one has now been received, as follows:-

"I have now had an opportunity to read around the question of the use of polymethylmethacrylate in the restoration of medieval stained glass. I make my comments with two reservations:

(1) While most literature references concern the behaviour of pure polymethylmethacrylate, in practice most polymers contain additives which may substantially alter their behaviour.

(2) No literature references or our present experience can guarantee the behaviour of polymer systems many years ahead, since environmental factors at present unknown may subsequently influence stability, eg, page 3 col. 1, para. 4, of your own bibliography.

Polymer degradations are basically of two types - chain scission (depolymerisation) or chain combination (cross-linking). I can find no mention of the natural cross-linking of polymethylmethacrylate; the essential breakdown mechanism in this case is depolymerisation. Therefore, I feel that you should not be too concerned with the possible difficulties of removing cross-linked polymethylmethacrylate.

If a polymer has become cross-linked it will be difficult to remove, and I am sceptical about the "chemical reforming" as described by Jones in your bibliography.

You will find a fairly detailed discussion of polymer breakdown in Polymer Processes, Vol. 10, ed. Schildknecht, Chapter 13, pages 525-550. Interscience Publishers, New York 1956. The degradation of polymethylmethacrylate by chain depolymerisation is reviewed in F. W. Billmeyer's Textbook of Polymer Chemistry, pages 272-278, Interscience Publishers, New York, 1957. F. R. HILLS".

9-A. FRENZEL (1970, a)

I can make some new comments on two of the items referred to in the original abstract, (a) that

the form for attack leading to the development of pits and craters may be random or may be concentrated along scratches or painted lines; (b) that "air pollution" causes the formation of sulphates in the weathering crust.

In connection with (a), Mr. Dennis King has sent me some samples which had been re-surfaced by grinding and polishing 20 years ago. They had been kept in a workshop atmosphere and now show one or two minute indications of attack which do not seem to be associated with any inclusions or impurities (photographs will be displayed at the York Colloquium). Nevertheless, there is ample evidence (see Ref. No. 32 below) that lines of pits can follow painted lines and there is also the very puzzling phenomenon where corrosion patterns on the back (outside) of the glass follow painted lines on the front. Is there any evidence that back-painting had been present in these cases? This would probably be difficult to establish because such painting would have been eroded away by the corrosion.

In connection with (b), Mr. Dennis King has sent me some glass from Ely Cathedral which has a heavy loose white crust on it. This crust was examined by X-ray diffraction and found to consist only of gypsum and syngenite as described by Geilmann as mentioned by Korn (Ref. No. 17) for air-polluted environments; however Ely Cathedral is situated in agricultural Cambridgeshire many miles from heavy industry (but Korn suggests that local concentrations of sulphur gases may be derived in agricultural areas from the sulphuration of hops).

10-A. FRENZEL (1970,b)

The title of this paper should have been:- "La conservation des vitraux anciens. II La nettoyage".

11-A. FRENZEL (1971)

The volume number quoted for Kirche u. Kunst, should have been 49. (Note by RGN - I have now had an opportunity of seeing some of these windows where the stained glass has been mounted separately, to the inside of the church compared with its original position. The gap could be not-loed (because light shone through the edges by the mullions) when it was as wide as 5 cm but I did not notice any unusual effect when the gap was only 2 cm. The outsides of these windows, of course, look somewhat flat and reflective compared with unaltered windows. Dr. Frenzel tells me that the total cost of making the change is about 60 DM per sq. m.).

12-A. HEDVALL et al (1951)

This paper was also published in Zeit- f. Phys. Chemie., 1950, 23-34.

14-A. JACOBI (1971)

(Note by RGN - I have been told that Jacobi's process is very expensive, being about 10 000 DM per sq. m. but I have not been able to confirm this: does anyone have any precise information?)

17-A. KORN (1971)

Case No. 1. The Schlüsselfelder window of the LorenzKirche in Nürnberg. The abstract is misleading in stating that the appearance in 1943 was better than in 1900! Fig. 20 (1943) looks better than Fig. 19 (1900) because the left eye and brow had been drawn in during the restoration work in 1900. The badly weathered state in 1969 is attributed to the continuous effects of condensation and (presumably) not to air pollution.

22-A. NEWTON (1972)

This article has now been published in "Glass Technology" 1972 13 (2) 54-56.

32-A. FRENZEL (1971)

Note by RGN - My remarks under item 32 "the old glass is then fixed to the inside of the new window are ambiguous. It is not attached to the new window but is supported on separate saddle-bars etc fixed in front of the grooves in the mullions where it used to be, is further inside the church. A useful space between the old and new windows is 2 cm (see 11-A above).

33-A. FRODL-KRAFT, Eva (1963)

With reference to her item (a) I asked her for a sample of the high-potash medieval window glass which can be attacked by acids and she kindly sent me a piece. I confirm that it can be attacked by acids and that it is also a high-potash glass which (had it been a soda glass) would have been expected to be acid-resistant. Further studies are to be carried out which will be reported later.

In her item (c) she refers to the treatment of a Roman glass jug with a mixture of SiO_2 and TiO_2. This jug is in the museum at Mainz and (through the courtesy of Dr. Decker) I had the opportunity of examining and photographing it. (Photographs will be displayed at the York Colloquium.) The surface is still in excellent condition (see item No. 68).

35-A. FRODL-KRAFT, Eva (1971)

In the original abstract it is stated that, when cleaning crusted glass, some of the crust should be left on the glass as a "protective coating" ("die Glasoberfläche selbst aber nicht anzutasten, sondern ihr eine gewisse Schutzschicht zu belassen."). There are now some doubts as to whether the remaining crust may actually accelerate corrosion, by harbouring alkali, rather than protecting the surface.

40-A. GEILMANN et al (1960)

The original abstract gave the authors' names incorrectly: they should have been:- GEILMANN, W., BERTHOLD, H. T., and TÖNS, G.

On p. 215 they comment that all the eleven glasses examined are high potash (18.20% to 24.80%), low soda (0.23 to 1.35%) glasses except for two unusual

glasses (Nos. 9 and 10 from Cologne Cathedral which seem to contain only 11.91% and 10.12% total alkali) and that the chemical compositions of the weathering products produced in widely spaced and climatically different areas show a high degree of similarity [exept eine grosse Ähnlichkeit], there being 17% to 28% of SO_3. (Note by RGN - does this argue against the case for damage by air pollution?) On p. 216 they comment that the trace amounts of lead and tin (0.1% to 0.01%) found in the weathering crust may have come from the lead and solder bars holding the glass. The nitrogenous products present are attributed to bacteria, algae or lichens.

They find that 45% of a typical weathering crust is soluble in water and most of the remainder dissolves in hydrochloric acid; any residue is then soluble in hydrofluoric acid. On page 217 they conclude that the sulphates in the crust do not necessarily indicate the presence of sulphuric acid in the air but such ores probably come from sulphur dioxide and hydrogen sulphide (sondern viel wahrscheinlicher als SO_2 oder H_2S, die von der nahen und zeitweise feuchten Oberfläche der Verwitterungsschicht absorbiert und dort zu H_2SO_4 oxydiert wurden). There is then a discussion of the probable conditions under which the soluble sulphates form in the crust and the suggestion that less readily soluble double salts are formed first (p. 217, col 2). On p. 219 they suggest that, if much water is present, the syngenite is converted to gypsum.

42-A. GELLMANN (1962)

The reference (Glastech. Ber. 35 186-192) was omitted.

43-A. HUSSONG and WIHR (1954)

The German materials which they recommend are said to be expensive. Cheaper equivalent materials made in Britain are SIMPLEX and STELLON RAPID; these are cold-cure acrylics usually supplied in a clear or pink colour for dental prosthetics but they can be coloured any shade or tone using metallic oxides. All of these self-curing resins tend to be slightly porous but if they are cured in a "hydroflask" (where they are heated under pressure) the porosity disappears. A new material, developed by Johnson & Johnson, called ADAPTIC has given good results for the repair of glass and ivory.

50. BACHER, E (1967) "Die Ornamentscheiben aus Spitz" [The ornamental panels at Spitz] "Österreichische Zeitschrift für Kunst und Denkmalpflege (ÖZKD) 21 (3/4) 191-2.

A walled-up early 16th century window was recently discovered in the parish church of Spitz on the Danube. The outside had been covered with mortar and the inside with a thick adherent layer of lime wash. Cleaning was carried out by soaking for four days in a bath of warm Calgon solution which was renewed several times. The cleaned glass was said to be completely smooth (völlig glatten).

51. BAUER, W. P. (1967 a) "Untersuchung Nr I. Analysen der Malfarben auf Glasproben des Chorfensters Nord II der Stiftskirche in Heiligenkreuz" ÖZKD 21, 201-202.

The paints on the windows were analysed for purely practical considerations concerning difficulties in selecting the method to be adopted for the restoration. It was found that in some cases the original line work had been overpainted with material containing an organic binder. The black enamel contained the usual iron and copper as well as significant amounts of lead but it was unusual in containing cobalt.

52. BAUER, W. P. (1967 b) "Untersuchung Nr 2 Analysen von acht Glasproben des Chorfensters Nord II der Stiftskirche in Heiligenkreuz" [Analysis of eight pieces of glass from the chancel window N. II at Heiligenkreuz]. ÖZKD 21, 203-206.

It was noticed that the 13th and 14th century bluish-green glass had hardly weathered at all whereas other equally old coloured glass had weathered badly and the colourless glass had deteriorated in markedly different ways; in order to examine these differences the glasses were analysed by emission spectroscopy. (Note by RGN- Unfortunately the analyses are qualitative ones and it is not possible to draw useful conclusions except that the glasses are basically silica-potash-lime ones and that certain elements are not present, eg, the ruby flashing does not contain gold.)

53. CVMA (1963) A paper read to the Erfurt meeting in 1962 written by Eva Frodl-Kraft and G. Frenzel, ÖZKD, 17, 93-114.

(a) The technique of medieval glass painting, G. Frenzel (pages 93-96) comments on the differences between glasses produced in different eras, especially in the layering of the coloured glasses. 13th century glass is of good quality but it is worse in the second half of the 14th century where the durability of the glass was low and extensive renovations and renewals were required in the 15th and 16th centuries. E. Frodl-Kraft gives a discussion (pages 96-98) of the way the paintings were built up and Frenzel then discusses the firing of the glass.

(b) Subsequent alterations to the original appearance. Frenzel discusses the weathering (pages 100-102) and Frodl-Kraft the relationship between weathering and painting (pages 102-108), particularly as between painting on the inside and on the outside of the glass, the latter often now being difficult to detect especially if the painted lines are less durable than the glass. (Note by RGN - The mysterious "back-matching contour" sometimes encountered on early glass (see her Fig. No. 121) may be the result of nothing more than painting on the back of the glass which matched the design on the front. If the painting on the outside was of the kind which causes enhanced weathering of the glass beneath it, then a line of corrosion would occur which matched the design on the front and, incidentally, removes the causal agent. This theory is being tested and the results will be reported at the York Colloquium. There is

a full discussion of the variations which are possible, some leading to the development of "negative images". The weathering of the inner face of the glass is also discussed (p. 103, col 2). (Note by RGN - There is an implication that modern heating and ventilation systems may have led to increased weathering on the inside, compared with earlier periods in the history of the glass - end of note by RGN.) On page 105, col.2 she asks whether there is any stained glass where the present appearance corresponds to the original, even if it had not been touched by restorers! (Es gibt wohl kaum ein Glasgemälde, vor dem wir uns, selbst wenn es von Restaurierungen unberührt geblieben ist, nicht die Frage vorlegen müssten, inwieweit seine heutige Erscheinung der ursprünglichen entspricht.) Regarding the grinding away of the external face of the weathered glass, she objects that this removes any external shadowing or stickwork which often occurred on early glass and makes it not only more difficult to date but also impossible to reconstruct the original appearance. (This may have gone anyway - RGN)

Frenzel then discusses (pages 108-112) the techniques of "overglazing" and remarks that some of the variants are of too recent use to enable an assessment to be made of their effectiveness. The three variants are (i) fusing on a new skin of low-melting glass powder solely for preserving black enamel which is at risk; (ii) doubling with cover glasses, any broken pieces being joined edge to edge with a soluble adhesive resin; and (iii) moving the stained glass into the church and fixing new glass in the mullions (see item 11-A above).

Finally the Editor of ÖZKD adds a note (pages 113-114) against using untried materials and describes an example of a window (Fig. 138, St. Florian's Foundation) restored in 1952 where part of the painting was removed when the applied organic layer separated from the glass.

54. CVMA (1969) A report on the 6th Colloquium of the CVMA, held in Ulm in October 1968, written by Eva Frodl-Kraft. ÖZKD, 1969 23 86-89.

She comments that for the first time restorers other than Dr. Frenzel took part in the proceedings (Miss Paloma de Hita, Spain and Mr. Dennis King, England) and it was agreed that the essential aim is to minimise any risk to the work of art; nevertheless, the views of the three restorers as to what constitutes the "least risk" were so widely divergent as to be almost opposed, especially on the question of whether industrial waste gases are harmful to ancient stained glass. It was agreed to circulate a list of precise questions about glass restoration to the experts in the various countries.

55. DUNCAN, G. S. (1960) "Bibliography of Glass (From the earliest records to 1940)" Dawsons of Pall Mall, London. £15.

This book provides a record of books, manuscripts and articles about glass in periodicals up to 1940, with some later papers also. There are 15,752 numbered items and about 20,000 entries in all. There are many references to stained glass which occupy two columns of the subject index.

56. FRENZEL, Gottfried (1969) "Die Instandsetzung des Kaiserfensters und des Kaiserfensters aus der St. Lorenzkirche zu Nürnberg". ÖZKD 23 75-85.

The title of this paper is exactly the same as in No. 51, and so are the first thousand words or so, but there are many subsequent differences between the two papers, especially in the illustrations; nine of the illustrations in No. 51 are absent from this paper which, however, has eleven other illustrations.

The new text (p. 76, col 2) draws attention to cases where medieval glass weathers by forming a very hard shiny and "apparently intact" surface (on both the inside and the outside) which is nevertheless quite opaque due to a layered structure. (Note by RGN - Frenzel concludes that "restoration came too late" but it seems that there are techniques, such as microsandblasting where these hard crusts can be removed without damaging the painting.)

On p. 82 he refers to the use in 1952 of the Jacobi laminating process (see Nos. 14, 14-A and 44) in the Kaiser window at Nuremberg and states that sunlight has caused these pieces to turn brown; this yellowing is however not due to the laminating material itself but to the intermediate material ["Tesa film"] which had been used temporarily to hold the splinters together. It had not been removed when the lamination was heated in the vacuum oven. When this window was restored the yellowing produced by the Tesa film presented a special problem because the yellow layer had eaten deep into the original glass (weil sich die Vergilbungsschicht in das Originalglas tief hineingefressen hatte).

Regarding the fixing of the loosened black paint of the Konhof and Rieter windows (using Schmitz's process, see last paragraph of No. 31) he now states that the principal risks are that if the fusion temperature is too high (above 600°C) a greyish green discolouration occurs, especially in the half-tone coatings; a faulty application of the flux could swell up or produce a "wet-look" (see Fig. 112); inadequate preparatory cleaning could cause lack of adhesion.

At the end he again emphasises his belief that the simplest procedure is to move the windows about 5 cm further into the church and place new glass in the mullions of the windows.

57. FRODL-KRAFT, Eva (1967,a) "Restaurierung und Erforschung, 1. Die Rösinse von Maria Strassengel" (Restoration and Research, 1. The southern rose window of Maria Strassengel), ÖZKD 21 192-197.

She points out that it is the policy of the Austrian Ministry of Ancient Monuments not to remove natural weathering crusts ("patina"), partly to

retain the ancient appearance of the work, partly because existing methods of removal can damage the painting, and because the patina can form a protective film on the glass. They have so far been lucky enough not to have to deal with a window which has been completely obscured but the present window is in such a condition, especially where parts (Fig. 228) have had the inner face placed outwards for a long time. The Calgon bath method was suitable for removing outside crusts provided the solution process was halted before the actual surface of the glass was reached and provided it was not allowed to touch the painting (because the liquid could creep under the paint and detach it).

The whole inner face of the glass was covered with a protective film (Acrylsol) which could easily be removed with toluene. The luminosity of the window now approaches that of the original.

58. FRODL-KRAFT, Eva (1967, b) "2 Heiligenkreuz, Chorfenster der Stiftskirche" (Heiligenkreuz, chancel window of the Collegiate Church) ÖZKD, 21 197-200.

She gives a detailed description of the techniques used (eg, a fluorescent lamp where there had been two lots of overpainting on the window).

59. FRODL-KRAFT, Eva (1969) "Die Prophetenscheiben von Lorch" (The prophet panels in Lorch), ÖZKD, 23 68-74.

This paper is concerned mainly with the correct reassembly and dating of the windowsé depicting the prophet heads but pages 73-74 discuss the problem of restoring two of the pieces of glass which had been set with the inside turned outwards and had weathered badly. It was decided that the panes could no longer be exposed to the weather and they were moved to a new position in the church where outside glazing could be used. The compromise was a preservation-orientated one and she discusses the way that the original conception had been changed by the different resistances to weathering of the painted and unpainted parts and the distortion of the highlights.

60. FRODL-KRAFT, Eva, (1970, b) "Konservierungsprobleme Mittelalterlicher Glasmalereien" (The problems of conserving medieval stained glass), 15 pages of typewritten text, presented to the Conference at Prague and due to be published in the Annals of the 5th Congress du Verre.

This is a general paper which starts by discussing the complex nature of the weathering of glass (Note by RGN - A statement is made that glass can crystallise, but see item 231 and goes on to outline the dilemma of the conservator to stop decay or to restore the original condition; opinions vary, despite the "Charter of Venice" which came down in favour of pure conservation).

Reference is made to the 13th century glass from St. Walpurgis in Steiermark from which five panels were removed in 1939 and are now in the Nuremberg museum. Those which remain in the church are more severely corroded on the outside and this is attributed to the steam engines used (until recently) to pull the trains which pass close to the church. The glass was taken out during the war and comparison of photographs taken in 1951 and 1970 shows a horrifying acceleration of corrosion in the last 20 years. (Note by RGN - How were the windows stored during the War?)

She discusses (i) the use of external protective glazing (and considers that it spoils the external appearance)and(ii) the protection of each individual pane of glass (and remarks that the window must be taken to pieces, the weight is doubled or trebled, and the future behaviour of the laminate is unpredictable); she concludes that it may be justified if the glass has been much splintered.

She comments that there would be much advantage in developing a protective film which was really adherent, water-resistant, and unaltered by ageing. Even if it could be achieved, care would be needed in applying it and acids in the pits would have to be neutralised.

English restorers have developed techniques for grinding away the weathering crust, and drilling out the craters, until sound glass is reached. The holes are then filled and the surface covered with a suitable resin. (Note by RGN - This is claimed to weaken the glass but, presumably, a strong and adherent resin would build up the thickness and, to a large extent, the strength also - end of note by RGN.) Attention is drawn to external weathering following the internal pattern (see 31(b) above) and the loss of this when the exterior is ground away. (Note by RGN - In cases where back-matching corrosion has occurred, the missing external painting could presumably be reintroduced, with photographs of the weathering pattern to guide the restorer.)

Grinding of the surface is therefore rejected, except when there is no other way of restoring the transparency, but it is regarded as less objectionable than the acid treatment used in the 19th century apparently because the rate of attack is claimed to be irregular and further corrosion is accelerated. The worst cases should be taken down and removed to a museum (although even here the change of climate may be dangerous). In less critical cases a scientific examination of the present condition must be undertaken (eg, at Heiligenkreuz the peeling of the painting was found to be solely that of the overpainting). Scientific work should, however, be not only investigational but also used to develop successful and above all harmless methods of conservation. (Es ist im Gegensatz mehr als dringlich, dass die Naturwissenschaften zur Entwicklung von erfolgreichen und vor allem ungefährlichen Konservierungsmethoden eingeschaltet werden.) Six scientific aims are set out:-

(i) When is a patina protective and when does it promote further weathering?

(ii) Can a process be developed to remove harmful materials from the interior without removing the surface?

(iii) Can a durable permanent adherent coating be developed?

(iv). Can a technique be developed for restoring lost transparency (without removing the crust)?

(v) Can a method be developed for cleaning very dirty internal faces without detaching loose black enamel?

(vi) Can a method be developed for fixing loose black enamel?

61. GRODECKI, L. (1954) "La restauration des vitraux du XII^e siècle provenant de la Cathédrale de Chalons-sur-Marne" (Restoration of 12th century windows in the Cathedral of Chalons-sur-Marne" Mem. Soc. Ag. Comm. Sci., Arts de la Marne, 2nd series XXVIII 323-352.

This is a fascinating history of the 12th century windows with an account of their confused state in 1951 (pages 323-327). The next 20 pages (with 94 extensive footnotes) give details of the steps taken to reconstitute the windows. The final difficulty lay in the fact that the present church no longer possessed an aperture capable of receiving the reconstructed window, all having disappeared in the 13th century. Eventually it was found possible to install it in the tower flanking the north transept, using artificial illumination.

62. HEDVALL, J. A. and JAGITSCH, R. K. J. (1944) "Förfaringssätt för behandling av föremål av glas eller föremål med glasemi yta till förhindrande av dess förstörelse jämte enligt förfaringssättet behandlat föremål" (Method of treating a glass object, or an object with a glass surface, to prevent its decay: and objects treated by this method.)

Swedish Patent No. 113009, applied for 20th April 1943 and published 23rd January 1945. This is a short patent, of slightly more than one page, giving details of their earliest process. No mention is made of any particular "resin" (contrast item 12) and the emphases in the claims are (1) vacuum impregnation after cleaning with acid; (2) the use of nitric acid for cleaning; (3) heating the cleaned glass before the vacuum treatment and (4) applying an unspecified liquid lacquer. (Note by RGN - I have been told that an article treated by "a Hedvall process" in a Swedish museum has deteriorated in some way, allegedly as a result of the treatment. And I am trying to establish the details.)

63. HELBIG, J. (1970) "Problems principaux concernant la conservation et la restauration des vitraux. Reponses fournies par les experts CALDERS EN ZOON, Glasschilderig, Restaurateurs, Drabstraat 9, Mortsel (Antwerpen)" (Principal problems in the conservation and restoration of windows as seen by the Belgian experts, Calders and Son.) Two pages of typescript.

These are the Belgian replies to the eleven questions discussed in item 8 (of the first bibliography) in general they conform to the conclusions already summarised, the following being stressed. They recommend plating (Q.3) only when the new glass carries a re-paint and the two glasses should be leaded together and not stuck. As regards cleaning (Q.4) they object to the removal of any patina: only the outside should be cleaned, and then only to remove bird droppings, soot and grime, etc. They are prepared to re-fire loose black paint (Q.5) if the crust is not too opaque and the paint is not too rich in metallic oxides. Restorations (Q.6) can be carried out with "Chutes de Versailles", available in six hues from Saint-Just-sur-Loire (France). (Q.9) - they prefer lavseed oil medium. Regarding reinforcements and supplementary stabilisation they have extensive views which should be consulted in the actual document.

64. INTERNATIONAL COMMISSION ON GLASS (1972) "The chemical durability of glass. A bibliographic review of the literature" Obtainable from M. Gilard c/o Institut National du Verre, Boulevard Defontaine 10, B-6000, Charleroi, Belgium, at a cost of 500 Belgian Francs.

This book of 211 pages provides a comprehensive list of references (about 900 in all) to the durability of glass. There are four sections, first a general introduction in English written by W. W. Fletcher (pages 29-50) and then a list of the papers arranged according to content (and then date of publication) in five groups:- general chemical durability, water attack, alkali attack, acid attack, and weathering (pages 53-98). The third section (numbered II) uses the system known as KWOC (Key Words out of Contextlie sims in English and it enables a rapid search to be made for particular aspects (pages 102-200); the fourth section (numbered III) is an author index (pages 203 to 211).

There are 34 references to weathering of glass and this moderately-priced book should be in the hands of everyone who is concerned with the behaviour of glass in the presence of agents which cause deterioration, especially as the list of papers is believed to be complete up to 1971.

65. LEWIS, Mostyn (1970) "Stained Glass in North Wales up to 1850", Sherratt.

This book, priced at £7.50 gives a detailed account of all the ancient glass in N. Wales and makes brief references (on pages 5, 7, 36, 38 and 42) to the fact that some of the Gresford glass was spoiled by overcleaning. (Note by RGN - It seems that a too-strong solution of "Flash" was used and much of the inside painting was destroyed. A discussion of the ways in which the design was revealed will take place at the York Colloquium.)

66. SCHRÖDER, H. and KAUFMANN, R. (1959) "Schutzschichten für alte Gläser" (Protective coatings for old glasses). This article forms pages 355-361 of Beiträge zur Angewanten Glasforschung, Ed. E. Schott, Stuttgart, 1959.

These authors pointed out that the protective coatings used for optical lenses might be useful for protecting museum objects also. The coatings

consisting of mixtures of SiO_2 and TiO_2, are completely invisible (because the proportions of SiO_2 and TiO_2 can be chosen to match the refractive index of the glass), uniform, adherent, and hard enough to resist reasonable abrasion.

The glass articles are immersed in a solution of $SiCl_4$ and $TiCl_4$ and slowly withdrawn to leave a film which is converted by hydrolysis and subsequent heating to 250°C to form a clear protective layer. Four hollow glass articles were treated (three Roman and one medieval) for the Museum of Antiquities in Mainz. (Note by RGN - All were reasonably high-silica glasses (67.6 to 70.9% SiO_2) with practically no potash; the soda contents were moderately high (16.9% to 21.5% Na_2O) and the CaO ranged between 3.3 and 8.3%; hence they would be expected to have reasonable durability). The articles were first freed from weathering products and dirt in a solution of 20% nitric acid and 2% hydrofluoric acid and dried at 250°C. The durability of the samples, both before and after treatment, was tested in three solutions:- hydrochloric acid (pH 2.5), sodium hydroxide (pH 12) and neutral sodium arsenate. Details of these test results are given and they conclude that the protective coating does not merely have an inhibiting effect for example by delaying diffusion but also (especially in the case of the medieval glass, which is particularly susceptible to attack by acids) brings the attack to a complete stop, perhaps by blocking any pores in the protective layer by reaction products. (Der Schutzmantel bleibt sogar schon nach ganz geringer Abtragung der Glassubstanz völlig stehen, was als Zeichen einer Verstopfung der Poren in der Schutzschicht durch die Reaktionsprodukte gedeutet werden kann.) Similarly good results were obtained with the neutral solution.

The authors admit that these tests do not predict what will happen to articles in the atmosphere (Note by RGN - even less to windows in churches, which they do not consider at all) but they point out that their commercial glasses do not undergo weathering. (Note by RGN - I took the opportunity of visiting Mainz in July 1972 and saw the Roman jug illustrated in Fig. 3b. This is still in excellent condition, after about 20 years in the museum case and photographs will be displayed at the York Colloquium. One disadvantage of the process is the need to heat the glass to 250°C and another possible disadvantage is the chain - which I shall try to follow up - that the chloride in the original solution can combine with alkali on the glass surface and form crystals of NaCl or KCl which might produce defects in the surface coating - end of note by RGN.)

67. SNEYERS, René (1970). An interesting letter dated 13th August 1970 from M. Sneyers, of the Institut Royal du Patrimoine Artistique, in Brussels, to Professor Hahnloser contains the following pertinent remarks. He suggests that it would be valuable to analyse several fragments of the same coloured glass from one window, and also for different colours of glass. The fatty of well-attested fragments would pose a problem but it would be important to have parallel analyses carried out at two or three experienced laboratories.

At present the IRPA are comparing various Venetian glasses using neutron activation analysis.

He also suggests that special attention should be given to treatments which are known to have been successful and also treatments which are known to have had disadvantageous effects. The IRPA are using ultrasonic equipment for cleaning metals and propose (1970) to extend it to treating ancient glasses.

68. TARALON, Jean (undated). "Programme de recherches sur la composition des vitraux et les maladies des verres. Etabli par la Cellule Scientifique de Recherches des Monuments historiques"

This is a typescript document of three pages in which it is proposed that the researches should be carried out using subdivided samples taken from different countries, the French ones coming from the collection of works of art at Chantes.

The proposals for scientific and archaeological studies would involve a full description of all the physical properties of the glass and of the weathering products, and full chemical analyses in a number of different laboratories. It is also suggested that attempts be made to use scientific methods of dating. (Note by RGN - but this would seem to be a hazardous approach compared with the literary and stylistic approaches.)

The conservation studies would include procedures for cleaning and experiments on protective materials.

69. WIHR, R. (1957). "Ergänzungen und Abgüsse Antiker Hohlgläser" (Restoration and reproduction of antique hollow glass) Deutsche Kunst U. Denkmalpflege 2 137-145.

This paper is a sequel to Hussong and Wihr, (item No. 43) and describes a new material. The earlier papers described Palavit "3000" but it develops so much heat of polymerisation that there is a risk of small bubbles developing. Type "3001" was then developed but distortion or poor hardening could occur. A new catalyst system was then developed (Types 4001a to 4003a) in which polymerisation can take up to 32 minutes but clearer and thicker-walled castings (up to 7.5 mm) can be obtained. (There is a graph of hardening times.)

The paper is concerned with restoring hollow glasses but an example is given where the restoration of a bowl required 72 working hours and 15 DM of materials, compared with 300 working hours and 2 DM for materials if "Perspex" had been used.

70. WINTER, A. (1965). "Alteration des surfaces des verres anciens" (Changes in the surfaces of ancient glasses) VIIth International Congress on Glass, Brussels. Paper No. 329 (12 pages).

Attempts were made in the laboratory to reproduce the changes in the surface of glass caused by different kinds of attack and it is remarked that any experimenter's efforts may extend for perhaps

20 years but not for centuries! Nevertheless some valid acceleration is possible both by raising the temperature and by studying the surface more minutely, but then the behaviour of any surface crust also comes into the picture.

The report is divided into seven sections, each of which contains both a theoretical discussion and some experimental work:- I, attack by water (but a resistant borosilicate glass was employed); II, attack by acid; little effect was found or predicted, unless glasses with high lead contents were used (but potash-containing glasses were not considered); III, attack by alkali was clearly severe. IV, attack by micro-organisms (pages 5-6); they generally do not attack clean glass directly but lodge on dirty surfaces and can then encourage attack by water and CO_2, but some bacteria will attack silica. The problem is more important in tropical climates but most ancient glasses bear traces of such attack. V, atmospheric attack (pages 6-8): he points out that the condensation of moisture is an essential preliminary and that removal of the condensate by washing (or even by rain) would greatly diminish further attack. He defines the "pierre du temps" as consisting of hydrated double carbonates of sodium and calcium (rather than as sulphates, but he does not give any evidence) and he ends by claiming that glasses exposed for many centuries are attacked both chemically (from dew and rain) but are also abraded by sand, dust and stones blown by the wind, and that the thick deposits on the exterior are formed of an agglomeration of particles held in place by the action of electrostatic charges created by the friction of dusty air on the glass! VI, decomposition in soil (pages 8-9) does not concern us here, and the seventh section (pages 9-12), which deals with the comparisons between the results of laboratory degradation, is highly speculative. For example, he states that the oldest part of the weathering crust is on the inside ("La couche la plus ancienne, celle en contact avec le verre, est plus claire que le reste du dépôt"), whereas I am sure that the oldest part is on the outside. He now admits that, in one case, sulphates are present in the crust but he suggests that the stonework of the stone walls of the building may contribute to the composition of the crust, and that the pock-marking of the surface may have an organic origin.

Some preliminary experiments were carried out using protective coatings of alumina, silicon monoxide and titanium dioxide, the latter being less resistant than the two former, both to a humid atmosphere and to sulphuric acid, but soda attacked all three coatings. An American patent (No. 1 343 914) is claimed to protect the surface with an ammoniacal complex of a metal such as Zn, Cu, Cr, Pb, Al or Be. Frequent washing with acidified water is recommended for keeping windows clean.

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APPENDIX - INDEX OF THE ABSTRACTS BASED ON DR. BRILL'S PAPER [Item Nos. 3 and 3-A]

The abstracts will be found in the following documents:-

Nos. 1 to 26 in the Review of Literature dated 13/19 April 1972.

Nos. 3-A, 12-A, 16-A, 23-A, and 27 to 49 in the First Supplement, dated 23.5.72.

Nos. 1-A, 2-A, 4-A, 6-A, 8-A, 9-A, 10-A, 11-A, 12-A, 14-A, 17-A, 22-A, 32-A, 33-A, 35-A, 40-A, 42-A, 43-A, and 50 to 70 are in this Second Supplement.

The appendix to Dr. Brill's paper (3-A) contains the following headings and the relevant abstract numbers are given in brackets.

1. CLEANING
The whole problem of cleaning is coupled with one of aesthetics (18) and with the "Charter of Venice" (62, 2nd para); various methods have been used:-
(a) water: 7, 10, 17, 35, 40-A, 63
(b) ammonia: 18
(c) detergents: 6.4, 10.1, 35, 50, 57, 65
(d) mineral acids: 6.4, 8, 12, 14, 16, 33(a), 40-A, 48, 65, 66, 67, 68
(e) hydrofluoric acid: 8.4, 7, 19, 40-A, 66
(f) dental tools: 18, 33(g)
(g) ultrasonic baths: 5, 67
(h) micro-sandblasting: 56
(j) grinding and polishing: 7, 8, 53(b), 60
(k) unsatisfactory methods: 17, 18, 65, 67
(l) an associated problem which has caused much controversy is whether or not the patina (or the crust) retards or accelerates weathering: 35, 35-A, 45, 57, 60(b), 70

2. RESTORATION OF THE PAINTING
(a) re-attaching existing paint: 8, 31, 33, 51, 53(b)
(b) re-firing: 8.4, 33(a), 33(b)
(c) plating: 8.4
(d) lacquering: 57, 69(i)
(e) faulty procedures: 3, 33(b), 56

3. CONSOLIDATION
(a) cementing cracks or re-leading?: 6.2, 63
(b) use of organic resins: 8, 12, 12-A, 13, 15, 18, 26, 41, 69
(c) plating: 5, 5.2, 7, 8, 59
(d) faulty methods: 5, 33(g), 56

4. PRESERVATION
(a) use of organic coatings: 8, 8-A, 12, 12-A, 18, 26, 33(a-g)
(b) use of inorganic " 33(e), 66, 70
(c) lamination: 14, 33(d), 44, 66,
(d) remounting the window inside a church: 6.1, 11, 11-A, 32, 56.
(e) museum conditions: 24, 49

5. MISCELLANEOUS
(a) discussion of air pollution: 8-A(b), 11, 17, 29, 35, 45-A, 47, 54
(b) condensation on church windows: 6.3, 17, 17-A, 53(b), 60
(c) presence of back-painting: 5, 7, 10.2, 17, 35, 39(b)
(d) sonic bangs: 6.1, 6-A
(e) effect of micro-organisms: 36, 48, 70