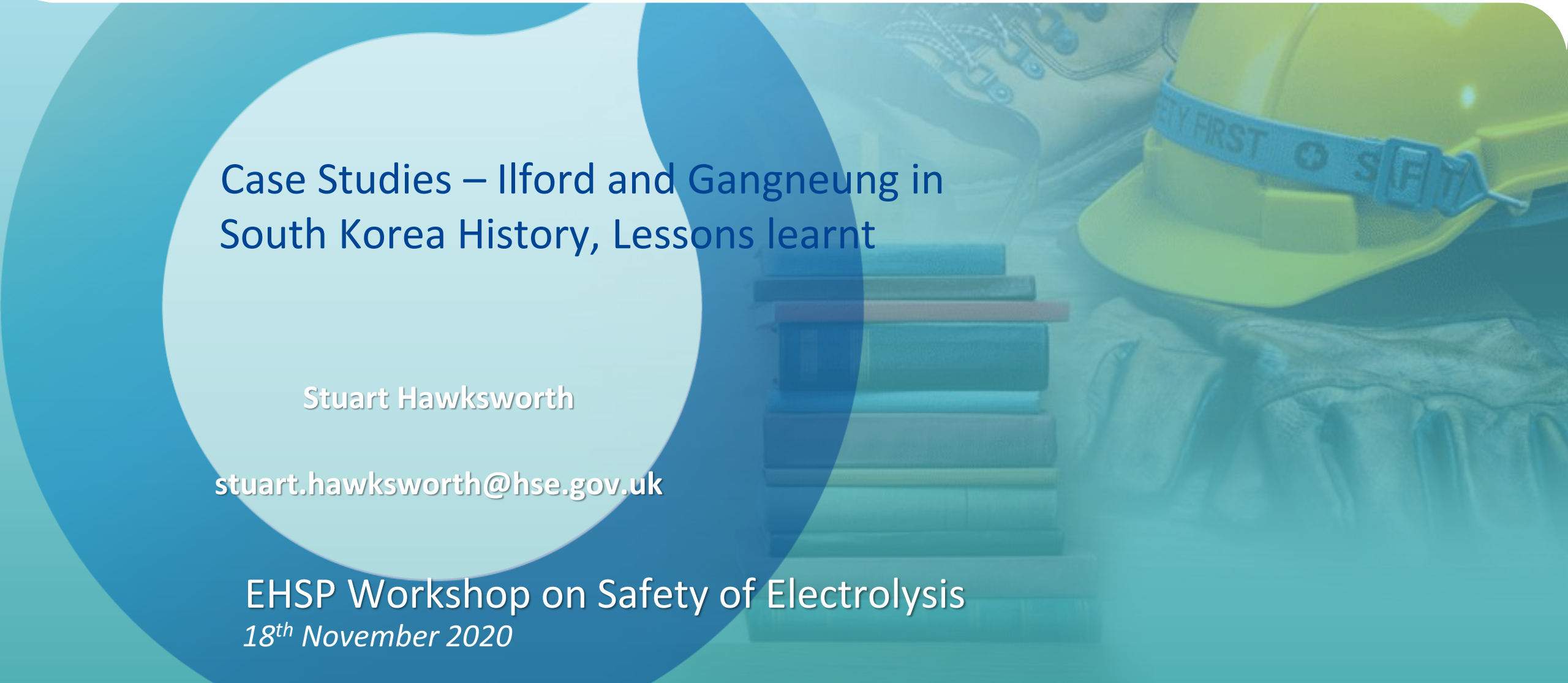

Case Studies – Ilford and Gangneung in South Korea History, Lessons learnt

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EHSP Workshop on Safety of Electrolysis

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Ilford Incident – 5 April 1975

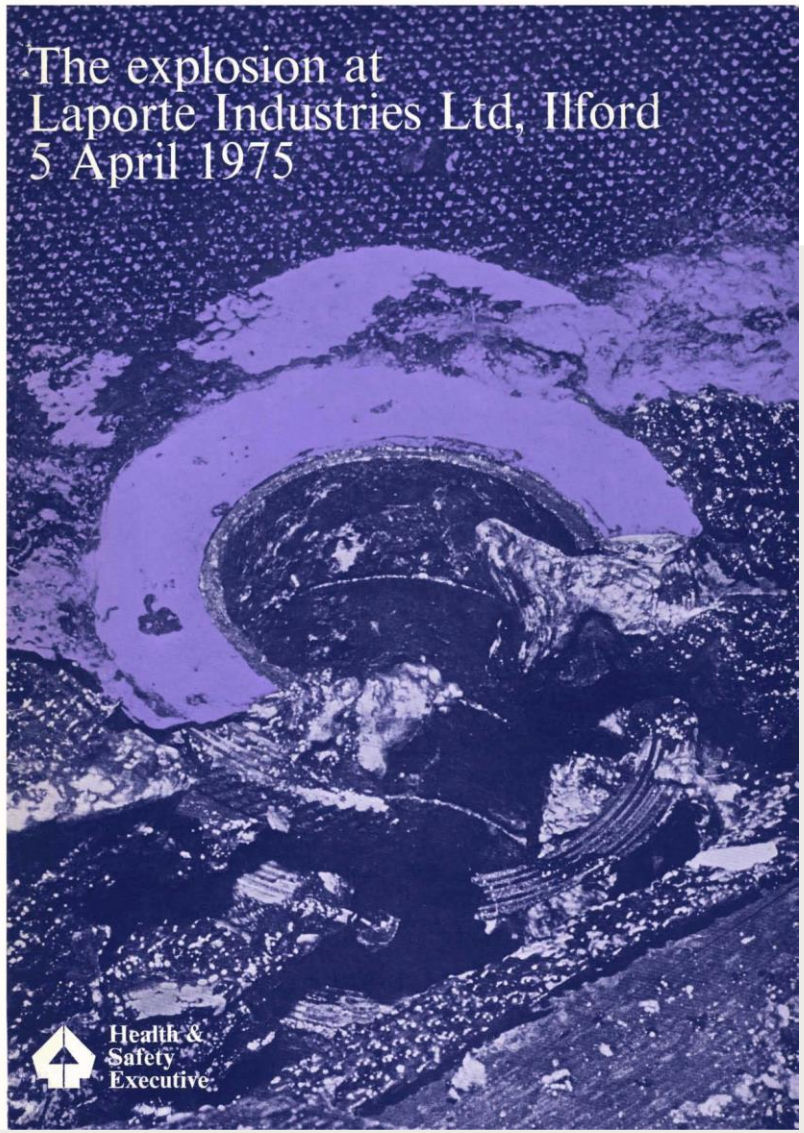
On 5 April 1975, an explosion occurred at the factory of Laporte Industries Limited which resulted in extensive damage to an electrolytor plant and the subsequent death due to injuries, of the plant operator.

The Health and Safety Commission directed the Health and Safety Executive on 22 April 1976, to investigate and make a special report on the accident. The investigation was conducted by HM Superintending Inspector of Factories, London and Home Counties (East) Division, **under Section 14(2)(a) of the Health and Safety at Work etc. Act 1974**. Certain metallurgical **examinations of material from the site were carried out by the Research and Laboratory Services Division**.

The report was presented to the Commission on 19 August 1975. HM Factory Inspectorate had by then decided that Laporte Industries Ltd should be prosecuted in the Magistrates Court, and an information alleging a breach of Section 2 of the Health and Safety at work Act 1974 had been laid. It was considered right to delay publication of the report until legal proceedings were completed. The hearing of the case was concluded on 17 March 1976 after several adjournments and the company **was fined £300**. Since the report was presented, further discussions have been held with the manufacturers, and much of the evidence on which the report is based was subject to close scrutiny in the Magistrates Court hearings. The authors have concluded that the results of these discussions and hearings do not significantly change the views contained in the report.

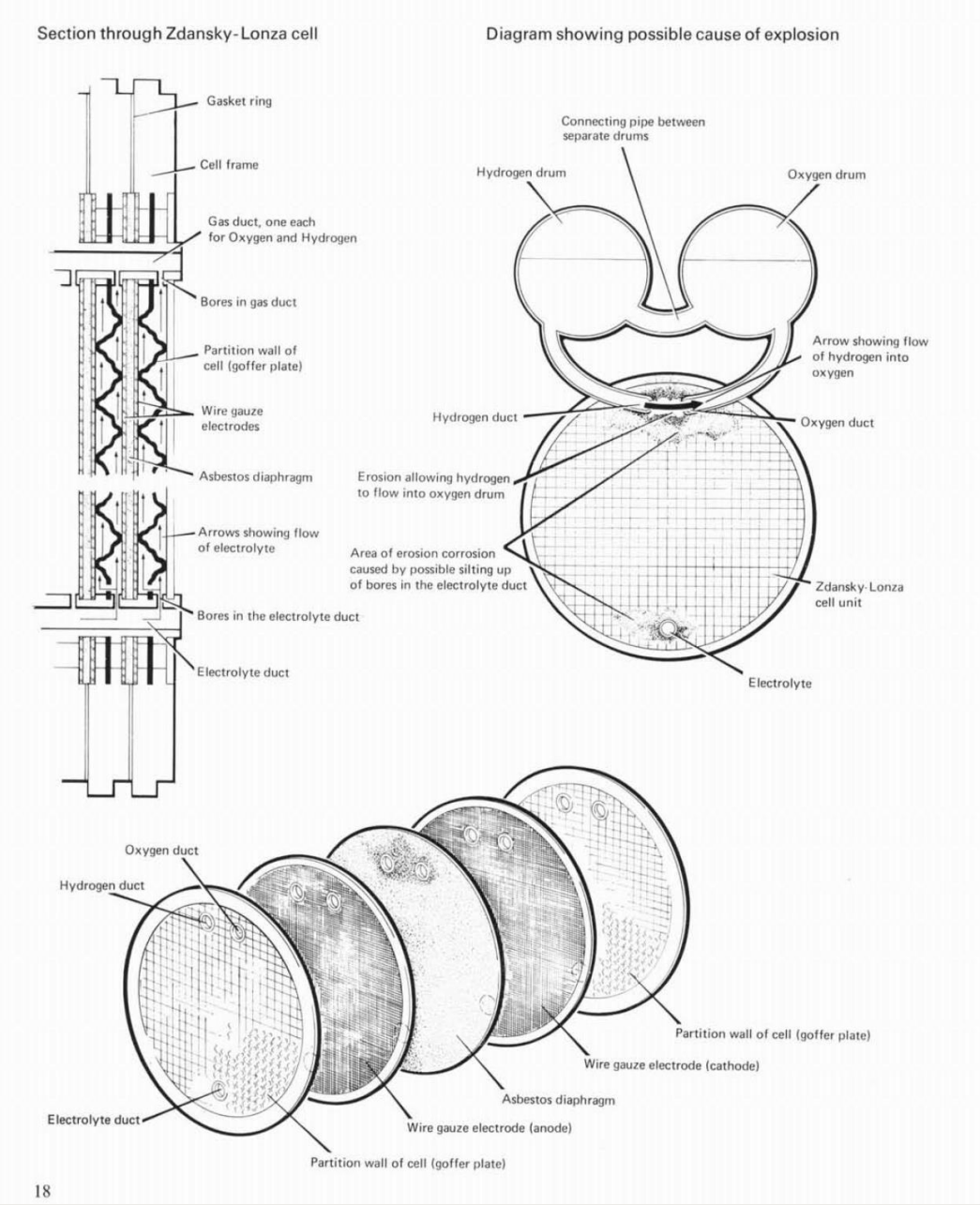
The Commission have decided that the report should be published in the form in which it was presented to them in August 1975, with a minor modification to Appendix 5, which has been made for reasons of clarity.

The original report to the Health and Safety Commission did not resolve the question of risk to the public. Further calculations have been made by HM Factory Inspectorate and Laboratory Services Division and the results are set out in Appendix 8.



https://www.icheme.org/media/13690/the-explosion-at-laporte-industries-ilford.pdf

Ilford Incident – 5 April 1975



- Permission was granted on 17 October 1960 and the plant was installed in 1962 by its makers Lurgi Gesellschaft Fur Warme Und Chemotechnik MBH.
- The purpose of the electrolytor is to produce hydrogen by the electrolysis of potassium hydroxide solution. The process also produces oxygen which is discharged as a waste product.
- Electrolysis is achieved in a "Zdansky-Lonza cell“ containing two gauze electrodes. The cells are circular, about 1.5m in diameter and 25mm thick. (Appendix 3.) Application of an electric current to the electrodes causes the electrolyte to give off hydrogen at the cathode and oxygen at the anode.
- The Electrolytor consists of four blocks of narrow cells, each block containing 135 cells (540 in all). Each cell is sealed on both sides by embossed steel plate (goffer plates) walls which are nickel plated and inserted in ring-shaped frames. Nickel plated steel wire gauze is placed on the anode and cathode side of the goffer plate to act as the active electrodes. The surface of the gauzes are activated by a special process. Anode and cathode compartments are separated by asbestos diaphragms and the cell frames are sealed on the outside by ptfe gaskets. (Appendices 2 & 3.)

Ilford Incident – 5 April 1975

Dismantling the cell block

23 The most obvious way in which a flammable mixture of hydrogen and oxygen could arise is by physical break-down of the internals of the cell blocks. Before the cell blocks were dismantled an internal examination was carried out by passing an Intrascope (an illuminated viewer) into the gas ducts which pass through the tops of the cells and collect the hydrogen and oxygen, together with electrolyte. Damage was seen in one particular area of one of the cell blocks.

24 The cell blocks were then carefully dismantled, under the supervision of HM Factory Inspectorate. All cells were examined and any which showed any signs whatsoever of abnormality were segregated for further detailed examination. It was found that:

Certain electrolyte and gas passages were blocked with sludge.

Crystalline potassium hydroxide deposits were seen on one plate, indicating gross over-heating.

There was heavy sludge deposition in some cells.

There was surface pitting of the plating on some of the goffer plates. (In some instances this had resulted in a hole right through the plate, fig 4.)

There was corrosion/erosion damage to some electrode gauzes with associated failure of the asbestos separators progressing to complete breakdown of the fabric of the cell, so that there was inter-connection between the hydrogen and oxygen ducts (fig 5).

In one case (at the point where the electrolyte leak was observed on 2 April) the flange of the cell was eroded through to the outside (fig 6).

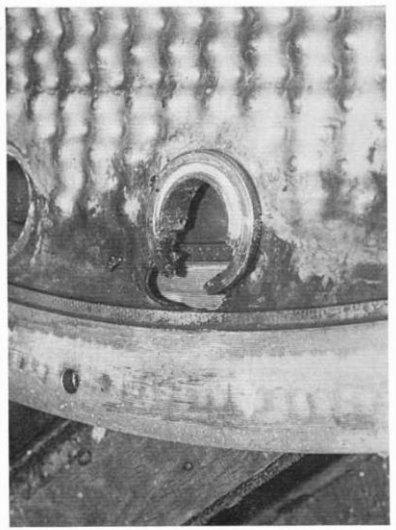


Fig 4 Perforated goffer plate

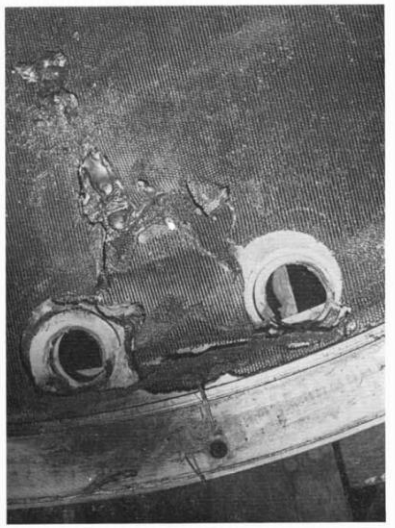


Fig 5 Cell 16/3 showing damage to electrodes and asbestos separator

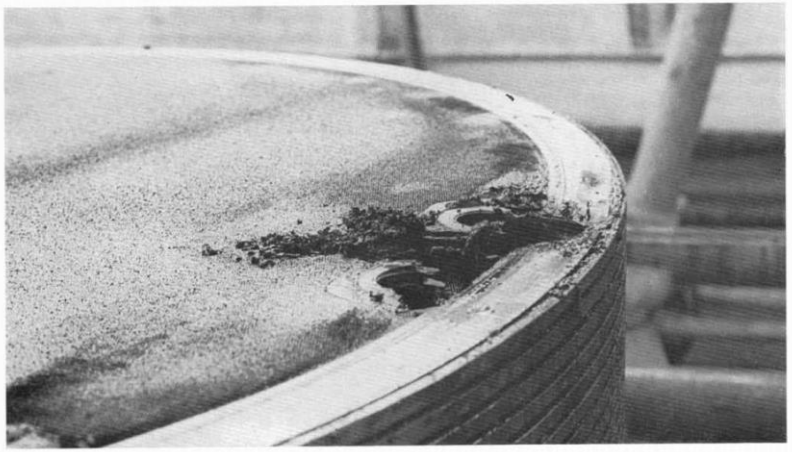
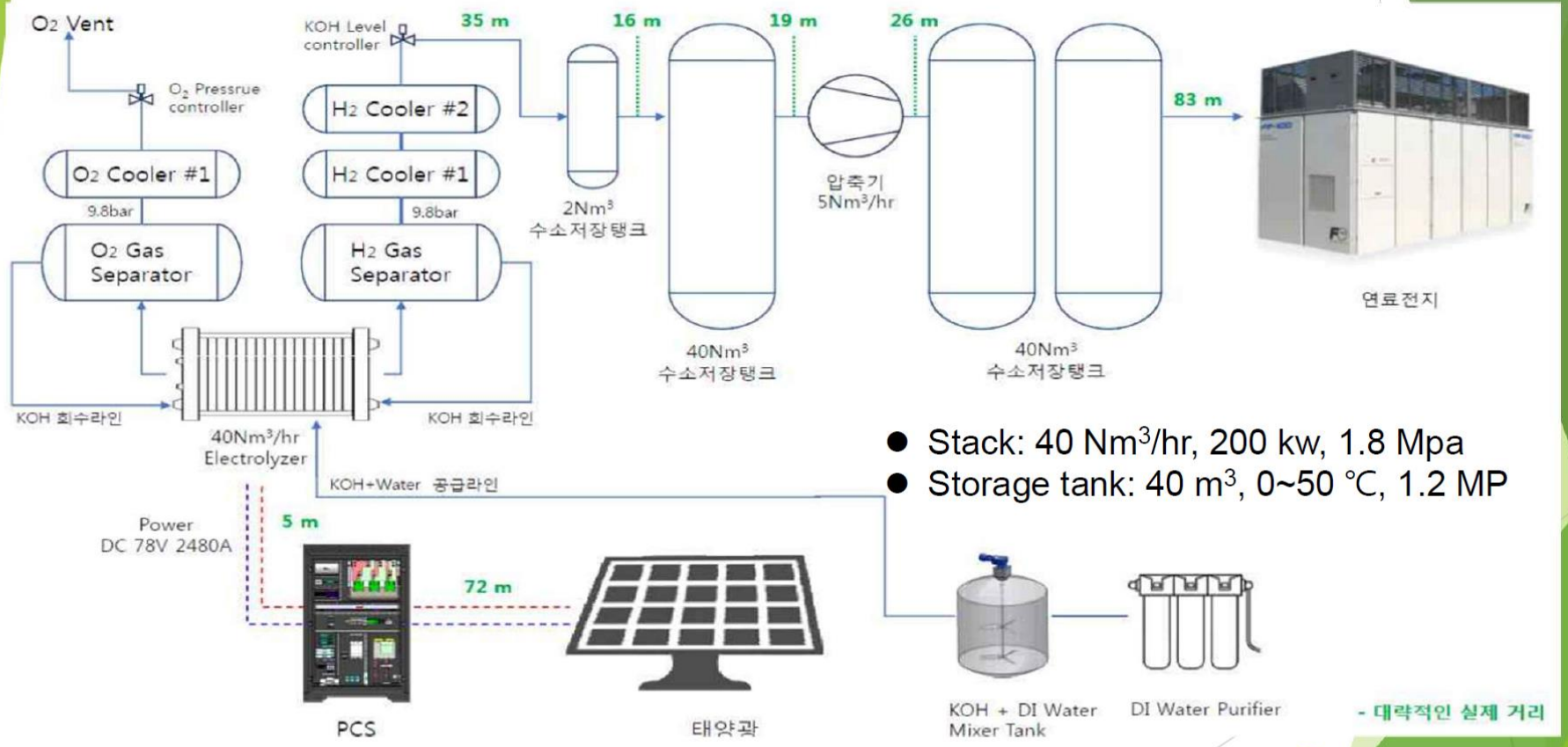


Fig 6 Cell 79 showing damage in vicinity of gas off-takes

◆ Accident at Research Facility in Korea: Facility



- Stack: 40 Nm^3/hr, 200 kw, 1.8 Mpa
- Storage tank: 40 m^3, 0~50 ℃, 1.2 MP

8

J. O. Choi, W. C. Cho, S. K. Kang jaeouchoi@postech.ac.kr, "Safety Issues of Electrolysis Systems in coupled Operation with Renewable Energy Sources", HySafe Research Priority Workshop 2020, October 28, 2020, Virtual Meeting.

◆ Outline of the Accident

- **Event:** Explosion of an outdoor hydrogen gas tank at the research facility of a water electrolyzer coupled with a solar photovoltaic power system. (May 23. 2019) >>>
  Two fatalities, six injuries, $30 million damage

- **Cause:** Ignition of a H2/O2 gas mixture within the tank

  - The source of ignition was unclear between either auto-ignition or an external spark.
  - Potential membrane degradation may have led to excessive oxygen crossover through the cell membranes into the hydrogen gas produced.

- **Lesson learned**:

  - Understand interrelation of gas permeability of electrolyzer membrane, its degradation, and dynamic operating range due to fluctuating power level of photovoltaic system.
  - Secure automatic isolation of gas storage and emergency stop of gas production when safety limits are exceeded.