



A.E.R.E. HARWELL

ACCIDENT

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PREVENTION

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### Use of Flammable Liquids and Gases in Glove Boxes

Several explosions in glove boxes have been reported, from various establishments in the Authority and elsewhere. At A.E.R.E., following one such incident, a working party was convened to examine the circumstances under which flammable liquids and gases could cause fires and explosions in glove boxes and other similar enclosures<sup>(1)</sup>. Approving the working party's report, the A.E.R.E. Safety Committee advised glove-box users that operations involving flammable liquids and gases should, as far as is practicable, be conducted within the framework of recommendations 1-5 below. Where, exceptionally, it is impracticable to comply with these, recommendation 6 applies.

1. IN AIR FILLED GLOVE BOXES THE ONLY COMPLETELY SAFE APPROACH IS TO PROHIBIT THE USE OF FLAMMABLE LIQUIDS AND GASES.
2. WHERE FLAMMABLE LIQUIDS MUST BE USED IN A GLOVE BOX IT IS STRONGLY RECOMMENDED THAT THE BOX ATMOSPHERE BE AN INERT GAS, SUCH AS ARGON, HELIUM, OR NITROGEN, OF SUFFICIENT PURITY TO ENSURE THAT COMBUSTION CANNOT TAKE PLACE.

This is supported by experimental evidence that any quantity of flammable liquid above 2 ml in a 15 cu. ft. box can explode dangerously. Although far from conclusive the evidence is that quantities below 2 ml are unlikely to ignite but if they do so the consequences are unlikely to be serious, provided that one glove at least is available as a relief volume.

3. IT IS ESSENTIAL THAT BOXES HAVING INERT ATMOSPHERES SHOULD BE PROVIDED WITH A MEANS OF ESTIMATING THE OXYGEN CONTENT OF THEIR ATMOSPHERES.

Before each occasion on which flammable gases or liquids are used in such boxes measurements must be made to show that the oxygen content is sufficiently low for combustion of the vapour to be impossible. Measurements must be repeated at suitable intervals throughout the working period.

4. IF RECOMMENDATION 2 IS NOT FOLLOWED AND FLAMMABLE LIQUIDS ARE USED IN AIR-FILLED BOXES ALL SOURCES OF IGNITION SHOULD BE PROHIBITED AND THE MAXIMUM PERMISSIBLE QUANTITY OF FLAMMABLE LIQUID WITHIN EACH BOX SHOULD BE STRICTLY RELATED TO THE AIR FLOW RATE. (See Appendix)

It is essential that an air flow meter should be fitted and that the box should carry a label indicating the maximum amount of flammable solvent to be allowed under specified air flow conditions.

Ignition as a result of a static discharge is still possible if local accumulations of flammable vapour occur.

5. IN CASES WHERE HYDROGEN OR SOME OTHER FLAMMABLE GAS MUST BE USED IN A GLOVE BOX IT IS STRONGLY RECOMMENDED THAT THE GAS BE DILUTED WITH AN INERT GAS TO FORM A NON-FLAMMABLE MIXTURE. IF THE USE OF A FLAMMABLE GAS AT HIGH CONCENTRATIONS IS UNAVOIDABLE THEN IT SHOULD BE CONTAINED WITHIN A SECONDARY GAS TIGHT CONTAINMENT IN THE GLOVE BOX WHICH ITSELF SHOULD HAVE AN INERT ATMOSPHERE.

In these cases the box atmosphere should be monitored for the flammable gas in addition to oxygen, or it should be shown that the maximum possible flammable gas flow rate and the minimum inert gas flow into the box are such that a flammable mixture cannot be formed within the box.



6. WHERE, EXCEPTIONALLY, IT IS IMPRACTICABLE TO COMPLY WITH THE FOREGOING RECOMMENDATIONS, ALTERNATIVE SAFEGUARDS MUST BE DEvised WHICH MUST HAVE THE WRITTEN APPROVAL OF THE DIVISION HEAD OR HIS NOMINEE.

Safety Secretariat,  
Building 424,  
A.E.R.E., Harwell.

7th June, 1966.

Reference

- (1) Report of the A.E.R.E. Working Party on the Use of Flammable Liquids and Gases in Glove Boxes.  
T. A. Hall. A.E.R.E.-M 1678.

## APPENDIX

### IGNITION AND OTHER RELATED DATA FOR SOME SOLVENTS

	Flash-point (Closed cup) °C	Auto-Ignition Temperature °C	Explosive Lower limit in air % v	Volume to give explosive mixture in 1 cu.ft. air* mls.
Acetone	-17	600	2.15	1.9
Benzene	-11	580	1.4	1.6
Carbon Disulphide	-22	120	1.0	0.8
Cyclo-hexane	2.5	265	1.35	1.8
Diethyl ether	-41	185	1.85	2.1
Ethanol	14	390	3.3	2.5
n-Heptane	-0.5	233	1.0	1.8
n-Hexane	-22	250	1.25	2.1
Methanol	6	470	6.72	3.4
Methyl ethyl ketone	-7	550	1.81	2.0
n-Octane	16	230	0.8	1.6
n-Pentane	-45	300	1.3	1.9
Toluene	4	550	1.3	1.8

\*Explanatory Note to Column 4

In an air filled box it is necessary to limit the quantity of flammable solvent such that an explosive mixture with air cannot form. This amount will depend on

- (a) the explosive limit of the vapour/air mixture
- (b) the air flow through the box
- (c) the degree of turbulence and mixing in the box.

As an arbitrary guide one can adopt a limitation based on the amount of solvent which would evaporate and mix with the air flowing through the box during the course of one minute. Assuming complete mixing and an air flow rate of 1 cu.ft./min., such as is normally used in glove boxes at A.E.R.E., this limitation would result in the amounts shown in column 4 of the above table.